Chapter 3
Description of Alternatives

3.1 Introduction

3.1.1 Preferred Alternative Under CEQA

From the standpoint of DWR as CEQA Lead Agency and the project applicant for the BDCP, Alternative 4, as described later in this chapter, is the *Preferred Alternative* for purposes of CEQA and is consistent with the proposed BDCP published concurrently with the publication of this Draft EIR/EIS.[1] Although, from an organizational standpoint, it might seem more logical to make the Preferred Alternative the first one addressed in an EIR/EIS (i.e., Alternative 1), in this case Alternative 4 did not emerge as the Preferred Alternative until well after the overall organization of this Draft EIR/EIS (including the numbering and placement of Alternatives) was already in place. Alternative 4 as described herein, moreover, represents a refinement (and improvement) on an earlier version of Alternative 4 that was found in a previous publicly available administrative draft of this Draft EIR/EIS.[2] The present version of Alternative 4 represents substantial refinements and additional scientific work and analysis to identify a form of the proposed BDCP that is grounded in solid science and reaches what DWR considers to be an optimal balance between ecological and water supply objectives in the Plan Area. Notably, identification of Alternative 4 as the preferred CEQA alternative is tentative only, and is subject to change as DWR and the CEQA responsible agencies, as well as the NEPA Lead Agencies, receive and consider public and agency input on this EIR/EIS. It is therefore possible that the final version of the BDCP may differ from Alternative 4 as described herein, either because Alternative 4 itself was refined, because another alternative was determined to be preferable, or because the Lead Agencies, in response to input, developed a new alternative with some features from some existing alternatives and other features from other existing alternatives.[3]

[1] As described in Chapter 1, *Introduction*, Section 1.1, the full Draft EIR/EIS should be understood to include not only the EIR/EIS itself and its appendices but also the proposed BDCP documentation including all appendices. Note that the BDCP also includes an Implementing Agreement (released in draft form in May 2014), and other administrative documents. Because t~~T~~hese documents represent agreements between parties involved in implementing the BDCP and involve the same set of physical activities already included within Alternative 4 (the BDCP), the content of such documents would not change the impact analysis within the EIR/EIS and therefore, such documents are not referenced within the EIR/EIS.

[2] The February 28, 2012 administrative draft EIR/EIS was made available on the BDCP website: http://baydeltaconservationplan.com.

[3] Just as further public and agency input may result in a new preferred CEQA alternative or a modification of Alternative 4 in its current form, the same is true of the text of the proposed Bay Delta Conservation Plan (BDCP) published contemporaneously with this Draft EIR/EIS. In particular, Chapter 9 of the BDCP, entitled *Alternatives to Take*, may be revised in light of further input regarding the practicability of the alternatives tentatively rejected therein. In other words, the current analysis in BDCP Chapter 9 of the impracticability of various alternatives to take, though representing DWR's best thinking as of the date of its release, remains subject to change. It should be noted that the alternatives set out in Chapter 9 of the BDCP are not identical to the EIR/EIS alternatives; nor are they subject to the same analysis. Within Chapter 9 of the BDCP, the analysis of the alternatives is focused solely on the potential for each of these alternatives to reduce the take of federally listed species in relationship to the proposed action. The alternatives addressed in the EIR/EIS, in contrast, are subject to a far broader analysis.

3.2 Alternatives Development Process

3.2.3 Development of DWR "Proposed Project" in 2012

On July 25, 2012, California Governor Edmund G. Brown Jr., Secretary of the Interior Ken Salazar, and National Oceanic and Atmospheric Administration (NOAA) Assistant Administrator for Fisheries Eric Schwaab outlined revisions to the proposed BDCP. As revised, the proposed conveyance alternative for CM1 includes the following: (1) the construction of water intake facilities with a total capacity of 9,000 cfs, down from an earlier proposal of 15,000 cfs; (2) operations that would be phased in over several years; and (3) a conveyance system designed to rely primarily ~~use~~ on gravity flow to maximize energy efficiency and to minimize environmental impact. Based on this information, the BDCP analyzed Intakes 2, 3, and 5; two tunnels to convey water by gravity; no intermediate pumping plant; and operations guided by Scenario H. The EIR/EIS analyzes the proposed BDCP as Alternative 4.[4]

That proposal was analyzed in the BDCP effects analysis and the Public Draft EIR/EIS. Based on public comments, the project proponents decided to alter Alternative 4 to minimize visual and construction impacts (e.g., on habitat for the greater Sandhill crane), decrease reliance on permanent power, and increase use of DWR-owned property. The new proposed project alignment also includes engineering improvements.

This proposal is analyzed in the BDCP effects analysis and this EIR/EIS. The proposed project, as embodied in the draft BDCP document published together with the EIR/EIS, will form a major portion of the HCP and NCCP that support applications for take authorization and other permits needed to proceed with implementation of the BDCP.

DWR's goal in this last step in the process of formulating alternatives was to identify a proposed version of CM1 that would be part of an overall BDCP that met the standards of the ESA and NCCPA while achieving the project objectives and meeting the project purpose and need. In order to minimize impacts in the Delta, DWR decided to propose only three (rather than five) intake facilities, thereby greatly reducing the potential CM1 footprint within the Delta itself. In doing so, DWR willingly reduced the export capacity of the proposed new north Delta diversions and conveyance structures while providing enough export capacity in the north to permit dual operations that could minimize adverse effects associated with operation of south Delta water conveyance facilities.

DWR also sought to identify proposed operations that provide balance maintaining exports and addressing ecological issues in the Delta, such that flow changes, habitat restoration, and other conservation measures may give all aquatic species what they need to reverse their declining population trends and contribute to their recovery. DWR and the fish and wildlife agencies used as their starting point the alternative described above as *Alternative 4A. Dual conveyance with a tunnel—Scenario 6 Operations—9,000 cfs north Delta intake capacity* because that option included only three new intakes with a total of 9,000 cfs capacity and included Scenario 6 operations developed with active input from USFWS, NMFS, and CDFW.

[4] In February 2012, Alternative 4 included Intakes 1, 2, and 3 and an intermediate pumping plant, along with a set of operational criteria including provisions for Fall X2. This alternative has been updated to reflect the elements introduced in the July 2012 announcement.

In reviewing the February 2012 effects analysis, including the evaluation of the preliminary BDCP proposal, the fish and wildlife agencies identified a number of concerns with the preliminary proposal. As a result of these concerns, a new set of operational criteria was developed and is presented in BDCP Section 3.4.1.4.3, *Flow Constraints*. These criteria are intended to meet the ESA requirement to minimize and mitigate incidental take to the maximum extent practicable, and the NCCPA requirement to conserve each of the covered species in the Plan Area.

To support the selection of a revised operational scenario, the fish and wildlife agencies conducted modeling to examine the recovery needs of the covered fish throughout their range in the absence of habitat restoration. This analysis was refined over multiple runs to explore the operational flexibility of the BDCP to help meet the rangewide recovery needs without adversely affecting upstream reservoir operations. The fish and wildlife agencies worked collaboratively with DWR to develop an operational scenario that contributed to the recovery of the covered fish and fit within the constraints of the BDCP. As a result, it has been agreed that the uncertainties about level of needed spring and fall outflow are to be addressed by adopting *decision trees* prescribing selection of criteria at the time the north Delta diversions become operational. The decision trees set criteria for spring outflow and fall outflow. Under the decision tree structure, one of four possible operational criteria will be implemented initially based on the results of targeted research and studies. Targeted research and studies will proceed until the north Delta intakes become operational, with the results of those studies forming the basis for determining the outcome of each decision tree. Operating criteria may also be modified after that time, based on concurrence by the permittees and the fish and wildlife agencies, by means of the adaptive management process specified in the Plan. The decision tree concept is discussed in detail in Appendix 3A, Section 3A.10.6, and the decision tree process and outcomes are described further in Section 3.6.4.2, *North Delta and South Delta Water Conveyance Operational Criteria,* for Scenario H.

3.3 Proposed Bay Delta Conservation Plan

3.3.1 Covered Activities and Associated Federal Actions

The BDCP and its alternatives include *covered activities* and *associated federal actions*. Covered activities are those actions that are carried out by nonfederal entities, such as the DWR, and that are expected to be covered by regulatory authorizations under ESA Section 10 and the NCCPA (California Fish and Game Code Section 2835). The covered activities (Table 3-2) consist of activities in the Plan Area associated with the conveyance and export of water supplies from the SWP's Delta facilities and with implementation of the BDCP conservation strategy. Each of these activities falls into one of six categories: (1) new water conveyance facilities construction, operation, and maintenance; (2) operation and maintenance of SWP facilities; (3) nonproject diversions[5]; (4) habitat protection, restoration, creation, enhancement, and management; (5) monitoring activities; and (6) research.

[5] This includes the ongoing operation of the existing nonproject diversions consistent with implementation of *CM21 Nonproject Diversions*. Under this conservation measure, some nonproject diversions would be removed, consolidated, or modified.

Table 3-2. BDCP Covered Activities

Covered Activities	Description
New water facilities construction, operations, and maintenance	This includes construction and operations of a new north Delta water conveyance facility to bring water from the Sacramento River in the north Delta to the existing water export pumping plants in the south Delta. In addition, the proposed intake facilities will require routine maintenance and periodic adjustment and tuning to ensure that operations are managed in accordance with governing fish passage criteria. This covered activity would also include improvements and routine maintenance of the Fremont Weir and Yolo Bypass and operation (not construction) of the North Bay Aqueduct Alternat~~iv~~e Intake Project. Water operations measures, through the management of flows, will support ecosystem functions associated with aquatic resources.
Operations and maintenance of SWP facilities[a]	This includes activities that would be carried out by DWR to operate and maintain SWP facilities in the Delta after the BDCP (or an alternative) is approved and implemented.
Nonproject diversions	This includes the ongoing operation of the existing nonproject diversions, consistent with implementation of *CM21 Nonproject Diversions.*
Habitat restoration, creation, enhancement, and management activities	These activities include all actions that may be undertaken to implement the physical habitat conservation measures.
Activities to reduce effects of methylmercury contamination	These activities include actions to minimize the methylation and mobilization of inorganic mercury in BDCP habitat restoration areas.
Activities to reduce predation and other sources of direct mortality	These activities include control of nonnative aquatic vegetation; predator control for covered fish species; and installation and operation of nonphysical fish barriers in the Delta.
Adaptive management and monitoring programs	Various types of monitoring activities would be conducted during BDCP implementation, including preconstruction surveys, construction monitoring, compliance monitoring, effectiveness monitoring, and system monitoring.
Other conservation actions	These actions may include (1) the continued operation and maintenance of an existing oxygen aeration facility in the Stockton Deep Water Ship Channel, which serves to increase dissolved oxygen concentrations and thereby minimize a potential fish passage barrier; and (2) the development of a delta and longfin smelt conservation hatchery by USFWS.

[a] ESA and California Endangered Species Act (CESA) coverage for existing operation and maintenance of the SWP and coordinated operations with the CVP prior to operation of new water conveyance facilities are addressed through separate compliance processes.

As noted in Chapter 1, Section 1.5, *BDCP EIR/EIS Project Area*, the Plan Area consists mainly of the statutory Delta, the Suisun Marsh, and the Yolo Bypass. The Areas of Additional Analysis are two areas outside the defined Plan Area that encompass power transmission corridors. One area lies west of the Plan Area and is considered in the analysis of proposed BDCP alternatives that include the western alignment for the water conveyance facility (Alternatives 1C, 2C, and 6C). The other area lies east of the Plan Area and represents the potential transmission line alignment analyzed for Alternative 4. Implementation of the BDCP (or an alternative) could also affect regions upstream of the Delta and throughout the SWP/CVP Export Service Areas. Consequently, the *project area* encompasses a larger geographic area than the Plan Area, comprising three defined regions: the Upstream of the Delta Region, the Delta Region (as defined in Chapter 1, Section 1.5, *BDCP EIR/EIS Project Area*—generally referred to as the Plan Area), and the SWP and CVP Export Service Areas (Figure 1-4).

BDCP-associated federal actions are those BDCP-related actions that are carried out, funded, or authorized by Reclamation within the Plan Area and that would receive appropriate ESA coverage through Section 7. These actions would be (1) operation of existing CVP Delta facilities to convey and export water in coordinated operations with the SWP after the BDCP (or an alternative) is approved and implemented; (2) associated maintenance activities; and (3) the creation of habitat.

Nonfederal actions are categorized as covered activities under ESA Section 10 and the NCCPA for DWR because of DWR's involvement in these actions. The federal actions by Reclamation would not be covered activities for the purposes of the ESA Section 10(a)(1)(B) permit. These federal actions are actions that occur within the Delta that would be coordinated with DWR to support DWR's compliance with the ESA Section 10 permit. Reclamation's activities are subject to ESA Section 7. ~~The Section 7 consultation would also include other CVP operation and maintenance activities that are not within the Plan Area.~~ Further discussion of the approval process and the process for implementation of the conservation measures appears in Chapter 1, Section 1.6, *Intended Uses of this EIR/EIS and Agency Roles and Responsibilities*.

BDCP covered activities are outlined in this section and presented in detail in Section 3.6, *Components of the Alternatives: Details*. Federal actions associated with the Plan are outlined in Section 3.6.4.1. Unless specifically identified otherwise, these activities would be the same under all the action alternatives.

3.3.2 Conservation Measures

3.3.2.1 Implementation Schedule

An example of possible schedules for implementation of the conservation measures within BDCP alternatives is provided in Chapter 6 of the BDCP, *Plan Implementation*. It is recognized that there would be some variation among alternatives. The schedule in Chapter 6 is for implementation of the proposed project (BDCP) and was developed to meet the following goals.

- Ensure that key implementation actions occur early in the permit term to offset expected effects of covered activities and meet the NCCPA requirement for rough proportionality of effects and conservation.
- Ensure that implementation actions occur by the implementation deadlines established in BDCP Chapter 3, *Conservation Strategy*.
- Ensure that implementation actions occur on a feasible schedule and allow adequate time for landowner negotiation for acquisition, project planning, permitting, funding, design, and construction.
- Group the related implementation actions or covered activities together or in the proper sequence (e.g., implementing riparian restoration and channel margin enhancement together).
- Require natural community protection and restoration to occur in almost every time period to ensure that progress is always being made toward the total conservation requirement in year 40.

The schedule for natural community protection and restoration establishes milestones for both restoration and protection to stay ahead of impacts. For restoration, these milestones are defined by when restoration construction is completed, not the time at which a restoration site must meet its performance criteria, because it will take years or even decades for restored natural communities to be fully functioning biologically.

The conservation strategy is divided into near-term (NT) and long-term (LT) implementation stages (see BDCP Chapter 6, *Plan Implementation*, for a detailed schedule of Plan implementation). The NT implementation would last until the north Delta diversions and the new water conveyance facilities are constructed and operational. LT implementation would last 40 years—that is, through the remainder of the proposed 50-year BDCP permit duration. The long-term (LT) implementation stage is further divided into two sub-phases: Early long-term (Year 11 through Year 15) and Late long-term (Year 16 through Year 50). This division of the implementation period was used because dual conveyance from north and south Delta intakes would bring significant flexibility and ecological changes to the system. As a result, many of the conservation measures are interrelated with operations of the new conveyance.

NT implementation of conservation measures would be intended to provide a response to currently degraded or absent ecological functions, while building the foundation to improve long-term ecological functions. The NT measures include early habitat creation or restoration actions, implementation of conservation measures that address other stressors on covered fish species, and acquisition of terrestrial and wetland habitat to facilitate conservation of covered wildlife and plant species.

The BDCP implementation schedule was informed by the data and analyses used to develop the conservation strategy, as summarized below.

- The near-term, early long-term, and late long-term restoration targets established for tidal, seasonally inundated floodplain, and channel margin habitats (BCDP Chapter 3, Section 3.4, *Conservation Measures*) and the extent of habitat restoration effects on natural communities and covered species habitats (BDCP Chapter 5, *Effects Analysis*).
- Vernal pool complex and grassland restoration targets (BCDP Chapter 3, Section 3.4, *Conservation Measures*) and the extent of habitat restoration effects on natural communities and covered species habitats (BDCP Chapter 5, *Effects Analysis*).
- Vernal pool complex, alkali seasonal wetland complex, grassland, and cultivated lands protection/preservation targets (BDCP Chapter 3, Section 3.4, *Conservation Measures*).
- The pipeline/tunnel construction schedule and the extent of construction effects on natural communities and covered species habitats (BDCP Chapter 5, *Effects Analysis*).

The duration and schedule for construction of the BDCP water conveyance facilities is provided in Appendix 3C, *Construction Assumptions for Water Conveyance Facilities*. Construction of the water conveyance facilities ~~would~~ may begin approximately ~~2~~ one year~~s~~ after permit issuance and continue for an estimated 9–10 years. Operations could begin as early as Year 11. The BDCP implementation schedule for CM3–CM10 (natural community restoration) and amount of acreage by conservation measure is provided in Table 3-4. The acreages shown in Table 3-4 would vary depending on the alternative selected. A total of 65,000 acres of tidal habitat would be restored under all action alternatives except ~~Alternative 5 (25,000 acres)~~as otherwise specified. A total of 10,000 acres of seasonally inundated floodplain habitat would be restored under all action alternatives except as otherwise specified~~Alternative 7 (20,000 acres)~~. A total of 20 linear miles of channel margin habitat would be enhanced under all action alternatives except as otherwise specified~~Alternative 7 (40 linear miles)~~. The implementation schedule for CM2 and CM11–CM~~22~~21 is provided in Section 3.6.2, *Conservation Components*.

Table 3-4. Implementation Schedule for Natural Community Protection and Restoration Conservation Measures (acres)

		Near-Term		Early Long-Term	Late Long-Term						
	Total	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50
BDCP Reserve System											
CM3: Natural Communities Protection and Restoration											
Valley/Foothill Riparian	750	400	350								
Vernal pool complex	600	200	200	200							
Alkali seasonal wetland complex	150		120	5	5	5	5	5	5		
Grassland	8,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000		
Managed wetland	1,500	500	1,000								
Managed wetland (natural community)	6,600	1,400	1,900	600	550	550	550	550	500		
Cultivated lands (non-rice)	48,125	7,700	7,700	6,700	5,200	5,200	5,200	5,200	5,225		
Cultivated lands (rice)	500	100	100	100	100	100					
Cultivated lands (rice or equivalent)	3,000	300	400	400	400	400	400	400	300		
Nontidal marsh	50	10	15	5	5	5	5	5			
Total Acquisition	**69,275**	**11,610**	**12,785**	**9,010**	**7,260**	**7,260**	**7,160**	**7,160**	**7,030**		
CM4: Tidal Natural Communities Restoration [1]											
Tidal brackish emergent wetland	6,000	1,000	1,000	2,050	350	400	400	400	400		
Tidal freshwater emergent wetland	24,000	4,425	4,425	4,450	2,150	2,150	2,150	2,150	2,100		
Tidal perennial aquatic (below MLLW)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
Tidal wetland of any type and transitional uplands	35,000	4,150	4,150	4,150	4,150	4,600	4,600	4,600	4,600		
Subtotal: Tidal wetland restoration	**65,000**	**9,575**	**9,575**	**10,650**	**6,650**	**7,150**	**7,150**	**7,150**	**7,100**		
CM5: Seasonally Inundated Floodplain Restoration [2]	10,000			1,000	1,800	1,800	1,800	1,800	1,800		
CM6: Channel Margin Enhancement (miles) [3]	20	5	5		5		5				
CM7: Riparian Natural Community Restoration	5,000	400	400	300	750	750	750	800	850		
CM8: Grassland Natural Community Restoration	2,000	570	570	340	100	100	100	100	120		
CM9: Vernal Pool and Alkali Seasonal Wetland Complex Restoration											
Vernal Pool Complex	67	20	20	27							
Alkali Seasonal Wetland	72	29	29	5	5	4					
CM10: Nontidal Marsh Restoration											
Nontidal Marsh Restoration	1,200	200	200	100	100	150	150	150	150		
Managed wetland	500	250	250								
Total Restoration	**83,839**	**11,044**	**11,044**	**12,422**	**9,405**	**9,954**	**9,950**	**10,000**	**10,020**		
Total Acquisition and Restoration	**153,114**	**22,654**	**23,829**	**21,432**	**16,665**	**17,214**	**17,110**	**17,160**	**17,050**		

[1] Under Alternative 5, 25,000 acres of tidal habitat would be restored under CM4.
[2] Under Alternative 7, 20,000 acres of seasonally inundated floodplain would be restored under CM5.
[3] Under Alternative 7, 40 linear miles of channel margin habitat would be enhanced under CM6.

3.4 Components of the Alternatives: Overview

3.4.1 Overview of Water Conveyance Facility Components

3.4.1.1 Physical Components

The following is a comprehensive list of possible water diversion and conveyance facilities that could be included in one or more of the action alternatives. Not all components listed below would be found in each alternative. A number of these components are identified in Table 3-5 by alternative, and all are described in detail in Section 3.6.1, *Water Conveyance Facility Components (CM1)*. Appendix 3C, *Construction Assumptions for Water Conveyance Facilities*, provides details about construction procedures and other related specifications. Assumptions regarding construction activity timing and duration are also provided in Appendix 3C. Detailed depictions of the physical components of the BDCP action alternatives are provided in Figures M3-1, M3-2, M3-3, M3-4, and M3-5 in the Mapbook Volume of this EIR/EIS.

Table 3-5. Water Conveyance Facilities Components of Each Alternative

Component	Alternative															
	No Action	1A	1B	1C	2A	2B	2C	3	4	5	6A	6B	6C	7	8	9
New north Delta fish-screened intakes		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
New intake(s) ~~pumping plants~~		X	X	X	X	X	X	X	X	X	X	X	X	X	X	
New intake pumping plants		X	X	X	X	X	X	X		X	X	X	X	X	X	
New diversion pumping plants																X
New intermediate pumping plant		X	X	X	X	X	X	X		X	X	X	X	X	X	
New Clifton Court Forebay combined pumping plant									X							
Use of existing SWP and CVP south Delta intake facilities	X	X	X	X	X	X	X	X	X	X				X	X	X
Operations of North Bay Aqueduct Alternat~~iv~~e Intake Project	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Byron Tract Forebay[a]		X	X	X	X	X	X	X		X	X	X	X	X	X	
Expanded Clifton Court Forebay[b]									X							
Intermediate forebay		X			X			X	X	X	X			X	X	
Primary Conveyance Facility																
Pipelines/tunnels		X		X	X		X	X	X	X	X		X	X	X	
Canals			X	X		X	X					X	X			
Channels	X															X
New operable barrier(s)					X	X	X		X							X
Fish movement and habitat corridor around Clifton Court Forebay																X

[a] *Byron Tract Forebay* currently refers to proposed forebays both north and south of Clifton Court Forebay.

[b] *Expanded Clifton Court Forebay* refers to modifications to Clifton Court Forebay and expansion on Byron Tract 2.

- Intakes
  - New on-bank intake facilities would be constructed on the Sacramento River between Clarksburg and Walnut Grove. Alternatives 1A through 8 would entail between one and five 3,000 cfs-diversion-capacity facilities in 12 possible locations—7 locations on the east bank of the river (for pipeline/tunnel, modified pipeline/tunnel, and east alignment alternatives) and 5 locations on the west bank (for west alignment alternatives). Any single action alternative would include the construction of between one and five intakes. These intakes would rise approximately 55 feet from river bottom to top of structure with a length of approximately 700–2,300 feet, depending on location; fish screen heights would vary with location. Construction of the on-bank intakes would require the installation of cofferdams. Each intake site would require a temporary cofferdam to create a dewatered construction area encompassing the entire intake site. A portion of the cofferdam would remain in place as an integral part of the intake structure within the existing water side levee. Under Alternative 9, two 2,800-foot-long intakes, each with a capacity of 7,500 cfs, would be placed at the entrances to the Delta Cross Channel and Georgiana Slough (described in more detail in Section 3.5.16.1). At the Delta Cross Channel location, there would potentially be a new

replacement intake control structure with gates. At the Georgiana Slough location, a new gated intake control structure with a flood flow capacity of 20,600 cfs would be constructed. Construction of Alternative 9 intakes would also require the installation of temporary cofferdams to create a dry work area within the subject waterway. All intakes would be equipped with self-cleaning, positive barrier fish screens designed to be protective of salmonids and delta smelt. Fish screens would comply with CDFW and National Marine Fisheries Service (NMFS) fish screening criteria (refer to the July 2011 BDCP Fish Facilities Technical Team Technical Memorandum for additional detail on fish screening criteria[6]).

  - New intake facilities would necessitate the widening of existing levees on the landside to increase crest width, to facilitate intake construction and accommodate the realignment of State Route 160. Minor dredging and channel modification activities would also take place along the face of the intakes.
  - New intake facilities would include gantry cranes, log boom and log boom piles, riprap, and electrical buildings.

- Pumping plants
  - For Alternatives 1A through 3 and 5 through 8, i~~I~~ntake pumping plants with a capacity of 3,000 cfs each would be constructed to convey water from intake facilities into pipelines, eventually connecting to the rest of the conveyance structures. Each plant and its associated facilities would ~~encompass approximately 20 to 60 acres~~lie adjacent to the intake facility. Pipeline/tunnel, ~~modified pipeline/tunnel,~~ east alignment, and west alignment alternatives would entail construction of between one and five intake pumping plants.
  - An intermediate pumping plant would convey the water collected from the intake facilities between intermediate conveyance structures such as tunnels, canals, and forebays, depending on the design of the particular alternative. One intermediate pumping plant would be constructed for the pipeline/tunnel, east alignment, and west alignment alternatives. Under the modified pipeline/tunnel alignment (Alternative 4), water would be fed by gravity from the intermediate forebay to the major tunnel segment. This approach could be applied to other alternatives as the Lead Agencies make their final decisions regarding the BDCP and associated permits.
  - The modified pipeline/tunnel alignment would include two 4,500 cfs pumping plants to the northeast of Clifton Court Forebay. Water would be collected at three intakes with a capacity of 3,000 cfs each, and then conveyed via gravity through a series of tunnels and into the Clifton Court Forebay pumping plants.
  - Diversion pumping plants with a capacity of 250 cfs would provide dilution flow at the confluence of the San Joaquin River and the head of Old River and upstream of the confluence of Middle River and Victoria Canal. These plants would be constructed under the through Delta/separate corridors alternative.
  - Intake ~~Pumping plant~~ facilities would include sedimentation basins, solids handling facilities, transition structures, surge/outlet towers, ~~one or two~~ substations or electrical buildings with~~,~~ transformers~~,~~ and a mechanical room, access roads, and other associated

[6] Available here: <http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/Fish_Facilities_Team_Technical_Memo_Final_7_15_2011.sflb.ashx>

facilities and utilities. Some or all of these facilities would be associated with pumping plants under each alternative.

- Pipelines
  - Intake gravity collector pipelines would carry water between intakes and intake pumping plants. Each intake facility would convey water through six 12-foot-diameter pipelines to the adjacent pumping plant. Each intake site associated with the pipeline/tunnel, ~~modified pipeline/tunnel,~~ east alignment, and west alignment alternatives would include these pipelines. The gravity collector pipelines would convey water into the sedimentation basin before reaching the intake pumping plant. Under the modified pipeline/tunnel alignment, box conduits would carry flows between each intake structure and the sedimentation basin.
  - Conveyance pipelines would carry water between intake pumping plants and other conveyance facilities such as tunnels, canals, and forebays. Two or four 16-foot-diameter conduits (or one 20-foot-diameter conduit) would be used for conveyance pipelines. Each intake site associated with the pipeline/tunnel, east alignment, and west alignment alternatives would include these pipelines. ~~Intakes 2 and 3 under Alternative 4 (the modified pipeline/tunnel alignment) would include short segments of these pipelines between pumping plants and tunnels.~~
- Tunnels
  - A single-bore 29-foot-inside-diameter tunnel would convey water approximately 3.8 miles from intake pumping plants to a new intermediate forebay immediately west of South Stone Lake. This tunnel would be constructed under each pipeline/tunnel alternative using Intakes 1 and/or 2.
  - A ~~29~~40-foot-inside-diameter tunnel and ~~a~~two single-bore ~~20~~28-foot-inside-diameter tunnels would convey water nearly 9 miles from intake~~s pumping plants~~ to a new intermediate forebay on Glannvale Tract. These tunnels would be constructed under Alternative 4.
  - A dual-bore 33-foot-inside-diameter tunnel would convey water 34.5 miles from the new intermediate forebay to a new Byron Tract Forebay adjacent to Clifton Court Forebay. This feature would be constructed for all pipeline/tunnel alternatives except Alternative 5, which would use a single-bore tunnel. Alternatives 1A, 2A, 3, 6A, 7, and 8 would have dual 33-foot-inside-diameter tunnels and Alternative 5 would have a single 33-foot-diameter tunnel.
  - A dual-bore 40-foot-inside-diameter tunnel would convey water 30.2 miles from the new intermediate forebay on Glannvale Tract to an expanded Clifton Court Forebay. These tunnels would be constructed under Alternative 4 (modified pipeline/tunnel alignment) and would be wider than tunnels constructed for the alternatives under the pipeline/tunnel alignment to facilitate the gravity-fed system proposed under Alternative 4 (instead of being pressurized and pumped through an intermediate pumping plant).
  - One dual-bore 33-foot-inside-diameter tunnel would convey water between the intermediate pumping plant on Ryer Island and a proposed canal segment on Hotchkiss Tract under the west alignment alternatives.
  - Three tunnel segments would be used as siphons to carry water under Lost Slough/Mokelumne River, San Joaquin River, and Old River, connecting canal segments under the east alignment alternatives.

- Canals
  - Canals would be unlined (earthen) or lined with concrete.
  - An approximately 2,000-foot-long canal would carry water from the Byron Tract Forebay to the existing approach canal to the Harvey O. Banks Pumping Plant (Banks Pumping Plant). This canal would be constructed for pipeline/tunnel, east alignment, and west alignment alternatives. For west alignment alternatives, this canal would be extended to convey water into the existing approach canal for the C. W. "Bill" Jones Pumping Plant (Jones pumping plant).
  - An approximately 4,000-foot-long canal would carry water from the north cell of the expanded Clifton Court Forebay, under the Byron Highway through a siphon, and to the existing approach canal to the Banks pumping plant. From this canal, another 6,000-foot-long canal would carry water to the existing approach canal for the Jones pumping plant. These canals would be constructed for the modified pipeline/tunnel alignment (Alternative 4).
  - An approximately 44-mile canal would convey water between the intake pumping plants and the Byron Tract Forebay across the east Delta, generally between Interstate (I-) 5 and the South Mokelumne and Middle Rivers. Canal segments would generally have a maximum top width of 700 feet and a depth of 23.5 feet. This canal would be constructed for the east alignment alternatives.
  - An approximately 17-mile canal would convey water between intake pumping plants and an intermediate pumping plant/tunnel entrance on Ryer Island. Canal segments would generally have a maximum top width of 700 feet and a depth of 23.5 feet. This canal would be constructed for the west alignment alternatives.
  - An approximately 10-mile canal would convey water between the tunnel exit portal on the Hotchkiss Tract and Byron Tract Forebay. Canal segments would generally have a maximum top width of 700 feet and a depth of 23.5 feet. This canal would be constructed for the west alignment alternatives.
  - A new 4,000-foot-long canal on Coney Island, adjacent to Victoria Canal, would connect the water supply corridor between siphons at Old River and West Canal across Coney Island. This canal would be constructed for the through Delta/separate corridors alternative.
  - A 4,000-foot-long intertie canal would be constructed from Clifton Court Forebay to the Tracy Fish Collection Facility (Tracy Fish Facility) for the through Delta/separate corridors alternative.
- Forebays
  - A 760-acre intermediate forebay would store water between intake facilities and the tunnel conveyance segment between South Stone Lake and the Sacramento River, just south of Hood. An emergency spillway would prevent the intermediate forebay from overtopping by spilling to an approximately 350-acre inundation area adjacent to the forebay (to the south). This forebay would be constructed for pipeline/tunnel alternatives. Pierson Tract is another potential site for this forebay. See Appendix 3H, *Intermediate Forebay Location Analysis*, for more information on siting of the intermediate forebay.
  - A ~~40~~37-acre intermediate forebay would store water between intake facilities and the main tunnel conveyance segment on Glannvale Tract, adjacent to Twin Cities Road. An emergency

spillway would prevent the intermediate forebay from overtopping by spilling to an approximately ~~120~~131-acre inundation area adjacent to and surrounding the forebay. This forebay would be constructed for Alternative 4 (modified pipeline/tunnel alignment).

  - Byron Tract Forebay, adjacent to Clifton Court Forebay, would store water between the new conveyance structures and existing SWP/CVP south Delta export facilities. For west alignment alternatives, this new forebay would be constructed northwest of Clifton Court Forebay. For pipeline/tunnel and east alignment alternatives, the new forebay would be constructed southeast of Clifton Court Forebay. The water surface area of Byron Tract Forebay would be 600 acres for the pipeline/tunnel, east alignment, and west alignment alternatives (Alternatives 1A–1C, 2A–2C, 6A–6C, 7, and 8); under Alternative 5, the water surface area would be 200 acres (see descriptions of individual alternatives in Section 3.5, *Alternatives*).

  - Clifton Court Forebay would be expanded to the south and would be dredged to provide additional storage capacity. New embankments would be constructed around the forebay and an embankment would be constructed across the forebay to create a north cell and a south cell. The north cell would receive water pumped from the north Delta through the proposed tunnels, while the south cell would receive water conveyed through the existing through Delta system. The north cell water surface area would be approximately ~~1,300~~850 acres, while the south cell would have a water surface area ~~larger than 1,400~~of approximately 1,700 acres. This represents an expansion of approximately ~~700~~ 600 acres. An emergency spillway at the north cell of Clifton Court Forebay would prevent the forebay from overtopping by spilling to Old River. This forebay expansion would be constructed under Alternative 4 (the modified pipeline/tunnel alternative).

- Fixed and operable barriers utilizing a range of gate technologies would variously allow the passage of fish, water, and boats through existing Delta channels. Operable barriers would be constructed for the through Delta/separate corridors alternative and those alternatives using Operational Scenarios B and H.

- Vertical, structurally reinforced wedge wire screen panels of stainless steel with 1.75-millimeter (0.069-inch) openings (i.e., fish screens) would be sized to reduce effects on fish and aquatic resources. All intakes, including the North Bay Aqueduct alternat~~iv~~e intake, under all alternatives would incorporate fish screens.

- Levees would protect new channel fill areas and serve modified channels and intake facility sites. Minor levee modifications would be necessary under all alternatives; the through Delta/separate corridors alternative would entail additional levee-related activities.

- Culvert siphons would convey water under existing channels and between sections of canals (e.g., through tunnels) or other conveyance facilities. These would be constructed for the modified pipeline/tunnel alignment, east alignment, west alignment, and through Delta/separate corridors alternatives.

- Gates and similar control structures would control the flow of water through conveyance facilities and facilitate maintenance of conveyance structures. Control structures would be constructed under all action alternatives.

- Concrete batch plants and fuel stations would be built to support construction. The volume of concrete needed for the conveyance options would require locating some concrete batch plants at the work site rather than importing concrete from outside suppliers. A suitable source of clean water would be required for each batch plant. Batch plants and fuel stations would be located side by side and would range in size from approximately 1~~2~~ acre~~s~~ to 40 acres. Depending on the alternative selected, concrete batch plants and fuel stations would be constructed at one or more of the following locations. If it is necessary to construct precast segment yards, they would be located adjacent to concrete batch plants but within footprints identified for batch plants or other work areas. ~~While~~ Under the modified pipeline/tunnel alignment, it is ~~anticipated~~ assumed that precast tunnel segments would be purchased and transported from two existing local precast plants and from one privately-constructed plant in the San Francisco area. The tunnel segments would be stored at these plants and then transported to individual CM1 tunnel sites by a combination of barge and truck~~, it is possible that one or more temporary plants would be constructed~~. ~~If it is necessary to construct precast segment yards, they would be located adjacent to concrete batch plants.~~

- Pipeline/tunnel alignment (Alternatives 1A, 2A, 3, 5, 6A, 7, and 8)
  - An approximately 2-acre concrete batch plant and 2-acre fuel station at Intake 2.
  - An approximately 2-acre concrete batch plant and 2-acre fuel station at Intake 4.
  - An approximately 40-acre concrete batch plant and 2-acre fuel station approximately 2.5 miles north of SR 12.
  - An approximately 40-acre concrete batch plant and 2-acre fuel station along the pipeline/tunnel alignment approximately 8.5 miles south of SR 12.
  - An approximately 2-acre concrete batch plant and 2-acre fuel station along the pipeline/tunnel alignment on Byron-Bethany Road.
- Modified pipeline/tunnel alignment (Alternative 4)
  - An approximately 1~~2~~-acre concrete batch plant and ~~2~~1-acre fuel station at Intake 2 (within the work area identified for Intake 2).
  - An approximately 1-acre concrete batch plant and 1-acre fuel station at Intake 3 (within the work area identified for Intake 3).
  - An approximately ~~2~~1-acre concrete batch plant and 1~~2~~-acre fuel station at Intake 5 (within the work area identified for Intake 5).
  - An approximately 38~~40~~-acre concrete batch plant and ~~2~~1-acre fuel station near Twin Cities Road and Interstate 5 (within a designated reusable tunnel material (RTM) storage site). (~~Reusable tunnel material [~~RTM~~]~~ is the by-product of tunnel excavation ~~using an earth pressure balance [EPB]~~ tunnel boring machine [TBM]; for additional description of the potential reuse of this material, see Appendix 3B, *Environmental Commitments*).
  - An approximately 30-acre concrete batch plant and 1-acre fuel station in the center of Bouldin Island (to the north of a designated RTM storage site).
  - An approximately 40-acre concrete batch plant and ~~2~~1-acre fuel station between Byron Highway and Italian Slough (within a designated RTM storage site).
- East Alignment (Alternatives 1B, 2B, and 6B)
  - An approximately 2-acre concrete plant and 2-acre fuel station at Intake 2.

    - An approximately 2-acre concrete plant and 2 acre fuel station at Intake 4.
    - An approximately 25-acre concrete plant and 2-acre fuel station along the canal alignment just south of Snodgrass Slough.
    - An approximately 40-acre concrete plant and 2-acre fuel station along the tunnel alignment approximately 8.5 miles south of SR 12.
  - West Alignment (Alternatives 1C, 2C, and 6C)
    - An approximately 2-acre concrete plant and 2-acre fuel station along the canal alignment adjacent to Willow Point Road.
    - An approximately 2-acre concrete plant and 2-acre fuel station between Intakes 3 and 4.
    - An approximately 40-acre concrete plant and 2-acre fuel station along the canal alignment approximately 1 mile south of the SR 84/SR 220 junction.
    - An approximately 40-acre concrete plant and 2-acre fuel station along the canal alignment just north of Franks Tract.
    - An approximately 2-acre concrete plant and 2-acre fuel station along the canal alignment approximately 1 mile north of the Byron Highway.
  - Through Delta/Separate Corridors (Alternative 9)
    - An approximately 2-acre concrete plant and 2-acre fuel station the east bank of the Sacramento River between The Meadows Slough and the community of Locke.
    - An approximately 2-acre concrete plant and 2-acre fuel station on eastern Webb Tract near the San Joaquin River, north of a proposed operable barrier.
    - An approximately 2-acre concrete plant and 2-acre fuel station adjacent to and north of Highway 4 on Victoria Island.
- Temporary barge unloading facilities would be constructed at locations adjacent to construction work areas along the conveyance alignments for the delivery of construction materials. These facilities would be sized to accommodate various deliveries (e.g., tunnel segments, batched concrete, major equipment). Access roads from these facilities to the construction work area would be necessary. The barge unloading facilities would be removed following construction.
- Other facilities to support the function of the conveyance may include new bridges to connect existing roads and highways, new access roads, improvements to existing roads or bridges, improvements to local drainage systems affected by the alternatives, and other utilities improvements. Some areas would be temporarily or permanently dedicated to borrow, spoil, dredged material, or RTM. Where specific locations for these facilities are known, such areas are identified in Mapbook Figures M3-1 through M3-5.

3.4.1.2 Operational Components

Operational Requirements Influencing Minimum Required Delta Outflow

In addition to rules controlling exports from the Delta, there are also several sets of rules governing Delta outflow. These include the minimum monthly outflows specified in D-1641 for each month, which often depend on the water year type (i.e., runoff conditions). These flow objectives were set to protect beneficial uses of Delta water for fish habitat. All the BDCP alternatives include these same D-1641 rules.

Delta outflow is also controlled by the maximum salinity objectives specified in D-1641 for each month or period. For example, salinity objectives are specified at certain Delta locations to protect agricultural diversions and drinking water supplies. Because Delta outflow is the major factor determining salinity within the Delta channels, these salinity objectives are satisfied by increasing Delta outflow. The Delta outflow required to meet these salinity objectives is simulated by evaluating historical outflow records (i.e., DAYFLOW) and salinity (electrical conductivity [EC] monitoring) to establish the relationship between these two metrics for each compliance location. The D-1641 salinity objectives are assumed to apply to the Existing Conditions, the No Action Alternative, and the BDCP action alternatives.[7]

Another set of rules controlling Delta outflow are the spring X2 objectives introduced in the 1995 WQCP. *X2*, the location of the 2 parts per thousand (ppt) salinity isohaline (i.e., the upstream edge of the low salinity zone), is specified on the basis of the month and the (unimpaired) runoff in the previous month. This objective supports several estuarine species whose abundance has been correlated with X2. This was formulated as an adaptive objective; the required outflow increased with higher runoff conditions.

The 2008 USFWS BiOp included an outflow requirement for September, October, and November of wet and above normal water year types. The *Fall X2* rule requires X2 to be at or downstream of Collinsville in above normal years and downstream of Chipps Island in wet years. The Fall X2 rule applies to the No Action Alternative and some of the BDCP action alternatives.

In addition, the State Water Board has recently explored additional operational rules that would require Delta outflow to be a specified percentage of monthly unimpaired flow (California State Water Resources Control Board 2010). This rule would be similar to the E/I ratio, but would be less negative in months with moderate runoff that was stored in upstream reservoirs. Because this possible Delta outflow rule would limit the total water diverted to storage or exported, higher outflows might be expected in many months. BDCP Alternative 8 includes a monthly outflow/unimpaired flow percentage of 55% from January through June.

3.4.3 Overview of Conservation Components Related to Reducing Other Stressors

The BDCP has identified several issues, beyond water exports and habitat conditions, that affect the survival of covered fish species in the Delta. These *other stressors* include but are not limited to exposure to contaminants, competition, predation and other changes to the ecosystem caused by nonnative species, entrainment at water intake pumps not operated by SWP and CVP, and fish passage. BDCP will implement measures intended to address the effects of other stressors (CM12–

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[7] An exception to D-1641 objectives under Alternatives 1A-3 and 5-9 is the proposal to change the compliance point from Emmaton to Threemile Slough. For the purposes of modeling, this assumption has been incorporated into the No Action Alternative, as well as each ~~action~~ of these alternatives. Under Alternative 4, the compliance point would remain at Emmaton.

CM21; Tables 3-3 and 3-4) under all action alternatives except as otherwise specified~~the No Action Alternative~~.[8] Section 3.6.3 provides a detailed description of these components.

- Control of methylmercury load in BDCP conservation sites.
- Control of nonnative submerged and floating aquatic vegetation in BDCP tidal habitat restoration.
- Improvement of dissolved oxygen levels in the Stockton Deep Water Ship Channel (DWSC) when covered species are present.
- Temporary reduction of local effects of predators on covered fish species.
- Installation of nonphysical barriers to improve survival of emigrating juvenile salmonids at channel junctions.
- Fund efforts to reduce illegal harvest of covered fish species.
- Establishment of new and expansion of existing conservation propagation programs for delta smelt and longfin smelt.
- Fund efforts to treat pollutant runoff from urban stormwater.
- Support current efforts to reduce the risk of introduction of invasive species by recreational vessels.
- Support installation of screens and alteration of nonproject diversions, as appropriate, to reduce the risk of entrainment of covered fish species.
- Implement avoidance and minimization measures to minimize effects on covered species and natural communities that could result from BDCP covered activities, rather than from other stressors.

3.5 Alternatives

3.5.2 Alternative 1A—Dual Conveyance with Pipeline/Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario A)

3.5.2.3 Measures to Reduce Other Stressors and Avoidance and Minimization Measures

Avoidance and Minimization Measures

To satisfy regulatory requirements of the ESA and the NCCPA, avoidance and minimization measures (AMMs) would be incorporated~~The primary purpose of *CM22 Avoidance and Minimization Measures* is to incorporate measures~~ into BDCP activities ~~that will~~to avoid or minimize direct take of covered species and minimize impacts on natural communities that provide habitat for covered

[8] With the BiOps, specific species' recovery plans, and the federal and state regulatory agency actions that monitor some of the other stressors listed (e.g., invasive species control, stormwater runoff), the No Action Alternative could involve reduction of several of these other stressors; however, it would be speculative to assess which would be substantively addressed and to what extent.

species. The AMMs will also minimize adverse effects on critical habitat, and jurisdictional wetlands and waters throughout the Plan Area. Comprehensive AMMs (e.g., best management practices [BMPs] to avoid erosion, sedimentation, and contaminant spills) will be~~This conservation measure would entail the implementation of avoidance and minimization measures (AMMs) (e.g., best management practices [BMPs] to avoid erosion, sedimentation, and contaminant spills)~~ implemented for each BDCP project. These~~, based on the comprehensive avoidance and minimization~~ measures are described in the BDCP Appendix 3.C, *Avoidance and Minimization Measures*.

3.5.9 Alternative 4—Dual Conveyance with Modified Pipeline/Tunnel and Intakes 2, 3, and 5 (9,000 cfs; Operational Scenario H; CEQA Preferred Alternative)

3.5.9.1 Physical and Operational Components

Under Alternative 4, water would primarily be conveyed from the north Delta to the south Delta through ~~pipelines/~~tunnels. Water would be diverted from the Sacramento River through three fish-screened intakes on the east bank of the Sacramento River between Clarksburg and Courtland. Water would travel ~~in gravity collector pipelines~~ from the intakes to a sedimentation basin before reaching the~~ intake pumping plants~~ tunnels. From the intakes~~ pumping plants~~ water would ~~be pumped gravity fed~~flow into ~~short segments of conveyance pipelines, and then through~~ an initial single-bore tunnel, which would lead to an intermediate forebay on Glannvale Tract. From the southern end of this forebay, water would pass through an outlet structure into a dual-bore tunnel where it would flow by gravity to the south Delta. Water would then reach pumping plants to the northeast of the Clifton Court Forebay, where water would be pumped~~ conveyed through a siphon under Italian Slough, and then~~ into the north cell of the expanded Clifton Court Forebay~~, whic~~. The forebay~~h~~ would be dredged and redesigned to provide an area isolating water flowing from the new north Delta facilities. The expanded Clifton Court Forebay would be designed to provide water to Jones pumping plant 24 hours per day, and to Banks pumping plant mostly during off-peak hours, although under certain conditions it may be necessary to operate Banks pumping plant during on-peak hours as well to obtain the SWP's daily water allocation.

A map and a schematic diagram depicting the conveyance facilities associated with Alternative 4 are provided in Figures ~~3-2,~~ 3-9~~,~~ and 3-10. Figure 3-~~2~~ 9 shows the major construction features associated with this proposed water conveyance facility alignment; a detailed depiction is provided in Figure M3-4 in the Mapbook Volume. New siphon and canal connections would be constructed between the north cell of the expanded Clifton Court Forebay and the Banks and Jones pumping plants, along with control structures to regulate the relative quantities of water flowing from the north Delta and the south Delta. Alternative 4 would entail the continued use of the SWP/CVP south Delta export facilities.

Alternative 4 would include the following new water conveyance facilities components, which are described in detail in Section 3.6.1, *Water Conveyance Facility Components (CM1)*. An overview of the proposed water conveyance features and characteristics (e.g., lengths, volumes) is presented in Table 3-11.

- Three north Delta intakes with fish screens along the east bank of the Sacramento River (Intakes 2, 3, and 5) with box conduits, sedimentation basins, gates, a drop structure, and solids drying lagoons.
- ~~Intake pumping plants at each intake location; A~~Associated facilities include an access road, fencing and security gates, an electrical ~~substation~~ building with transformers, switching equipment, a backup generator and fuel tank, storage buildings, communication devices, and ~~surge~~ an outlet tower~~s~~.
- ~~Discharge pipelines conveying water from intake pumping plants to initial tunnels.~~
- One single-bore tunnel connecting Intake ~~Pumping Plant~~ 2 to Intake ~~Pumping Plant~~ 3, and the intermediate forebay (Tunnel 1a), with a launch, retrieval, and vent shaft. The segment of this tunnel between Intakes ~~Pumping Plants~~ 2 and 3 would have an inside diameter of ~~20~~28 feet and the segment between Intake ~~Pumping Plant~~ 3 and the intermediate forebay would have an inside diameter of 40~~29~~ feet.
- One ~~20~~28-foot-inside-diameter single-bore tunnel between Intake ~~Pumping Plant~~ 5 and the intermediate forebay (Tunnel 1b), with a launch, retrieval, and vent shaft.
- ~~Valve vaults~~Gates, and flowmeters ~~vaults, and discharge headers~~ between ~~discharge pipelines~~ intakes and ~~larger conveyance tunnels~~sedimentation basins, junction structures, or tunnel shafts.
- Transition structures, such as stop logs and vents, between tunnel shafts and the intermediate forebay.
- Inlet structures with roller gates, trashracks, gate hoist gantry, and stop logs.
- An intermediate forebay, a pass-through facility.
- An outlet structure to convey water from the intermediate forebay into each main tunnel bore (Tunnel 2) via a vertical shaft.
- Two 40-foot-inside-diameter tunnels (Tunnel 2) between the intermediate forebay and ~~a culvert siphon~~two 4,500 cfs pumping plants leading to the expanded Clifton Court Forebay, with large-diameter TBM launch/retrieval shafts, safe haven work areas, and vent shafts at approximately 4-mile intervals.
- An expanded Clifton Court Forebay with new embankments and an embankment dividing the forebay into a north cell and a south cell.
- Connections and control structures to the Banks and Jones pumping plants.
  - A culvert siphon between the north cell of Clifton Court Forebay and a new canal segment.
  - A canal and set of gates between the siphon leading from the north cell and the approach canal to the Jones Pumping Plant.
  - A culvert siphon, two segments of canal, and a set of gates between the siphon leading from the north cell of Clifton Court Forebay and the approach canal to Banks Pumping Plant, downstream of Skinner Fish Facility.
  - A set of gates in the existing approach canal to the Banks Pumping Plant downstream of the connection to the north cell of Clifton Court Forebay.

  - A set of gates in the existing approach canal to the Jones Pumping Plant downstream of the connection to Old River.

- Transmission lines running from the existing electrical grid to project substations. Under Alternative 4, the method of delivering power to construct and operate the water conveyance facilities is assumed to be a "split" system that would connect to the existing grid in two different locations—one in the northern section of the alignment, and one in the southern section of the alignment. It is anticipated that only the southern interconnection would remain in place during conveyance facility operations.

- Borrow areas and areas identified for the storage and/or disposal of spoil, RTM, and dredged material.

Table 3-11. Summary of Physical Characteristics under Alternative 4

Feature Description/Surface Acreage[a]	Approximate Characteristics
Overall project/2,000 acres	
Conveyance capacity (cfs)	9,000
Overall length (miles)	45
Intake facilities/approximately 90 acres average per site	
Number of on-bank fish-screened intakes	3
Maximum diversion capacity at each intake (cfs)	3,000
~~Intake pumping plants/(included with intake facilities)~~	
~~Six pumps per intake plus one spare, capacity per pump (cfs)~~	~~500~~
~~Total dynamic head (ft)~~	~~59–73~~
Tunnels/170 acres (permanent subsurface easement = ~~1,720~~1,700 acres)	
Tunnel 1a connecting Intakes 2 and 3 to the intermediate forebay	
Tunnel length (~~ft~~mi)	~~47,400~~8.73
Number of tunnel bores; number of shafts (total)	1; 4
Tunnel finished inside diameter (ft)	~~20~~ 28 (between Intakes 2 and 3); ~~29~~ 40 (between Intake 3 and the intermediate forebay)
Tunnel 1b connecting Intake 5 to the intermediate forebay	
Tunnel length (~~ft~~mi)	~~24,900~~4.77
Number of tunnel bores; number of shafts (total)	1; 3
Tunnel finished inside diameter (ft)	~~20~~28
Tunnel 2 connecting intermediate forebay to Clifton Court Forebay	
Tunnel length for each bore (~~ft~~mi)	~~159,000~~30.1
Number of tunnel bores; number of shaft sites (total per bore)	2; 9
Tunnel finished inside diameter (ft)	40
Intermediate forebay/~~245~~ 243 acres	
Water surface area, at elevation 0 ft (acres)	~~41~~37
Active storage volume (af)	~~710~~750
Emergency spillway inundation area (acres)	131~~25~~

Feature Description/Surface Acreage[a]	Approximate Characteristics
Clifton Court Pumping ~~p~~Plant~~s~~	
Total Number of Pumps (both pumping plants)	12
~~5~~8 large pumps ~~plus one spare~~, capacity per pump (cfs)	~~900~~1,125
~~2~~4 small pumps, capacity per pump (cfs)	~~300~~563
Total dynamic head (ft)	~~48-57~~37
Expanded Clifton Court Forebay/~~2,950~~ 2,600 acres (total ~~finished~~ water surface area at maximum operation level)	
Forebay dredging area (acres)	~~2,030~~2,010
Expanded water surface area (acres)	~~690~~590
Active storage volume (af)	~~9,260~~4,300 to 10,200 (north cell) ~~8,110~~14,000 (south cell)
Power requirements	
~~Total conveyance~~Estimated pumping electric load (MW)	~~50–60~~36

af = acre-feet.
cfs = cubic feet per second.
ft = feet.
MW = megawatt.
[a] Acreage estimates represent the permanent surface footprints of selected facilities. Characteristics of other areas including temporary work areas and those designated for borrow, spoils, and reusable tunnel material are reported in Appendix 3C. Overall project acreage includes some facilities not listed, such as permanent access roads.

Facilities under Alternative 4 would be operated to provide diversions up to a total of 9,000 cfs from the new north Delta intakes. The total diversion capacity for the south Delta export facilities would remain constant at 15,000 cfs due to the limited capacity of downstream conveyance structures, but the north Delta facilities would provide flexibility in where water is being diverted from (north vs. south Delta). Operations of the existing SWP/CVP south Delta export facilities would continue as described in Section 3.5.1 for the No Action Alternative.

Geotechnical exploration would be required under Alternative 4 to obtain data to support the development of an appropriate geologic model, characterize ground conditions, and reduce the geologic risks associated with the construction of proposed facilities. Exploration methods would include soil borings and conventional piezocones and seismic cones, as well as sampling for gas within soils and groundwater at selected locations.[9]

Alternative 4 water conveyance operations would follow the criteria described as Operational Scenario H and would include criteria for north Delta diversion bypass flows, south Delta OMR

[9] If the Lead Agencies ultimately select an alternative that proposes an alignment different from the modified pipeline/tunnel alignment, it is anticipated that a similar plan for geotechnical exploration would be designed and implemented, as described in Appendix 3B, *Environmental Commitments.* A discussion of the potential environmental effects resulting from implementation of these activities appears in Chapter 31, *Other CEQA/NEPA Required Sections*, Section 31.5.1.1. Because additional detail pertaining to the location and extent of these efforts under the modified pipeline/tunnel alignment has been developed since the release of the Public Draft EIR/EIS, the potential effects of these activities have been incorporated into relevant portions of the impact analysis pertaining to construction of the water conveyance facilities.

flows, south Delta E/I ratio,[10] flows over Fremont Weir into Yolo Bypass via operable gates, Delta inflow and outflow, Delta Cross Channel gate operations (in addition to NMFS BiOp Action IV.1.2), additional Rio Vista minimum flow requirements, operations for Delta water quality and residence (per D-1641), and water quality for agricultural and municipal/industrial diversions (per D-1641). Delta outflow under Scenario H would be determined by the outcome of a decision tree process being used to account for potential uncertainties related to flow requirements. The decision tree process and outcomes are described further in Section 3.6.4.2, *North Delta and South Delta Water Conveyance Operational Criteria*, for Scenario H.

3.5.9.2 Conservation Components

Alternative 4 includes activities intended to address conservation needs across a variety of habitat types and locations. Activities would be carried out in the habitat types and amounts listed below. These activities are described in detail in Section 3.6.2.

- 65,000 acres of restored tidal perennial aquatic, tidal mudflat, tidal freshwater emergent wetland, and tidal brackish emergent wetland natural communities within the BDCP ROAs (CM4).
- 10,000 acres of seasonally inundated floodplain habitat within the north, east, and/or south Delta ROAs (CM5).
- 20 linear miles of channel margin habitat enhancement in the Delta (CM6).
- 5,000 acres of restored native riparian forest and scrub habitat (CM7).
- 2,000 acres of restored grassland and 8,000 acres of protected or enhanced grassland within BDCP CZs 1, 8, and/or 11 (CM8 and CM3).
- Up to 67 acres of restored vernal pool complex and 72 acres of restored alkali seasonal wetland in CZs 1, 8, and/or 11 (CM9), and 600 acres of protected vernal pool complex within CZs 1, 8, and/or 11 (CM3).
- 1,200 acres of restored nontidal marsh within CZs 2 and 4 and/or 5, and the creation of 500 acres of managed wetlands (CM10).
- 50 acres of protected nontidal marsh (CM3).
- 150 acres of protected alkali seasonal wetland complex in CZs 1, 8, and 11 (CM3 and CM11).
- 1,500 acres of protected managed wetlands (CM3 and CM11).
- 6,600 acres of protected managed wetland natural community (CM3)
- 48,125 acres of cultivated land (non-rice), up to 500 acres of cultivated land (rice), and 3,000 acres of cultivated land (rice or equivalent) protected (CM3 and CM11).

[10] In computing the E/I ratio for Scenarios H1 and H3, the Sacramento River inflow is considered to be downstream of the north Delta intakes. However, in computing the E/I ratio for Scenarios H2 and H4, the Sacramento River inflow was assumed to be upstream of the proposed north Delta intakes.

3.5.9.3 Measures to Reduce Other Stressors and Avoidance and Minimization Measures

Measures to Reduce Other Stressors

Alternative 4 includes the following conservation measures (CM12–CM21) related to reducing other stressors (exposure to contaminants, competition, predation and changes to the ecosystem caused by nonnative species, entrainment at intake pumps not operated by SWP and CVP, and fish passage). These conservation measures are described in detail in Section 3.6.3.

- Methylmercury Management (CM12) – Actions implemented under this conservation measure would minimize conditions that promote production of methylmercury in restored areas and the subsequent introduction of methylmercury to the foodweb and to covered species.
- Invasive Aquatic Vegetation Control (CM13) – Actions implemented under this conservation measure would control the introduction and spread of invasive aquatic vegetation in BDCP aquatic restoration areas.
- Stockton Deep Water Ship Channel Dissolved Oxygen Levels (CM14) – Through funding provisions, this conservation measure would ensure that the Stockton DWSC Aeration Facility continue operations to maintain DO concentrations in the DWSC in accordance with TMDL objectives.
- Localized Reduction of Predatory Fishes (Predator Control) (CM15) – Actions implemented under this conservation measure would reduce populations of predatory fishes at specific locations and eliminate or modify holding habitat for predators at selected locations of high predation risk.
- Nonphysical Fish Barriers (CM16) – Implementation of this conservation measure would entail the installation of nonphysical barriers (structures combining sound, light and bubbles) potentially at the head of Old River, the Delta Cross Channel,~~ and~~ Georgiana Slough, ~~and potentially at~~ Turner Cut, and Columbia Cut (note that Turner and Columbia Cut each have two channels, and thus would require two barriers)~~, the Delta-Mendota Canal intake, Clifton Court Forebay, and other locations~~, to direct outmigrating juvenile salmonids away from Delta channels in which survival is lower.
- Illegal Harvest Reduction (CM17) – Under this conservation measure, funding would be provided to CDFW to increase the enforcement of fishing regulations to reduce illegal harvest of Chinook salmon, Central Valley steelhead, green sturgeon, and white sturgeon in the Delta, bays, and upstream waterways.
- Conservation Hatcheries (CM18) – This conservation measure would establish new conservation propagation programs and expand the existing program for delta and longfin smelt to ensure the existence of refugial captive populations of both delta and longfin smelt, thereby helping to reduce risks of extinction for these species.
- Urban Stormwater Treatment (CM19) – Under this conservation measure, the BDCP Implementation Office would provide a mechanism, through funding, for implementing stormwater treatment measures in urban areas that would result in decreased discharge of contaminants to the Delta.
- Recreational Users Invasive Species Program (CM20) – Under this conservation measure, the BDCP Implementation Office would fund a Delta Recreational Users Invasive Species Program,

which would implement actions to prevent the introduction of new aquatic species and reduce the spread of existing aquatic invasive species via recreational watercraft, trailers, and other mobile recreational equipment used in aquatic environments in the Plan Area.

- Nonproject Diversions (CM21) – Under this conservation measure, the BDCP Implementation Office would fund actions that would minimize the potential for entrainment of covered fish species associated with operation of nonproject diversions (diversions other those related to the SWP and CVP).

Avoidance and Minimization Measures

As described in Section 3.5.2.3, ~~The primary purpose of *CM22 Avoidance and Minimization Measures*, is to~~AMMs would be incorporated ~~measures~~ into BDCP activities ~~that will~~to avoid or minimize direct take of covered species and minimize impacts on natural communities that provide habitat for covered species, critical habitat, and jurisdictional wetlands and waters throughout the Plan Area. ~~This conservation measure would entail the~~Comprehensive AMMs ~~implementation of AMMs~~ (e.g., BMPs to avoid erosion, sedimentation, and contaminant spills) would be implemented for each BDCP project~~, based on the comprehensive avoidance and minimization measures~~. A detailed description of the AMMs is provided ~~described~~ in the BDCP Appendix 3.C, *Avoidance and Minimization Measures*.

3.5.9.4 Issuance of Federal Incidental Take Permits

USFWS and NMFS would issue 50-year ITPs under ESA Section 10(a)(1)(B) to DWR for the incidental take of federally listed species from the construction, operation, and maintenance associated with water conveyance, ecosystem restoration, and other activities as described in the BDCP and under Alternative 4 (see Table 1-1 in Chapter 1, *Introduction*, for a list of the species for which BDCP proponents are seeking coverage).

3.5.9.5 Issuance of State Incidental Take Permits

CDFW would approve the BDCP as an NCCP and issue permits pursuant to Fish and Game Code Section 2835 to DWR for the incidental take of covered species from the construction, operation, and maintenance associated with water conveyance, ecosystem restoration, and other activities as described in the BDCP and under Alternative 4 (see Table 1-1 in Chapter 1, *Introduction*, for a list of the species for which BDCP proponents are seeking coverage).

3.6 Components of the Alternatives: Details

3.6.1 Water Conveyance Facility Components (CM1)

The permanent and temporary physical/structural components related to water conveyance facilities would vary with alternative. During construction, temporary work areas and facilities throughout the Delta would be needed to construct the conveyance facilities. Temporary facilities would be removed following construction, and the work areas would be returned to their preconstruction condition to the extent possible. Demolition and/or removal of existing infrastructure (e.g., buildings and fences) would be required prior to the construction of some water conveyance facilities. Due to the relatively high groundwater level in some proposed work areas, dewatering would be necessary to provide a dry workspace. Dewatering and activities associated with tunneling were assumed to occur 7 days per week and 24 hours per day, while other construction activities would occur 5 days per week (Monday through Friday) up to 24 hours per day.

The major components of CM1, both permanent and temporary, are listed below; detailed descriptions follow. Additional construction detail is provided in Appendix 3C, *Construction Assumptions for Water Conveyance Facilities*.

- North Delta Intakes
  - Concrete intake structure
  - Fish screens
  - Sedimentation basin
  - Solids lagoon
  - ~~Intake p~~Pumping plant
  - Intake pipelines
  - New access roads
  - New perimeter berm/levee modifications
  - Parking, lighting, fencing, and landscaping
  - New utility corridors
- Conveyance Facilities
  - Pipelines/tunnels
    - Pipelines
    - Concrete-lined soft ground tunnel
    - Permanent right-of-way (ROW)/subsurface easements
    - Ventilation and tunnel access shafts
    - RTM conveyors and storage/disposal areas
  - Canals
    - Canal
    - Culvert siphons
    - Intermediate pumping plant
    - Tunnel siphons (concrete-lined soft ground tunnel)
    - New bridges
    - New access roads
- Operable barriers
- Forebays

  - Intermediate forebay, emergency spillway, embankment, and intermediate pumping plant
  - Byron Tract Forebay
  - Expanded Clifton Court Forebay
  - Gate control structures
- New utility corridors
- New bridges
- New access roads
- Connections to Banks and Jones pumping plants
- Power supply and grid connections
- Through Delta/separate corridors conveyance—levee construction and modification
  - Screened intakes (without pumping plants)
  - Diversion pumping plants
  - Operable barriers (some with boat locks)
  - Fixed barriers
  - New access roads
  - New utility corridors
  - New levee sections
- Temporary access and work areas for intake, canal, and pipeline/tunnel construction
  - Temporary barge unloading facilities
  - Road haul routes and temporary access roads
  - Concrete batch plants and fuel stations ~~(and potentially precast segment plants)~~
  - General construction work areas, including field offices, warehouse, and maintenance shops.

Habitat restoration, protection, creation, and enhancement; stressor reduction conservation measures; and avoidance and minimization measures (CM2–CM~~22~~21) could also include physical/structural components related to new roads for site access, levee work, and similar elements. These conservation measures are analyzed at the program level in this EIR/EIS.

3.6.1.1 North Delta Intakes

Depending on the alternative, CM1 would include construction of up to five new intakes on the east or west bank of the Sacramento River. A total of 17 potential intake locations were identified, based on discussions with the Lead Agencies regarding specific fishery considerations as described in the Fish Facility Technical Team (FFTT) Report.[11] These original 17 sites were narrowed to 12 sites, of which 7 are located along State Route (SR) 160/River Road on the east bank of the Sacramento

[11] BDCP Fish Facilities Technical Team. 2011. Bay Delta Conservation Plan Technical memorandum. July. Access date: October 16, 2013. Available: http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/Fish_Facilities_Team_Technical_Memo_Final_7_15_2011.sflb.ashx

River from south of Freeport to the historical community of Vorden, and 5 are located on the west bank from the Pocket Area south to near Randall Island. Along with the criteria previously identified in the FFTT report, sites were recommended based on the site's ability to minimize effects on aquatic and terrestrial species, maintain a diversion structure's functionality, provide adequate river depth, provide adequate sweeping flows, maintain flood neutrality, and minimize impacts on land use and local communities. A detailed description of the process and steps used in identifying and refining proposed intake locations is described in Appendix 3F, *Intake Location Analysis*. A maximum of five intake sites would be selected for any given alternative; each intake would divert a maximum of 3,000 cfs from the Sacramento River. Typically, ~~Each~~ each intake site would comprise a concrete structure, a fish screen, a sedimentation basin, a solids lagoon, a pumping plant, conveyance pipelines to a point of discharge into the conveyance facility (pipelines/tunnels or canals, depending on the alternative), a 69-kilovolt (kV) substation, and new access roads. These construction activities would necessitate realignment of existing roadways, employee parking, lighting, fencing, control and communication devices, and landscaping. A new perimeter berm would be constructed, and the space enclosed by the existing levee and new perimeter berm would be backfilled up to the elevation of the top of the perimeter berm, creating a building pad for the intake structure and adjacent pumping plant.

A conceptual rendering of the intake design is provided in Figure 3-19. A schematic of a typical intake structure is shown in Figure 3-20.

Under the modified pipeline/tunnel alignment (Alternative 4), pumping plants would not be located adjacent to intake facilities; instead, they would be located northeast of Clifton Court Forebay in the southern part of the conveyance alignment. At the intakes, water would flow via gravity from sedimentation basins into a shaft that would discharge into a tunnel leading to the intermediate forebay. Additionally, a different design for conveying water from the intake structures to the tunnels is proposed under this alternative. Differences between Alternative 4 and other alternatives are noted at the end of each subsection below. A conceptual rendering of the intake design under the modified pipeline/tunnel alignment is provided in Figure 3-19a and a schematic of a typical intake structure is shown in Figure 3-20a.

Two 7,500 cfs intake structures and two pumping plants would be constructed under Alternative 9. These intakes would be located where the Sacramento River meets the Delta Cross Channel and Georgiana Slough; the pumping plants, which include their own small intake structures, would be located on the San Joaquin River at the head of Old River and on Middle River upstream of Victoria Canal. However, these facilities differ substantially from those that would be incorporated into other alternatives. The differences are noted at the end of each subsection below.

Description

Intake Perimeter Berm

The intakes would be sited along the existing Sacramento River levee system, requiring levee modifications to facilitate intake construction and to provide continued flood management. At each intake pumping plant site, a new perimeter berm would be constructed on the landside (see Figure 3-20). The space enclosed by the perimeter berm would be filled up to the elevation of the top of the perimeter berm, creating a building pad for the adjacent pumping plant. The new perimeter berms would be designed to provide the same level of flood protection as the existing levee. Transition levees would be constructed to connect the existing levees to the new perimeter berms.

A typical new perimeter berm would have a broad-based, generally asymmetrical triangular cross section. The berm height, as measured from the adjacent ground surface on the landside vertically up to the elevation of the berm crest, would range from approximately 20 to 45 feet to provide adequate freeboard above anticipated water surface elevations. The width of the perimeter berm (toe of berm to toe of berm) would range from approximately 180 to 360 feet. The minimum crest width of the berm would be 20 feet; however, in some places it would be larger to accommodate roadways and other features. Cut-off walls would be constructed to avoid seepage, and the minimum slope of levee walls would be three units horizontal to one unit vertical. All levee reconstruction will comply with applicable state and federal flood management engineering and permitting requirements.

Under Alternative 4, the levee sections adjacent to intakes would be widened and box conduits would be installed through the levee section to provide transition for flows between the intake structure and the sedimentation basins. The perimeter berm at these sites would surround the sedimentation basins, outlet shaft, and storage buildings, and would be designed to provide the same level of flood protection as the levee at each intake site. A slurry cutoff wall would also be constructed around the perimeter of the intake facility. This perimeter cutoff wall would tie into short sections of diaphragm wall within the widened levee crest and would increase public flood protection during construction. It is anticipated that earthwork at each intake site would require approximately 1.4 million cubic yards of borrow material.

Construction of the Georgiana Slough intake for Alternative 9 would require the relocation of a levee and associated road to create space for a boat channel and lock to allow continued boat access between the Sacramento River and Georgiana Slough. Both diversion pumping plants, along with their associated facilities, would be constructed on engineered fill, with a final ground level of approximately 25 feet for the Old River plant and 15 feet for the Middle River plant.

Intake Structure and Fish Screens

The intake structure would consist of a reinforced concrete structure subdivided into individual bays that can be isolated and individually managed. Water would be diverted from the river by gravity into the screened bays and routed from each bay through multiple parallel conveyance conduits to a receiving partitioned or channelized sedimentation basin. Each bay would be fitted at opposing faces with screen panels, flow control baffles, and provisions for bulkhead isolation. The bank of vertical stainless steel screen panels with stainless steel wire fabric would prevent impingement and entrainment of fry-sized salmonids and juvenile smelt. The series of self-contained flow control baffle assemblies would be located behind the screens and would uniformly distribute approach velocities at the screen face. Log booms and/or deflector equipment would protect the intakes from debris and other floating objects.

From the river bottom to the top of the structure, the intake structure would be approximately 55 feet tall, with the top deck elevation aligning with the top of the adjacent levee to maintain flood protection and provide access. Depending on the height of the river at the intake location, the intake would rise above the river's surface by 20–30 feet. At Intakes 1 and 2 for alternatives using the pipeline/tunnel alignment, the pumping plants would require a surge tower in lieu of an air vent; the elevation of the top rim of the surge tower would be approximately 65–70 feet (North American Vertical Datum of 1988 [NAVD 88]). ~~For Alternative 4, surge towers~~ shafts ~~would be required at all three intake~~ the Clifton Court ~~pumping plant sites (Intakes 2, 3, and 5). The elevation of the top of~~

~~the surge towers shafts would be approximately 33 feet, similar to the pad level for the pumping plant area. range from approximately 70 to 105 feet.~~

The intakes would be sized to provide screen area, in accordance with federal and state standards, sufficient to prevent entrainment and impingement of salmonids and delta smelt. The intake sizes (length along the river at the face of the intake) would vary depending on intake location from approximately 700 to 2,500 feet for the pipeline/tunnel, modified pipeline/tunnel, and east alignments; and from 850 to 2,300 feet for the west alignment. Each intake, with the exception of the intakes proposed for Alternative 9, would have a maximum conveyance capacity of 3,000 cfs.

The intake facilities would use on-river vertical flat plate screens, which represent the best available technology for reducing entrainment and impingement risk to fish species. Although the diversions would be located outside of the main range for delta and longfin smelt, ~~For the purposes of this EIR/EIS, it is assumed that~~ the fish screens would be designed to meet delta smelt criteria, which require 5 square feet/cfs and result in approach velocity less than or equal to 0.2 feet/s. When coupled with equal or less sweeping velocities, delta smelt impingement and screen contact is minimized (Swanson et al. 2005; White et al. 2010). The delta smelt screening criteria are also protective of salmonids, for which the standards for Chinook salmon fry are 0.33 feet/s approach velocity.

Each of the intake facilities would vary slightly in terms of bathymetric conditions and design river levels. The fish screen sizes, like the individual intake sizes, would vary depending on intake location and would range from 10 to 22 feet in height and from 915 to 1,935 feet in length. ~~It is anticipated that the screen cleaning system would include several traveling brush cleaning systems installed on the waterside of the intake. As an alternative to the fixed screen panel and brushing system, a traveling screen system with a screen belt and stationary brush/water jet system could be used.~~

Each screen would be as large as the largest fish screens in the Central Valley, such as those at the Glenn-Colusa Irrigation District (GCID), Tehama-Colusa Canal Authority (TCCA) and Freeport Regional Water Authority (FRWA) facilities. Differences between the GCID and TCCA screens and those proposed for the intake locations include slower ambient flow conditions and weaker swimming fish species like delta smelt. The FRWA diversion uses flat plate screens with approach velocities suitable for delta smelt and has similar flow conditions (FFTT 2011). Because of changes in river flow and tidal influence (i.e. tidally-influenced flows), approach velocities would be maintained by a system of vertically and horizontally adjustable flow control baffles placed behind the screens (FFTT 2011).

Fish will be prevented from being drawn into the intakes by a fish screen system of screen panels at the lowest portion of the intake structure face, with solid panels stacked above the screens in guides that extend above the deck of the intake structure. The screen panels are arranged in groups that provide enough area for the maximum possible diversion when added in multiples of 6 screen groups, with each of the groups being hydraulically independent. The screens are a vertical flat plate profile bar type made of stainless steel, with an opening of 0.069 inches and porosity of 43 percent. Each individual screen bay group will have a dedicated screen cleaning system using large brushes supported by a monorail and driven by an electric motor and cable system that would clean the screens at a minimum of every five minutes. A log boom system would protect the screens and cleaning system from large river debris.

Because of the length of the screens and extended fish exposure to their influence (screens and cleaners), fish refugia areas have been recommended to be incorporated into the screen design of the intakes (FFTT 2011). These areas would consist of small areas created within the columns between the fish screens that will provide small fish resting areas and protected cover from predators. Design concepts for fish refugia are still in their infancy and are usually site-specific, with designs recommended by the fish agencies (Svoboda 2013). Two recent examples of the refugia design and installation process include the Red Bluff fish screen and Reclamation District 2035, on the Sacramento River just north of Sacramento (Svoboda 2013). The Red Bluff fish screen design used a physical model study to assess hydraulic parameters such as velocity and turbulence in relation to behavior of juvenile Chinook salmon, white sturgeon, and rainbow trout. Bar spacing at the entrance to the refuge was selected based on fish size (to allow species for protection in, while excluding predators) and a final configuration was chosen to reduce velocity in the refuge while minimizing turbulence; a total of four fish refugia were constructed along 1,100 feet of screen. At the Reclamation District 2035 fish screen, an initial design included a single refuge pocket midway along the intake, which was subsequently modified to include 2-ft-long refugia between each screen panel along the intake. This fish screen also included juvenile fish habitat elements into the upstream and downstream sheet pile training walls and the sloped soil areas above the training walls, with grating materials attached to the sheet pile walls to prevent predatory fish from holding in the corrugated areas by the walls and to another form of refuge for small fish (Svoboda 2013). These two examples serve to illustrate the site-specific design considerations that are necessary for construction of large intakes.

The two intake structures for Alternative 9 would not divert water toward a pumping plant but into existing channels. These structures would be 2,800 feet wide and 15 feet high. Each intake would divert up to 7,500 cfs. Radial gates downstream of the intakes would limit flow to this maximum, while slide gates on each bay would equalize approach velocity across the face of the fish screen. The intake at Georgiana Slough would entail construction of a boat lock to allow continued passage between the slough and the Sacramento River. Two smaller intake structures would not include fish screens; these would divert up to 250 cfs into the diversion pumping plants, redirecting flows of existing channels, and would include automatic self-cleaning trash racks, along with sluice gates between the intake and the pumps.

Sedimentation Basins and Solids Handling Facilities

Although the intake fish screens would remove debris and sediment from the intake inflow, a sedimentation basin would be constructed between the intake structure and the pumping plant to remove the suspended solids that pass through the screen. Settled sediment in the sedimentation basin would be collected by solids collection equipment in the sedimentation basin and conveyed by positive displacement/progressive cavity pumps to up to three solids lagoons for further settling and disposal. Water would be conveyed from the solids lagoons by gravity to the inlet structure of the sedimentation basin.

The sedimentation basin would be approximately 120 feet long by 40 feet wide by 55 feet deep, and would have interior concrete walls to create separate sedimentation channels. The channels would divide the flow, and each channel would be capable of being independently isolated for maintenance. Under the modified pipeline/tunnel alignment (Alternative 4), the sedimentation basin would be divided into three sedimentation channels. Each channel would be 500 feet long by 200 feet wide by 23 feet deep. The structural system for the basins would consist of reinforced concrete walls and mat slab foundation supported on piles. The walls would be designed to retain external soil loads and contain internal hydrostatic and dynamic loads. The bottom of the basin would be at an elevation between -28.0 and -20.9 feet (NAVD 88) and the top of the walls would be at the flood protection elevation.

The solids lagoons would be concrete lined to prevent seepage to the groundwater or adjacent riverbed, and would be approximately 10 feet deep~~, and would have~~with sloped sides with a top width of 86 feet and a top length of 165 feet. Under the modified pipeline/tunnel alignment (Alternative 4), the solids lagoons would be approximately 15 feet deep and would have a bottom width of 200 feet and a bottom length of 400 feet. Up to three solids lagoons would be used in a rotating cycle with one basin filling, one settling, and the third being emptied of settled and dewatered solids. The volume of solids generated on a daily basis would depend on the volume of water pumped through the intakes, as well as on the sediment load within the river. It is anticipated that during most periods when five intakes are operating at about 3,000 cfs each, approximately 137,000 dry pounds of solids per day would be pumped to the solids lagoons. During periods of high sediment load in the Sacramento River, the daily mass of solids would be expected to increase up to 253,000 dry pounds per day. The annual volume of solids is anticipated to be 486,000 cubic feet (dry solids basis).

Under the modified pipeline/tunnel option, reinforced concrete collector box conduits would be constructed across the back wall of the fish screens at each intake and would funnel flow from the intake structure into the sedimentation basins. Under this alignment, the sedimentation system at each intake would consist of a jetting system in the intake structure that will re-suspend accumulated sediments for transport to the intake collector box conduits; twin unlined, earthen sedimentation basins; and solids lagoons for drying and consolidating prior to disposal. The basins would be triangular in shape and would be approximately 250 to 677 feet wide (with the maximum width facing the intake channels), 660 feet long, and 25 feet deep (for normal settling depth and sediment storage depth). The bottom of the basin would be at an elevation between -28 and -23 feet and the deck surrounding basin would be 3 feet above the water surface elevation corresponding to a 200-year flood (inclusive of projected sea level rise). The basins would be divided by an earthen berm running the full length of the basin, with three fish screen bays connected by the box conduits serving each half of the overall sedimentation basin.

Under the modified pipeline/tunnel option, four sediment drying lagoons would be constructed at each intake site. Each lagoon would be approximately 160 feet wide (at the bottom), 350 feet long, and 15 feet deep with sloped sides. The top of each lagoon would be level with the site and would be protected from the design flood condition. Two drying lagoons would be available for each sedimentation basin allowing for a yearly rotation cycle with one drying lagoon filling and one settling and being dewatered through underdrains and a decant system.

Intake structures built as part of Alternative 9 would not require sedimentation basins or solids lagoons. However, typical maintenance activities associated with river intakes would be performed to ensure that sediment buildup is controlled. These activities may include those listed below.

- Suction dredging around the intake structures using raft- or barge-mounted equipment and pumping sediment to a landside spoils area.
- Mechanical excavation around intake structures using track-mounted equipment and a clamshell dragline from the top deck after installing a floating turbidity control curtain to isolate the work area.
- Dewatering the intake bays to remove sediment buildup using small front-end loading equipment and manual labor.

Intakes, Pumping Plants, and Appurtenant Facilities

All pumping plants would include a cast-in-place- (CIP-) reinforced concrete structure and a superstructure, a 230 kV power substation and transformer to supply power, an access road, flood protection embankments, parking, outdoor lighting, security fencing, and communication equipment. In addition, intakes and intake pumping plants would have concrete sedimentation basins, associated solids handling facilities, and conveyance piping to a point of discharge into the proposed conveyance structure (i.e., pipelines/tunnels or canals). These structures/facilities would be located on the landside of the levee. To protect the structures from flood waters, the sedimentation basins, solids lagoons, and pumping plant would be constructed on engineered fill above design flood condition. All construction and modifications will comply with applicable state and federal flood management, engineering, and permitting requirements.

Each of the intake pumping plant sites would be approximately 1,000 by 1,000 feet (approximately 20 acres). The pumping plant would be approximately 262 feet long by 98 feet wide. ~~Under the modified pipeline/tunnel alignment (Alternative 4), each of the pumping plant sites would be approximately 1,800 by 1,500 feet (approximately 60 acres). The pumping plant would be approximately 400 by 150 feet.~~ Intake pumping plants would be constructed of reinforced concrete and have multiple floors to house mechanical and electrical equipment. The primary structural support systems used for the pumping plants would consist of reinforced concrete slabs and walls at and below grade, with steel framing and exterior metal wall and roof panels for the above-grade building. The pumping plant mechanical building system design criteria would conform to the requirements of Title 24, the California Mechanical Code, and other applicable codes, and would include heating, ventilation, air conditioning, plumbing, and fire protection systems.

The intake pumping plant would include seven 500-cfs pumps, including one standby pump. The intake pumps would be orientated vertically and would operate in parallel. Each pump would discharge into an individual 96-inch-diameter (8-foot) pipe. Pumping capacity could be varied by reducing the number of pumps on line and/or adjusting the pump operating speed. Variable frequency drives (VFDs) and flow meters would be required on all pumps to vary the pumping rate.

Conceptual engineering indicates that the intake pumping plants would require a deep foundation supporting a common concrete mat. Based on a preliminary pile foundation evaluation, using a 24-inch concrete-filled pipe pile, an estimated pile length of 40–45 feet below the founding level of the intake pumping plant would be necessary. ~~Under the modified pipeline/tunnel alignment (Alternative 4), 42-inch diameter pipe piles filled with reinforced concrete would be driven to a length of 65–75 feet below the founding level of the pumping plant.~~ Foundation types and dimensions will be refined further when site-specific subsurface geotechnical data becomes available. Ground improvements would also be needed to improve foundation materials that are susceptible to liquefaction.

A facility control system could provide local and remote automatic and manual control and monitoring of the facilities. It is anticipated that the control system would use a combination of buried fiber optic systems, microwave radio, and leased telecommunications lines. A global positioning satellite (GPS)-based time clock at each pumping plant would support the control system. This equipment would require that a small dish antenna be mounted on the roof of the pumping plant. Two additional antennae would be mounted on ~~the~~ a pumping plant ~~at Intake 1~~ to support a communications system.

A communications system would connect to the existing DWR Delta Field Division Operations and Maintenance Center near Banks Pumping Plant and the DWR communications headquarters in Sacramento. Buried fiber optic conduit would be installed from the southern end of the new conveyance facility at Byron Tract Forebay ~~(or, under Alternative 4, Clifton Court Forebay)~~ along the inlet canal to the Banks Pumping Plant and the Delta Field Division Operations and Maintenance Center. The conduit route would be adjacent to roads, highways, railroads, utilities, or other easements.

As described above, under the modified pipeline/tunnel option, the pumping facilities would not be constructed adjacent to the intake facilities. Instead, they would be located at the northeastern corner of Clifton Court Forebay on a small DWR-owned island south of Kings Island. Here, the two main tunnels would terminate at the base of two pump plant shafts. These shafts would (1) provide for gravity flow when system hydraulics allow (via a separate spillway into Clifton Court Forebay), (2) provide for surge protection via the spillway, and (3) house the pumps and their controls. The two pumping plants receive flow from the pump shafts and lift the water into Clifton Court Forebay, discharging water through pipes into a spillway basin within the northern section of forebay. Each pumping plant would have a design pumping capacity of 4,500 cfs and would include 4 large pumps (1,125 cfs capacity) and 2 smaller pumps (563 cfs capacity). The pumps would be vertical column discharge pumps, and one large pump at each plant would be a spare. Each pumping plant would be housed within a building and would have an associated electrical building. The pumping plant buildings would be circular structures with a diameter of 182 feet and each would be equipped with a bridge crane that would rotate around the building and allow for access to the main floor for pump removal and installation. The total site for the pumping plants, electrical buildings, substation, spillway, access roads, and construction staging areas is approximately 95 acres. The main floor of the pumping plants and appurtenant permanent facilities would be constructed at a minimum elevation of 25 feet to provide flood protection. The bottom of the pump shafts would be at an elevation of approximately -163 feet, though a concrete base slab, shaft lining, and diaphragm wall would be constructed to deeper levels (to an elevation of -275 feet). Under the MPTO, a control room within an electrical building at the pumping facility site would be responsible for controlling and monitoring the communication between the intake structures, pumping plants, and the Delta Field Division Operations and Maintenance Center, DWR Headquarters, and the Joint Operations Center.

Pumping plants constructed for Alternative 9 would not pump water from intake facilities into other conveyance facilities. Rather, these pumping plants would provide diversion flow into existing channels. Each of the pumping plants would have three pumps plus one spare; each plant would have a 250 cfs capacity. The San Joaquin River plant would convey additional flows with organic material into Old River. The Middle River plant would convey additional flows with lower salinity levels into Old River. These plant sites would include a dewatering sump and discharge piping, flow meter vaults, outfall piping, an electrical and control building, an access road, and a transformer.

~~Intake~~ Pumping Plant Substation

Each intake pumping plant would be served by a 69 kV substation with a footprint of about 150 by 150 feet. Here, transformers would convert power from 69 kV to the voltage needed for ~~the~~ pumps and auxiliary equipment at the adjacent structures. For Alternatives 1B, 2B, and 6B, one intake pumping plant would also house a 230 kV substation, which would be located in a 268- by 267-foot enclosure. This substation and its transformers would convert power from the conveyance facility's main 230 kV transmission line to 69 kV, for use by the pumping plants and other facilities.

The substations would be constructed adjacent to the pumping plants on concrete pads with sufficient ground preparation. The substation would be at the same elevation as the pumping plant operating floor and at the flood protection level; excavation is not anticipated.

To supply power during construction of the intake and pumping plant structures and power for the tunneling and excavating machines, substations would be constructed early in the overall construction schedule.

Under the modified pipeline/tunnel alignment, a 230 kV transmission line and associated 230kV-115kV substation used during construction would be repurposed and used to power the pumping plants at the Clifton Court Forebay location during operations. The repurposed substation would provide power to a new substation that would convert power from 115kV to 13.8kV. This substation would then include 13.8 kV feeder lines to a proposed electrical building to distribute the power to the major loads including the main pumps, dewatering pumps, and 13.8kV to 480V transformers.

Intakes and pumping plants constructed for Alternative 9 would not necessitate substations but would incorporate transformers.

Fencing, Lighting, and Landscaping

Security fencing and lighting would be installed at all pumping plants. Outdoor lighting fixtures would be luminaries with individual photocells. Critical paths, entrances, and walkways would be illuminated. High bay lighting fixtures would be high-pressure sodium vapor, instant-on lamps.

The need for fencing will be determined in accordance with DWR's Water Resources Engineering Memorandum (WREM) No. 41a to protect the public from hazards associated with the conveyance facilities and ensure security of the facilities and operational personnel. Fencing would be placed within the ROWs of the facilities.

Vegetation and signage are to be determined in accordance with DWR's sensitivity to their impact on the Delta environment, guided by DWR's WREM No. 30a, *Architectural Motif, State Water Project*. All proposed vegetation and signage will be coordinated with local agencies through an architectural review process.

Intake Access

The intakes would all be sited on the existing Sacramento River levee and levee roads. The intake design includes parking for employees during operations and maintenance. Along with the levee modifications discussed above, the levee roads would need to be realigned. Temporary access roads would be needed to connect the existing road network to the intake site for delivery of materials and construction equipment and personnel. Temporary access roads around the building site would also be necessary during construction. The existing levee roads are public roads that carry traffic through the Delta, and include SR 160 and various county roads. Access for travelers through the Delta on these existing roadways would be maintained by use of temporary new road detours around the intake sites. The existing alignment of these roadways would be modified to accommodate the intake structure, and the roadways would be reopened to traffic following construction.

Under the modified pipeline/tunnel alignment ~~alternative~~, during the initial construction phase, the levee adjacent to each intake would be widened and raised. During this initial phase, SR 160 would be permanently relocated from its current alignment along the top of the river levee to a new alignment established on top of the widened levee (and box conduits), aligned approximately 220 feet further inland than the current alignment. Turn pockets and other features would be built to allow continued access to the intake sites. ~~elevated via a precast bridge above Intakes 2 and 3.~~

Operations and Maintenance

The proposed intake facilities (including intakes, pumping plants, sedimentation basins, and solids lagoons) would require scheduled routine or periodic adjustment and tuning to remain consistent with design intentions. Emergency maintenance is also anticipated. Routine facility maintenance would consist of activities such as painting, cleaning, repairs, and other tasks to operate facilities in accordance with design standards after construction and commissioning. It is anticipated that major equipment repairs and overhauls would be conducted at a centralized maintenance shop at one of the intake facilities sites or at the intermediate pumping plant site.

Routine visual inspection of the facilities would be conducted to monitor performance and prevent mechanical and structural failures of project elements. Maintenance activities associated with river intakes could include removal of sediments, debris, and biofouling materials. These maintenance actions could require suction dredging or mechanical excavation around intake structures; dewatering; or use of underwater diving crews, boom trucks or rubber wheel cranes, and raft- or barge-mounted equipment. Periodic mussel cleaning in the sedimentation basins and solids removal from solids lagoons for off-site disposal would be required. Sediment in channels would also be removed periodically.

Construction

Intake Construction

Depending on foundation material, foundation improvements would require excavation and replacement of soil below the new levee footprint and potential ground improvement. The levees would be armored with riprap—small to large angular boulders—on the waterside. All construction and modifications will comply with applicable state and federal flood management, engineering and permitting requirements.

~~Intake construction would begin during the first construction season.~~ Each intake would require approximately 3.5–4.5 years to complete; construction of multiple intakes would overlap such that several intakes could undergo simultaneous construction, depending on the alternative. Intakes would be constructed using a sheetpile cofferdam in the river to create a dewatered construction area that would encompass the intake site. The cofferdam would lie approximately 10–35 feet from the footprint of the intake. The distance between the face of the intake and the face of the cofferdam would be dependent on the foundation design and overall dimensions. The length of each temporary cofferdam would vary by intake location, but would range from 740 to 2,440 feet. Cofferdams would be supported by steel sheet piles and/or king piles (heavy H-section steel piles). Installation of these piles would require both impact and vibratory pile drivers; piles would be driven using barge-mounted cranes and cranes mounted on temporary decks~~(see Chapter 1, *Introduction*, Table 1-3 for a summary of permits relevant to BDCP)~~. ~~Approximately 8–12~~For the purposes of analysis, it is assumed that up to 60 sheetpiles would be driven per day for construction of the cofferdam ~~per~~ at each intake site. For further details regarding pile driving activities, see Appendix 3C, Table 3C-2.

Some clearing and grubbing of levees would be required prior to installation of the sheet pile cofferdam, depending on site conditions. Additionally, if stone bank protection, riprap, or mature vegetation is present at intake construction site, it would be removed prior to sheet pile installation.

Once the cofferdam is completed, the enclosed area would be excavated to the level of design subgrade using clam shell or long-reach backhoe before ground improvements and installation of foundation piles. The anticipated ground improvement methods may include jet grouting and deep soil mixing. The foundation construction would either be carried out by in-the-wet construction or conventional construction using dewatering methods. Electric-powered dewatering wells would be installed throughout the site. Diesel-powered standby power generator(s) would be used to power the dewatering pumps during power outages. A backup pump would be provided at every dewatering location with pumps. Dewatering pumping may occur 24 hours per day, 7 days per week, and would continue throughout intake construction. Water would be pumped out of the cofferdam and stored in sedimentation tanks at landside work areas. Groundwater removed with the dewatering system would ultimately be treated as necessary and disposed of in surface waters under a National Pollutant Discharge Elimination System (NPDES) permit. Prior to dewatering, fish rescue and salvage plans (discussed in Appendix 3B, *Environmental Commitments*) would be implemented, as necessary, for dewatering operations. Velocity dissipation facilities, such as rock or grouted riprap, would be used to reduce velocity/energy and prevent scour where dewatering discharges reenter the river.

The area behind the cofferdam would be excavated to the necessary depth and cast-in-drilled-hole (CIDH) or concrete-filled steel pipe foundation piles would be installed to support the intake structures. CIDH piles are installed by drilling a shaft, installing rebar, and filling the shaft with concrete; no pile driving is necessary with CIDH methods. Use of concrete filled steel piles would involve vibratory or impact-driving hollow steel piles, and then filling them with concrete. The required number of piles would vary by intake length~~ from 450 (for short intakes) to 800 (for long intakes)~~. ~~The number of intake~~For the purposes of analysis, it is assumed that up to 60 steel piles would be driven ~~in a~~per day ~~would range from approximately 8 to 12 per~~ for the construction of the intake structure at each intake site and that each intake structure would require 500 piles. Minor channel work would be necessary to install the intake fish screens; the channel disturbance area would vary by intake location and would range from approximately 2.5 to 7.1 acres. Foundation type, dimensions, and construction methods will be revised further when additional site-specific subsurface geotechnical data becomes available.

All in-water construction activities are expected to be restricted to the period between June 1 and October 31, when the potential for fish and aquatic species of concern to be present would be at a minimum. Construction outside this period would only be allowed if authorized by relevant permitting agencies, and additional construction timing restrictions could also be imposed by these agencies, to protect specific species. ~~To the extent possible, all in-water construction activities would take place between June 1 and October 31.~~ No additional in-water work would be conducted for construction of the intakes until the cofferdam is removed and rock protection is installed during the in-water work window. In-water work would not occur every season over the duration of construction. Activities occurring within a dewatered cofferdam are not considered “in-water work” for the purposes of these restrictions.

After intake structure construction is complete, the cofferdam would be flooded by removing the sheet pile walls in front of the intake structure. The removal of sheet pile walls would be performed by underwater divers using torches or plasma cutters to trim at the intake structure slab. Rock protection would be installed along the river banks upstream and downstream and along the front of the intakes to protect the intakes, prevent bank and channel erosion, and provide a transition from the river bottom to the intake structure. The length of bank protection required on either side of the intake would vary by intake location but would range from approximately 100 to 2,200 feet for the pipeline/tunnel, modified pipeline/tunnel, and east alignments, and from 500 to 1,800 feet for the west alignment. The intake structures and associated bank protection would permanently change existing substrates and local hydraulic conditions in the immediate vicinity of the intakes.

The Sacramento River would remain navigable during construction of the intakes. River channel width at several intake sites varies from about 400 to 600 feet. The anticipated protrusion of cofferdams into the river is about 40 to 60 feet. Cofferdams would be installed around intake construction sites. Warning signs and buoys would be posted upstream of, downstream of, and at the construction sites. Buoy lights would also be provided for nighttime navigation during construction. The completed intake structures would have proper lighting to prevent boat collisions with the structure at night.

Under the modified pipeline/tunnel option, the intake systems would convey water from the river through the levee to landside sedimentation basins via an on-bank intake structure and gravity collector box conduits. The levees at intake sites would be widened to increase the crest width, facilitate intake construction, provide a pad for sediment handling, and accommodate the realignment of SR 160. To widen the levees, low permeability levee fill material (in accordance with USACE specifications) would be placed on the landside of the levee. The material would be compacted in lifts and keyed into the existing levee and ground. The levees would be widened by approximately 250 feet at each site. Ground improvement through jet grouting or other means would be provided to reduce the risk of liquefaction-induced settlement beneath the intake structure, box conduits, and pad fill area. The widened levee sections would allow for construction of the intake cofferdams, associated diaphragm walls, and levee cutoff walls within the existing levee prism while preserving a robust levee section to remain in place during construction. A slurry cutoff wall would also be constructed around the perimeter of the construction area for the landside facilities. This slurry wall, which would be tied into the diaphragm wall at the levee, would be intended to help prevent river water from seeping through or under the levee during periods when deep excavations and associated dewatering are required on the landside. By constructing a slurry wall in conjunction with a diaphragm wall, the open cut excavation portion of the work on the landside of the levee would be completely surrounded by cutoff walls, minimizing induced seepage from the river during and following construction.

Intake Gravity Collector Pipelines

To allow for the installation of pipe segments to connect the intake to the sedimentation basin, construction~~ could involve trenchless methods or open-cut trenching.~~ is expected to use open-cut methods after the pipe manifold portion of the cofferdam is backfilled. Trenchless installation methods to install the collector pipes between the manifold cofferdam and the sediment basins may also be considered during final design. If trenchless methods ~~is~~ are employed, conduits would be constructed from inside the cofferdam or shaft to the landside of the levee prior to construction of the intake. Trenchless construction would be done using pipe ramming or tunnel boring machines. The process for handling RTM from tunneling ~~would be removed using conveyors or pumps and transferred to a separation plant to remove the suspended solids from the soil cuttings of the RTM. The RTM would be treated (, drained and aerated), dried, and transported to stockpiles consistent with the NPDES permit requirements~~is described in Section 3.6.1.2, Conveyance Facilities.

If open-cut trenching is used and the native materials are generally of good quality in the area of conduit construction, excavated material from the trench would be used as embedment and backfill materials. If the native soils are not suitable as foundation materials for the trench, suitable materials would be imported to the site.

Cut and cover construction would likely be used for landside pipe placement using long reach backhoes, scrapers, and excavators placed on levees or on the landside of the levees. Dewatering systems, if required to control groundwater and ensure a stable excavation trench, would be similar to those described for the intake structure foundations.

Under the modified pipeline/tunnel option, reinforced concrete box conduits would be used to convey flows by gravity from the intake structure to the sedimentation basins. Twelve box conduits would be constructed at each intake (two box conduits for each fish screen bay group). Each box conduits would have a height and width of 12 feet. Flow meters and flow control sluice gates located on each box conduit would ensure that approach velocity standards are met. The box conduits would extend through a widened levee section and terminate with a wing wall transition structure located in the sedimentation basins. The length of each box conduit would be approximately 375 feet, which would allow for construction of a permanent relocation of SR 160 as part of the initial construction phase at the intake sites.

3.6.1.2 Conveyance Facilities

Tunnels

Design

The tunnel conveyance would consist of a single bore, 29-foot inside diameter (ID) tunnel on the northern end of the alignment (Tunnel 1) and a dual-bore, 33-foot ID tunnel on the longer, southern end of the alignment (Tunnel 2); Alternative 5 would convey water through a single-bore tunnel on the southern end. ~~For Alternative 4, Tunnel 1a would be a single bore 208-foot ID tunnel between Intakes 2 and 3 and a 2940-foot ID tunnel between Intake 3 and the intermediate forebay. Tunnel 1b would be a single bore 208-foot ID tunnel between Intake 5 and the intermediate forebay. Tunnel 2 for Alternative 4 would be constructed with a dual-bore 40-foot ID tunnel.~~ An intermediate forebay would be constructed to provide a hydraulic break before the diverted water enters the common tunnel conveyance system downstream. This hydraulic break would provide water conveyance operational flexibility and allow independent operation of each intake facility.

The tunnel system would be operated under pressurized conditions at a constant volume with isolation facilities to allow reducing the number of tunnels in operation during periods of lower flow and to maintain velocity in active tunnels. ~~Under Alternative 4, the tunnel would be operated with a gravity feed system rather than with an intermediate pumping plant with an optional gravity bypass system at the outlet of the intermediate forebay.~~

In alluvial soils with high groundwater pressures, the tunnel would be constructed at depths greater than 60 feet using mechanized closed-face pressurized tunneling machines. The tunnel invert elevation is preliminarily assumed to be at 100 feet below mean sea level (msl), primarily to avoid peat deposits. ~~It would be lowered to 160 feet below msl under~~ Under the San Joaquin River and Stockton DWSC, the tunnel would be lowered to a depth sufficient to maintain ~~sufficient~~ necessary cover between the tunnel and dredging operations in the shipping channel. The final depth and profile of the tunnel would be set in the preliminary design phase for CM1, after detailed geotechnical investigations have been completed. A minimum horizontal separation of two outside tunnel diameters would be maintained in reaches with two tunnel bores. Because of the high groundwater level throughout the proposed tunnel alignment area, extensive dewatering (by means of dewatering wells along the tunnel alignment) and groundwater control in the tunneling operation and shaft construction would likely be necessary.

The main construction or launching shafts for each tunnel would be about 120 feet in diameter to accommodate construction and construction support operations. The TBM retrieval shaft would be approximately 90 feet in diameter, and 50-foot-diameter intermediate ventilation shafts would be located approximately every 3 miles. Tunnel ventilation would adhere to California Division of Occupational Health and Safety (Cal-OSHA) tunnel ventilation requirements. The tunnels would be lined with precast concrete bolted-and-gasketed segments. The tunnel concrete liner would serve as permanent ground support and would be installed immediately behind the tunnel-boring machine, thereby forming a continuous watertight vessel.

Upon completion of construction, launching, retrieval, and ventilation shafts would be converted to permanent access shafts so that personnel can gain access to the tunnel for inspections and maintenance. The large-diameter construction shafts would be modified to approximately 20-foot diameter access shafts that would rise approximately 20 feet above existing grade. The twin-bore tunnels would have two shafts, and would be surrounded by an earthen pad with approximate dimensions of 250 feet by 125 feet, and approximately 20 feet high. Road access to the top of the pad will be provided for maintenance vehicles.

Under the modified pipeline/tunnel option, Tunnel 1a would be a single bore 28-foot ID tunnel between Intakes 2 and 3 and a 40-foot ID tunnel between Intake 3 and the intermediate forebay. Tunnel 1b would be a single bore 28-foot ID tunnel between Intake 5 and the intermediate forebay. Tunnel 2 for Alternative 4 would be constructed with a dual-bore 40-foot ID tunnel. Under the modified pipeline/tunnel option, the tunnel would be operated with a gravity feed system rather than with an intermediate pumping plant and an optional gravity bypass system at the outlet of the intermediate forebay. The main construction or launching shafts for each tunnel would be 113 feet in diameter to accommodate construction and construction support operations. The TBM retrieval shaft would be 100 feet in diameter, and an intermediate access shaft 85 feet in diameter would be located along each tunnel drive to allow the contractor to make repairs to the TBM prior to completion of that tunnel drive.

The finished sizes of the respective shafts at Intakes 2, 3, 5, and the intermediate forebay would match the diameter of the adjoining tunnel segments. These shafts would accommodate hydraulic functionality and provide access for maintenance and repair during operation of the water conveyance facilities. Access shafts associated with Tunnels 1a and 1b would be between 75–85 feet in diameter and would be backfilled following tunnel construction. The finished sizes of the main shafts associated with Tunnel 2 would be a minimum of 20 feet to allow for ongoing operation and maintenance. The permanent pad for each tunnel shaft would require protection against flooding. Aside from the pump shafts adjacent to Clifton Court Forebay, the finished shaft area pad elevations would be approximately 32 to 34 feet above mean sea level.

Refer to Table 3-7 for a description of the physical characteristics of the tunnel conveyance facility under Alternatives 1A, 2A, and 6A; Tables 3-10 and 3-12 for Alternatives 3 and 5 respectively; and Table 3-13 for Alternatives 7 and 8. Details of the conveyance facility under Alternative 4 are shown in Table 3-11. A conceptual drawing of the configuration of a typical tunnel segment is shown in Figure 3-21.

Operation and Maintenance

Maintenance requirements for the tunnels have not yet been finalized. Some of the critical considerations include evaluating whether the tunnels need to be taken out of service for inspection and, if so, how frequently. Typically, new water conveyance tunnels are inspected at least every 10 years for the first 50 years and more frequently thereafter. In addition, the equipment that the facility owner must put into the tunnel for maintenance needs to be assessed so that the size of the tunnel access structures can be finalized. Equipment such as trolleys, boats, harnesses, camera equipment, and communication equipment would need to be described prior to finalizing shaft design, as would ventilation requirements. As described above, it is anticipated that, following construction, large-diameter construction shafts would be modified to approximately 20-foot diameter access shafts.

At the time of preparation of this EIR/EIS, the use of remotely operated vehicles or autonomous underwater vehicles is being considered for routine inspection, reducing the number of dewatering events and reserving such efforts for necessary repairs.

Construction

Construction staging areas would include space for offices, parking, shops, segment storage, fan line storage, daily spoils pile, power supply, water treatment, and other space requirements. Depending on the method selected to construct the walls for the shafts, the staging areas may also include space for the slurry ponds required for slurry wall construction. Work areas for RTM handling and spoils storage would also be necessary.

~~On occasion, a~~Access to the ~~face of a~~ TBM cutterhead will~~may~~ be required for equipment inspection and/or maintenance ~~or emergency~~ purposes. Such maintenance ~~interventions~~ work or “interventions” can be performed under pressurized conditions from within the TBM (referred to as “pressurized safe haven interventions”), and some work can be better performed in “free air” or atmospheric conditions (referred to as “atmospheric safe haven interventions”). ~~for the TBM cutterhead~~In either case, this work ~~would~~ will be performed in discrete areas~~—*safe havens*—within~~ along the tunnel alignments. The atmospheric interventions will occur at pre-planned locations along the tunnel alignments. With the current understanding of the geotechnical conditions in the project area, atmospheric interventions are planned at two-mile intervals on the alignments. The preliminary locations of these planned atmospheric interventions are shown on mapbook figures and are presented as either “vent shaft” locations or “safe haven work areas.” The precise locations of the unplanned pressurized safe haven intervention areas have not yet been determined because the locations would depend on site-specific mining conditions and therefore, these sites are not shown on mapbook figures. ~~At minimum, there would be one safe haven area between each tunnel shaft (launching and vent shafts). Intervention (or~~Pressurized safe haven~~)~~ interventions~~zones~~ could be situated at intervals of 2,000 feet along the tunnel alignment, depending on the specific geology encountered by the TBMs. ~~These subsurface intervention sites would be constructed by injecting grout from the surface to a point in front of the TBM. The TBM would then bore into the grouted area. The purpose of grouting an intervention site is to allow pressures to be equalized between the face of the TBM and the tunnel, facilitating access and eliminating the need for working in hyperbaric conditions.~~

Surface disturbance activities at each of the~~se~~ intervention sites will differ depending on the type of intervention that is being executed. The pressurized safe haven work site will~~would~~ be limited to a surface~~n~~ area no larger than 1 acre. These safe haven intervention sites would be constructed by injecting grout from the surface to a point in front of the TBM, or by using other ground improvement techniques including ground freezing or installing dewatering wells to depressurize the ground around the TBM. Once the ground has been stabilized by one of these techniques, the TBM would then bore into the treated area. The purpose of treating an intervention site in one of these manners is to allow access to the cutterhead so that workers can either eliminate the need for working in hyperbaric conditions, or greatly reduce the pressures inside the cutterhead while maintenance work is being performed, which will greatly increase the speed and efficiency of the maintenance work. Surface equipment required to construct the safe haven intervention site would include a small drill rig and grout mixing and injection equipment, and facilities to control groundwater runoff at the site. The surface drilling and ~~grouting~~ treatment operation would typically ~~be completed within~~ take about eight ~~2~~ weeks to complete. Once complete, all equipment would be removed and the surface features reestablished. To the greatest extent possible, established roadways would be used to access the intervention sites. ~~Access to most intervention sites would be over established roadways.~~ If access is not readily available ~~over surface routes~~, ~~surface sites would be accessed by helicopter~~temporary access roads would be established.

Atmospheric safe haven interventions will occur at either 1) the identified tunnel vent shaft sites which become permanent features after construction is completed, or at 2) temporary small-diameter shafts that are used only during the tunnel construction work (those areas identified as “safe haven work areas” on mapbook figures). The location and size of the permanent vent shaft work areas are shown on the figures. For the safe haven work areas, a small shaft, roughly equal to the diameter of the TBM cutterhead, will be excavated to tunnel depth at the approximate locations shown on the figures. The exact location of these shafts will depend on the specific tunneling conditions that are encountered. Approximately 3 acres will be required at each of these locations to set up equipment, construct flood protection facilities, excavate/construct the shaft, and set up and maintain the equipment necessary for the TBM maintenance work. It is anticipated that all work associated with developing and maintaining these shafts will occur over approximately 9 to 12 months. At the completion of the TBM maintenance at these sites, the TBM will mine forward, erect segments, and the shaft location will be backfilled to preexisting conditions.

Because the need for TBM maintenance or emergency access is dependent on the condition of the cutting face, the number and locations of intervention sites (either pressurized sites or atmospheric sites) are not known. Impacts from construction of either type of intervention site will be minimized or avoided by locating the ~~intervention~~ work on disturbed sites either associated with construction of the tunnel or other activities or agricultural lands used to grow lower value crops. Discharge of drilling muds or other materials required for drilling and grouting would be confined to the work site and would be disposed of offsite at a permitted facility. Disturbed areas would be returned to preconstruction conditions by careful grading, reconstruction of features such as irrigation and drainage facilities, and replanting of crops and/or compensating farmers for crop losses.

To the greatest extent possible, intervention sites would be located to avoid sensitive terrestrial and aquatic habitats. In the event these areas cannot be avoided, DWR will ensure that impacts are minimized to the greatest extent possible. DWR would work with the appropriate permitting agencies to ensure that impacts are minimized and/or compensated and that permits allowing surface disturbance are secured. If needed, supplemental environmental compliance documentation will be completed.

The proposed tunnels are anticipated to be constructed in soft, alluvial soils with high groundwater pressures. Because of this, the tunnels would be constructed using mechanized soft ground tunneling machines. Each tunnel would require appropriately sized launching and TBM retrieval shafts to accommodate equipment. If dense gravels, cobbles, or boulders are encountered in the older alluvium at depth, other mining methods may be utilized, such as grouting, jet grouting, use of a slurry TBM, or freezing and hand mining. All shaft locations may also require dewatering activities, which would be implemented in a similar manner to dewatering for the construction of intake facilities, as described above. Dewatering systems would be designed and operated to control seepage pressures in the vicinity of the main bore and the vertical shafts to ensure that excavations remain stable. Discharge water would be conveyed to aboveground treatment facilities to comply with permit conditions before being discharged into the river. A diesel-powered train would transport construction workers through the tunnel during construction.

During construction, all shaft locations would be protected from flooding caused by failure of a levee. This protection would be achieved by constructing a raised earthen pad at each shaft site (or by use of another suitable method). The size of the pad would vary from site to site, depending on specific location conditions. It is anticipated that the height of the shaft protection pads will be at the 100-year design flood elevation for each island.

After construction of the tunnels, the launching and retrieval shafts would be backfilled around steel pipes or formed concrete pipes, or would be cast against reusable forms to the required finished diameter and geometry. The intermediate shafts would be excavated using conventional augers and would be supported using steel casings. The shafts would be drilled to below the tunnel invert elevation before the boring machine reaches the shaft stationing.

Reusable Tunnel Material

As previously indicated, RTM is the by-product of tunnel excavation using a TBM. The RTM would be a plasticized mix consisting of soil cuttings, air, ~~and~~ water, and may also include soil conditioning agents. Soil conditioning agents such as foams, polymers, and bentonite may be used to make soils more suitable for excavation by a TBM. Modern soil conditioners are non-toxic and are biodegradable. Before the RTM can be reused or disposed of, it must be managed and, at a minimum, go through a drying process. Additional RTM processing, beyond the conventional atmospheric drying process, would be implemented if deemed necessary to comply with regulatory requirements. For further discussion of this process, please see the description of “Disposal and Reuse of Spoils, Reusable Tunnel Material (RTM), and Dredged Material,” in Appendix 3B, *Environmental Commitments.*

The daily volume of RTM that would be withdrawn from the tunneling operations at any one shaft location would vary, with an average volume of approximately 6,000 cubic yards per day. It is assumed that the transport of the RTM out of the tunnels and to the RTM storage sites would be nearly continuous during mining or advancement of the TBM. The RTM would be carried on a conveyor belt from the TBM to the base of the launching shaft. The RTM would be withdrawn from the tunnel shaft with a vertical conveyor and placed directly into the RTM work area using another conveyor belt system. From the RTM work area, the RTM would be rough segregated for transport to RTM storage and water treatment (if required) areas as appropriate. RTM would be transported and deposited via conveyor and/or truck to designated RTM storage areas, ranging in size from approximately 100 to 1,100 acres, depending on the action alternative. In total, approximately 1,595 acres may be needed for RTM storage for the pipeline/tunnel alignment. Under this alignment, it was assumed that RTM would be stacked to a height of 10 feet and that storage areas would be located adjacent to main tunnel shafts north of Scribner Road, east of the Sacramento River, on northern Brannan-Andrus Island, on southeastern Tyler Island, on eastern Bacon Island, and on northwestern Victoria Island, as shown in Mapbook Figure M3-1. ~~Under the modified pipeline/tunnel alignment (Alternative 4), approximately 3,500 acres may be needed for storage of tunnel material and spoils from dredging Clifton Court Forebay. This area also includes land that would be required for access roads, staging and laydown areas, and other ancillary facilities required for the processing and storage of RTM. Therefore, the area required for storage of the material itself would be closer to 2,800 acres. Under this alignment, it was assumed that RTM and dredged material would be stacked to a height of 6~~ 10-12 ~~feet and that storage areas would be located adjacent to tunnel shafts, including sites just north~~east ~~of Intake 2, several parcels west of Interstate 5 near the intermediate forebay, on northern Staten Island, on southern Staten Island, on southwestern Bouldin Island, and on Byron Tract west of Clifton Court Forebay, as shown in Mapbook Figure M3-4. During future stages of engineering, it may be determined that it is preferable to store RTM at a height of 10 feet, as was assumed for alternatives under the pipeline/tunnel alignment. Using this assumption, approximately 1,800 acres would be required for the storage of RTM and dredged material under Alternative 4.~~

Under the modified pipeline/tunnel alignment (Alternative 4), approximately 30.7 million cubic yards of RTM would be excavated throughout the alignment. At the southernmost launch shaft located at the northeast corner of Clifton Court Forebay, a conveyor would move the RTM westward to Italian Slough. At Italian Slough a trenchless crossing would be constructed to transport the RTM under the slough to the RTM storage area on Byron Tract. The trenchless crossing would consist of a small diameter pipe (approximately 72 inches in diameter) and its construction would entail microtunneling or pipe jacking under Italian Slough. Once the pipe is in place, an electric conveyor belt would be installed in the pipe. Once construction of the water conveyance structure for Alternative 4 has been completed, this pipe would be backfilled with concrete.

Under the modified pipeline/tunnel alignment, approximately 2,600 acres may be needed for storage of tunnel material and spoils from dredging Clifton Court Forebay. This area also includes land that would be required for access roads, staging and laydown areas, and other ancillary facilities required for the processing and storage of RTM. Therefore, the area required for storage of the material itself would be closer to 2,100 acres. Under this alignment, it was assumed that RTM and dredged material would be stacked to a height of 6-10 feet at storage areas (except at sites adjacent to the north Clifton Court Forebay and on Glannvale Tract, where material would be stacked to a height of 10-15 feet) and that storage areas would be located adjacent to tunnel shafts, including sites just northeast of Intake 2, several parcels west of Interstate 5 near the intermediate forebay, on southea~~we~~stern Bouldin Island, and on Byron Tract west of Clifton Court Forebay, as shown in Mapbook Figure M3-4.

RTM Drying and Storage

Once the RTM is removed from the tunnel, it must be suitably dewatered prior to final long-term storage or reuse. Atmospheric drying by tilling and rotating the material, combined with subsurface collection of excess liquids is typically sufficient to render the material dry and suitable for long-term storage or reuse. Disposal of the decant liquids requires permitting in accordance with current NPDES and RWQCB regulations. ~~Only for those areas where controlled and contained storage of material is deemed to be required,~~ It is assumed that a retaining dike and underdrain liquid collection system (composed of a berm of compacted soil, gravel and collection piping, as described below), may would be built at the RTM storage area(s). The purpose of this berm and collection system would be to contain any liquid runoff from the drying material. The berm geometry would conform to applicable design guidelines and standards. Based on the soil properties, the volume of material to be processed, and the size of the material storage area, the area may be subdivided into a system of dewatering or processing areas. The dewatering process would consist of surface evaporation and draining through a drainage blanket consisting of rock, gravel, or other porous drain material. The drainage system would be designed per applicable permit requirements. Treatment of liquids (primarily water) extracted from the material could be done in several ways, including conditioning, flocculation, settlement/sedimentation, and/or processing at a package treatment plant to ensure compliance with discharge requirements.

Once the material has been suitably dewatered, and depending on the constituents of the material, the RTM would be placed in either a lined or unlined storage area, suitable for long-term storage. These long-term storage areas may be the same area in which the material was previously dewatered or it may be a new site adjacent to the dewatering site. The storage areas would be created by excavating and stockpiling the native topsoil for future reuse. Once the area has been suitably excavated, and if a lined storage area is required, an impervious liner would be placed on the invert of the material storage area and along the interior slopes of the berms surrounding the pond. Due to the expected high groundwater tables, it is anticipated that there would be minimal excavation for construction of the long-term material storage areas. Additional features of the long-term material storage areas would include berms and erosion protection measures to contain storm runoff if necessary and provisions to allow for truck traffic during construction, as appropriate.

Depending on the type of soil removed through tunneling, the type of soil conditioners added, and the material management and water treatment processes required, RTM may be reused locally (e.g., for levee reinforcement or as fill material in support of restoration activities) or transported to another location for reuse. Dried material that is not reused may be graded, covered with previously-stockpiled topsoil, and seeded for vegetation. RTM would be tested per applicable standards and assessed for usability prior to reuse. Treated water from RTM could be reclaimed, discharged, or disposed according to NPDES and other applicable codes and regulations.

A study conducted by DWR consisted of mixing native soil samples collected from the potential tunnel zone with representative soil conditioner products and conducting laboratory tests to measure the following qualities of RTM:

- Geotechnical properties to evaluate constructability if used as structural fill,
- Environmental properties to characterize potential toxicity if placed in the environment, and
- Planting suitability to assess sustainability for habitat growth and agricultural use. (URS 2014)

While the study consisted of a limited number of samples and tests, and does not constitute a complete evaluation of RTM, based on the results of the geotechnical, environmental, and planting suitability tests, DWR concluded that RTM appears to be suitable for the above proposed beneficial uses following storage and drying (URS 2014). The contractor would need to chemically characterize RTM and associated decant liquid prior to reuse or discharge. Consultation with governing regulatory agencies would be required to obtain the necessary approvals and permits. While it appears that at least some RTM may be suitable for various means of reuse, to provide for a reasonable worst-case analysis with respect to the areal impact of proposed RTM storage, it is assumed that all RTM storage areas would represent a “permanent” impact, and that RTM would not be removed and reused from these sites. Further discussion of the process for disposal and reuse of RTM is provided in Appendix 3B, *Environmental Commitments*.

Canals

Design

The canal conveyance would consist of a trapezoidal, open channel, earthen or concrete-lined canal formed by embankments constructed of compacted engineered fill. Details for a lined canal would be finalized in the preliminary design phase for CM1; however, in this EIR/EIS, impacts for lined and unlined canal are analyzed in resource chapters where applicable (e.g., Chapter 7, *Groundwater*).

A cross section of a typical canal segment is shown in Figure 3-22. The canal would require new access roads for maintenance, a drainage system to carry surface runoff and floodwater, and irrigation ditches to maintain existing agricultural ditches. Short segments of buried pipeline would also be utilized to convey water from the intake pumping plants to the canal. A new access toe road would be constructed on each side of the canal embankment to provide maintenance access to the drainage and irrigation ditches and to areas otherwise cut off by the canal. The toe road would be paved where existing paved roads have been disrupted by the canal. In other areas where existing roads are gravel or not surfaced, the toe road is assumed to be gravel. The toe road would connect to the embankment maintenance road at locations where the embankment maintenance road is interrupted at the ends of the embankments and at bridges. The toe roads would tie into existing public roads and may or may not be publicly accessible.

In areas where the existing ground slopes toward the canal on both sides, a drainage ditch would be constructed along both sides of the canal to collect water and direct it to collection points for removal by pumping. It is anticipated that these new ditches would be approximately 5 feet deep and would connect to the existing drainage system. In areas where the ground slopes away from the canal on both sides, or if surface runoff would be intercepted and conveyed around the canal by an existing drainage feature, no new drainage areas would be constructed.

Where the canal water surface elevation is generally above existing ground, the canal would be formed by earth embankments constructed of compacted engineered fill. The crests of the embankments would be wide enough to allow for two maintenance vehicles traveling in opposite directions to pass each other. The canal would be designed with 2 feet of concrete-lined freeboard[12] plus 2 feet of unlined freeboard for a total of 4 feet of freeboard on the waterside. Waterside embankments could include wind and wave erosion control, such as concrete lining, riprap, or lining with articulated concrete mat.

Seepage from the canal could occur where the normal water level in the canals is higher than the groundwater levels of the adjacent areas. Seepage could potentially raise the water table on the landside of the embankments through more permeable lenses of sand and/or gravel in the foundation. Control of seepage could include the following methods.

- Installation of a slurry cutoff wall through the canal embankments and foundation. A cutoff wall would be most effective in areas where a canal cuts through layers of permeable sands and gravels.

[12] Vertical distance between the design water surface elevation and the elevation of the bank or levee that contains the water.

- Use of a drainage ditch parallel to the canal to control seepage and groundwater levels. Water in the drainage ditch would then be pumped into the sloughs or back into the canals.
- Installation of pressure relief wells along the drainage ditch to collect subsurface water and direct it into the parallel drainage ditch.

The risk to the canal from flooding in the adjacent islands may be reduced by providing a means for drainage water to pass from one side of the canal to the other. The water could be routed by any of the means listed below.

- Under the canal with a culvert to existing drainage systems.
- Over the canal with an overchute to existing drainage systems. Overchutes require piers similar to those supporting bridges to support the structure and span the width of the canals.
- Around the canal and through a gap between the existing levee and the ends of the canal embankments.
- To new storm drain pumps that would pump the water to sloughs or the canal.

Construction of irrigation ditches to supply water for agricultural use may be required in areas where irrigation water supply ditches are separate from drainage ditches. The irrigation ditches would likely need to be elevated above the existing ground to allow for gravity flow. New pumps or siphons may be required to supply the irrigation ditches.

Inverted culvert siphons would be used to convey diverted water from canals under major waterways and railroads. The 15,000 cfs culvert siphons would consist of reinforced concrete rectangular cells 26 by 26 feet each. Siphon length would vary from 595 to 2,400 feet, including concrete portions and upstream and downstream transition structures. The water velocity would be approximately 2 feet per second in the canal approaching the culvert siphon and 5–6 feet per second in the culvert. The culvert size and shape were selected as a compromise between head loss and potential sedimentation. The top of the culvert would be situated about 15 feet below the lowest elevation of the crossing to prevent exposure resulting from scour in the water body and to prevent uplift by the groundwater in the vicinity of the crossing. Culvert siphons would be installed using a cut and cover method, where one half of the water body to be crossed would be isolated with a cofferdam. Once the culvert(s) are placed and buried, the cofferdam would be removed and the same process would be repeated from the opposite bank. The installation of culvert siphons would require driving precast concrete or steel pipe foundation piles within a dewatered cofferdam using a combination of vibratory and/or impact driving. It is estimated that ~~approximately 8–12~~up to 30 foundation piles would be driven per day. For further details regarding pile driving activities, see Appendix 3C, Table 3C-2.

Because the culvert siphons would need to be placed during low-flow periods (approximately August through November), it may be necessary to conduct this in-water work outside the June 1–October 31 in-water work window. Control structures would be provided at the inlet to the culvert siphon to allow for regulation of upstream water surface elevation. Control structures would also be provided at intermittent locations along the canal to provide for improved control of the water surface elevations where siphons are not required. For this analysis, it was assumed that radial gates with electric motors would be utilized to provide for control of the water surface elevation in the canal. A conceptual drawing of a typical culvert siphon is shown in Figure 3-23.

Where canals cross existing water bodies, tunnels would be used to convey water between canal segments. For the west alignment (Alternatives 1C, 2C, and 6C), a 17-mile-long tunnel segment would convey water from Ryer Island to Hotchkiss Tract. In the east alignment (Alternatives 1B, 2B, and 6B), shorter tunnel siphons would connect canal segments, crossing Lost Slough/Mokelumne River (5,400 feet), San Joaquin River (2,700 feet), and Old River (1,700 feet).

Tables 3-8 and 3-9 present a description of the physical characteristics of the canal conveyance features (Alternatives 1B, 2B, and 6B for the east alignment and Alternatives 1C, 2C, and 6C for the west alignment). A conceptual drawing of a typical canal segment is shown in Figure 3-24.

~~Three~~ Two culvert siphons would be constructed under Alternative 4. One ~~would serve as a transition between Tunnel 2 and the expanded Clifton Court Forebay under Italian Slough, one~~ would connect the north cell of the expanded Clifton Court Forebay to a new approach canal to the Banks and Jones Pumping Plants under the ~~south cell of the~~existing Clifton Court Forebay outlet channel, and one would connect the new approach canal to the existing approach canal to Banks Pumping Plant under Byron Highway and the Southern Pacific Railroad. At this proposed siphon location, a segment of Byron Highway and the Southern Pacific Railroad would be temporarily rerouted to accommodate construction of the siphon.

Two canal segments would be constructed for Alternative 9. One canal would be constructed on Coney Island to connect the south Delta separate water supply corridor from an enlarged and realigned Victoria Canal to Clifton Court Forebay, with culvert siphons conveying water under the existing West Canal and Old River. The Coney Island Canal would run approximately 4,000 feet, beginning at the downstream end of the siphon under Old River and ending at the upstream end of the siphon under West Canal. The second canal, with a control gate, would be constructed to connect Clifton Court Forebay to the Tracy Fish Facility. This canal, also approximately 4,000 feet long, would begin at the southeast corner of Clifton Court Forebay, cross Byron Tract, and connect to the Tracy Fish Facility utilizing a new levee (embankment) to close off the existing connection to Old River.

Operation and Maintenance

The flow rate and water level in the canal would be controlled by control structures such as radial gates to divide the canal into pools. Drawdown rates of water within the pools would be determined on the basis of the stability of the conveyance side embankment slopes.

Maintenance requirements for an unlined canal would include control of vegetation and rodents, embankment repairs in the event of flooding and wind wave action, and monitoring of seepage flows.

Sediment would be expected to build up on the bottom of the canal and require periodic removal by dredging. Sediment traps may be constructed to reduce the sediment that would collect in the siphons and tunnels.

Construction

Construction of the canal and pipeline segments connecting the intakes to the canal are assumed to be constructed at approximately 30 foot depths in open-trench excavations for the majority of the alignment, except where crossing a major waterway. As discussed above for tunnel construction, major waterways would be crossed using deep tunnel siphons at depths of approximately 120 feet msl. For the canal, excavation would proceed first with the excavated materials initially being hauled to storage areas or stockpiled nearby. Once a sufficient area has been excavated, the foundation for the embankments would be prepared and the embankments constructed. The canal and embankments would be constructed in independent segments. In addition to excavation for the canal, borrow areas, haul roads at the toe of the embankments, grading for drainage, and drainage pumping stations would be required to construct the canal.

Excavation of unsaturated soils could be performed using scrapers or excavators loading into large dump trucks. Excavations below the groundwater table using the same types of equipment would require extensive dewatering. Pipeline dewatering wells would be installed as part of construction (1) to provide a dry, stable excavation bottom for placement of bedding, pipe material, and backfill; (2) to dewater the lenses of silts and sands encountered during excavation; and (3) to dewater highly permeable prolific sand layers below the excavation. In addition, due to the high level of the groundwater table, dewatering facilities may also be considered postconstruction for inspection, maintenance, or in the case of emergency.

Excavated materials that are suitable for embankment fill could be hauled and placed directly into areas ready for embankment construction or stockpiled for future use; unusable material would be hauled to spoils disposal areas. However it is unlikely that excavation of the canal would yield sufficient quantities of suitable material to build the embankments. Therefore, additional embankment material from borrow locations would be needed. The imported embankment materials would be placed and compacted on the dewatered foundation. Moisture conditioning of the embankment materials would generally be performed in the borrow areas prior to hauling and placement in the embankments.

The most likely method for construction of the shallower culvert siphon crossings is a cut-and-cover type excavation. Water in the slough would be diverted by use of a partial cofferdam across the slough (with continuous flow pumping of typical irrigation or flood flows) or by a temporary realignment of the slough during construction. Under the modified pipeline/tunnel alignment, cofferdams would be used to construct the outlet siphon from the north cell of Clifton Court Forebay, and shoring would be used to construct the siphon in a single phase under Byron Highway and the Southern Pacific Railroad, requiring temporary realignment of these features during construction.

3.6.1.3 Operable Barriers

Design

An operable barrier at the head of Old River would be constructed to support operations of Alternatives 2A, 2B, 2C, and 4. This control structure is intended to prevent migrating and outmigrating salmon from entering Old River from the San Joaquin River, minimizing exposure to the SWP and CVP pumping facilities. It would be located at the divergence of the head of Old River and the San Joaquin River and would be approximately 210 feet long and 30 feet wide, with top elevation of 15 feet msl (NAVD 88). This structure would include seven bottom-hinged gates, totaling approximately 125 feet in length. Other components associated with this barrier are a fish passage structure, a boat lock, a control building, a boat lock operator's building, and a communications antenna. Appurtenant components include floating and pile-supported warning signs, water level recorders, and navigation lights. The barrier would also have a permanent storage area (180 by 60 feet) for equipment and operator parking. Fencing and gates would control access to the structure. A communications antenna for telephone and telemetered data transmission would also be constructed, and a propane tank would supply emergency power backup.

The boat lock would be 20 feet wide and 70 feet long and would have floating boat docks for temporary mooring, navigation signs and lights, warning signs, and video surveillance capability. The fishway would be designed according to guidelines established by NOAA Fisheries and USFWS for several species including salmon, steelhead, and green sturgeon. The fishway would be approximately 40 feet long and 10 feet wide and would be constructed with reinforced concrete. Stoplogs would be used to close the fishway during the spring when not in use to protect it from damage.

When the gate is partially closed, flow would pass through the fishway traversing a series of baffles. The fishway is designed to maintain a 1-foot-maximum head differential across each set of baffles. The historical maximum head differential across the gate is 4 feet; therefore, four sets of baffles are required. The vertical slot fishway is entirely self-regulating and operates without mechanical adjustments to maintain an equal head drop through each set of baffles regardless of varying upstream and downstream water surface elevations.

Physical operable barriers would be primary structures to support water conveyance under Alternative 9. Under this alternative, operable barriers would serve to hydraulically isolate the corridors dedicated to fish movement and estuary habitat from those dedicated to diverting water from the Sacramento River and conveying it toward existing SWP and CVP facilities in the south Delta. The operable nature of the barriers would allow adjustments to channel flows to correct for changes in water quality and quantity in the Delta. Alternative 9 would use three types of barriers to accomplish different goals: inlet flow control, fish isolation, irrigation level control, flood control, and boat passage.

Depending on the characteristics of a specific barrier site and the intended function of the barrier, a variety of gate styles could be used. Depth of water, differences in water elevation between gate sides, whether the gates would be used to vary flow, and whether gates would permit boat passage are all factors that would determine the gate type(s) selected for any particular barrier. Similarly, the number of gate bays required at any given barrier would depend on the width and bottom profile of the channel.

Each barrier would tie into levees on both sides of the waterway. For those gates providing a flood protection function, the top elevation of the gates and barrier walls would be set to the same elevation as the existing levee crest adjacent to the barrier. Otherwise, gates would be slightly higher than normal waterway flow. All construction and modifications will comply with applicable state and federal flood management, engineering, and permitting requirements.

Type I barriers would use bottom-hinged navigable gates in locations where the majority of the waterway width requires gates and where depth is less than 20 feet. Type II barriers involve the use of nonnavigable radial gates for flow control and navigable wicket or miter gates for the operable portions; these would be used where waterway depth exceeds 20 feet. Type III barriers, like Type I barriers, would use bottom-hinged navigable gates for operable portions but would use rock walls for the fixed portions. This type of barrier would be used where gates are only required for recreational boat passage and where flood neutrality is not an issue.

Each barrier location would be accompanied by a 15-foot-wide by 53-foot-long control building. For those barriers requiring boat locks, the control building would also include an operations room on a second floor. Each site would also include a ground-mounted transformer and emergency generator.

Table 3-14 lists the operable barrier locations and types for Alternative 9.

Operation and Maintenance

For the operable barrier proposed under Alternative 4, periodic maintenance of the gates would occur every 5 to 10 years. Maintenance of the motors, compressors, and control systems would occur annually and require a service truck. Maintenance dredging around the gate would be necessary to clear out sediment deposits. Dredging around the gates would be conducted using a sealed clamshell dredge. Depending on the rate of sedimentation, maintenance would occur every 3 to 5 years, removing no more than 25% of the original dredged amount, using a sealed clamshell dredge. Because of constraints related to fish and other species of concern, the timing and duration of maintenance dredging would be limited. Spoils would be dried in the areas adjacent to the gate site. A formal dredging plan with further details on specific maintenance dredging activities will be developed prior to dredging activities. Guidelines related to dredging activities, including compliance with in-water work windows and turbidity standards are described further in Appendix 3B, *Environmental Commitments,* under *Disposal and Reuse of Spoils, Reusable Tunnel Material (RTM), and Dredged Material*.

Gates constructed for Alternative 9 would also require routine annual inspection of gate facilities and systems, as well as associated equipment. Some gates may not be required to operate for extended periods and would be operated at least two times per year. Each gate bay would be inspected annually at the end of the wet season for sediment accumulation. Sediment would be removed during the summer. Each miter or radial gate bay would include stop log guides and pockets for stop log posts to facilitate the dewatering of individual bays for inspection and maintenance. Major maintenance could require a temporary cofferdam upstream and downstream for dewatering.

Construction

For construction of the barrier at the head of Old River under Alternatives 2A, 2B, 2C, and 4, one of two methods would be chosen: (1) cofferdam construction, which creates a dewatered construction area for ease of access and egress; and (2) in-the-wet construction, which allows the river to flow unimpeded and eliminates the time, material, and cost of constructing a cofferdam. For the purposes of analysis, it was assumed that the cofferdam construction method would be chosen. Regardless of which construction method is chosen, standard measures—such as those proposed under AMMs 1 through 9—would be implemented to minimize effects. To ensure the stability of the levee, a sheetpile retaining wall would be installed in the levee where the gate would be constructed. All in-water work, including the construction of cofferdams, sheetpile walls and pile foundations, placing rock bedding and stone slope protection, and dredging, would occur between August 1 and November 30 to minimize effects on delta smelt and juvenile salmonids. All other construction would take place from a barge or from the levee crown and would occur throughout the year.

The cofferdam construction method would enable the gates to be constructed in two phases and would allow in-water work to continue through the winter. The first phase would involve the placement of a cofferdam in half of the channel and then dewatering the area so the bottom of the channel could be used as a project construction site. The gates would be constructed within this area and on the adjacent levee. The cofferdam would remain in the water until the completion of half of the gate. It would then either be removed or cut off at the required invert depth and another cofferdam would be installed in the other half of the channel. In the second phase, the gate would be constructed using the same methods, with the cofferdam either removed or cut off, and incorporated into the final gate layout. Cofferdam construction would begin in August and last approximately 35 days. Construction activities within the cofferdam project area would last until approximately early November or could occur throughout the winter, depending upon weather and river flow conditions. The temporary barriers at this site would continue to be installed and removed as they are currently until the permanent gates are fully operable.

The in-the-wet method would involve working within the natural channel as it flows. No cofferdam or dewatering of the construction site would occur. Each gate would be constructed within the confines of the existing channel, and there would be no levee relocation. The channel invert would be excavated to grade using a sealed clamshell excavator working off the levee or from a barge. H-piles or other suitable deep foundation would be placed in the channel. Gravel and tremie concrete would be placed for the foundation within the confines of the H-piles. Reinforced concrete structures would then either be floated in or cast in place using prefabricated forms to be placed on top of the gravel, tremie concrete, and H-piles. Divers would complete the final connections between the concrete structures and the piles.

The boat lock for the Head of Old River Barrier would be constructed using sheetpiles and include two bottom-hinged gates on each end, measuring 20 feet wide and 10 feet high. Each gate would weigh approximately 8 tons and would be opened and closed using an air-inflated bladder. The invert of the lock would be at elevation –8.0 feet msl, and the top of the lock wall would be at elevation 15 feet. The boat lock would transport boats with the use of the bottom-hinged gates and a valve system for equalizing water levels, and would function by filling and emptying the lock chamber with a 36-inch valve. For boats traveling upstream, the lock chamber would be emptied to the downstream water level. The downstream gates would be opened and boats would enter the lock chamber. With the gates closed, the lock chamber would be filled to the upstream water level and the upstream gates would be opened to allow boat passage. For boats traveling downstream, the procedure would be reversed.

The construction of operable barriers under Alternative 9 would require dredging several hundred feet upstream and downstream of gate structures to transition the channel sides to fit the depth and width of the gates. Riprap would then be installed in these areas to control erosion. The majority of dredged material under Alternative 9 (including dredgings from channel expansion activities) would be stored in upland storage sites, and approximately 0.5% may be disposed of in an offsite landfill. Gates for Type I and III barriers could be constructed with existing waterways either wet or dry. Wet construction would require offsite prefabrication with attachment of concrete sills. The site would be dredged and sheet piles and H-piles installed. Then the sills and gates would be lifted into place using either barge-mounted cranes or catamarans made of sectional barges. Type II barriers would be constructed during summer low-flow periods. A closed steel sheet pile cofferdam would be constructed across part of the waterway. After dewatering, the structure would be constructed. Then the cofferdam would be removed and a new one installed for construction of the adjacent section. Construction through the winter high-flow periods is not anticipated. Additional temporary cofferdams may also be necessary upstream and downstream of deeper gate bays to allow dewatering and gate panel installation to take place. Barrier structures for Type II miter gates would include reinforced concrete walls, piers, and foundation mats. For the purposes of this analysis, it is assumed that a 60-ton bearing capacity would guide the depth of pile driving for foundation piles, anticipated to be between 60 and 80 feet below foundation level. A barge-mounted crane would install the rock walls for Type III barriers. The rocks may need a prepared foundation, depending on local site conditions.

A temporary work area of up to 15 acres would be required in the vicinity of each barrier for such uses as storage of materials, fabrication of concrete forms or gate panels, stockpiles, office trailers, shops, and construction equipment maintenance.

3.6.1.4 Forebays

Design

Intermediate Forebay and Intermediate Pumping Plant

Under the pipeline/tunnel alignment, an intermediate forebay near Hood would provide storage of approximately 5,250 af with a surface area of 760 acres and would provide a transition between the north Delta intakes and the intermediate pumping plant. ~~Under Alternative 4 (the modified pipeline/tunnel alignment), the proposed intermediate forebay would be located on Glannvale Tract, would provide storage of 368 af with a surface area of 40 acres, and would feed into an outlet control structure to Tunnel 2. Under both alignments, t~~This feature would also include a seepage cutoff wall to the depth of the impervious layer and a toe drain would surround the forebay embankment to capture water and pump it back into the forebay. The forebay would allow the intermediate pumping plant to operate efficiently over a wide range of flows and hydraulic heads in the pipelines/tunnels. Limitations on delivery of water from the intakes into the intermediate forebay and the need to operate the intermediate pumping plant efficiently would limit the ability to deliver flow from the pipelines/tunnels during portions of the day to the existing Banks and Jones pumping plants. For the Banks Pumping Plant, this would entail operating at low flows during hours with high electrical costs and at maximum capacity during "off-peak" periods to minimize electrical power costs. The Jones Pumping Plant must operate continuously (i.e., 24 hours per day, 7 days per week). The Byron Tract Forebay (see description below) would alleviate some of the impacts of these operational constraints and provide storage to balance inflow with outflow.

The intermediate pumping plant would include ten 1,500-cfs pumps to be used in higher hydraulic head condition, and six 1,500-cfs pumps for lower hydraulic head conditions. The pumping plant would include an approach channel from the forebay to the pump bays, the pumping plant structure, discharge pipes with flow measurement, transition manifold, and transition pipelines for discharge to the tunnel. The pipeline/tunnel alignment would require two 33-foot diameter (minimum) surge towers, the elevation of which would be approximately 105 feet (NAVD 88) at the rim. The intermediate pumping plant for the west alignment would also require two 33-foot diameter surge towers, the elevation of which would be as high as 70 to 80 feet (NAVD 88) at the rim, depending on the final pump selection and pipe arrangement. No surge towers would be required at the intermediate pumping plant for the east alignment.

The intermediate forebay allows for operation of a gravity bypass of the intermediate pumping plant by balancing the difference in water surface elevations between the intermediate forebay and the Byron Tract Forebay.

~~Under Alternative 4, the passage of water from the intermediate forebay would rely exclusively on gravity flow. Under this alternative, therefore, the intermediate pumping plant, along with its~~

~~associated surge towers and other facilities, would not be constructed. Instead, the intermediate forebay would be designed as a pass-through facility.~~

The intermediate pumping plant would be staffed 24 hours each day and would require similar maintenance activities to the intake pumping plants, as described in Section 3.6.1.2, *Conveyance Facilities*. It is assumed that the intermediate pumping plant would require periodic harvesting of pond weeds to maintain flows and forebay capacity. The harvesting would occur in the forebay and at the trashracks immediately upstream of the intermediate pumping plant.

The east and west alignments (Alternatives 1B, 2B, and 6B and 1C, 2C, and 6C, respectively) would incorporate a similar intermediate pumping plant. The east alignment plant would be approximately 3 miles south of the point where the alignment crosses the San Joaquin River. The west alignment plant would be at the entrance to the tunnel segment on Ryer Island, approximately 1.2 miles east of the Sacramento River DWSC. The intermediate pumping plant under these conveyance alignments would provide diverted water with the necessary head to flow into the Byron Tract Forebay.

Under the modified pipeline/tunnel alignment, the proposed intermediate forebay would be located on Glannvale Tract and would serve mainly as a pass-through facility providing an atmospheric break between Tunnels 1 and 2. Its capacity would be 750 af with a surface area of approximately 37 acres (at an elevation of 0 feet), and would feed into an outlet control structure to Tunnel 2. Under this alignment, the passage of water from the intermediate forebay would rely exclusively on gravity flow. Therefore, the intermediate pumping plant, along with its associated surge towers and other facilities, would not be constructed.

Byron Tract Forebay

The Byron Tract Forebay (Alternatives 1A, 1B, 1C, 2A, 2B, 2C, 3, 5, 6A, 6B, 6C, 7, and 8) would be adjacent to Clifton Court Forebay and would provide storage of approximately 4,300 af with a surface area of 600 acres. The Byron Tract Forebay would be used to balance variations in pipeline/tunnel inflow with outflow on a daily basis. For the Banks pumping plant, this includes operating at low flows during hours with high electrical cost and at maximum capacity during off-peak periods to minimize electrical power costs. The Jones pumping plant would operate continuously. For Alternatives 1A, 1B, 2A, 2B, 3, 4, 5, 6A, 6B, 7, and 8, the Byron Tract Forebay would be constructed on the southeast side of Clifton Court Forebay. For Alternatives 1C, 2C, and 6C, the Byron Tract Forebay would be constructed on the northwest side of Clifton Court Forebay.

Expanded Clifton Court Forebay

Under the modified pipeline/tunnel alignment ~~(Alternative 4)~~, Clifton Court Forebay would be dredged and expanded by approximately ~~690~~ 590 acres to the southeast of the existing forebay. Additionally, a new embankment would be constructed around the perimeter of the forebay, as well as an embankment dividing the forebay into a northern cell and a southern cell. Tunnel 2 (from the north Delta intakes) would enter the pumping plant facility at the northeastern end of Clifton Court Forebay immediately south of Victoria Island and flows would be pumped into the northern cell of the forebay.~~The northern end would receive water from Tunnel 2 (from the north Delta intakes), which would pass under Italian Slough in a culvert siphon before entering Clifton Court Forebay (north).~~ The northern cell of Clifton Court Forebay would provide storage ~~of~~ between approximately ~~6,070~~4,300 to 10,200 af. The southern cell of the forebay would continue to provide functionality for the existing through-Delta conveyance system and would provide storage of approximately ~~26,000~~14,000 af.

Operation and Maintenance

New forebays would be dredged to remove sediment and maintain design capacity. Maintenance requirements for the forebay embankments would include control of vegetation and rodents, embankment repairs in the event of island flooding and wind wave action, and monitoring of seepage flows. Maintenance of control structures could include roller gates, radial gates, and stop logs. Maintenance requirements for the spillway would include the removal and disposal of any debris blocking the outlet culverts. Dredging may be necessary to remove sediments in the forebays. As designed, both forebays are expected to have capacity to store sediment accumulated over a 50-year period. However, depending on the actual sedimentation rate, dredging may be necessary more or less often.

Construction

Under the pipeline/tunnel alignment, approximately 6 million cubic yards of earth would be excavated from portions of the intermediate forebay, and approximately 14 million cubic yards would be excavated from the Bryon Tract Forebay. ~~Under the modified pipeline/tunnel alignment (Alternative 4), approximately 700,000 cubic yards of earth would be excavated from portions of the intermediate forebay, and approximately 4 million cubic yards of earth would be excavated for the expanded portion of the Clifton Court Forebay.~~ These excavation amounts include the embankment foundation. Dewatering would be required for excavation operations. Much of the excavated material at both locations is expected to be high in organics and unsuitable for use in embankment construction. Some of the excavated material below the peat layers at both locations may be suitable for use in constructing the embankments. To the extent possible, spoils to be used for the embankments would be stored onsite. ~~Under the modified pipeline/tunnel alignment, nearly 8 million cubic yards of material would be dredged from Clifton Court Forebay, equivalent to an average of about 2 feet throughout the forebay.~~

Under the modified pipeline/tunnel alignment, approximately 4.4 million cy of earth would be excavated or borrowed from portions of the intermediate forebay, and approximately 14.1 million cubic yards of earth would be excavated, borrowed, or dredged for the modification and expansion of Clifton Court Forebay. Dredged material would be transported to and stored at an area also designated for storage of RTM to the west of Clifton Court Forebay. Guidelines for the disposal and reuse of dredged material are provided in Appendix 3B, *Environmental Commitments.*

3.6.1.5 Connections to Banks and Jones Pumping Plants

Design

For Alternatives 1A, 1B, 2A, 2B, 3, 5, 6A, 6B, 7, and 8, an approximately 2,000-foot-long canal would be constructed to connect the Byron Tract Forebay with the existing approach canal to the Banks pumping plant, with a series of radial gates to isolate the facilities. Under these alternatives, another series of radial gates constructed in an opening in the embankment of Byron Tract Forebay would allow for the control of water flow between the forebay and the approach canal to the Jones pumping plant. For Alternative 4, a culvert siphon (similar to those described above in relation to canals), would be constructed to connect the northern cell of the expanded Clifton Court Forebay to a new canal leading to the approach canal to the Jones Pumping Plant. An additional siphon would be constructed under the Byron Highway and into a short segment of canal before leading into the approach to the Banks Pumping Plant. For Alternatives 1C, 2C, and 6C, a canal would stretch from

Byron Tract Forebay to approach canals for both existing pumping plants. The dual conveyance alternatives would also include the construction of gates in the existing approach canals upstream of the connections with the new facilities. These structures would allow operational flexibility between pumping from the north Delta and pumping from the south Delta.

Operations and Maintenance

Maintenance requirements for the canal would include erosion control, control of vegetation and rodents, embankment repairs in the event of island flooding and wind wave action, and monitoring of seepage flows. Sediment traps may be constructed by overexcavating portions of the channel upstream of the structures where the flow rate would be reduced to allow suspended sediment to settle at a controlled location. The sediment traps would be periodically dredged to remove the trapped sediment.

Construction

Canal construction would include use of scrapers, excavators, and/or draglines. The top layer of soil along some portions of the canal could consist of up to 25 feet of organic and peat soils deemed unsuitable for support of the canal embankments. In such areas, these soils would be removed and disposed of offsite; it is estimated that approximately 0.1% of spoil may need to be disposed of in a landfill. The removal of the full depth of the peat and organic soil could be limited to the area of the embankment foundations. In other areas, potentially liquefiable sands could be present below the organic soils. It would be necessary to remove or stabilize the liquefiable soils as part of the excavation for the canal embankments.

3.6.1.6 Power Supply and Grid Connections

Electric power would be required for intakes, pumping plants, operable barriers, boat locks, and gate control structures throughout the various proposed conveyance alignments. Temporary power would also be required during construction of water conveyance facilities.

New temporary power lines to power construction activities would likely be built prior to construction of permanent transmission lines to power conveyance facilities (see Mapbook Figures M3-1 through M3-5 to see the assumed alignment of both temporary and permanent lines under the various alternatives). These lines would extend existing power infrastructure (lines and substations) to construction areas, generally providing electrical capacity of 12 kV at work sites. Main shafts for the construction of deep tunnel segments would require the construction of 69 kV temporary power lines. Under Alternatives 1A through 8, electrical power to operate the new north Delta pumping plant facilities would be delivered through 230 kV transmission lines that would interconnect with a local utility at a new or existing utility substation depending on the conveyance alignment. The alignment of this transmission line and its interconnection point would be based on the selection of a power provider for the BDCP following selection of a conveyance alignment. Possible alignments for the 230 kV transmission lines are shown in Figure 3-25. For the purposes of analysis, one sub-option has been selected for each of the four conveyance alignments that would require a 230 kV line. For the west alignment, this line would extend west from the intermediate pumping plant on Ryer Island. For the pipeline/tunnel alignment, the line would extend south from the intermediate pumping plant and would generally follow the tunnel connecting to existing utility facilities at the Banks pumping plant. The 230 kV line for the east alignment would also connect to the existing grid at this point, but would follow alongside the Byron Tract Forebay and canal ROW northeast to the intermediate pumping plant.

Under Alternative 4, the modified pipeline/tunnel alignment, the method of delivering power to construct and operate the water conveyance facilities is assumed to be a “split” system that would connect to the existing grid in two different locations. The northern point of interconnection would be located north of Lambert Road and west of Highway 99. From here, a ~~230 kV~~new transmission line would run west, along Lambert Road, where one segment would run south to the intermediate forebay on Glannvale Tract~~, and then on to tunnel shaft locations on Staten Island~~; and one segment would run north to connect to a substation where 69 kV lines would connect to the intakes~~ pumping plants~~. While this new transmission line could be 230 kV, 115 kV, or 69 kV depending on further study, a 230 kV line was conservatively assumed for the purposes of analysis. At the southern end of the modified pipeline/tunnel alignment, the point of interconnection may be in one of two possible locations: southeast of Brentwood near Brentwood Boulevard or adjacent to the Jones pumping plant. While only one of these points of interconnection would be used, both are depicted in figures, and the effects of constructing transmission lines leading from both sites are combined and accounted for in resource-specific impact analysis. A 230 kV line would stretch from one of these locations to a tunnel shaft northwest of Clifton Court Forebay, and would then continue north, following tunnel shaft locations, to Bouldin Island~~, where a 34.5 kV line would continue to the southern end of Staten Island~~. Lower voltage lines would be used to power intermediate and reception shaft sites between the main drive shafts. Because the power required during operation of the water conveyance facilities would be much less than that required during construction, and because it would largely be limited to the ~~intakes, ~~pumping plants~~ and intermediate forebay~~, the “split” system would enable all of the new power lines in the northern part of the alignment to be temporary. Similarly, the new lines between Bouldin Island and the new pumping plant facility at Clifton Court Forebay~~extending from the southern point of interconnection to ~~would also be temporary, limited to the construction schedule for the relevant tunnel reaches and features associated with Clifton Court Forebay. Under this alternative, an existing 500kV line, which crosses the area proposed for expansion of the Clifton Court Forebay, would be relocated to the southern end of the expanded forebay in order to avoid disruption of existing power facilities.~~Additionally, those segments extending south of the intermediate forebay on McCormack-Williamson Tract and Staten Island would also be removed following construction of associated tunnel facilities.~~

It is assumed that a new permanent substation would be constructed within or adjacent to the utility’s existing transmission ROW. Some utility grid reinforcement and upgrade may be needed to accommodate this large new pumping load. The 230 kV transmission line would terminate at the BDCP’s main 230 kV substation, which would be adjacent to one of the new pumping plants in a 268- by 267-foot enclosure. At the main 230 kV substation, the electrical power would be transformed from 230 kV to 69 kV and delivered to the adjacent main 69 kV substation to power the adjacent pumping plant. Additionally, the main 69 kV substation would deliver power on a new overhead 69 kV subtransmission line, looping into each of the other intake substations. Each 69 kV substation would have a footprint of approximately 150 by 150 feet. The subtransmission line would generally follow the alignment ROW. At the main 69 kV substation and at each of the intake substations, electrical power would be transformed from 69 kV to the voltage needed for the pumps and auxiliary equipment at the adjacent structures.

For Alternatives 1B, 1C, 2B, 2C, 6B, and 6C, a main 69 kV substation would be constructed at the intermediate pumping plant, and an overhead 69 kV subtransmission line would be constructed along a route parallel to the canal and within the project ROW. To supply power for communications, monitoring, and control of the gates at the tunnel and siphon entrances along the canal, 12 kV distribution lines would be extended along the canal from the 69 kV substations. Wherever possible, this 12 kV line would be constructed on the same poles as the 69 kV subtransmission line. A local utility distribution line would provide power for gate controls along the south canal of Alternatives 1C, 2C, and 6C. For Alternatives 1A, 2A, 3, ~~4,~~ 5, 6A, 7, and 8, the main 69 kV substation would be built at the intermediate forebay with 69 kV subtransmission lines looping into each intake pumping plant substation.

Under the modified pipeline/tunnel alignment, temporary substations would be constructed at each intake, at the intermediate forebay, and at each of the launch shaft locations. To serve permanent pumping loads, a permanent substation would be constructed adjacent to the pumping plants at Clifton Court Forebay, where electrical power would be transformed from 230 kV to appropriate voltages for the pumps and other facilities at the pumping plant site. For operation of the three intake facilities and intermediate forebay, it is assumed for the purposes of analysis that existing distribution lines would be used to power gate operations, lighting, and auxiliary equipment at these facilities. Use of the existing distribution system for the purposes of construction and operations may require upgrades to existing lines, including reconductoring. While it is anticipated that utility interconnection facilities would be completed in time to support most construction activities, for some activities that need to occur early in the construction sequence (e.g., constructing raised pads at shaft locations and excavating the shafts), onsite generation may be required on an interim basis. As soon as the connection to associated utility grid power was completed, electricity from the interim onsite generators would no longer be used.

Three utility grids could supply power to the BDCP (or an alternative) conveyance facilities: Pacific Gas and Electric Company (PG&E) (under the control of the California Independent System Operator), the Western Area Power Administration (Western), and/or the Sacramento Municipal Utility District (SMUD). The electrical power needed for the conveyance facilities would be procured in time to support construction and operation of the facilities. As the operator of the SWP, DWR is an active participant in the activities of the California electric grid, from long-term planning to day-to-day operation. The power will be provided from the SWP power portfolio of existing physical generation facilities, long-term power contracts, and short-term power contracts—including Day-Ahead market purchases. Purchased energy may be supplied by existing generation, or by new generation constructed to support the overall energy portfolio requirements of the western electric grid. It is unlikely that any new generation will be constructed solely to provide power to the BDCP conveyance (or an alternative) facilities.

PG&E's distribution system would likely provide power for the through Delta/separate corridors alignment (Alternative 9) because the system currently reaches most of the proposed facilities. The pumping plants and intakes would receive 12 kV service from the local distribution system, while service to other facilities, including operable barriers, siphons, control gates, intakes, and boat locks would be at 480 volts. Operable barriers under this alignment would also have backup generation to ensure continued operational control during outages. Wood poles for the 12 kV service would be spaced 300 feet apart, on average, with a height of 40–45 feet, and would result in a disturbed area 2 feet in diameter. Facilities receiving 480 volt service require a three phase service drop (three or four wires) from a utility pole with a 12 kV/480 volt three phase transformer mounted on it. Alternatively, the utility may choose to site the transformer on a pad (ground level) at the point of service and bring 12 kV utility service to the transformer. For a pad-mounted transformer, there would be a disturbed area of 8 feet by 8 feet.

Towers for 230 kV transmission lines employed in other conveyance alignments would be spaced, on average, 750 feet apart. Their physical footprint would be approximately 30 feet square, with foundations at each leg measuring 3.5 to 5 feet in diameter. If a horizontal conductor configuration is chosen, the average tower height will be 95–100 feet, while towers configured for vertical conductors would be 130 feet high. Based on the potential utility providers' design practices, the 230 kV towers would most likely be monopoles (both utilities), with H-frame and lattice towers being options for a Western interconnection. The configuration may need to be a dual circuit design to accommodate future expansion for the utility. To discourage raptor perching, a dipped cross-arm configuration could be used in place of davit arms on monopole structures.

The 69 kV transmission lines would almost certainly be monopoles of either steel or wood depending on the utility. To meet the raptor-safe design guidelines, the 69 kV wood pole structure should be 60 inches minimum between the conductor (end of insulator) and pole face in areas of raptor concern. Poles for the 69 kV lines would be spaced 450 feet apart, on average. Wood poles would result in a disturbed area with a diameter of 2 feet while steel poles typically entail foundations 5–6 feet in diameter. Poles would typically be about 60 feet above ground (70-foot poles, embedded 10 feet). A shield wire (at the top of the structure) may be required by either utility for both 230 kV and 69 kV transmission. ~~Analysis assumes that 34.5 kV power lines would be constructed to similar specifications.~~

For the electrical transmission facilities provided from the utility interconnection to and between the BDCP facilities, industry standard techniques will be incorporated into power line designs to minimize impacts on birds. For monopole and lattice structures, the material coating would be selected for color and reflectivity consistent with meeting visibility goals to mitigate bird strikes and collisions.

Construction

New transmission lines would generally follow the conveyance alignments and would be constructed within or adjacent to the alignment ROW. Temporary lines would be constructed from existing facilities to each worksite where power is necessary for construction. Construction of all transmission lines would require three phases: site preparation, tower or pole construction, and line stringing. For 12 kV and 69 kV lines, cranes would be used during the line stringing phase. For stringing transmission lines between 230 kV towers, cranes and helicopters would be used.

Construction of 230 kV and 69 kV transmission lines would require a corridor width of 100 feet and, at each tower or pole, 100 feet on one side and 50 feet on the other side for construction laydown, trailers, and trucks. Construction would also require about 350 feet along the corridor (measured from the base of the tower or pole) at conductor pulling locations, which includes any turns greater than 15 degrees and/or every 2 miles of line.

For construction of 12 kV lines (when not sharing a 69 kV line), a corridor width of 25–40 feet is necessary, with 25 feet in each direction along the corridor at each pole. Construction would also require 200 feet along the corridor (measured from the base of the pole) and a 50-foot-wide area at conductor pulling locations, which includes any turns greater than 15° and/or every 2 miles of line. For a pole-mounted 12 kV/480 volt transformer, the work area is only that normally used by a utility to service the pole (typically about 20 by 30 feet adjacent to pole). For pad-mounted transformers, the work area is approximately 20 by 30 feet adjacent to the pad (for construction vehicle access).

Consideration of Underground Transmission Lines

As part of the transmission line planning process, DWR evaluated a number of locations and options for power transmission to CM1 conveyance intakes and other facilities. One option that has been considered and is the subject of ongoing discussion is the potential to underground all or portions of the temporary and permanent transmission lines that could pose bird strike risks. This option has not yet been incorporated into any of the alternatives assumptions for CM1 facilities but DWR is continuing to evaluate its feasibility at the request of wildlife agencies, and because AMM20 in the Plan accounts for potentially locating some existing transmission lines underground to reduce impacts on greater sandhill cranes. The following key feasibility factors would be evaluated to determine if underground transmission lines are a viable option for this project.

- Consequences for critical water infrastructure associated with the time and process to repair faults or breaks in overhead lines versus underground lines.
- Potential for additional construction and environmental impacts related to underground lines and associated facilities.
- Costs associated with construction, operation, and maintenance of aboveground lines versus underground lines.

The following is a brief summary of these feasibility issues.

Critical Infrastructure

The SWP and CVP are critical infrastructure for the state of California. Operation of the SWP and CVP relies on interconnection to the power grid, and any disruption to power requires coordination among operators, power grid operators, and grid controllers. This is necessary to plan for reliable return to service, including resuming or replenishing water deliveries, after either a planned or unplanned power outage. One of the primary concerns with underground lines is the additional time necessary to repair outages. Faults or breaks in overhead lines can usually be located almost immediately and repaired within hours or, at most, 1 or 2 days. The duration of underground outages can vary widely, from several days to several months, depending on the circumstances of the failure, type of underground line, and availability of skilled repair personnel.

Outages of a few days or less generally present fewer effects, require less stringent coordination protocols, and may allow a portion of the effect to be avoided or minimized through short-term operational adjustments. A prolonged disruption or outage generally requires greater coordination to ensure that grid operators and grid controllers can manage other grid infrastructure, resources, and loads reliably during the outage. The larger the load or aggregate load interrupted for a prolonged time, the more likely there would be a need to re-evaluate the expected electrical system behavior. Power is also needed to maintain communications and controls systems during both normal and emergency situations. While backup power may temporarily and partially provide power to these critical systems during an outage, return to normal power would be necessary to reliably support these systems and their security, especially information systems networked to the SWP and CVP.

Construction and Environmental Impacts

The design and construction of underground transmission lines differ from overhead lines because two significant technical challenges need to be overcome: (1) providing sufficient insulation so that cables can be within inches of grounded material, and (2) dissipating the heat produced during the operation of the electrical cables. Overhead lines are separated from each other and surrounded by air. Open air circulating between and around the conductors cools the wires and very effectively dissipates heat. Air is also an insulator that can recover if there is a flashover. In contrast, a number of different systems, materials, and construction methods have been used during the last century to achieve the necessary insulation and heat dissipation required for underground transmission lines.

Different types of cables require different ancillary facilities. When assessing the impacts of underground transmission line construction and operation, the impacts of the ancillary facilities must also be considered. Ancillary features may include vaults, transition structures, and pressurizing systems. Some of these facilities are constructed underground, while others are aboveground and may have a significant footprint. Installation of an underground transmission cable generally involves the following sequence of events: (1) ROW clearing, (2) trenching/blasting, (3) laying and/or welding pipe, (4) duct bank and vault installation, (5) backfilling, (6) cable installation, (7) adding fluids or gas, and (8) site restoration. Trenching for the construction of underground lines would create greater soil disturbance than constructing overhead lines. Overhead line construction disturbs the soil mostly at the site of each transmission pole, while underground lines require 6- to 8-foot deep trenching along the entire line. Trenching an underground line through farmlands, forests, wetlands, and other natural areas can cause significant land disturbances. Other construction impacts include dirt, dust, noise, and traffic disruption. In non-urban areas, soil compaction, erosion, and mixing may also be problematic. The special soils often placed around an underground line may slightly change the responsiveness of surface soils to farming practices. Post-construction, trees and large shrubs would not be allowed within the ROW due to potential problems with roots, although some herbaceous vegetation and agricultural crops may be allowed to return to the ROW. The ROW also must be kept safe from accidental contact by subsequent construction activities.

In addition to environmental impacts from construction, impacts may occur from fluid leaks. Fluid-filled lines must have a spill control plan. The estimate for potential line leakage is about one leak every 25 years. Soil contaminated with leaking dielectric oil is classified as a hazardous waste. This means that contaminated soils and water would have to be remediated. The types of dielectric fluid used in underground transmission lines include alkylbenzene and polybutene. These are not toxic, but are slow to degrade. The release and degradation of alkylbenzene could cause benzene compounds, a known carcinogen, to appear in plants or wildlife. In areas with a relatively high groundwater table, such as the Delta, the potential for groundwater contamination could be high. A nitrogen leak from a gas-filled line would not affect the environment, but would be a safety concern; workers would need to check oxygen levels in the vaults before entering.

Costs

Costs for construction and maintenance of underground lines are substantially higher than those associated with aboveground lines. Cost estimates for constructing underground transmission lines range from 4 to 14 times greater than those associated with overhead lines of the same voltage and same length, especially when traveling through challenging geographic regions containing certain soil and rock formations, mountains, urban areas, and protected wetland habitats. In a 2011 report prepared by the Public Service Commission of Wisconsin, the cost of a typical new 69 kV overhead single-circuit transmission line was approximately $285,000 per mile as opposed to $1.5 million per mile for a new 69 kV underground line (Public Service Commission of Wisconsin 2011). A new 138 kV overhead line cost approximately $390,000 per mile as opposed to $2 million per mile for underground. Many engineering factors significantly increase the cost of underground transmission facilities. As the voltage increases, engineering constraints and costs dramatically increase. This is one reason why underground distribution lines (12–24 kV) are not uncommon, while underground transmission lines are constructed far less frequently. Repair costs for underground lines also tend to be greater than costs for an equivalent segment of overhead line. Finally, underground cables tend to have a substantially shorter service life than those used for overhead lines.

3.6.1.7 Through Delta/Separate Corridors Levee Construction and Modification

Description

The through Delta/separate corridors alternative (Alternative 9) would rely on existing levees to contain and convey water to existing diversion facilities in the south Delta.

This alignment would entail construction of a 4,000-foot segment of new on-channel levee at Old River, isolating Old River from the Tracy Fish Collection Facility and connecting Clifton Court Forebay to the fish facility. Setback levees (approximately 2,000 feet total) on the south side of Victoria Canal would also be constructed to accommodate the dredged and expanded canal under this alternative. The majority of dredged material under Alternative 9 would be stored in upland storage sites, and approximately 0.5% may be disposed of in an offsite landfill. Spoils would be disposed of in designated spoils areas, and approximately 0.1% of spoils may be disposed of in offsite landfills.

New facilities protection levees would be constructed around pumping plants and equipment for the operable barriers. New levees or levee modifications constructed for the through Delta/separate corridors alternative would be designed to meet similar flood protection levels as the existing levees.

A typical new levee would share the shape, slope, and dimensions of those described above for intake facilities. A notable difference is that the height of the levees would be approximately 10–15 feet, matching the height of existing levees in the Delta. This corresponds to a base width of approximately 80–260 feet. All construction and modifications will comply with applicable state and federal flood management, engineering, and permitting requirements.

Refer to Table 3-14 for a description of the physical characteristics of the through Delta/separate corridors alternative.

Operation and Maintenance

Levee maintenance facilities would typically be composed of material stockpile areas, sized to accommodate materials, equipment, and sufficient area for staging and loading of materials. Such areas would typically be rectangular in plan and range from approximately 50 to 500 feet on a side, depending on the length of levee serviced by the maintenance facility.

Access roads would be used regularly for inspection of the levees. Inspection would be performed for both the waterside and landside slopes and features. Maintenance activities include periodic addition of waterside armoring material, which may necessitate access and work either from the levee crest (e.g., using an excavator to place riprap) or from the water (e.g., using a barge and crane to place rip-rap). Levee maintenance may also include operations designed to prevent and repair damage from animal burrowing within the levee. Vegetation control measures would be performed as part of levee maintenance.

Construction

To construct levees, compacted lean clayey and/or silty soils would be imported to the site. Excavation and foundation improvement activities would be similar to those described above, with the use of riprap for waterside armoring. Access roads would be maintained along the landside levee toe or along the levee crest, while a dedicated ROW would preclude encroachment from features that could compromise levee integrity. Where levees cross existing agricultural channels, new channels would need to be constructed.

Beneath the levee, a zone of native soils would typically be removed and replaced. The depth of replacement is estimated to range from approximately 5 to 15 feet, but is expected to be 5 feet typically. The width of replacement would be slightly greater than the width of the base of the levee. This zone would be replaced with compacted clayey or silty soils as described above. The typical configuration would include some type of *in situ* foundation improvement to strengthen and stiffen the relatively weak and compressible soils present underneath most of the levee alignments. A zone of improved foundation materials would extend from the waterside levee toe to the landside toe. The zone of improved foundation materials would extend down to depths ranging from approximately 20 to 60 feet. The zone of improved foundation materials would typically be composed of a combination of existing *in situ* materials and added materials, mixed together. Armoring material would be rip-rap, which generally is composed of small to large angular boulders. The on-channel levee would be subject to waterway flows and could be armored for the full slope length on the waterside.

An access road would be maintained either along the landside toe of the levee, along the levee crest, or along a combination of these locations. A dedicated ROW would extend along the landside levee to preclude encroachment of channels, ditches, trenches, or pits near the levee.

3.6.1.8 Temporary Access and Work Areas for Intake, Canal, and Pipeline/Tunnel Construction

Temporary Barge Unloading Facilities

Temporary barge unloading facilities would be constructed at locations adjacent to construction work areas along the conveyance alignments for the delivery of construction materials. These facilities would be sized to accommodate various deliveries (e.g., tunnel segments, batched concrete, major equipment). The docks would ~~be approximately 50 by 300 feet~~ range from approximately 0.7 acres to 5.7 acres, and would be~~and~~ supported on approximately 32 two-foot-diameter steel piles. Piles would be driven within the allowable window for in-river construction.

Access roads from these facilities to the construction work area would be necessary. The barge unloading facilities would be removed following construction. Depending on the alternative selected, barge unloading facilities could be constructed at one or more of the following locations.

- SR 160 west of Walnut Grove (Alternatives 1A, 2A, 3, 5, 6A, 7, and 8).
- Venice Island (Alternatives 1A, 2A, 3, 4, 5, 6A, 7, and 8).
- Bacon Island (Alternatives 1A, 2A, 3, 4, 5, 6A, 7, 8, and 9).

- Woodward Island (Alternatives 1A, 2A, 3, 5, 6A, 7, and 8. Two barge facilities would be constructed at this location under Alternative 9).
- Victoria Island (Alternatives 1A, 2A, 3, 4, 5, 6A, 7, 8, and 9).
- Tyler Island (Alternatives 1A, 2A, 3, 5, 6A, 7, and 8).
- Hog Island (Alternatives 1B, 2B, and 6B).
- Ryer Island (Alternatives 1C, 2C, and 6C).
- Brannan Island (Alternatives 1C, 2C, and 6C).
- ~~Byron Tract on Italian Slough~~Clifton Court Forebay ~~on West Canal~~ (Alternative 4).
- Glannvale Tract on Snodgrass Slough near the proposed intermediate forebay (Alternative 4).
- Bouldin Island on San Joaquin River (Alternative 4).
- Mandeville Island at the intersection of Middle River and San Joaquin River (Alternative 4).
- ~~Staten Island on South Mokelumne River (Alternative 4).~~
- Webb Tract (two barge facilities would be constructed on Webb Tract under Alternative 9—one at the northwest corner and one on the eastern side).
- Upper Jones Tract (Alternative 9).

In addition, there is an existing dock at Hood that would likely be used during construction for Alternatives 1A, 1B, 2A, 2B, 3, 4, 5, 6A, 6B, 7, and 8. The barge unloading facilities would be used for the delivery and removal of construction materials and equipment. A pier would be built within the worksite footprint of the intake or tunnel for these activities. The barge unloading facility at each location is assumed to be used for the duration of the construction of the intake or tunnel (for approximately 5–6 years). Piers would be disassembled and removed from the site at the end of construction. Under Alternative 4, ~~it is assumed that~~ barge loading/unloading activities could require construction of a working pad on the landside of the levee, construction of a backfilled sheetpile wall to serve as a marginal wharf where barges could be moored, or construction of on-land or in-water mooring dolphins to secure barges during loading and unloading. Loading and unloading could be performed by a crane barge, ramps, a tracked or fixed-base crane, and/or conveyor. All facilities affecting levees would be designed, constructed and operated in full compliance of the requirements of the CVFPB, USACE, and the local district with jurisdiction of the specific levee.~~would take place on levees using a ramp barge in conjunction with a crane/excavator barge or a crane or excavator positioned on or near the levee.~~

Road Haul Routes

It is assumed that the majority of haul routes would include interstates, state routes, and local arterial roadways, depending on the location of the work area and the origin/destination of the trip. Key roadways to be utilized as haul routes are assumed to be the federal and state facilities and their intersecting roadways listed below.

- I-5
- I-80
- I-580

- I-205
- SR 160
- SR 12
- SR 4

The reader is referred to Chapter 19, *Transportation*, for a more detailed discussion of potential existing public roads that may be used as haul routes.

In addition, haul routes ~~could~~ would include all-weather access roads and private roads. All-weather roads would be required for year-round construction and for access to delivery areas and permanent spoils areas, including RTM areas. All-weather roads are typically surfaced with a minimum of 24 inches of gravel. Construction traffic would also require the use of private roads to access the work sites, including tunnel shaft sites and barge landings. Private roads would carry construction traffic from the nearest state highway or county road through private land to the construction site. The majority of private access roads expected to be used are dirt or gravel access roads on agricultural land, though private levee roads may also be used for construction traffic.

General Construction Work Areas

Work areas during construction would include areas for construction equipment and worker parking, field offices, a warehouse, maintenance shops, equipment and materials laydown and storage, RTM spoils areas, and stockpiles. Where not otherwise defined, these areas are identified as temporary “Work Areas” or “Proposed Temporary Surface Impact” areas on mapbook figures. Under Alternative 4, one of these areas would be located adjacent to Hood on the southern side of the community, and would serve as a staging area during the construction phase. It would consist of facilities such as parking areas, offices, and construction equipment storage. Each construction site would also include some combination of required processing operations including concrete batch plants, pug mills, soil mixing facilities, and cement storage. Specific locations have been identified for concrete batch plants and fuel stations. Batch plants, along with fine and coarse aggregate stockpiles, would produce concrete needed for various structures. Pug mills would be provided for roller compacted concrete and other soil materials. Soil mixing facilities may be required for some aspects of RTM disposal and for ground improvement activities. Cement and other materials would be stored at each site as needed to support concrete production, slurry wall construction, ground improvement, soil mixing, and other activities. Material stockpiles, tunnel segment storage areas, and handling areas would support the concrete and soil processing features described above. Other features with substantial earthwork components would require onsite material processing.
Materials to be stockpiled may include those listed below.

- Strippings from various excavations for possible reuse in landscaping or as topsoil replacement for agricultural areas.
- RTM that is slated for reuse after treatment ~~for embankment or fill construction~~as needed.
- Peat spoils for possible use on agricultural land, as safety berms on the landside of haul roads, or as toe berms on the landside of embankments (cannot be part of the structural section).
- Aggregates or soil materials to be used for concrete, rolled compacted concrete, soil cement, or other processed materials of construction.

- Other materials being stockpiled on a temporary basis prior to hauling to permanent stockpile areas.

Such materials can be stockpiled in the construction areas of the project for later use. Some stockpiles may be used for material conditioning and potential reuse. Temporary stockpile areas may also allow for staging deliveries (offloading), for equipment/materials storage, and for temporary field offices for construction.

Site clearing and grubbing, work area limits, and site access to stockpile locations will be developed. Silt fencing and straw bale dikes will be installed, as needed, to address drainage issues. Dust abatement and other environmental concerns relating to stockpiles will be addressed by environmental commitments (Appendix 3B, *Environmental Commitments*) and mitigation measures introduced throughout the impact analysis. Stockpile areas may require security fences, gates, and/or cameras.

Depending on the selected RTM handling method, RTM areas may be permanent. Similarly, borrow or spoils areas that cannot be returned to previous uses may constitute permanent physical effects, subject to appropriate environmental permitting (see Table 1-~~3~~ 2 in Chapter 1, *Introduction*, for a summary of permits relevant to the BDCP). While these areas are treated as "permanent surface impacts" throughout the assessment of impacts, it is anticipated that much of the RTM and spoil material could be reused, as described further in Appendix 3B, *Environmental Commitments*. For the purposes of analysis, it was assumed that all borrow material required for construction would be procured either from areas or materials associated with other project features (such as excavated material from forebays or tunnels or native materials from areas identified for storage of RTM or other spoil material) or from existing permitted facilities.

A potable water supply system would be necessary at main construction work areas. Accordingly, wells would be drilled to provide approximately 500 gallons per minute during construction activities. Geotechnical studies would be performed prior to drilling. If necessary, package water treatment plants would be brought to the site. These facilities would be anticipated to be located within the tunnel work areas.

3.6.1.9 SWP and CVP South Delta Export Facilities

Under most alternatives, existing SWP and CVP conveyance facilities would continue to be active physical components of the water conveyance system; as such, these facilities are described below. Operation and maintenance of these facilities and modifications proposed under the alternatives are detailed in Section 3.6.4. These facilities include the SWP Clifton Court Forebay, Skinner Fish Facility, Banks Pumping Plant, Tracy Fish Facility, Delta Cross Channel, Jones Pumping Plant, south Delta temporary barriers, Barker Slough Pumping Plant and North Bay Aqueduct, portions of the CCWD Diversion Facilities, and Suisun Marsh Facilities. Because CCWD's facilities are not operated or maintained by the CVP, the BDCP does not include modifications to them. Coverage under ESA and CESA for existing operation and maintenance of the SWP, coordinated operations of the SWP with the CVP, and operation and maintenance of CCWD's facilities are addressed through separate compliance processes and not addressed in the BDCP.

Clifton Court Forebay

Clifton Court Forebay is a 31,000-af regulatory reservoir for the SWP about 10 miles northwest of Tracy. Water flows through Grant Line Canal and Old River and into Clifton Court Forebay through radial gates near the confluence of Grant Line Canal and West Canal. The gates are operated on the tidal cycle to reduce approach velocities, prevent scour in adjacent channels, and minimize water elevation fluctuation in the south Delta by taking water in through the gates at times other than low tide. When a large head differential (difference in water surface elevation) exists between the outside and the inside of the gates, theoretical inflow can be as high as 15,000 cfs for a short time, though actual inflow would be constrained in accordance with the BDCP conservation strategy. The intake gates enable incoming flow into Clifton Court Forebay to be measured and conveyed to the Banks Pumping Plant. Water can be stored in Clifton Court Forebay to be conveyed at a later time to maximize pumping during off-peak hours. The off-peak hours are typically 10:00 p.m. to 7:00 a.m. Monday through Saturday, all day Sunday, and many holidays. The gates prevent reverse flow back into Old River.

The period of the tidal cycle in which the Clifton Court Forebay intake gates are opened is selected to minimize impacts on south Delta water users. DWR reports that the surface water elevation in Clifton Court Forebay varies throughout the day, typically between -2 feet and +0 to +2 feet depending on tidal conditions and predetermined gate opening priority for the forebay. Typical operation is targeted to restore the surface elevation to -1 foot each day at midnight. This water level creates the required hydraulic head differential between the available water in the Delta and Clifton Court Forebay to allow water to flow from the Delta into the forebay to provide sufficient water for SWP's Delta Export Allocation for the following day. The Clifton Court Forebay gates are closed once DWR's daily water allocation has been achieved. If tidal or other conditions prevent DWR's daily allocation from being achieved, the schedule for the following day's water conveyance operation is adjusted to minimize impacts on DWR deliveries.

The maximum design operating storage at Clifton Court Forebay is 28,653 af at the water surface elevation of +5 feet. The minimum design operating storage is 13,965 af at the minimum water surface elevation of -2 feet. DWR has indicated that unless engineering improvements are made to the perimeter embankment around Clifton Court Forebay, the maximum operating water surface elevation for future water operations should be limited to +4 feet. For the modified pipeline/tunnel alignment (Alternative 4), Clifton Court Forebay will be reconfigured by dividing it into two cells, a north cell and a south cell. The south cell will continue to function using existing operating rules for Clifton Court Forebay. The normal operating water surface elevation would range from an elevation of +1.1 feet to +8.1 feet in the south cell. The normal operating water surface elevation for the north cell would range from +1.1 feet to +7.1 feet under isolated north Delta operations and from +5.1 feet to +14.7 feet under dual operations. ~~The~~ Between both cells, the maximum design operating storage ~~will~~ would therefore be reduced to about ~~26,000~~24,200 af. The perimeter embankment ~~however~~ will be ~~completely rebuilt~~ reconstructed to comply with~~to~~ current flood protection and seismic design standards, thereby improving its reliability.

Skinner Fish Facility and Banks Pumping Plant

Water from Clifton Court Forebay is conveyed through Skinner Fish Facility to the California Aqueduct Intake Channel, which extends to the Banks Pumping Plant. Large fish and debris are directed away from the Banks Pumping Plant by a 388-foot-long trash boom. Smaller fish are diverted from the intake channel into bypasses by a series of metal louvers into a secondary system of screens and pipes, and then into holding tanks. The salvaged fish are returned to the Delta in oxygenated tank trucks. For the modified pipeline/tunnel alignment (Alternative 4), only water from the south cell will be conveyed through the Skinner Fish Facility.

The 2009 NMFS BiOp requires DWR to initiate studies to develop predator controls in Clifton Court Forebay to reduce salmonid and steelhead losses in the forebay by March 31, 2014, such that losses do not exceed 40%, and to remove predators in the secondary channel at least once per week. The NMFS BiOp also requires modifications to operations of the Skinner Fish Facility to achieve at least 75% salvage efficiency for Central Valley salmonids, steelhead, and the southern Distinct Population Segment of North American green sturgeon.

Banks Pumping Plant has an installed pumping capacity of 10,670 cfs. It discharges into five pipelines that convey water into a roughly 1-mile-long canal, which in turn conveys water to Bethany Reservoir. Bethany Reservoir serves as a regulating reservoir for the downstream canals that deliver SWP water.

The maximum daily pumping rate at Banks Pumping Plant is controlled by a combination of the State Water Board's D-1641, an adaptive management process described in the 2008 USFWS and the 2009 NMFS BiOps, and permits issued by USACE that regulate the rate of diversion of water into Clifton Court Forebay. The diversion rate is normally restricted to 6,680 cfs as a 3-day average inflow and 6,993 cfs as a 1-day average inflow to Clifton Court Forebay. The diversions may be greater in the winter and spring, depending on San Joaquin River flows at Vernalis.

The Byron-Bethany Irrigation District diverts water from the California Aqueduct Intake Channel through a canal between the Skinner Fish Facility and Banks Pumping Plant. This diversion occurs under an agreement related to historical water rights to the waters near Clifton Court Forebay.

Tracy Fish Facility and Jones Pumping Plant

The Tracy Fish Facility, located at the Delta-Mendota Canal intake, and Jones Pumping Plant operate continuously because the CVP facilities do not include a regulating reservoir such as Clifton Court Forebay. Water is diverted from Old River upstream of its confluence with Grant Line Canal, through the Tracy Fish Facility into the 2.5-mile unlined upper reach of the Delta-Mendota Canal, which conveys water to the Jones Pumping Plant. The Tracy Fish Facility uses louver screens to divert fish into holding tanks, where they are then placed in tanker trucks and released into the Delta. The salvaged fish are returned to the Sacramento River near Horseshoe Bend and the San Joaquin River upstream of the Antioch Bridge.

The CVP facilities do not include storage capacity in the south Delta. Consequently, the facilities usually operate continuously when diversions are allowed. Water supply operations of the Jones Pumping Plant are constrained by tidal fluctuations and the capacity of the Delta-Mendota Canal between the Jones Pumping Plant and the San Luis Reservoir complex. This capacity, including pumping capacity at the O'Neill Pump-Generating Plant, is about 4,200 cfs. Accordingly, operations of the Jones Pumping Plant are limited to 4,200 cfs unless deliveries are required for CVP water service contractors that divert upstream of the O'Neill Pump-Generating Plant. In many months, operations criteria limit the Jones Pumping Plant to diversions of less than 4,200 cfs; however, in summer, fall, and winter months, there are opportunities to divert up to 4,600 cfs.

Delta-Mendota Canal/California Aqueduct Intertie

Construction of the Delta-Mendota Canal/California Aqueduct Intertie (Intertie) was completed in April 2012. The Intertie was designed to include a pipeline between the Delta-Mendota Canal and the California Aqueduct south of the Banks and Jones Pumping Plants, and a new pumping plant on the Delta-Mendota Canal that allows up to 467 cfs to be pumped from the Delta-Mendota Canal to the California Aqueduct. Prior to operation of this facility, the O'Neill Pump-Generating Plant, farther south along the Delta-Mendota Canal, created a bottleneck due to a design capacity of 4,200 cfs, causing Jones Pumping Plant to pump below capacity in fall and winter. Diverting an additional 400 cfs to the California Aqueduct allows the Jones Pumping Plant to pump at a maximum monthly average of about 4,600 cfs throughout the year. This operational modification is intended to be implemented primarily September through March. Conversely, up to 900 cfs can be conveyed from the California Aqueduct to the Delta-Mendota Canal along the same pipeline by gravity. Operations of the Intertie are subject to all applicable export pumping restrictions for water quality and fisheries protection.

South Delta Temporary Barriers Project

The existing South Delta Temporary Barriers Project consists of seasonal installation and removal of three temporary rock barriers in Middle River near Victoria Canal, Old River near Tracy, and Grant Line Canal near Tracy Boulevard Bridge. These rock barriers are designed to act as flow-control structures, trapping tidal waters behind them following high tide. These barriers improve water levels and circulation for local south Delta farmers. A fourth barrier, installed at the head of Old River at the divergence from the San Joaquin River, is designed to improve migration conditions for salmon originating in the San Joaquin River watershed during adult and juvenile migrations, which occur annually in the fall and spring, respectively. In the fall, the head of Old River barrier improves downstream dissolved oxygen conditions; during the spring, the barrier is intended to prevent downstream migrating salmon smolt in the San Joaquin River from entering Old River. In 2009 and 2010, DWR installed and operated a nonphysical barrier at the head of Old River as an alternative to the spring rock barrier at this location. The nonphysical barrier uses underwater bubbles, light, and sound as a behavioral deterrent and tests the effectiveness of excluding outmigrating smolts from entering the south Delta via Old River without having to physically block the flow of water into the channel with a rock structure. In the future, DWR may install and operate the nonphysical barrier at the head of Old River as an alternative to the spring rock barrier.

Joint Point of Diversion

Under State Water Board D-1641 (December 1999, revised March 2000), Reclamation and DWR are authorized to use/exchange diversion capacity between the SWP and CVP to enhance the beneficial uses of both projects. The sharing of the SWP and CVP export facilities is referred to as Joint Point of Diversion (JPOD). In general, JPOD capabilities are used to accomplish the following four objectives.

- When wintertime excess pumping capacity is available during Delta excess conditions, and total SWP and CVP San Luis Reservoir storage is not projected to fill before the spring pulse flow period, the project with the deficit in San Luis Reservoir storage may elect to use JPOD capabilities.
- When summertime pumping capacity is available at the Banks Pumping Plant and CVP reservoir conditions can support additional releases, the CVP may elect to use JPOD capabilities to enhance annual CVP releases for south of Delta water supplies.
- When summertime pumping capacity is available at the Banks or Jones Pumping Plant to facilitate water transfers, the JPOD may be used to further facilitate the water transfer.
- During certain coordinated SWP and CVP operation scenarios for fish entrainment management, the JPOD may be used to shift SWP and CVP exports to the facility with the least fish entrainment impact and minimize exports at the facility with the most fish entrainment impact.

Barker Slough Pumping Plant and North Bay Aqueduct

The Barker Slough Pumping Plant diverts water from Barker Slough into a pipeline, the North Bay Aqueduct, for delivery in Napa and Solano Counties. The North Bay Aqueduct intake is approximately 10 miles from the mainstem Sacramento River ~~at the end of~~on Barker Slough in the Cache Slough area. The ~~maximum pumping~~pipeline conveyance capacity is 175 cfs~~ (pipeline capacity)~~. ~~During the last few~~In recent years, daily pumping rates have ranged between 0 and 140 cfs.

Currently, DWR and the Solano County Water Agency are evaluating an alternat~~iv~~e intake for the pumping plant because operations have been limited by water quality constraints and provisions in the USFWS and NMFS BiOps. Water conveyance operations of this potential new facility are incorporated in this analysis and discussed in Section 3.6.4.

Water Transfers

State and federal laws governing water use in California promote the use of water transfers to manage water resources, particularly water shortages, provided that certain conditions of the transfer are met to protect source areas and users. Transfers requiring export from the Delta are conducted at times when pumping and conveyance capacity at the SWP or CVP export facilities are available to move the water. Additionally, operations to accomplish these transfers must be carried out in coordination with SWP and CVP operational criteria, such that the capabilities of the projects to exercise their own water rights or to meet their legal and regulatory requirements are not diminished or limited in any way.

SWP and CVP contractors have independently acquired water and arranged for its pumping and conveyance through SWP facilities. State Water Code provisions grant other parties access to unused conveyance capacity, although SWP contractors have priority access to capacity not being used by DWR to meet SWP operational demands, including SWP water deliveries.

Conveyance of transfer water by Authorized Entities is a covered activity provided that the transfers are consistent with the operational criteria described in CM1 and the effects analysis described in BDCP Chapter 5, *Effects Analysis*. However, the withdrawal of transfer waters from source areas is outside the scope of the covered activity. Additional information regarding water transfers is provided in Appendix 1E, *Water in California: Types, Recent History, and General Regulatory Setting*; Appendix 5C, *Historical Background of Cross-Delta Water Transfers and Potential Source Regions*; and Appendix 5D, *Water Transfer Analysis Methodology and Results.*

Suisun Marsh Facilities

The existing Suisun Marsh facilities comprise the Suisun Marsh Salinity Control Gates, Morrow Island Distribution System, Roaring River Distribution System, Goodyear Slough Outfall, and various salinity monitoring and compliance stations throughout the marsh. Since the early 1970s, the California Legislature, State Water Board, Reclamation, CDFW, Suisun Resource Conservation District (SRCD), DWR, and other agencies have engaged in efforts to preserve beneficial uses of Suisun Marsh to mitigate the potential impacts on salinity regimes associated with reduced freshwater flows to the marsh. Initially, salinity standards for Suisun Marsh were set by State Water Board D-1485 to protect production of alkali bulrush, a primary waterfowl plant food. Subsequent standards set under State Water Board D-1641 reflect the intention of the State Water Board to protect multiple beneficial uses. A contractual agreement between DWR, Reclamation, CDFW, and

SRCD includes provision for measures to mitigate the effects of operation of the SWP and CVP and other upstream diversions on Suisun Marsh channel water salinity. The Suisun Marsh Preservation Agreement requires DWR and Reclamation to meet specified salinity standards, sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements. Maintenance activities for existing facilities include levee repairs, vegetation removal, fish screen cleaning and installation of new screens, mechanical repairs, structural repairs, removal or replacement of monitoring and compliance stations (including in-water work), and instrumentation installation on or near existing facilities.

3.6.1.10 Geotechnical Exploration

DWR will perform a series of geotechnical investigations along both the selected water conveyance alignment and at locations proposed for facilities or material borrow areas. The work to be performed will constitute a subsurface investigation program to provide information required to support the design and construction of the water conveyance facilities. Geotechnical investigations will be conducted to identify surface and subsurface conditions necessary to complete design of the water conveyance facilities. DWR has developed a Draft Geotechnical Exploration Plan (Phase 2) for the Alternative 4 conveyance alignment (MPTO). The geotechnical investigation plan provides additional details regarding the rationale, investigation methods and locations, and criteria for obtaining subsurface soil information and laboratory test data (California Department of Water Resources 2014).

The proposed exploration is designed as a two-part program (Phases 2a and 2b) to collect geotechnical data. The two-part program will allow refinement of the second part of the program to respond to findings from the first part. The proposed subsurface exploration will focus on geotechnical considerations of the following aspects of water conveyance facility development: engineering considerations, construction-related considerations, permitting and regulatory requirements, and seismic characterization considerations.

The data obtained during the geotechnical exploration will be used to support the development of an appropriate geologic model, to characterize ground conditions, and to reduce the geologic risks associated with construction of proposed facilities.

Representative samples of subsurface materials will be collected from selected locations along the MPTO alignment and at proposed facility sites, and the collected samples will be tested to support design. The distance from Intake 2 (the northern extent of the MPTO) to the Clifton Court Forebay (the southern extent) is approximately 39 miles. The proposed facilities include river intakes, conveyance pipelines, sedimentation basins, pumping plants, transition structures, forebays, construction and vent shafts, access roads, bridges, and tunnels. The proposed subsurface exploration will consist of field tests and laboratory testing of soil samples. The field tests will consist of soil borings, cone penetration testing (CPT), geophysical testing, pressure meter testing, excavation of test pits, installation of piezometers and groundwater extraction wells, dissolved gas sampling, and aquifer tests. The field exploration program will be planned to evaluate soil characteristics and to collect samples for laboratory testing, which will include soil index properties, strength, compressibility, permeability, and specialty testing to support TBM selection and performance specification.

The proposed Phase 2a and 2b exploration on land will consist of approximately 1,500–1,550 exploration locations including drilling boreholes and performing CPTs as well as conducting approximately 60 shallow test pit excavations (typically 4 feet wide, 12 feet long, and 12 feet deep) in soils to evaluate bearing capacity, physical properties of the sediments, location of the groundwater table, and other typical geologic and geotechnical parameters. CPT consists of pushing a cone connected to a series of rods into the ground at a constant rate, allowing continuous measurements of resistance to penetration both at the cone tip and the sleeve behind the cone tip. The resulting information correlates to the nature and sequence of subsurface soil strata, groundwater conditions, and physical and mechanical properties of soils.

Temporary pumping wells and piezometers may be installed at intake, forebay, pump shaft, and tunnel shaft sites to investigate soil permeability and to allow sampling of dissolved gases in the groundwater. Small test pits will be excavated to obtain near-surface soil samples for laboratory analysis. Drilling will take place at project sites that are readily accessible by truck or track-mounted drill rigs.

After each site is explored, the boring, CPTs, and/or piezometers will be backfilled with cement-bentonite grout in accordance with California regulations and industry standards (Water Well Standards, DWR 74-81 and 74-90). Test pits will be backfilled with the excavated material on the same day as they are excavated with the stockpiled topsoil placed at the surface and the area restored as closely as possible to its original condition.

Exploration activities may consist of auger and mud-rotary drilling with soil sampling using a standard penetration test (SPT) barrel (split spoon sampler) and Shelby tubes; cone penetrometer testing; temporary well installation; test pits; and electrical resistivity and other geophysical surveys. All exploration methods will require a drill rig and support vehicle for the drillers and vehicles for the geologists and environmental scientists. Best management practices applicable to construction of conveyance facilities, such as those set forth in Draft BDCP Appendix 3.C, *Avoidance and Minimization Measures*, Appendix 3B, *Environmental Commitments*, as well as those incorporated as mitigation measures throughout the EIR/EIS, will also apply to the implementation of geotechnical explorations, where applicable (e.g., in-water activities may, in some cases, require application of a different set of commitments than activities taking place on land). Direct impacts to buildings, utilities, and known irrigation and drainage ditches will be avoided during geotechnical exploration activities. The various on-land exploration methods may last from a few hours to several days.

Approximately 90–100 overwater geotechnical borings and CPTs are proposed to be drilled in the Delta waterways. These include approximately 30 overwater geotechnical borings and CPTs in the Sacramento River to obtain geotechnical data for the proposed intake structures. Approximately 25–35 overwater borings and CPTs are planned at the major water undercrossings along the planned MPTO tunnel alignment. An additional 30–35 overwater geotechnical borings and CPTs are proposed for the barge unloading facilities and Clifton Court Forebay modifications. The depths of borings and CPTs are planned to range between 100 and 200 feet below the mud line (i.e., river bottom).

DWR plans to conduct overwater drilling only during the period from August 1 to October 31 between the hours of sunrise and sunset. Duration of drilling at each location will vary depending on the number and depth of the holes, drill rate, and weather conditions, but activities are not expected to exceed 60 days at any one location. Overwater borings for the intake structures and river crossings for tunnels will be carried out by a drill ship and barge-mounted drill rigs.

As discussed above, the proposed subsurface exploration has been structured into two major phases: 2a and 2b. The elements of Phases 2a and 2b have been defined to support engineering design and construction as described below.

Phase 2a Geotechnical Exploration

Phase 2a exploration will focus mainly on collecting data to support preliminary engineering. This includes overwater and land-based soil borings and CPTs. The overwater explorations are planned to collect subsurface information to support the design of intake structures and the major water crossings along the MPTO. Land-based explorations are planned for the intake perimeter berms, State Route 160 (SR 160), sedimentation basins, pumping plants, forebay embankments, tunnel construction and vent shafts, and other appurtenant facilities proposed for the MPTO. Approximately 600 boring and CPT locations are proposed for the Phase 2a exploration.

For the proposed MPTO tunnels, Phase 2a would entail soil borings approximately every 2,000 feet along the tunnel alignment and CPTs approximately every 2,000 feet midway between the borings. Overwater boreholes and CPTs are planned in Potato Slough, San Joaquin River, Connection Slough, and Clifton Court Forebay. All of the land-based boreholes along the tunnel alignments will be converted into piezometers. CPTs are also proposed to be co-located at every third borehole to enable calibration of the CPT data with the in-situ geology encountered in the boreholes.

For tunnel shaft sites and Clifton Court Forebay pumping plant shaft sites (see Section 3 for a description of the revised location for pumping plants under the MPTO), six soil borings and four CPTs will be advanced at each planned shaft location. Once drilling is completed at each shaft site, two of the boreholes will be converted into groundwater extraction wells and the other four boreholes will be converted into piezometers.

Boreholes and CPTs are also proposed for the intake and pumping plant sites, as well as the planned location for the realignment of SR 160 adjacent to each intake. Approximately six of the boreholes at each of the north Delta intakes would be converted into piezometers.

Phase 2b Geotechnical Exploration

Phase 2b exploration is proposed to collect geotechnical data to support final design, permitting requirements, and planning for procurement and construction-related activities. In addition to soil borings and CPTs, test pits would be created as part of Phase 2b exploration. Additional explorations may also be carried out before construction to affirm the validity of the data collected during the design phase. The Phase 2b subsurface exploration will aim to collect geotechnical data from those project site areas and facility locations that have been verified by preliminary engineering and other associated studies. Approximately 950 boring, CPT, and test pit locations are proposed for the Phase 2b exploration.

For the proposed MPTO tunnels, the Phase 2b exploration will consist of advancing soil borings near the Phase 2a CPT locations such that a borehole will have been located at approximately 1,000-foot intervals along the entire tunnel alignment. CPTs will be advanced midway between the boreholes. This configuration would provide for a land-based exploratory location (borehole or CPT) spacing of approximately 500 feet along the tunnel alignment, a spacing that generally conforms to typical design efforts for tunnels like those proposed as part of the MPTO. The exploration proposed for the construction and ventilation shaft sites in Phase 2a would be expanded to include areas for accessing the TBMs for equipment inspection and maintenance (“safe haven intervention sites”) in

Phase 2b. Overwater boreholes and CPTs are planned in the Sacramento River, Snodgrass Slough, South Fork Mokelumne River, San Joaquin River, Potato Slough, Middle River, Connection Slough, Old River, North Victoria Canal, and Clifton Court Forebay.

Schedule for Geotechnical Explorations

The estimated duration to complete the proposed Phase 2a and 2b land-based explorations is about 24 months, assuming six land-based drill rigs operating concurrently for six days per week. The estimated duration to complete the Phase 2a and 2b overwater explorations is about 14 months, assuming two drill rigs operating concurrently for 6 days per week. However, to maintain the project development schedule, it is likely that 10–15 land-based drill rigs would be used simultaneously for 12–18 months to complete the exploration. The exploration duration will vary depending on the availability of site access, drilling contractors and equipment, permitting conditions, and weather. The proposed explorations are planned to be performed during the first 3 years of implementation.

~~Prior to actual drilling and sampling of each planned boring/CPT location, field reconnaissance, marking or staking the exploration site, and calling the Underground Service Alert (USA) for utility clearance will be performed.~~

3.6.2 Conservation Components

3.6.2.1 Yolo Bypass Fisheries Enhancement (CM2)

Many covered species depend upon periodic inundation of floodplains to complete their life cycles, for rearing, or to support emigration or dispersal. Loss of floodplain habitat and river connectivity in recent decades has been linked with decreasing abundance of these species. Under CM2, the Fremont Weir and Yolo Bypass would be modified to increase the frequency, duration, and magnitude of floodplain inundation and improve fish passage in the Yolo Bypass. During periods when the bypass is inundated, a relatively high production of zooplankton and macroinvertebrates serves, in part, as the forage base for many of the covered fish species. CM2 is expected to advance the following benefits.

- Provide access to additional spawning habitat for Sacramento splittail. Because splittail are primarily floodplain spawners, successful spawning is predicted to increase with increased floodplain inundation.
- Provide additional juvenile rearing habitat for Chinook salmon, Sacramento splittail, and possibly steelhead. Growth and survival of larval and juvenile fish has been shown to be higher within the inundated floodplain compared to those rearing in the mainstem Sacramento River (Sommer et al. 2001).
- Improve downstream juvenile passage conditions for Chinook salmon, Sacramento splittail, river lamprey, ~~and possibly~~ steelhead and Pacific lamprey. An inundated Yolo Bypass is used as an alternative to the mainstem Sacramento River for downstream migration of juvenile salmonids, Sacramento splittail, river lamprey, and sturgeon; rearing conditions and protection from predators are believed to be better in this area. The expected increased habitat and productivity resulting from increased inundation of Yolo Bypass are likely to also provide some benefits to covered species, including steelhead and lamprey.

- Improve adult upstream passage conditions of migrating fish using the bypass such as Chinook salmon, steelhead, sturgeon, and lamprey. An inundated Yolo Bypass is used as an alternative route by upstream migrating adults of these species when Fremont Weir is spilling. Increasing the frequency and duration of fish passage during inundation events will provide these improved conditions for more covered species over longer portions of their migrations. A modified Fremont Weir can be operated to minimize stranding potential as flows are reduced. The overall benefits of providing additional flow in the bypass will be assessed through adaptive management. Monitoring for fish stranding will also be implemented, and fish salvage and rescue operations will be carried out, as necessary, to avoid stranding and migration delays for covered fish species.
- Increase food for rearing salmonids, Sacramento splittail, and other covered species on the floodplain.
- Potential exists for exported organic material and phytoplankton, zooplankton, and other organisms produced from the flooded bypass to increase the availability and production of food in the Delta, Suisun Marsh, and bays downstream of the bypass.
- Increase the duration of floodplain inundation and the amount of associated rearing and migration habitat during periods that the Yolo Bypass is receiving water from both the Fremont Weir and the westside tributaries (e.g., Cache and Putah Creeks).
- Reduce losses of adult Chinook salmon, sturgeon, and other fish species to stranding and illegal harvest by improving upstream passage at the Fremont Weir (*CM17 Illegal Harvest Reduction*) and monitoring for fish stranding below Fremont Weir as flow into Yolo Bypass from the Sacramento River recedes. As necessary, implement fish salvage and rescue operations to avoid stranding and migration delays for covered fish species.
- Reduce the exposure and risk of juvenile fish migrating from the Sacramento River into the interior Delta through the Delta Cross Channel and Georgiana Slough, by decreasing the number of fish passing through these areaspassing juvenile fish into and through the Yolo Bypass upstream of the interior Delta.
- Reduce the exposure of outmigrating juvenile fish to entrainment or other adverse effects associated with the proposed north Delta intakes and the proposed Barker Slough Pumping Plant facilities by passing juvenile fish into and through the Yolo Bypass upstream of the proposed intakes.
- Improve fish passage, and possibly increase and improve seasonal floodplain habitat availability, by retrofitting Los Rios Check Dam with a fish ladder, or creating another fish-passable route by which water from Putah Creek can reach the Toe Drain.

To achieve these benefits, CM2 includes modifications to the Yolo Bypass that, in balance with existing uses, would benefit covered fish by increasing the frequency, duration, and magnitude of floodplain inundation and improving fish passage. Any modification to the Yolo Bypass or other CM2 actions would be required to be designed and implemented to maintain flood conveyance capacity at the design flow level and to comply with other flood management standards and permitting processes. These activities would be coordinated, as appropriate, with USACE, DWR, Central Valley Flood Protection Board (CVFPB), and other flood management agencies.

Besides BDCP and CM2, Oother local, state, and federal planning actions are also proposed within the Yolo Bypass, including those proposed in the Central Valley Flood Protection Plan (CVFPP) and the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan (HRFPIP), including an associated EIS/EIR, which is under development~~ as of the publication of the BDCP EIR/EIS Public Draft~~. The integration of these separate, but overlapping processes will occur formally once BDCP has been approved. Until that time, coordination will occur through the Yolo Bypass Fishery Enhancement Working Group. This working group provides the forum to coordinate and discuss integration and the consideration of these and other planning efforts that are ongoing in the Yolo Bypass.

Yolo Bypass fisheries enhancement would be achieved with site-specific component projects to construct fish passage improvements and facilities to introduce and manage additional flows for seasonal floodplain habitat. Prior to construction for each project, necessary preparatory actions would include interagency coordination, feasibility evaluations, site or easement acquisition, coordination related to any required modifications to agricultural practices, development of site-specific plans, and regulatory compliance.

Actions to be implemented as part of CM2 fall into one of three categories. The component projects described in the pages below identify the category into which each action would fall.

- Category 1—Actions are generally small in scale, address a known problem and can be implemented relatively easily, or will provide an interim solution until a more permanent solution can be implemented. Category 1 actions would proceed immediately after BDCP permits are issued and before the Yolo Bypass Fisheries Enhancement Plan (YBFEP) is completed.
- Category 2—Actions are larger in scale and may require further evaluation, research, design, and coordination with the fish and wildlife agencies and stakeholders to refine the action to provide the greatest biological benefit while also addressing stakeholder concerns and accommodating stakeholder needs. Category 2 Actions will be further defined in the YBFEP, and will not proceed until the YBFEP is completed.
- Category 3—Actions may affect stakeholders or may be controversial and/or substantially change the existing conditions of the Yolo Bypass. Category 3 Actions would also be defined within the YBFEP, but would proceed only after an Environmental Impact Report /Environmental Impact Statement (EIR/EIS) for the YBFEP is completed and the Record of Decision/Notice of Determination (ROD/NOD) is signed (i.e., CEQA/NEPA compliance) and all permits have been received.

The YBFEP would propose a sustainable balance among important uses of the Yolo Bypass~~ and consideration of existing conservation easements~~. Important uses of the Yolo Bypass include enhanced floodplain function to achieve biological goals and objectives, as well as flood protection, agriculture, threatened and endangered terrestrial species habitat (including implementation of the Yolo Natural Heritage Program), ~~fisheries habitat, the Yolo Natural Heritage Program, ~~and managed wetlands habitat, as described in existing state and federal land management plans associated with the Yolo Bypass Wildlife Area and existing conservation easements on private land. With stakeholder and scientist input, the YBFEP would further refine CM2 and the component projects that would be evaluated. The YBFEP and ~~an ~~associated YBFEP EIR/EIS would be completed by year 4 of BDCP implementation. During their development, the component projects would be evaluated, individually or grouped as alternatives, to ensure that they are consistent with achieving a sustainable balance, with primary emphasis on achieving the biological goals and objectives. ~~the component projects would provide the greatest biological benefit to the covered fish species,~~

~~consistent with the goals of this measure and the biological goals and objectives of the BDCP. Projects must also minimize impacts on other uses of the Yolo Bypass, such as flood control, agriculture, waterfowl use and hunting, and habitat for covered and non-covered species.~~ Project design and environmental compliance documentation would also be completed, including the YBFEP EIR/EIS. Consistent with the requirements of CEQA, all significant impacts will be mitigated to the extent feasible.

The BDCP identifies a number of anticipated component projects, which are summarized below. As a result of the YBFEP process and completion of the environmental review process a final YBFEP will be adopted for implementation by the Executive Council. The final YBFEP will include the component projects which contribute toward achievement of the biological goals and objectives and the Sustainability Principles. ~~The component projects that are expected to achieve the desired biological outcomes of CM2 would be further developed and implemented. If the YBFEP evaluation does not support implementation of one or more of the component projects, they would not be implemented.~~ Reasons that component projects will not be included in the final ~~implementation may not be supported by the~~ YBFEP include, but are not limited to, the following: the action would not be effective; the action is not needed because of the effectiveness of other actions; the action would have ~~unacceptable~~ significant negative effects on flood control; the action would have ~~unacceptable~~ significant negative effects on existing land use~~,~~ or species, which cannot be mitigated to less than significant ~~(both covered and non-covered native species), or habitat~~; the action will not achieve a sustainable balance; or landowner agreement cannot be achieved with respect to implementing the action.

Many component projects will be evaluated in a parallel environmental compliance process because they are required by the RPA. Selected component projects that trigger EIR/EIS-level evaluation under CEQA/NEPA (Category 3 Actions) would be brought to a preliminary level of design for the YBFEP EIR/EIS. Permitting and the remainder of engineering design would begin after the YBFEP EIR/EIS is complete and a final YBFEP is adopted. Component projects requiring USACE Section 408 permissions may require that any real estate transactions have been completed, and Section 408 permissions may delay finalization of the ROD/NOD until USACE accepts final design.

The CM2 Executive Council will coordinate with its member agencies and other stakeholders (i.e., Yolo County, USACE, DWR, CVFPB, Bureau of Reclamation, USFWS, NMFS, CDFW, state and federal water contractors and landowners) through the Yolo Bypass Fisheries Enhancement Planning Team during the preparation of the YBFEP EIR/EIS to help identify the reasonable range of alternatives to be considered and evaluated within the YBFEP EIR/EIS, which will meet the purpose and need of CM2 and the YBFEP while achieving a sustainable balance. The alternatives that will be considered within the YBFEP EIR/EIS are expected to include various inundation footprints and durations, which would achieve the sustainable balance.

Completion of the YBFEP and associated project-specific YBFEP EIR/EIS is anticipated to take 3 to 4 years. Full engineering design and permitting of multiple component projects are anticipated to take up to 3 additional years, depending upon the scope and scale of component projects. Preparing and ~~letting~~ awarding construction contracts, and constructing the component projects within appropriate work windows are anticipated to span approximately 2 calendar years.

~~This conservation measure would be implemented under all action alternatives.~~ CM2 actions are proposed for implementation in four phases: Phase 1—year 1 to year 5 of BDCP implementation; Phase 2—year 6 to year 10; Phase 3—year 11 to year 25; and Phase 4—year 26 to year 50. The discussion below identifies and summarizes the various conceptual component projects that would be implemented as part of CM2 and identifies which projects are currently considered Category 1, 2, or 3 actions. The Category 2 and 3 actions would be more fully defined and evaluated in the YBFEP and/or YBFEP EIR/EIS, as appropriate.

Phases 1 and 2 (Year 1 to Year 10)

Projects to be Implemented

- **Component Project 1: Fish Rescue.** Provide funding to accelerate fish rescue and improvements to fish stranding assessments (Phase 1, Category 1 Action).
- **Component Project 2: Monitoring and Research.** Perform compliance and effectiveness monitoring, research actions, and adaptive management (Phase 1, Category 1 or 2 Action).
- **Component Project 3: Fish-Rearing Pilot Project at Knaggs Ranch (not to exceed 10 acres).** Evaluate the use of water from Knights Landing Ridge Cut to solely provide or supplement flows, and evaluate the effectiveness of applying water pond by pond, rather than across a contiguously inundated, heterogeneous floodplain (Phase 1 or before, Category 1 Action).
- **Component Project 4: Expanded Fish Rearing at Knaggs Ranch.** Expand pilot project fish rearing via supplemental or sole flows from Knights Landing Ridge Cut to broader area over multiple years (Phase 1 or 2, Category 2 Action).
- **Component Project 5: Fish Ladder Operations Study at Fremont Weir.** Experiment with different approaches to operating the existing ladder (e.g., removing wooden baffles and monitoring fish passage) (Phase 1 or before, Category 1 or 2 Action).
- **Component Project 6: Experimental Sturgeon Ramps at Fremont Weir.** Construct and study up to four experimental ramps at the Fremont Weir to test whether they can provide effective passage for adult sturgeon and lamprey from the Yolo Bypass over the Fremont Weir to the Sacramento River when the river overtops the weir by approximately 3 feet. The species-specific biological goals and objectives for both green and white sturgeon include the reduction of stranding at the Fremont Weir. Developing effective passage through experimental sturgeon ramps would contribute toward reducing stranding at Fremont Weir. Monitoring technologies would be used to collect information on fish passage to evaluate its efficacy at passing adult fishes (Phase 1, Category 3 Action).
- **Component Project 7: Auxiliary Fish Ladders at Fremont Weir.** Construct up to three sets of auxiliary fishways. At least one set would serve the western length of Fremont Weir. Because Fremont Weir is nearly 2 miles long and is constructed in two distinct lengths, these auxiliary fish ladders would help fish pass the weir regardless of the location from which they approach it. At least one of the fish ladders would replace, and possibly increase the width of, the existing Fremont Weir fish ladder. At least one multistage, multispecies fishway would be placed adjacent to the main gated seasonal floodplain inundation channel (in its ultimate location) to provide passage when velocities or partially opened gates would otherwise be impassable or provide poor fish passage. Fish ladder placement would result in positive drainage from the stilling basin, with very little, if any, additional work on the stilling basin (Phase 1 or 2, Category 3 Action).

- **Component Project 8: Fish Screens for Small Yolo Bypass Diversions.** If YBFEP determines screening small Yolo Bypass diversions to be an appropriate means to hold existing irrigation practices harmless, construct fish screens on small Yolo Bypass diversions. Such work would be applied toward the 100 cfs per year remediation target identified in *CM21 Nonproject Diversions* (Phase 2, Category 2 Action).
- **Component Project 9: New or Replacement Impoundment Structures and Agricultural Crossings at the Tule Canal and Toe Drain.** Replace agricultural crossings of the Tule Canal and Toe Drain with fish-passable structures such as flat car bridges or earthen crossings with large, open culverts. Construct new or replacement operable check-structures to facilitate continued agriculture in the Yolo Bypass while promoting fish passage in season (Phase 1, Category 3 Action).
- **Component Project 10: Lisbon Weir Improvements.** Replace the Lisbon Weir with a structure that improves fisheries management and improves the ability to impound water for irrigation, while reducing maintenance (Phase 1, Category 3 Action).
- **Component Project 11: Lower Putah Creek Improvements.** Lower Putah Creek would be realigned to improve upstream and downstream passage of Chinook salmon and steelhead. The action would also include floodplain habitat restoration to provide benefits for multiple species on existing public lands. This action would be designed so that it would not create stranding or migration barriers for juvenile salmon (Phase 1, Category 3 Action).[13] This action would be covered in the YBFEP, and may be covered in separate environmental analysis because it is a required action under the 2009 BiOp.
- **Component Project 12: Water Supply Improvement for the Yolo Bypass Wildlife Area.** Improve Yolo Bypass Wildlife Area water supply at Lisbon Weir to support wildlife management in the Yolo Bypass Wildlife Area (by reducing reverse flows in the Toe Drain) and potentially benefit the aquatic foodweb and downstream fish. Other actions not yet fully defined or developed would be considered. These may include a subsidy of Yolo Bypass Wildlife Area pumping costs or procurement of additional water from western tributary sources. This project incorporates goals of the Westside Concept (Phase 1 or 2, Category 3 Action).
- **Component Project 13: Use of Supplemental Flow through Knights Landing Ridge Cut.** Evaluate the desirability of using supplemental flows through Knights Landing Ridge Cut, introduced by means of redesigning Colusa Basin Drain Outfall Gates, increased operation of upstream unscreened pumps, or other means. If currently unscreened pumps were to be used for more than a pilot period, the pumps would need to be screened or replaced with fish-friendly pumps. This project incorporates goals of the Westside Concept (Phases 1 and 2, Category 3 Action).
- **Component Project 14: Flood-Neutral Fish Barriers.** Construct and test flood-neutral fish barriers to prevent fish from straying into Knights Landing Ridge Cut and the Colusa Basin Drain. These barriers would be most effective when employed in association with attraction flows to a location, such as at Fremont Weir, that is fish-passable and leads to the mainstem Sacramento River. This project incorporates goals of the Westside Concept (Phase 2, Category 3 Action).

[13] Improvements to Upper Putah Creek, outside the Plan Area, will be included as part of the YBFEP. Improvements to Upper Putah Creek will support fish passage, water quality, and spawning habitat improvements in Putah Creek upstream of the Yolo Bypass Wildlife Area and downstream of Solano Diversion Dam (Phase 1).

- **Component Project 15: Gated Seasonal Floodplain Inundation Channel Past Fremont Weir.** Modify a section of the Fremont Weir to enable introducing managed flows to the Yolo Bypass at times when Fremont Weir is not overtopping. The Fremont Weir would continue to passively overtop when the Sacramento River stage exceeds the height of the weir. In the BDCP effects analysis, it is assumed that a section of the Fremont Weir would be lowered to 17.5 feet (NAVD 88). Lower elevations may be considered if necessary to satisfy inundation targets or fish passage needs. For operational modeling purposes, an additional opening at 11.5 feet was assumed. Because the Fremont Weir is perched on the natural levee that bounds the Yolo Basin, including the northern edge of the Yolo Bypass, it would be necessary to excavate through that area of higher ground to hydraulically connect the Sacramento River to the Yolo Bypass at these lower flow stages. Thus, the new section of gates would replace the former section of Fremont Weir and also extend below it, to govern flows in the excavated channel. The new section of operable gates would allow for controlled flow into the Yolo Bypass when the Sacramento River stage at the weir exceeds approximately 17.5 feet NAVD88, leaving the remaining portion of Fremont Weir to overtop passively when the Sacramento River stage is higher than the top of the weir (32.8 feet NAVD 88). The seasonal floodplain inundation flows will attract fish migrating upstream. Therefore, the gates and the fishways immediately adjacent to them would be designed so that when they are operated to provide seasonal floodplain inundation flows, they also allow the efficient upstream and downstream passage of sturgeon and salmonids between the Yolo Bypass and the Sacramento River. If additional work to ensure positive drainage of the entire length of Fremont Weir is required, it would be completed as part of this project (Phase 2, Category 3 Action).

- **Component Project 16: Nonphysical or Physical Barriers to Attract Juvenile Salmon into the Yolo Bypass.** If deemed necessary to enhance capture of juveniles into Yolo Bypass through the gated seasonal floodplain inundation channel (described in Component Project 15), construct and operate nonphysical or physical barriers in the Sacramento River. Examples of such barriers include bubble curtains or log booms (Phase 2 or 3, Category 3 Action).

- **Component Project 17: Support Facilities.** Construct associated support facilities (e.g. operations buildings, parking lots, access facilities such as roads and bridges) throughout the Yolo Bypass necessary to provide safe access for maintenance, monitoring, and fish rescue (Phase 2, Category 3 Action).

- **Component Project 18: Levee Improvements.** Improve levees adjacent to the Fremont Weir Wildlife Area, as necessary, to maintain existing level of flood protection, or to beneficially reuse excavated earth (Phase 2, Category 3 Action).

- **Component Project 19: Yolo Bypass Modifications to Direct or Restrain Flow.** Through modeling and further concept development, determine which of the following actions are necessary to improve the distribution (e.g., wetted area) and hydrodynamic characteristics (e.g., residence times, flow ramping, and recession) of water moving through the Yolo Bypass: grading, removal of existing berms, levees, and water control structures (including inflatable dams); construction of berms or levees; reworking of agricultural delivery channels; and earthwork or construction of structures to reduce Tule Canal and Toe Drain channel capacities. The project would include modifications that would allow water to inundate certain areas of the bypass to maximize provide biological benefits to covered species,and reduce stranding of covered fish species in isolated ponds, minimize effects on terrestrial covered species, including giant garter snake, and achieve a sustainable balanceaccommodate other existing land uses (e.g.,

~~wildlife, public, recreation and agricultural use areas)~~. Necessary lands would be acquired in fee-title or through conservation or flood easement (Phase 2, Category 3 Action).

- **Component Project 20: Yolo Bypass Wildlife Area Modifications.** Modifications to the Yolo Bypass Wildlife Area required as a result of implementation of the YBFEP to maintain public access and hunter opportunity. This component project will construct and acquire as necessary new managed wetlands and facilities (e.g., check stations, parking lots, access facilities such as roads and bridges) throughout the Yolo Bypass necessary to provide safe access for hunting, wildlife viewing, wetland management and maintenance, and monitoring.

Phase 3 (Year 11 to Year 25)

Final permissions/permits from the permitting agencies for construction of the component projects directly affecting flood control structures (Fremont Weir, Sacramento Weir, and Colusa Basin Drain Outfall Gates, if affected, as well as project levees) not obtained in Phase 1 or 2 would be received by Phase 3 at the latest. Those component projects that are not able to obtain permits and be constructed during Phases 1 and 2 would do so in Phase 3. Full buildout is estimated to be completed in years 10, 11 or 12, at which time operations of these component projects would begin.

The following project would be designed, permitted, and if feasible, constructed in Phase 3.

- **Component Project ~~20~~21: Sacramento Weir Improvements.** At a minimum, modifications would be made to reduce leakage at the Sacramento Weir and thereby reduce attraction of fish from the Yolo Bypass to the weir, where they cannot access the Sacramento River and could become stranded. The YBFEP would review the benefits and necessity of constructing fish passage facilities at the Sacramento Weir to improve upstream adult fish passage and positive drainage to reduce juvenile fish stranding. This action may require excavation of a channel to convey water from the Sacramento River to the Sacramento Weir and from the Sacramento Weir to the Toe Drain; construction of new gates at all or a portion of the weir; and modifications to the stilling basin (Phase 3, Category 3 Action).

Phase 4 (Year 26 to Year 50)

Phase 4 would encompass project operation, monitoring, and continued adaptive management. A matrix of criteria would be developed and tested prior to Phase 4, and operations would be adjusted accordingly. For example, if results of monitoring and studies indicate that shorter or earlier gate operations within the adaptive management range yield equivalent or better fish benefits, operation of the gated channel at Fremont Weir would be modified accordingly and additional environmental analysis completed, as appropriate. If scientific results indicate that the wetter, later end of the adaptive management range is more effective biologically, operations would shift accordingly.

3.6.2.3 Tidal Natural Communities Restoration (CM4)

CM4 would provide for the restoration of 65,000 acres of tidal natural communities and transitional uplands. Some or all of the transitional uplands may become tidal during the 50-year permit term and beyond. The tidal natural communities restoration will be focused within the ROAs. However, tidal restoration projects may be implemented outside of the ROAs, as needed, to meet the biological goals and objectives, provided that take limits resulting from such restoration do not exceed those established for the BDCP. The transitional upland areas, which are included in the 65,000-acre total, may accommodate sea level rise by evolving into tidal marsh plain if sea level rises as expected in the future.

The 65,000 acres of restored tidal natural communities and protected transitional uplands must include 6,000 acres of tidal brackish emergent wetland and 24,000 acres of tidal freshwater emergent wetland. The remainder of the 65,000 acres would consist of a combination of any of the restored tidal natural communities (tidal brackish emergent wetland, tidal freshwater emergent wetland, and tidal perennial aquatic) and protected transitional uplands to accommodate sea level rise during and after the 50-year permit term. The intent of this conservation measure is to gain tidal wetlands and accommodate sea level rise, and while a portion of the 65,000 acres will consist of subtidal aquatic areas (tidal perennial aquatic natural community), these areas are expected to be a byproduct of the tidal restoration and not the primary restoration goal. Therefore, restoration will be designed to maximize tidal emergent wetlands and minimize deep subtidal areas. Under Alternative 5, 25,000 acres of tidal habitat would be restored.

Of the 65,000-acre target for restored tidal natural communities, 20,600 acres must occur in particular ROAs, consistent with the following minimum restoration targets. The rationale for the tidal natural community targets is provided in Appendix 3G, *Background on the Process of Developing the BDCP Conservation Measures*.

- Restore 7,000 acres of brackish tidal natural communities, of which at least 6,000 acres are tidal brackish emergent wetland and the remainder can be any combination of tidal brackish emergent wetland, tidal perennial aquatic, and tidal mudflat, in Suisun Marsh ROA.
- Restore 5,000 acres of freshwater tidal natural communities (tidal freshwater emergent wetland, tidal perennial aquatic, tidal mudflat) in the Cache Slough ROA.
- Restore 1,500 acres of freshwater tidal natural communities (tidal freshwater emergent wetland, tidal perennial aquatic, and tidal mudflat) in the Cosumnes/Mokelumne ROA.
- Restore 2,100 acres of freshwater tidal natural communities (tidal freshwater emergent wetland, tidal perennial aquatic, and tidal mudflat) in the West Delta ROA.
- Restore 5,000 acres of freshwater tidal natural communities (tidal freshwater emergent wetland, tidal perennial aquatic, and tidal mudflat) in the South Delta ROA.

The remaining 44,400 acres of restored tidal natural communities and protected transitional uplands will be distributed among the ROAs, or may occur outside the ROAs in order to meet the biological goals and objectives, provided the restoration does not result in effects on terrestrial covered species habitats that exceed the incidental take limits established for terrestrial covered species described in the BDCP, Chapter 5, *Effects Analysis*. Tidal wetland restoration in the South Delta ROA would not begin until substantial progress had occurred toward tidal wetland restoration targets in other portions of the Delta, as described in Appendix D, *Substantive BDCP Revisions*, Section D.3.2.3.

Although specific locations have not been confirmed, the conceptual locations listed below have been identified for all the action alternatives except Alternative 9. A brief discussion of each ROA follows the summary of the conservation measure. The complete details of the conservation measure are available in Chapter 3, *Conservation Strategy* (Section 3.4.4), of the BDCP document.

The following restoration variables would be considered in the design of restored freshwater tidal natural communities.

- Distribution, extent, location, and configuration of existing and proposed restored tidal natural communities.
- Potential for improving habitat linkages that allow covered and other native species to move among protected habitats in and adjacent to the Plan Area.
- For tidal brackish restoration, distribution of restored tidal natural communities along salinity gradients to optimize the range and habitat conditions for covered species and food production.
- For tidal brackish restoration, elevation and location along the existing Suisun Marsh fringe to maximize opportunities for restoring middle and high marsh (as opposed to subtidal and low marsh), with a minimum of 1,500 acres, but more as feasible.
- Predicted tidal range at tidal natural communities restoration sites following reintroduction of tidal exchange.
- Size and location of levee breaches necessary to restore tidal action.
- Cross-sectional profile of tidal natural communities restoration sites (elevation of marsh plain, topographic diversity, depth, and slope).
- Density and size of restored tidal channels appropriate to each restoration site.
- Potential hydrodynamic and water quality effects on other areas of the Delta.
- Ability to accommodate sea level rise.
- Cost of the restoration project relative to benefits

The following general methods and techniques may be used to achieve the purposes of CM4.

- Restore natural remnant meandering tidal channels.
- Excavate channels to encourage the development of sinuous, high-density dendritic channel networks within restored marsh plain.
- Modify ditches, cuts, and levees to encourage more natural tidal circulation and better flood conveyance based on local hydrology.
- Prior to levee breaching, recontour the ground surface to maximize the extent of surface elevation suitable for establishment of tidal marsh vegetation (marsh plain) by scalping higher-elevation land to provide fill for placement on subsided lands to raise surface elevations (taking into consideration that the surface sediment in higher elevation land that is seasonally inundated can be a significant source for zooplankton and aquatic invertebrates, and scalping may temporarily remove that resource).
- Prior to breaching, import dredge or fill and place it in shallowly subsided areas to raise ground surface elevations to a level suitable for establishment of tidal marsh vegetation (marsh plain).
- Prior to breaching, cultivate stands of tules through flood irrigation for sufficiently long periods to raise subsided ground surface to elevations suitable to support marsh plain; breach levees when target elevations are achieved.

Additional methods specific to freshwater and brackish tidal natural communities are discussed in Chapter 3, *Conservation Strategy* (Section 3.4.4), of the BDCP.

Suisun Marsh Restoration Opportunity Area

Suisun Marsh ROA encompasses the Suisun Marsh and is located at the western end of the Plan Area, in Conservation Zone 11. Brackish tidal natural communities will be restored in Suisun Marsh ROA in coordination with the *Suisun Marsh Habitat Restoration and Management Plan*. Those areas suitable for tidal natural communities restoration in Suisun Marsh ROA consist of diked wetlands that are managed for waterfowl and experience little natural tidal action. These managed areas are separated from tidal sloughs by gated culverts and other gated structures that control water exchange and salinity. Waterfowl club managers control the timing and duration of flooding to promote growth of food plants for waterfowl. Some of these are managed as perennial wetlands, others are dry-managed during the summer and early fall months then prepared for waterfowl habitat and hunting with a series of flood-drain-flood cycles. The periodic flooding and discharge of managed wetlands can lead to periods of severely low DO events in adjoining water bodies, which cause acute mortality in at-risk fish species and impair valuable fish nursery habitat (Siegel 2007). Co-occurring with these low DO levels are elevated levels of methylmercury, a toxin prevalent in the Delta that bioaccumulates in the foodweb and adversely affects fish and wildlife.

Cache Slough Restoration Opportunity Area

The Cache Slough ROA includes the southern end of the Yolo Bypass in Conservation Zone 1 and lands to the west in Conservation Zone 2 supporting a complex of sloughs and channels. This ROA supports multiple covered fish species and may currently be the only area where delta smelt spawn and rear successfully. The Cache Slough ROA has been recognized as possibly containing the best functioning tidal natural communities in the Delta. The complex includes Liberty Island, which is likely the best existing model for freshwater tidal natural communities restoration in the Delta for native fishes. Additionally, this ROA encompasses a substantial area of land with elevations suitable for freshwater tidal natural communities restoration that would involve few impacts on existing infrastructure or permanent crops relative to other areas of the north Delta. The Cache Slough ROA provides an excellent opportunity to expand the natural communities supporting multiple aquatic and terrestrial covered species. Based on existing land elevations, approximately 21,000 acres of public and private lands in the area are potentially suitable for restoration of tidal natural communities. Areas suitable for restoration in this ROA include, but are not limited to, Haas Slough, Hastings Cut, Lindsey Slough, Barker Slough, Calhoun Cut, Little Holland, Yolo Ranch, Shag Slough, Little Egbert Tract, and Prospect Island.

Cosumnes/Mokelumne Restoration Opportunity Area

The Cosumnes/Mokelumne ROA is located in the eastern portion of the Plan Area, in Conservation Zone 4. This ROA consists primarily of cultivated lands and a complex of sloughs and channels at the confluence of the Cosumnes and Mokelumne Rivers, providing an opportunity to create extensive gradients of tidal and nontidal wetlands. Suitable restoration sites in this ROA include McCormack-Williamson, New Hope, Canal Ranch, Bract, and Terminous Tracts north of State Highway 12, and lands adjoining Snodgrass Slough, South Stone Lake, and Lost Slough.

West Delta Restoration Opportunity Area

The West Delta ROA consists of multiple small areas where tidal natural communities can be restored in the western Delta, in Conservation Zones 5 and 6. It primarily supports cultivated lands and grasslands in areas that were historically tidal wetlands but have been diked and hydrologically altered, isolating tidal natural communities in the Cache Slough ROA from Suisun Marsh. Areas suitable for restoration include Dutch Slough, Decker Island, portions of Sherman Island, Jersey Island, Bradford Island, Twitchell Island, Brannon Island, Grand Island, and along portions of the north bank of the Sacramento River where elevations and substrates are suitable.

South Delta Restoration Opportunity Area

The South Delta ROA, located in Conservation Zone 7, consists primarily of cultivated lands and a riverine system including the San Joaquin River and its tributaries. Potential sites for restoring freshwater tidal natural communities include Fabian Tract, Union Island, Middle Roberts Island, and Lower Roberts Island.

Site Preparation, Earthwork, and Other Site Activities

Construction site preparation could require clearing and grubbing, demolition of existing structures, surface water quality protection, dust control, establishment of storage areas and stockpile areas, temporary utilities and fuel storage, and erosion control.

Earthwork activities for development of the restoration habitat areas could include the construction activities described below on the landside and waterside of existing levees in areas that would be selected for tidal habitat restoration.

Modification of Landforms

Existing land elevations could be modified through grading and filling or subsidence reversal. These activities could be completed prior to breaching of levees and associated inundation of the site, as well as in the water.

Grading activities performed as part of restoration actions could include excavation and filling of material, shaping disturbed soils to smoothly transition into existing elevations at boundaries of construction areas, and smoothing and contouring of the disturbed ground surfaces to provide shallow elevation gradients from marsh plain to upland transition habitat. The specific landform plans would be developed for each location and evaluated in future environmental documentation.

Soil could be moved from higher elevations in the area to provide fill for placement on subsided lands for establishment of tidal marsh. Fill could also be imported to fill the subsided areas. In some areas, tules could be planted and farmed for several years to raise the elevation of subsided lands.

In adjacent areas that would not be inundated, grading could occur to ensure positive drainage and provide more diverse geomorphic surfaces for habitat.

As described in Appendix 3B, *Environmental Commitments*, erosion and dust control measures would be implemented during construction, and a Stormwater Pollution Prevention Plan (SWPPP) would be developed for each site.

Breaching and Modification of Levees

Levee modifications, including levee breaching or lowering, could be performed to reintroduce tidal exchange, reconnect remnant sloughs, restore natural remnant meandering tidal channels, encourage development of dendritic channel networks, and improve floodwater conveyance. Levee modifications could involve the removal of vegetation and excavation of levee materials. Excess earthen materials could be temporarily stockpiled, then respread on the surface of the new levee slopes where applicable or disposed of offsite. Any breaching or other modifications would be required to be designed and implemented to maintain the integrity of the levee system and to comply with flood management standards and permitting processes. This would be coordinated with the appropriate flood management agencies. Those agencies may include USACE, DWR, CVFPB, and other flood management agencies.

During detailed analyses of each location, levee breach sizes necessary to provide full tidal exchange between sloughs, open water, and restored tidal marsh areas would be identified. Breach lengths would be developed for each site depending on channel hydraulic geometry. In larger inundated areas (e.g., more than 200 acres), the breaches could be more than 100 feet long and extend below the water elevations during high or low tides. The edges of the breaches would be protected from erosion and related failure of the adjacent levee. Erosion protection could include geotextile fabrics, rock revetments, riprap, or other material selected during future evaluations for each location. Aggregate rock could be placed on the remaining levees to provide an access road to the breach location.

Levee lowering could involve removal of material in the upper sections of an existing levee, re-contouring of the levee slopes to provide stability for the shorter levee, placement of erosion protection on the slopes and specifically on the top of the levee that was previously subject to tidal action. Lowering levees provides opportunities for seasonal or periodic inundation of lands during high flows or high tides. This technique could be used to improve habitat or to reduce velocities and elevations of floodwaters. To reduce erosion potential on the new levee crest, a paved or gravel access road could be constructed with short (approximately 1 foot) retaining walls on each edge of the crest to reduce undercutting of the roadway by high tides. Levee modifications could also include excavation of watersides of the slopes to allow placement of slope protection, such as riprap or geotextile fabric, and to modify slopes to provide levee stability. Erosion and scour protection could be placed on the landside of the levee and continued for several feet onto the land area away from the levee toe.

Exit channels would be excavated on lands to be inundated to allow fish to leave the inundated area as waters recede.

Neighboring levees could require modification to accommodate increased flows or to reduce effects of changes in water elevation or velocities along channels following inundation of tidal marshes. Hydraulic modeling would be used during subsequent analyses to determine the need for such measures.

New Levees

New levees would be constructed to separate lands to be inundated for tidal marsh from non-inundated lands, including lands with substantial subsidence. Levees could be constructed as described for the new levees at intake locations. Any new levees would be required to be designed and implemented to comply with applicable flood management standards and permitting processes. This would be coordinated with the appropriate flood management agencies, which may include USACE, DWR, CVFPB, and local flood management agencies.

Dredging

Restoration actions may include channel dredging, drying dredged spoils before hauling or placement, placement of dredged material on lands or levees, and disposal in spoils areas.

Depending on the locations and restrictions related to habitat and channel configuration, dredging operations may be staged from a barge floating in the channel or from the top of the levee. Dredging could be required periodically to maintain tidal circulation. Dredging methods can generally be classified in two categories: hydraulic dredging and mechanical dredging.

Hydraulic Dredging

Hydraulic dredging utilizes barge-mounted pumps equipped with hydraulic cutter jets to mobilize sediments and a siphon with a pump to move the water and dredge spoils, referred to as slurry, to settling ponds for dewatering. The size of the dewatering areas depends on slurry flow rate, amount of total dredge spoils, and settling rate of the material. This type of dredging results in the lowest developed sediment plumes in waterways; however, it requires management of large volumes of water. Hydraulic dredging is used in situations where there are large areas to be dredged, the concern for induced turbidity and harm to benthic vegetation is great, and there is ample area available for drying basins, as this method entrains more water in the sediment and requires greater drying capacity.

Mechanical Dredging

Mechanical dredging utilizes barge-mounted clamshell-type buckets or land-based drag line buckets to excavate the dredge spoils. Typically, the spoils are placed in holding areas on the barge for dewatering and transferred to a land disposal area for disposal. This dredging method results in more sediment in the waterway than does hydraulic dredging. However, the amount of water to be removed from the sediment prior to transport and disposal is less.

The clamshell dredging method excavates a water-sediment mix from the channel bottom with a clamshell bucket and deposits it to a drying basin or onto a barge to be transported to a drying basin. The operation may be staged from a barge floating in the channel or from the top of the levee, depending on restrictions in habitat and channel width. This method would likely be used in situations where there is limited space for drying basins, the likelihood of major disruption to vegetation and other organisms in the channel bottom is minimal, the area to be dredged is small, there are channel islands, or there is limited concern regarding temporary turbidity and sedimentation in the water.

The dragline dredging method excavates a water-sediment mix from the channel bottom with a bucket and deposits it either into a drying basin or onto a barge to be transported to a drying basin. The use of the dragline method requires sufficient height and swing clearance for the crane. The dragline method is effective in shaping the channel bottom with relative control.

Drying Operations

Dredged material may be placed into drying basins to be dried for beneficial reuse. Drying basins may be constructed on the landside of the levees, typically adjacent to the channel or suitable interior low areas. The basins would be constructed of onsite soil and compacted to reduce embankment erosion.

Three basins—primary, secondary, and return—are generally used for slurry from hydraulic dredging due to the amount of water in the slurry. The basins are typically connected by flashboard riser structures that control the overflow of water into the next basin and the waterway to ensure proper settling of sediments. The primary and secondary basins settle sediments over a period of 4–

5 weeks in each basin. Water in the return basin is then returned to the waterway. Each unlined basin could be up to 100 acres in surface area and up to 6 feet deep with 2 feet of freeboard.

For mechanical dredging, a single basin could be used. The sediments settle over a period of 2–6 weeks. Dredged material would be tested to determine the presence of toxic materials prior to reuse. Clean dredge spoils could be hauled and placed on agricultural land or on low areas identified for subsidence reversal.

Construction Detour/Access Roads and Utilities Relocation

Relocation of existing roads and utilities could be required to support construction and postconstruction activities at the restoration project site or services to adjacent lands protected by levees. Roads and utilities on the levees to be breached or lands to be inundated that required modification would be constructed to a condition equal to or better than the preconstruction conditions.

Revegetation

Restored freshwater tidal marsh plains would be vegetated primarily with tules and other native freshwater emergent vegetation to reflect the historical composition and densities of Delta tidal marshes. Restored brackish tidal marsh plains, such as Suisun Marsh, would be dominated by native brackish marsh vegetation (e.g., pickleweed, saltgrass) appropriate to marsh plain elevations, mimicking the composition and densities of historical Suisun Bay brackish tidal marshes.

To facilitate revegetation of disturbed areas, weed eradication could be used followed by a combination of passive and active revegetation approaches. Passive revegetation techniques could include altering the hydrologic regime to promote the establishment of desirable native vegetation. Active revegetation techniques may include direct seeding and planting of seedlings or containerized stock. Prior to revegetation, undesirable vegetation species could be treated or removed from the restoration site. Disking and ripping could be required to allow for water filtration and deeper penetration and faster growth of plant roots. Direct seeding could be done by broadcasting, hydroseeding, or drill seeding. Soil amendments could be applied to the revegetated area.

Implementation of this conservation measure will be informed through compliance and effectiveness monitoring, and adaptive management, as described in Chapter 3, *Conservation Strategy* (Section 3.4.4), of the BDCP.

3.6.3 ~~Conservation~~ Measures to Reduce Other Stressors

The BDCP has identified several issues, beyond water exports and habitat conditions, that affect the survival of covered species in the Delta. These other stressors include exposure to contaminants, competition, predation and changes to the ecosystem caused by nonnative species, entrainment at water intake pumps not operated by SWP and CVP, and fish passage. The proposed BDCP components related to reducing other stressors are described below. These components would be implemented under all action alternatives, except as otherwise specified.

3.6.3.1 Methylmercury Management (CM12)

This measure would minimize conditions that promote production of methylmercury in restored areas and its subsequent introduction to the foodweb, and to covered species in particular. Implementation of this conservation measure would require the following actions.

- Assessment of pre-restoration conditions to determine the risk that the project could result in increased mercury methylation and bioavailability
- ~~Define~~ Definition of design elements that minimize conditions conducive to generation of methylmercury in restored areas.
- ~~Define~~ Definition of adaptive management strategies that can be implemented to monitor and minimize actual post-restoration creation and mobilization of methylmercury into environmental media and biota.
- Implement appropriate measures to monitor and minimize methylmercury in site-specific restoration designs.

Restoration design would focus on the ecosystem restoration objectives; design considerations for mercury methylation would not interfere with restoration objectives. ~~The d~~Design elements that help to mitigate mercury methylation would be integrated into site-specific BDCP restoration designs based on site conditions, community type (tidal marsh, nontidal marsh, floodplain), and potential concentrations of mercury in pre-restoration sediments. The adaptive management strategies could be applied where site conditions indicate a high probability of methylmercury generation and effects on covered species. The minimization and mitigation of restoration-related mercury methylation will be accomplished primarily through implementation of Project-Specific Mercury Management Plans for each restoration project. Through this program, site-specific factors that determine methylation potential can be more accurately assessed, efforts can be coordinated with ongoing research and TMDL compliance efforts of the DWR Mercury Monitoring and Evaluation Section, and the best approaches to restoration design and adaptive management can be implemented. For each BDCP restoration project under CM4 *Tidal Habitat Restoration*, a project-specific methylmercury management plan would be developed and would ~~incorporate all of the methylmercury management measures discussed below or would include an explanation of why a particular measure should not or cannot be incorporated. Each project-specific plan would~~ include the following components.

- A brief review of available information on levels of mercury expected in site sediments/soils based on proximity to sources and existing analytical data.
- A determination if sampling for characterization of mercury concentrations ~~and/or post-restoration monitoring is warranted~~.
- A plan for conducting the sampling, if characterization sampling is recommended.
- A determination of the potential for the BDCP restoration action to result in increased mercury methylation.

If a potential for increased mercury methylation under the restoration action is identified, the following will also be included.

- Identification of any restoration design elements, mitigation measures, adaptive management measures that could be used to mitigate mercury methylation, and the probability of success of those measures, including uncertainties.

- Conclusion on the resultant risk of increased mercury methylation, and if appropriate, consideration of alternative restoration areas.

The BDCP Implementation Office, in conjunction with the Central Valley Water Board Methylmercury TMDL program, would provide for a programmatic quality assurance/quality control (QA/QC) program specifying sampling procedures, analytical methods, data review requirements, a QA/QC manager, and data management and reporting procedures. Each project-specific plan would be required to comply with these procedures to ensure consistency and a high level of data quality.

Because methylmercury is an area of active research in the Delta, each new project-specific methylmercury management plan would be updated based on the latest information about the role of mercury in Delta ecosystems or methods for its characterization or management. Results from monitoring of methylmercury in previous restoration projects would also be incorporated into subsequent project-specific methylmercury management plans. This program would be developed and implemented within the context of Methylmercury TMDL and Mercury Basin Plan Amendment requirements. In each of the BDCP project-specific methylmercury management plans developed under CM12, relevant findings and mercury control measures identified as part of TMDL Phase I Control Studies will be considered and integrated into restoration design and management plans. CM12 would also be implemented to meet any requirements of the U.S. Environmental Protection Agency (EPA) or the California Department of Toxic Substances Control actions.

The timing and phasing of implementing CM12 would be contingent upon the timing and phasing of individual restoration projects developed under BDCP.

The purpose of CM12, the Methylmercury TMDL, and the Mercury Basin Plan Amendment is to coordinate research and inform future actions concerning mercury methylation and measures to reduce methylation. In particular, the control studies conducted as part of the Methylmercury TMDL will include a description of mercury management practices identified in Phase I, and an evaluation of the effectiveness, costs, potential environmental effects, and overall feasibility of the control actions. At this time, there is no proven method to reduce methylation and mobilization of mercury into the aquatic system resulting from inundation of restoration areas. The measures listed below are meant to provide a list of current research that has indicated potential to mitigate mercury methylation. This list would be updated as additional information is produced by the Phase I Methylmercury TMDL control studies and other related research.

- Characterize mercury concentrations in soil to inform restoration design, postrestoration monitoring, and adaptive management strategies.
- Sequester methylmercury using low-intensity chemical dosing.
- Minimize microbial methylation through restoration design or management.
- Design restoration sites to maximize photodegradation, which removes methylmercury by converting it to the biologically unavailable, inorganic form of mercury.
- ~~Remediate sulfur-rich sediments with iron to reduce the activity of sulfide and the methylation of mercury.~~Add amendments to mitigate methylation.
- Cap mercury-laden sediments to limit methylmercury flux into the water column and exposure to biota.

Implementation of this conservation measure will be informed through compliance and effectiveness monitoring, research actions, and adaptive management, as described in Chapter 3, *Conservation Strategy,* (Section 3.4.12) of the BDCP. Key uncertainties associated with CM12 include the effectiveness of the measure in minimizing production and mobilization of methylmercury from lands in the reserve system and the foodweb and whether actions under CM12 interfere with the potential of a restoration project to meet its intended purpose. Compliance monitoring will document completion and implementation of site-specific methylmercury management plans for restoration sites. Effectiveness monitoring will assess how well CM12 minimizes production and mobilization of methylmercury from BDCP activities into the aquatic system and the foodweb. See Appendix D, *Substantive BDCP Revisions*, Section D.3.4.12, for further details regarding this measure.

3.6.3.4 Localized Reduction of Predatory Fishes (Predator Control) (CM15)

CM15 would reduce populations of predatory fishes at specific locations and eliminate or modify holding habitat for predators at selected locations of high predation risk (i.e., predation *hotspots*). This conservation measure seeks to benefit covered salmonids by reducing mortality rates of juvenile migratory life stages that are particularly vulnerable to predatory fishes. Predators are a natural part of the Delta ecosystem. Therefore, this conservation measure is not intended to entirely remove predators at any location, or substantially alter the abundance of predators at the scale of the Delta system. This conservation measure would also not remove piscivorous birds. Because of uncertainties regarding treatment methods and efficacy, implementation of CM15 would involve a discrete ~~pilot projects~~hotspot feasibility assessment study and research actions coupled with an adaptive management and monitoring program to evaluate effectiveness. Effects would be temporary, as new individuals would be expected to occupy vacated areas; therefore, removal activities would need to be continuous during periods of concern.

There are a number of sites throughout the Delta that are currently considered hotspots of predator aggregation or activity:

- Clifton Court Forebay
- CVP intakes
- Head of Old River
- Georgiana Slough
- Old and Middle Rivers
- Franks Tract
- Paintersville Bridge
- Human-made submerged structures (e.g., abandoned boats)
- Salvage release sites

In addition to these existing predation hotspots, the proposed BDCP is expected to create new hotspots:

- North Delta water diversion facilities – Large intake structures have been associated with increased predation by creating predator ambush opportunities and flow fields that disorient juvenile fish.

- Nonphysical fish barriers – Nonphysical fish barriers may attract predators such as striped bass.

There are likely other hotspots in the Delta beyond those listed here. The actions in this conservation measure would be applied to other hotspots in the Plan Area if those actions would help to fulfill the purpose of this conservation measure and help to meet the applicable biological goals and objectives.

The proposed program for a BDCP predator control measure includes two elements.

- Hotspot ~~Pilot Program~~Feasibility Assessment Study – Implement experimental treatment at priority hotspots, monitor effectiveness, assess outcomes, and revise operations with guidance from the BDCP Adaptive Management Team.
- Research Actions – With the adaptive management program, support focused studies to quantify the population-level efficacy of the ~~pilot program~~feasibility assessment study and any program expansion(s) intended to increase salmonid smolt survival through the Delta.

Under the ~~Hotspot~~ hotspot ~~Pilot Program~~feasibility assessment study, physical reduction techniques, such as ~~boat electrofishing,~~ hook-and-line fishing, predator lottery fishing tournaments, and passive and active capture, would be employed. The ~~pilot program~~feasibility assessment study would also evaluate the effectiveness of modifying or eliminating habitat features that provide holding habitat for predatory fish and/or increase capture efficiency by predators (e.g., abandoned boats and derelict structures). Because of the high degree of uncertainty regarding predation/competition dynamics for covered fish species and the feasibility and effectiveness of safely removing large fractions of existing predator populations, the proposed predator reduction program is envisioned as an experimental ~~pilot program~~feasibility assessment study within an adaptive management framework. The ~~pilot program~~feasibility assessment study would be carefully monitored and refined to determine which practices are effective. If the feasibility assessment study~~pilot program~~ shows that the main issues are resolvable, a defined predator reduction program may be implemented (i.e., defined in terms of predator reduction techniques and the sites and/or areas of the Plan Area where techniques will be employed). Research and monitoring would continue throughout the duration of the program to address remaining uncertainties and ensure the measures are effective (i.e., that they reduce ~~numbers and densities~~local abundance of predators and increase survival of covered salmonids).

The progress of the ~~Hotspot~~ hotspot ~~Pilot Program~~feasibility assessment study and research activities would be documented annually in the Adaptive Management and Monitoring Report. During year 1, the Implementation Office would evaluate the strategies for logistical issues, relative effectiveness, incidental impacts on covered fish, and cost-effectiveness. After year ~~1~~ 2 of ~~pilot program~~feasibility assessment study implementation, the Implementation Office would refine the scope and methodology of the ~~pilot program~~study—based on review and coordination with the resource agencies—and continue with implementation for an additional ~~5~~ 4 to ~~7~~ 6 years. At the end of this ~~pilot~~ implementation period, ~~program~~ study assessment would involve independent science review and publication of findings. After the reviews are considered, the Adaptive Management Team, in collaboration with the resource agencies, would refine operations and decide whether and in what form predator reduction and further adaptive management would continue. Key uncertainties associated with this measure include determining where predation is likely to occur in vicinity of new north Delta intakes, determining the best predator reduction techniques, determining predator density and distribution in vicinity of the north Delta intakes, prioritizing hotspots for localized predator reduction, and assessing the effects of localized predator reduction measures on covered fish species.

3.6.3.5 Nonphysical Fish Barriers (CM16)

CM16 would be implemented to improve the survival of outmigrating juvenile salmonids by using nonphysical barriers to redirect the fish away from channels and river reaches in which survival is lower than in alternate routes. The BDCP Implementation Office may install nonphysical barriers which would consist of technology appropriate for each site. These barriers may ~~that~~ use a combination of sound, light, and bubbles similar to the BioAcoustic Fish Fences (BAFFs) tested at the head of Old River and at Georgiana Slough. In addition to these BAFF system evaluations of what may be considered true nonphysical barriers, studies are also underway to determine the effectiveness of a floating fish guidance structure. This structure uses steel panels suspended from floats to change water currents so that fish are guided towards the center of the river (away from other channel entrances), but does not substantially change the amount of water entering the channels. Potential sites for nonphysical barrier placement include Georgiana Slough,~~at~~ head of Old River, Delta Cross Channel, ~~Georgiana Slough, and possibly~~ Turner Cut, and Columbia Cut (note that Turner and Columbia Cut each have two channels, and thus would require two barriers). Barriers at these locations have a high potential to deter juvenile salmonids from using specific channels/migration routes that may contribute to decreased survival resulting from increased predation and/or entrainment~~, or to direct juvenile salmonids to areas that may increase their survival such as Yolo Bypass~~. Other locations may be considered in the future if, for example, future research demonstrates differential rates of survival in Sutter and Steamboat Sloughs or in Yolo Bypass relative to the mainstem Sacramento River that justify redirecting fish into these migration pathways. Nonphysical barrier placement may also be accompanied by methods to reduce local predator abundance, if monitoring results indicate that barriers attract predators or direct covered fish species away from potential entrainment hazards but toward predator hotspots. Nonphysical fish barriers have not been shown to be effective for other covered fish species; thus, this conservation measure is only expected to yield beneficial outcomes for salmonids.

Site-specific conditions will drive the design of nonphysical barrier in terms of techniques to anchor and secure the structure, measures to indicate the location of the structure for the safety of waterway users (i.e., recreational boaters), and preferences for fish migration routes. BAFF structures may be appropriate at the Georgiana Slough, Head of Old River, and Delta Cross Channel sites, while floating structures may be suitable at the Turner Cut and Columbia Cut sites. As described in the BDCP, Chapter 8, *Implementation Costs and Funding Sources,* (Section 8.4.16), the capital and operational costs of nonphysical barriers increase dramatically in deep and wide sections of channels. Therefore, the expected and measured benefits of ~~the~~ barriers at ~~a~~ particular locations ~~will~~ must be evaluated against ~~its~~ their biological benefits.

Nonphysical barriers would be installed and operated from October to June or when monitoring determines that salmonid smolts are present in the target areas. Barriers would be removed and stored offsite while not in operation.

Implementation of this conservation measure by the BDCP Implementation Office would be informed through effectiveness monitoring that would be conducted as described in the BDCP Section 3.6, *Adaptive Management and Monitoring Program*. Monitoring would include studies to evaluate the effectiveness of nonphysical barriers using tagged juvenile salmonids. The studies would document the interaction of tagged fish with nonphysical barriers and the effectiveness of nonphysical barriers at directing fish toward preferred migration routes/channels and away from channels or migration routes that have higher mortality associated with either predation and/or entrainment.

Uncertainty regarding the potential attraction of predators to nonphysical barriers and the effectiveness of barriers under certain conditions (i.e., in high flow areas, areas with complex bathymetry or cover, or other areas that may have physical conditions that may limit their effectiveness) will be resolved as this conservation measure is implemented on an individual project level. Thus evaluating the potential attraction of predators and the effectiveness of nonphysical barriers under various conditions would also be part of the monitoring to be completed as part of this conservation measure. Changes, should any be warranted based upon the results of monitoring and evaluating the effectiveness of nonphysical barriers, would be approved through the adaptive management decision making process, and implemented through subsequent annual work plans.

Implementation of this conservation measure will be informed through compliance and effectiveness monitoring, research actions, and adaptive management, as described in Chapter 3, *Conservation Strategy,* (Section 3.4.16) of the BDCP. Monitoring elements may be modified, as necessary, to best assess the effectiveness of CM16 based on the best available information at the time of implementation.

3.6.3.7 Conservation Hatcheries (CM18)

This conservation measure would support establishment of new and expand existing conservation propagation programs and expand the existing programs for delta and longfin smelt. The BDCP Implementation Office would support two programs.

- The development of a delta and longfin smelt conservation hatchery by USFWS to house ~~a~~ delta and longfin smelt refugial populations and provide a continuing source of delta and longfin smelt for experimentation.
- The expansion of the refugial population of delta smelt and establishment of a refugial population of longfin smelt at the University of California (UC) Davis Fish Conservation and Culture Laboratory (FCCL) in Byron.

The principal purpose of this measure is to ensure the existence of refugial captive populations of both delta and longfin smelt, ~~thereby helping~~ to ~~reduce risks of~~provide insurance against the extinction ~~for~~ of these species. Bay-Delta populations of both delta smelt and longfin smelt have experienced dramatic declines over the past five decades of monitoring, including further declines over the past decade or so due to a combination of factors (Sommer et al. 2007; Baxter et al. 2008, 2010). The use of two refugial facilities will decrease the likelihood of ~~catastrophic~~ loss of captive fish to catastrophe, such as loss of facility power or water supply, or to disease. The second purpose of the refugial populations is to provide ~~would also constitute~~ a source of animals for experimentation, as needed, to address key uncertainties about delta and longfin smelt biology, the long-term genetic management of the refugial populations, and marking techniques that may facilitate future capture-mark-recapture research on wild fish. This approach minimizes the need to harvest wild stock for research purposes. The refugial populations established and maintained by USFWS with funding from the BDCP could also function as a source of animals for reintroduction or supplementation of wild populations. Reintroduction or supplementation is not proposed by the BDCP. However, if deemed necessary by the fish and wildlife agencies, and if technically feasible, the hatcheries could be used for this purpose independent of the BDCP.

~~Bay-Delta populations of both delta smelt and longfin smelt have experienced dramatic declines over the past five decades of monitoring, including further declines over the past decade or so due to a combination of factors (Sommer et al. 2007; Baxter et al. 2008, 2010). Delta smelt continue to decline. It is possible that very low population size could result in an Allee effect,[14] causing an even more rapid decline of the species due to factors unique to small populations (Baxter et al. 2008). Allee effects occur because, below a certain threshold, the individuals in a population can no longer reproduce rapidly enough to replace themselves, and the population spirals toward extirpation. Thus, if Allee effects are acting on the delta smelt population now, or do so in the future, then the risk of extirpation of delta smelt would increase. Longfin smelt abundance has followed a trend similar to delta smelt, culminating in record low abundance indices several times in the past decade (Sommer et al. 2007; Baxter et al. 2008, 2010), so there may also be a potential for Allee effects in the longfin smelt population.~~

The new facility proposed by USFWS would house genetically managed refugial populations of delta and longfin smelt. State-of-the-art genetic management practices would be implemented to maintain close genetic variability and similarity between hatchery-produced and natural-origin fish. The facility would be designed to provide captive propagation of other species, if necessary, in the future. The specifications and operations of this facility have not been developed, nor has the facility location been determined, though it is expected to be located within the Plan Area~~ in the vicinity of Rio Vista~~. Additional permitting and environmental documentation would be needed to implement this conservation measure once facility designs and funding are available. Because of these challenges, it is expected that design, permitting, and construction of the facility would take approximately 6 years, with the facility becoming operational by year 7.

The BDCP Implementation Office would, as appropriate, enter into binding Memoranda of Agreement or similar instruments with USFWS and UC Davis. If and when populations of these species are considered recovered by USFWS, the Implementation Office would terminate funding for the propagation of the species and either fund propagation of other BDCP covered fish species, if necessary and feasible, or discontinue funds to this conservation measure and reallocate them to augment funding of other conservation measures identified in coordination with the fish and wildlife agencies through the BDCP adaptive management process.

Implementation of this conservation measure will be informed through compliance and effectiveness monitoring that will be conducted by the BDCP Implementation Office, as described in Chapter 3, *Conservation Strategy,* (Section 3.4.18) of the BDCP. There is one key uncertainty associated with CM18: Can refugial populations of both delta and longfin smelt be maintained with little or no supplementation from wild stocks? Answering this question will require the development of techniques for ensuring successful breeding and survivorship, so that refugial populations can be shown to increase without further supplementation from wild stocks.

3.6.3.11 Avoidance and Minimization Measures ~~(CM22)~~

~~Under CM22, t~~The BDCP Implementation Office would implement measures to avoid and minimize effects on covered species and natural communities that could result from BDCP covered activities. The AMMs that would be implemented through this framework are detailed in the BDCP Appendix 3.C, *Avoidance and Minimization Measures*, RDEIR/SDEIS Appendix D, and summarized in

[14] ~~Examples of Allee effects are when reproductive output per fish declines at low population levels and/or increases at high population levels (Allee 1931).~~

Table 3-15. These measures would be implemented for covered activities throughout the BDCP permit term.

Specific AMMs would be developed for each individual BDCP project, as appropriate, based on the comprehensive avoidance and minimization measures described in Appendix 3.C, *Avoidance and Minimization Measures* of the BDCP, and summarized in Table 3-15. Identification and implementation of the appropriate AMMs for each project would occur in four phases.

- **Planning-level surveys and project planning.** Site-specific surveys would be conducted during the project planning phase to identify natural communities, covered species habitat, and covered species to which AMMs apply. Projects would be designed to avoid and minimize impacts as described in Appendix 3.C, *Avoidance and Minimization Measures*, of the BDCP.
- **Preconstruction surveys.** Biological surveys may be necessary during the months or weeks prior to project construction, depending on the results of the planning surveys, as specified in Appendix 3.C, *Avoidance and Minimization Measures*, of the BDCP. Results of the planning surveys will be used to determine whether additional measures would be applied just prior to or during construction (e.g., establishing buffers around kit fox dens or covered bird species nests). Preconstruction surveys may also involve site preparation actions such as collapsing unoccupied burrows.
- **Project construction.** BMPs and other AMMs would be implemented during project construction as described in Appendix 3.C of the BDCP, *Avoidance and Minimization Measures*. For some activities, as specified in Appendix 3.C, a biological monitor will be present to ensure that the measures are effectively implemented. For some species (e.g., California red-legged frog), the biological monitor would relocate individuals from the construction area to specified nearby safe locations.
- **Operation and maintenance.** Some of the AMMs apply to long-term operation and maintenance activities, such as operation and maintenance of the water conveyance facilities and ongoing covered species' habitat enhancement and management. Appropriate measures would be identified during the project planning phase and implemented throughout the life of the project. AMMs applicable to long-term enhancement and management would be incorporated into site-specific management plans.

1 **Table 3-15. Summary of the Avoidance and Minimization Measures**

Number	Title	Summary
Benefit All Natural Communities and Covered Species		
1	Worker Awareness Training	Includes procedures to educate construction personnel on the types of sensitive resources in the project area, including sensitive timing windows for covered species, the applicable environmental rules and regulations, and specific training on the measures required to avoid and minimize effects on these resources.
2	Construction Best Management Practices and Monitoring	Standard practices and measures that will be implemented prior, during, and postconstruction to avoid or minimize effects of construction activities on sensitive resources (e.g., species, habitat), and monitoring protocols for verifying the protection provided by the implemented measures.
Primarily Benefit Covered Fishes		
3	Stormwater Pollution Prevention Plan	Includes measures that will be implemented to minimize pollutants in stormwater discharges during and after construction related to covered activities, and that will be incorporated into a Stormwater Pollution Prevention Plan to prevent water quality degradation related to pollutant delivery from project-area runoff to receiving waters.
4	Erosion and Sediment Control Plan	Includes measures that will be implemented for ground-disturbing activities, to control short-term and long-term erosion and sedimentation effects and to restore soils and vegetation in areas affected by construction activities, and that will be incorporated into plans developed and implemented as part of the National Pollutant Discharge Elimination System permitting process for covered activities. It is anticipated that multiple erosion and sediment control plans will be prepared and implemented for BDCP construction activities, each taking into account site-specific conditions such as proximity to surface water, erosion potential, drainage, etc.
5	Spill Prevention, Containment, and Countermeasure Plan	Includes measures to prevent and respond to spills of hazardous material that could affect navigable waters, including actions used to prevent spills, in addition to specifying actions that will be taken should any spills occur, and emergency notification procedures. Measures in AMM5 will be included in site-specific plans.
6	Disposal and Reuse of Spoils, Reusable Tunnel Material (RTM), and Dredged Material	Includes measures for handling, storing, beneficial reuse, and disposing of excavation or dredge spoils and RTM, including procedures for the chemical characterization of this material or the decant water to comply with permit requirements, and reducing potential effects on aquatic habitat, as well as specific measures to avoid and minimize effects on species in the areas where RTM would be used or disposed.
7	Barge Operations Plan	Includes measures to avoid or minimize effects on aquatic species and habitat related to barge operations, by establishing specific protocols for the operation of all project-related vessels at the construction and/or barge landing sites. AMM7 also includes monitoring protocols to verify compliance with the plan and procedures for contingency plans. Measures in AMM7 will be included in a Barge Operations Plan.
8	Fish Rescue and Salvage Plan	Includes measures that detail procedures for fish rescue and salvage to avoid or minimize the number of Chinook salmon, steelhead, green sturgeon, and other covered fish stranded during construction activities, especially during placement and removal of cofferdams at intake construction sites. Measures in AMM8 include appropriate procedures for excluding fish from the construction zones and procedures for removing and handling fish should they become trapped, and will be included in a Fish Rescue and Salvage Plan.

Number	Title	Summary
9	Underwater Sound Control and Abatement Plan	Includes measures to minimize the effects of underwater construction noise on fish, particularly from impact-pile-driving activities. Potential effects of pile driving will be minimized by restricting work to the least sensitive period of the year and by controlling or abating underwater noise generated during pile driving.
Primarily Benefit Covered Plants, Wildlife, or Natural Communities		
10	Restoration of Temporarily Affected Natural Communities	Restore and monitor natural communities in the Plan Area that are temporarily affected by covered activities. Measures in AMM10, including methods for stockpiling and storing topsoil, restoring soil conditions, and revegetating disturbed areas; schedules for monitoring and maintenance; strategies for adaptive management; reporting requirements; and success criteria, will be incorporated into restoration and monitoring plans.
11	Covered Plant Species	Conduct botanical surveys during the project planning phase and implement protective measures, as necessary. Redesign to avoid indirect effects on modeled habitat and effects on core recovery areas.
12	Vernal Pool Crustaceans	Design projects to minimize indirect effects on modeled habitat and avoid effects on core recovery areas. Where practicable, the project will be planned and designed to ensure no ground-disturbing activities or alterations to hydrology will occur within 250 feet of vernal pool crustacean habitat; over the 50-year permit term no more than 20 wetted acres will be indirectly affected by covered activities within 250 feet of vernal pools. If conservancy or longhorn fairy shrimps are detected in core recovery areas, conduct protocol-level surveys, and redesign projects to ensure that no suitable habitat within these areas is adversely affected, due to the rarity of these species.
13	California Tiger Salamander	During the project planning phase, identify suitable habitat in and within 1.3 miles of the project footprint and implement protective measures in those areas. During the planning phase, aquatic habitats in potential work areas will be surveyed (nonprotocol) for California tiger salamander larvae and eggs. If California tiger salamander larvae or eggs are found, the project will be designed to avoid and minimize impacts on the aquatic habitat. If the aquatic habitat cannot be avoided, measures will be developed to relocate larvae or eggs to the nearest suitable aquatic habitat, as determined by the USFWS- and CDFW-approved biologist.
14	California Red-Legged Frog	During the project planning phase, identify suitable habitat in and within 1 mile of the project footprint, conduct one preconstruction survey within 1 week of construction, and implement protective measures for areas where species presence is known or assumed. During the planning phase, appropriate buffer distances will be established around aquatic habitat to minimize direct and indirect effects on California red-legged frog. If aquatic habitat cannot be avoided, aquatic habitats in potential work areas will be surveyed (nonprotocol) for tadpoles and egg masses. If California red-legged frog tadpoles or egg masses are found, and the aquatic habitat cannot be avoided, measures will be developed to relocate tadpoles and eggs to the nearest suitable aquatic habitat, as determined by the USFWS- and CDFW-approved biologist.
15	Valley Elderberry Longhorn Beetle	During the project planning phase, conduct surveys for elderberry shrubs within 100 feet of covered activities involving ground disturbance, and design project to avoid effects within 100 feet of shrubs, if feasible. Implement additional protective measures, as stipulated in AMM2. Elderberry shrubs identified within project footprints that cannot be avoided will be transplanted to previously approved conservation areas in the Plan Area.

Number	Title	Summary
16	Giant Garter Snake	During the project planning phase, identify suitable aquatic habitat (wetlands, ditches, canals) in the project footprint. Conduct preconstruction surveys during active period (May 1 to September 30) of suitable habitat using survey protocols approved by USFWS and CDFW, and implement protective measures. To the extent practicable, construction activities will be avoided within 200 feet of the banks of giant garter snake aquatic habitat, particularly in areas with a moderate to high likelihood of giant garter snake presence.
17	Western Pond Turtle	Identify suitable aquatic habitat and upland nesting and overwintering habitat in and within the project footprint. Conduct preconstruction surveys in suitable habitat twice, including 1 week before and within 48 hours of construction. Implement protective measures as described.
18	Swainson's Hawk and White-Tailed Kite	Conduct preconstruction surveys of potentially occupied breeding habitat in and within 0.25 mile of the project footprint to locate active nest sites. Surveys will be conducted to ensure nesting activity is documented prior to the onset of construction activity. Swainson's hawks nest in the Plan Area between approximately March 15 and September 15. Construction activity that is planned after March 15 of any year will require surveys during the year of the construction. If construction is planned before March 15 of any year, surveys will be conducted the year immediately prior to the year of construction. If construction is planned before March 15 of any year and subject to prior-year surveys, but is later postponed to after March 15, surveys will also be conducted during the year of construction.
19	California Clapper Rail and California Black Rail	Identify suitable habitat in and within 500 feet of the project footprint. Surveys will be initiated sometime between January 15 and February 1. A minimum of four surveys will be conducted. The survey dates will be spaced at least 2 to 3 weeks apart and will cover the time period from the date of the first survey through the end of March and mid-April. Surveys can be avoided if presence is assumed and protective measures are implemented as if the species is present. Implement protective measures in areas where species is present or assumed to be present. Activities within or adjacent to tidal marsh areas (and managed wetlands for California black rails) will be avoided during the rail breeding season (February 1 through August 31), unless surveys are conducted to determine rail locations and territories can be avoided.
20	Greater Sandhill Crane	Conduct preconstruction surveys within the identified greater sandhill crane winter use area to determine the presence of occupied winter roost sites in and within 0.5 mile of the project footprint during mid-September through March 7 of each construction year. Implement protective measures in occupied areas. Minimize indirect effects of conveyance facility construction through temporary (during construction) establishment of 700 acres of roosting/foraging habitat. The established habitat will consist of active cornfields that are sequentially flooded following harvest to support roosting cranes and provide highest-value foraging habitat. Individual fields will be at least 140 acres in 40-acre rotating blocks. These fields can shift locations throughout the Greater Sandhill Crane Winter Use Area, but will be located within 0.25 mile of the indirectly affected habitat.
21	Tricolored Blackbird	Conduct preconstruction surveys in breeding habitat in and within 1,300 feet of the project footprint if the project is to occur during the breeding season. Three surveys will be conducted within 15 days of ground disturbance during the breeding season (approximately mid-March through late August) prior to project activity, and during the construction year. Implement protective measures in occupied areas. Projects will be designed to avoid construction activity to the maximum extent practicable up to 1,300 feet, but not less than a minimum of 250 feet, from an active tricolored blackbird nesting colony.

Number	Title	Summary
22	Suisun Song Sparrow, Yellow-Breasted Chat, Least Bell's Vireo, Western Yellow-Billed Cuckoo	Conduct preconstruction surveys of potential breeding habitat in and within 500 feet of project activities. At least five surveys will be conducted in suitable habitats within 30 days prior to construction, with the last within 3 days prior to ground disturbance. It may be necessary to conduct the breeding bird surveys during the preceding year depending on when construction is scheduled to start. Implement protective measures in occupied areas.
23	Western Burrowing Owl	Western burrowing owl habitat surveys will be required where burrowing owl habitat (or sign) is encountered within and adjacent to (within 150 meters [492 feet]) a proposed project area. Species surveys in suitable habitat are required in both breeding and nonbreeding seasons. If burrowing owls or suitable burrowing owl burrows are identified during the habitat survey, and if the project does not fully avoid direct and indirect impacts on the suitable habitat, preconstruction surveys will be required. Preconstruction surveys may be conducted up to 14 days before construction. Suitable habitat is fully avoided if the project footprint does not impinge on a designated nondisturbance buffer around the suitable burrow. For occupied burrowing owl nest burrows, this nondisturbance buffer could range from 50 to 500 meters (164 to 1,640 feet).
24	San Joaquin Kit Fox	Conduct habitat assessment in and within 250 feet of project footprint. If suitable habitat is present, implement USFWS guidelines. Within 14 to 30 days prior to ground disturbance conduct a preconstruction survey in areas identified by the habitat assessment as being suitable breeding or denning habitat. Surveys will be conducted within the project footprint and the area within 250 feet beyond the footprint to identify known or potential San Joaquin kit fox dens. Implement protective measures in occupied areas.
25	Riparian Woodrat and Riparian Brush Rabbit	Surveys will be conducted for projects occurring within suitable habitat as identified from habitat modeling and by additional assessments conducted during the planning phase of construction or restoration projects following USFWS *Draft Habitat Assessment Guidelines and Survey Protocol for the Riparian Brush Rabbit and the Riparian Woodrat*. Implement protective measures in suitable habitat.
26	Salt Marsh Harvest Mouse and Suisun Shrew	Identify suitable habitat in and within 100 feet of the project footprint for projects in the species range. Ground disturbance will be limited to the period between May 1 and November 30, to avoid destroying nests with young. Prior to ground-disturbing activities, vegetation will first be removed with nonmechanized hand tools (e.g., goat or sheep grazing, or in limited cases where the biological monitor can confirm that there is no risk of harming salt marsh harvest mouse or Suisun shrew). Implement protective measures in suitable habitat.
27	Selenium Management	Develop a plan to evaluate site-specific restoration conditions and include design elements that minimize any conditions that could be conducive to increases of bioavailable selenium in restored areas. Before ground-breaking activities associated with site specific restoration occur, identify and evaluate potentially feasible actions for the purpose of minimizing conditions that promote bioaccumulation of selenium in restored areas.
28	Geotechnical Studies	Conduct geotechnical investigations to identify the types of soil avoidance or soil stabilization measures that should be implemented to ensure that the facilities are constructed to withstand subsidence and settlement and to conform to applicable state and federal standards. The geotechnical investigation will also include a small-scale environmental screening to assess the presence or absence of dissolved gases that will help guide the tunnel ventilation design and disposal considerations for excavated materials and tunnel cuttings. Detailed subsurface investigations will be performed at the locations of the water conveyance alignment and facility locations and at material borrow areas.

Number	Title	Summary
29	Design Standards and Building Codes	Ensure that the standards, guidelines, and codes, which establish minimum design criteria and construction requirements for project facilities, will be followed. Follow any other standards, guidelines, and code requirements that are promulgated during the detailed design and construction phases and during operation of the conveyance facilities.
30	Transmission Line Design and Alignment Guidelines	The location and design of the proposed new transmission lines will be conducted in accordance with electric and magnetic field (EMF) guidance adopted by the California Public Utility Commission, *EMF Design Guidelines for Electrical Facilities* (2006). The alignment of proposed transmission lines will be designed to avoid sensitive terrestrial and aquatic habitats when siting poles and towers to the maximum extent feasible. When not feasible, impacts will be minimized to the greatest degree feasible and disturbed areas will be returned, as near as reasonably and practically feasible, to preconstruction conditions. Tower and pole placement will avoid existing structures to the extent feasible. Where poles or towers are to be constructed in agricultural areas, the following BMPs will be implemented, as applicable and feasible.
31	Noise Abatement	Develop and implement a plan to avoid or reduce potential construction-, maintenance-, and operation-related in-air noise impacts. To the extent feasible, the contractor will employ best practices to reduce construction noise, particularly during daytime and evening hours (7:00 a.m. to 10:00 p.m.) such that construction noise levels do not exceed 60 dBA L_{eq} (1 hour) at the nearest residential land uses.
32	Hazardous Material Management	Develop and implement site specific plans that will provide detailed information on the types of hazardous materials used or stored at all sites associated with the water conveyance facilities (e.g., intakes, intake pumping plants, maintenance facilities); phone numbers of applicable city, county, state, and federal emergency response agencies; primary, secondary, and final cleanup procedures; emergency-response procedures in case of a spill; and other applicable information. The plan will include appropriate practices to reduce the likelihood of a spill of toxic chemicals and other hazardous materials during construction and facilities operation and maintenance. A specific protocol for the proper handling and disposal of hazardous materials will be established before construction activities begin.
33	Mosquito Management	To aid in mosquito management and control during construction of project facilities, consult with appropriate Mosquito and Vector Control Districts (MVCDs). Consultation will occur before the sedimentation basins, solids lagoons, and the intermediate forebay inundation area become operational. Once these components are operational, consult again with the MVCDs to determine if mosquitoes are present in these facilities, and implement mosquito control techniques as applicable. Develop and implement ~~a~~ one or more mosquito management plans, in consultation with appropriate MVCDs, for designing and planning restoration and conservation activities.
34	Construction Site Security	All security personnel will receive environmental training similar to that of onsite construction workers so that they understand the environmental conditions and issues associated with the various areas for which they are responsible at a given time. Security operations and field personnel will be given the emergency contact phone numbers of environmental response personnel for rapid response to environmental issues resulting from vandalism or incidents that occur when construction personnel are not onsite.

Number	Title	Summary
35	Fugitive Dust Control	Implement basic and enhanced control measures at all construction and staging areas to reduce construction-related fugitive dust and ensure the project commitments are appropriately implemented before and during construction, and that proper documentation procedures are followed. Ensure that measures will be implemented to the extent feasible to control dust during general construction activities.
36	Notification of Activities in Waterways	Before in-water construction or maintenance activities begin, appropriate agency representatives will be notified when these activities could affect water quality or aquatic species. The notification procedures will follow stipulations included in applicable permit documents for the construction operations.
37	Recreation	Implement measures to site and construct trails and other recreational facilities to avoid and minimize effects on sensitive habitat areas.

Implementation of ~~this~~ the ~~conservation measure~~AMMs will be informed through compliance and effectiveness monitoring and adaptive management, as described in Chapter 3, *Conservation Strategy,* (Section 3.4.22) of the BDCP and Appendix D of the RDEIR/SDEIS.

3.6.4 Water Conveyance Operational Components

3.6.4.1 Operations of Covered Activities and Associated Federal Actions

Covered Activities

North Bay Aqueduct Alternate Intake Project

The BDCP (or an alternative) would cover operation~~s~~, but not construction, of ~~any new facility associated with~~ the North Bay Aqueduct Alternat~~iv~~e Intake Project. ~~It is not yet known for certain when this facility will be constructed, nor have the details of construction been finalized. C~~The construction of ~~this~~ new ~~facility~~ facilities associated with the North Bay Aqueduct Alternate Intake Project is not covered under the BDCP. Consequently, construction activities will require separate environmental compliance, and compliance with ESA Section 7 and CESA. However, if the project is constructed and operated, its operations and maintenance are a covered activity, provided that they occur as here characterized. Operations will necessarily be an indirect effect to be evaluated under ESA Section 7 and compliance with applicable BiOps will ensure that the facility is operated in a manner that minimizes incidental take and avoids jeopardy or adverse modification of critical habitat. The BDCP addresses the possibility of providing further mitigation for permitted operational incidental take, and operational effects to non-ESA-listed covered species. The Proposed Authorized Entities will address these issues on behalf of the facility operator. This project includes an additional intake on the Sacramento River that would operate in conjunction with the existing North Bay Aqueduct intake at Barker Slough. The project would be used to accommodate projected future peak demand of up to 240 cfs.

3.6.4.2 North Delta and South Delta Water Conveyance Operational Criteria

Scenario H

Scenario H would incorporate criteria for the same elements as those referenced under Scenario B (the south Delta components of which are also sometimes referred to as Scenario 6). However, under this scenario, Delta outflow requirements in the spring and fall would be determined by the outcome of the decision tree. This scenario consists of ~~four~~ possible combinations of spring and fall outflow criteria that could result from the decision tree. Although the EIR/EIS only applies this scenario to Alternative 4 (the CEQA Preferred Alternative), Scenario H could be implemented with any other project alternative in order to create a hybrid alternative within the bookends created by the entire range of alternatives addressed in the EIR/EIS. As discussed in Section 3A.10.6.3 in Appendix 3A, if such a hybrid alternative is ultimately identified, the analysis of Alternative 4 (and Scenario H) in the EIR/EIS will provide important evidence and analysis to assist the public and decision makers to determine the relative impacts of the hybrid in combination with such outflow criteria. As described in Appendix D, *Substantive BDCP Revisions*, Section D.3.2.1, Scenario H incorporates additional guidelines pertaining to the activities of the adaptive management program and implementation of a real-time operations program. The extent to which real-time adjustments may be made to operations of CM1 or CM2 facilities would be limited by the criteria and/or ranges set out in CM1 and CM2. That is, operational adjustments would be consistent with the criteria, and within any ranges, established in the conservation measures.

Delta Inflow and Outflow Criteria

Decision Trees

The decision tree process is a focused form of adaptive management that will be used to determine, at the start of new operations the fall and spring, outflow criteria that are required to achieve the conservation objectives of the BDCP for delta smelt and longfin smelt and to promote the water supply objectives of the BDCP. Other BDCP-covered fish species, including salmonids and sturgeon, may also be affected by outflow. Their outflow needs will also be investigated as part of the decision tree process.

Under Scenario H, CM1 includes two decision trees, one for fall outflow and one for spring outflow, that specify potential alternative outcomes for each criterion. Because each decision tree identifies two possible outcomes, the decision trees lay out four potential outcomes in outflow criteria when the spring and fall outflow components are combined, as described in Table 3-25. These four outcomes will be aggressively investigated through the decision tree process. Project operating criteria will be subject to a new determination by the fish and wildlife agencies, consistent with the adaptive management process for the BDCP, based on best available science developed as described below, specifying what the spring and fall outflow criteria will be at the time CM1 operations begin. These criteria may correspond to one of the decision tree outcomes, or to an intermediate outcome that falls within the limits established by the four decision tree outcomes.

Under the decision-tree process, hypotheses supporting each criterion will be tested in detail during the years before CM1 operations commence. The information gained during this period will be used to conduct a reevaluation of the initially specified criteria, based on all new scientific information, to decide what criteria (or operating criteria intermediate between those of each decision tree) will be selected for implementation at the beginning of CM1 operations. The decision-tree process will involve the following steps.

1. Clearly articulate scientific hypotheses designed to reduce uncertainty about what outflow criteria are needed to achieve the biological objectives for covered smelt species, salmonids, and sturgeon.

2. Develop and implement a science plan and data collection program based on the decision tree management alternatives to test the hypotheses and reduce uncertainties.

3. At the time CM1 operations begin, the fish and wildlife agencies identify spring and fall outflow criteria sufficient to meet the Plan's biological objectives for covered fish species.

Once CM1 operations begin, the decision-tree process will end. Thereafter, the adaptive management and monitoring program will continue as the primary process for adjusting all aspects of the conservation strategies, including spring and fall outflow operating criteria for CM1 operations for all covered species.

Evaluation of the Decision Trees in Impact Analysis

As described in the sections above, Scenario H includes two decision trees and each decision tree has two ~~possible~~ outcomes. When combined, there are four ~~possible~~ primary outcomes (scenarios) in outflow criteria (however, as described above, operating criteria may correspond to an intermediate outcome that falls within the limits established by these primary decision tree outcomes). Because the environmental effects resulting from each of these scenarios may differ, in some resource chapters, Scenario H is divided into four scenarios, as shown Table 3-25. The range of environmental effects that could result from these four scenarios of the decision trees is then presented.

Table 3-25. Potential Outcomes for Delta Outflow under Scenario H Operations (Alternative 4)

		March–May	
		Outflows per D-1641 with adaptive management	Outflows per Table 3-24
September–November	Outflows per D-1641 with adaptive management	Scenario H1	Scenario H2
	Outflows per USFWS delta smelt BiOp for Fall X2	Scenario H3	Scenario H4

Operations for Delta Water Quality and Residence Criteria

The operations for Delta water quality and residence criteria under Scenario H would be the same as under Scenario A.

In-Delta Municipal, Industrial, and Agricultural Water Quality Requirements Criteria

The in-Delta municipal, industrial, and agricultural water quality requirements criteria under Scenario H would be the same as undersimilar to Scenario A. However, under Scenario H, water operations would be in accordance with State Water Board D-1641, including the Sacramento River compliance point at Emmaton (i.e., a shift in the compliance location to Threemile Slough would not be proposed, as under other alternatives).

3.7 Environmental Commitments

As part of the project planning and environmental assessment process, DWR will incorporate certain environmental commitments and BMPs into the proposed action alternatives to avoid or minimize potential impacts. DWR will also coordinate planning, engineering, design and construction, operation, and maintenance phases of the Plan with the appropriate agencies. Environmental commitments that will be incorporated in the project are described in Appendix 3B, *Environmental Commitments*. A number of these commitments are similar to one or more of the Avoidance and Minimization Measures described under Section 3.6.3.11. Because the AMMs have been specifically designed to avoid and minimize effects on covered species and natural communities, parallel environmental commitments have been identified in order to recognize the capacity of these practices to avoid or minimize potential impacts related to other environmental topics.

3.9 References Cited

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