Chapter 4
Approach to the Environmental Analysis

This chapter generally describes the approach to the environmental resource evaluation for the BDCP EIR/EIS. Specifically, this chapter presents an overview of the following.

- The framework for the environmental consequences analyses, including any relevant evaluation timeframes, and an overview of the project- and program-level analysis elements.
- The overall organization and content of the resource-specific analyses (Chapters 5–30).
- An overview of tools, analytical methods, and applications.

Resource-specific information on the approach and methodology for evaluating the alternatives is provided in each of the specific resource chapters.

4.1 Framework for the Environmental Analysis

The overall framework common to the environmental resource evaluations is described below. Specific analytic approaches and variations from the information provided below are described for each resource in Chapters 5–30 of this EIR/EIS.

4.1.1 Timeframes for Evaluation

As discussed in Chapter 3, *Description of Alternatives,* Section 3.3.2.1, the proposed BDCP would be implemented over a 50-year period, corresponding to the proposed 50-year lifespan of the incidental take permits. The conservation measures (CMs) that make up the BDCP alternatives have been designed to accommodate and respond over time to new information and greater scientific understanding of the Delta (adaptive management). Some CMs would be implemented immediately upon completion of environmental approvals, and others would be implemented over time. The implementation process and schedule will be coordinated, to the extent possible, to ensure that the proposed BDCP can be phased in a balanced manner so that sufficient environmental *commitments* (e.g., Best Management Practices [BMPs]) and mitigation occur before or concurrent with CM1 water facilities and related actions.

As described in the BDCP, Chapter 3, *Conservation Strategy*, the conservation strategy is divided into *near-term* and *long-term* implementation stages.[1] Implementation of the CMs will generally begin in year 0, the year in which regulatory authorizations are issued by the federal lead agencies and CDFW pursuant to the BDCP, and will be completed within 50 years.[2] CM1 would be implemented initially, including acquisition of lands, preparation and submittal of regulatory permit applications, preparation and execution of construction-related contracts, and facilities construction. As described in the BDCP, many of the remaining CMs are interrelated with operation of the facilities in CM1 and thus will be phased in following implementation of CM1, throughout the 50-year life of the

[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.

[2] Some projects will be implemented prior to permit issuance. For a description of these, please refer to Chapter 6 of the BDCP, Section 6.1, *Implementation Schedule*.

permits. (Refer to BDCP Chapter 6, *Plan Implementation*, for a detailed implementation schedule and a discussion of the adaptive management strategy to be used by the lead agencies in implementing and monitoring the success of the CMs.)

4.1.2 Project-Level and Program-Level Analyses

To address the level of scientific and commercial data underlying the BDCP, the length of time necessary to implement and achieve the benefits of the BDCP, and the extent to which the BDCP incorporates adaptive management strategies, the BDCP alternatives were evaluated at two levels of specificity in this EIR/EIS.

The broad environmental effects of the overall BDCP conservation strategy were evaluated at a program level of analysis. The BDCP conservation strategy incorporates an adaptive management process that is designed to facilitate and improve decision making during the implementation of the project. This process entails identifying adjustments and modifications to the BDCP as new information becomes available over time. Additionally, locations for restoration and preservation actions within the conservation zones have not been specifically identified at this time. Design information for the restoration and conservation strategies for aquatic and terrestrial habitat and other stressor reduction measures in CM2–CM22 is currently at a conceptual level. Accordingly, the analyses in this EIR/EIS address the effects of typical construction, operation, and maintenance activities that would be undertaken for implementation of CM2–CM22 at a program–level of analysis, describing what environmental effects may occur in future project phases. Additional, project-level environmental review will be completed as necessary prior to implementation of specific conservation measures other than CM1. For additional discussion of the other conservation measures which may require additional environmental review, see Appendix 1F, *Potential Future Environmental Compliance*. CM2–CM22 are described in detail in Chapter 3 of the EIR/EIS, Section 3.4, as well as in the BDCP, and are incorporated herein by reference.

Design information on the water conveyance facilities and existing facility operational changes is available at a project level; consequently, the CM1 elements of the BDCP alternatives are analyzed at a project level[3] of detail in this EIR/EIS. Chapter 3, *Description of Alternatives,* Section 3.4.1, provides a detailed description of the components of CM1, which, in summary, consist of various combinations of the following.

- New physical/structural components to divert and convey water with fish protections.
- New intakes with fish screens to divert water from locations along the Sacramento River in the north Delta, including installation of cofferdams during construction.
- An intermediate forebay and pumping plant for holding the diverted water.
- Conveyance options for carrying the diverted water south, consisting of a new pipeline/tunnel, a new peripheral canal, or new diversion gates and operable barriers on existing Delta channels.
- A new forebay at Byron Tract near Clifton Court Forebay connecting to existing State Water Project (SWP) and Central Valley Project (CVP) facilities.

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[3] Specific data on the location, design, schedule, and operation of the various components of CM1 have been developed. Available data include specific footprints for alternative CM1 facilities, locations of access roads and staging areas, estimates of crew sizes and construction equipment and vehicle use, and construction schedules, as well as employees and equipment required for operations. This information was used to analyze, at the project level, the effects of implementing the CM1 elements of the BDCP alternatives.

- Changes in existing SWP and CVP system operations that would affect the following.
  - Operation of the upstream SWP and CVP facilities and reservoirs, and associated changes in downstream river reaches.
  - Use of the south Delta intakes.
  - Water operations to improve aquatic habitat conditions and continue SWP and CVP Delta exports.

4.1.3 Analysis of the BDCP Alternatives

The BDCP consists of water conveyance facility components combined with water conveyance operational components (collectively CM1) and other conservation measures (CM2–CM22). Depending on the alternative, the water conveyance facility components would create a new conveyance mechanism to divert water from the north Delta to existing SWP and CVP export facilities in the south Delta, interacting with operational guidelines to achieve the planning goals outlined in the BDCP Planning Agreement. The BDCP conservation measures comprise specific actions that would be implemented to achieve the biological goals and objectives of the proposed Plan, and are a component of the Plan's conservation strategy.

The BDCP conservation strategy consists of multiple components designed to collectively achieve the overall BDCP planning goals of ecosystem conservation and water supply reliability. The conservation strategy includes biological goals and objectives; conservation measures; avoidance and minimization measures; and a monitoring, research, and adaptive management program. The conservation measures and effects analysis in the BDCP are incorporated by reference into this EIR/EIS. However, an independent impact analysis has been prepared for each of the resource areas (Chapters 5–30) and mitigation is presented where the impact analysis indicates it is necessary to meet the requirements of CEQA and NEPA.

Within the resource chapters, each impact discussion begins with a general explanation and assessment of potential effects relating to implementation of an action alternative. Within this discussion, a "*NEPA Effects*" header identifies the portion of the analysis which contains a conclusion specific to NEPA. This discussion is followed by a "*CEQA Conclusion*" section which may reflect the preceding analysis but draws a conclusion in reference to the CEQA baseline.

4.2 Resource Chapter Organization

Chapters 5–30 are organized as shown below.

- Environmental Setting/Affected Environment
- Regulatory Setting
- Methods for Analysis
- Environmental Consequences (including Mitigation Measures to avoid, reduce, or compensate for adverse effects)

A brief overview of each of these sections is provided below.

4.2.1 Environmental Setting/Affected Environment

4.2.1.1 CEQA and NEPA Baselines

Because CEQA and NEPA have different directives related to using a baseline for determining the impacts of the action, this draft EIR/EIS uses two baselines: one for determining the impacts of state and local agency actions under CEQA and one for determining the impacts of federal actions under NEPA. The CEQA baseline for assessing significance of impacts of any proposed project is normally the environmental setting, or existing conditions, at the time a Notice of Preparation (NOP) is issued (State CEQA Guidelines Section 15125[a]). This directive was recently interpreted and applied by the California Supreme Court in *Neighbors for Smart Rail v. Exposition Metro Line Construction Authority* (2013) 57 Cal.4th 439 (*Neighbors for Smart Rail*)) There, the court reiterated that "[t]he CEQA Guidelines establish the default of an existing conditions baseline even for projects expected to be in operation for many years or decades." (*Id*. at p. 455.) According to the Court, for such a project, "existing conditions constitute the norm from which a departure must be justified—not only because the CEQA Guidelines so state, but because using existing conditions serves CEQA's goals in important ways." (*Ibid*.) For example, "[e]ven when a project is intended and expected to improve conditions in the long term—20 or 30 years after an EIR is prepared—decision makers and members of the public are entitled under CEQA to know the short- and medium-term environmental costs of achieving that desirable improvement." (*Ibid*.) Further, "[a]n EIR stating that in 20 or 30 years the project will improve the environment, but neglecting, without justification, to provide any evaluation of the project's impacts in the meantime does not 'giv[e] due consideration to both the short-term and long-term effects' of the project … and does not serve CEQA's informational purpose well." (*Ibid*., quoting CEQA Guidelines, § 15126.2, subd. (a).) Although the Supreme Court did not adopt a strict prohibition against the exclusive use of a future baseline consisting of anticipated conditions at the commencement or mid-point of project implementation, any sole reliance on such a future baseline is only permissible where a CEQA lead agency can show, based on substantial evidence, that an existing conditions analysis would be "misleading or without informational value." (*Neighbors for Smart Rail*, *supra*, 57 Cal.App.4th at 457.)

Although originally formulated prior to the issuance of the *Neighbors for Smart Rail* decision, the CEQA baseline employed in this EIR/EIS is consistent with the principles outlined above. Following CEQA Guidelines section 15125(a), the CEQA baseline is developed to assess the significance of impacts of the BDCP alternatives in relation to the existing conditions at the time of the NOP. The Existing Conditions assumptions for the BDCP EIR/EIS include facilities and ongoing programs that existed as of February 13, 2009 (publication date of the most recent NOP and Notice of Intent [NOI] to prepare this EIS/EIR), that could affect or could be affected by implementation of the BDCP alternatives (refer to Appendix 1D, *Final Scoping Report*, for copies of the NOP and NOI).

In some instances, though, certain assumptions were updated within the CEQA lead agency's reasonable discretion. For example, the June 2009 Biological Opinion (BiOp) for salmonid species from National Marine Fisheries Service (NMFS) was included within the CEQA baseline even though it had not been issued in its final form as of February 2009. Because the December 2008 BiOp for the delta smelt from the United States Fish and Wildlife Service (USFWS) was in place as of February 2009, it made sense to also include the NMFS BiOp, which had been released in draft form prior to February 2009. DWR decided that it would have been anomalous to rely on the most current USFWS

BiOp with respect to delta smelt issues, but to ignore the soon to be adopted NFMS BiOp with respect to salmonid issues.

Even so, because of the importance of focusing on existing conditions, DWR as CEQA lead agency did not assume implementation of *all* aspects of either BiOp. In particular, DWR did not assume full implementation of a particular requirement of the delta smelt BiOp, known as the "Fall X2" salinity standard, which in certain water year types can require large upstream reservoir releases in fall months of wet and above normal years to maintain the location of "X2" at approximately 74 or 81 river kilometers inland from the Golden Gate Bridge. As of spring 2011, when a lead agency technical team began a new set of complex computer model runs in support of this EIR/EIS, DWR determined that full implementation of the Fall X2 salinity standard as described in the 2008 USFWS BiOp was not certain to occur within a reasonable near-term time frame because of a recent court decision and reasonably foreseeable near-term hydrological conditions. As of that date, the United States District Court in litigation filed by various water users over the delta smelt BiOp had failed to sufficiently explain the basis for Fall X2, and its implementation was uncertain in the foreseeable future. This uncertainty, together with CEQA's focus on existing conditions, led DWR to the decision to use a CEQA baseline without the implementation of the Fall X2 action in the draft EIR/EIS. However, for NEPA purposes, which uses a different method for assessing environmental effects of the action alternatives, the Fall X2 action is included in the NEPA point of comparison as discussed below.

Consistent with these considerations of the CEQA baseline, Existing Conditions for the BDCP EIR/EIS include continuation of operations of the SWP and CVP by DWR and Reclamation, respectively. Assumptions for the Existing Conditions related to operations of the SWP and CVP are described in the *Biological Assessment on the Continued Long-term Operations of the Central Valley Project and the State Water Project* (August 2008) prepared by Reclamation (2008) as modified by certain elements of the June 2009 NMFS BiOp and the December 2008 USFWS BiOp which would be expected to occur even in the absence of the proposed project. Detailed assumptions for the SWP and CVP operations are represented in hydrological and water quality analytical models, as described in Appendix 5A*, BDCP EIR/EIS Modeling Technical Appendix*, of the BDCP EIR/EIS. Appendix 3A, *Identification of Water Conveyance Alternatives, Conservation Measure 1*, provides additional information on assumptions made for Existing Conditions. Appendix 3D, *Defining Existing Conditions, No Action Alternative, No Project Alternative, and Cumulative Impact Conditions*, provides additional information on assumptions made and how these conditions are defined.

Neither NEPA nor the CEQ regulations for implementing NEPA contain a specific directive for using a baseline for determining an action's significant effects on the quality of the human environment. CEQ's *Forty Most Asked Questions Concerning CEQ's NEPA Regulations* provides that the no-action alternative may be used as a "benchmark, enabling decision makers to compare the magnitude of environmental effects of the action alternatives." Under NEPA, federal agencies have the discretion to define the point of comparison for assessing environmental effects of the alternatives as the no action alternative. Accordingly, the NEPA portion of this EIR/EIS uses the No Action Alternative (as described in Chapter 3, *Description of Alternatives*, Section 3.5.1) as the point of measurement for determining impacts of the federal action under NEPA. The No Action Alternative, sometimes referred to as the *future no action condition*, considers No Action to include continuation of operations of the SWP and CVP as described in the 2008 USFWS and 2009 NMFS BiOps and RPAs and other relevant plans and projects that would likely occur in the absence of BDCP actions. NEPA requires the evaluation of the potential effects of alternatives in comparison with the likely future No Action condition from the time that proposed actions are implemented and/or become operational. Nothing in NEPA or NEPA case law precludes NEPA lead agencies when using No Action scenarios as the point of comparison from including anticipated future conditions in the impact assessment. The No Action Alternative, unlike the CEQA baseline, assumes implementation of the Fall X2 salinity standard as described in the 2008 USFWS BiOp, as well as changes due to climate change that would occur with or without the proposed action or alternatives (Appendix 3D, *Defining Existing Conditions, the No Action/No Project Alternative, and Cumulative Impact Conditions*, Section 3D.2.2).

The No Action Alternative for the BDCP EIR/EIS entails programs, projects, and policies included in Existing Conditions assumptions (refer to Appendix 3D, *Defining Existing Conditions, the No Action/ No Project Alternative, and Cumulative Impact Conditions*). These assumptions also encompass programs, projects, and polices with clearly defined management and/or operational plans which are likely to occur by 2060, as well as facilities under construction as of February 13, 2009, because such actions and facilities are consistent with the continuation of existing management direction or level of management for plans, policies, and operations. The No Action Alternative assumptions also include facilities and programs that received approvals and permits in 2009 because those programs were consistent with existing management direction as of the NOP, assumptions for climate change and sea level rise, and those for implementation of selected RPA actions described in the 2008 USFWS and 2009 NMFS BiOps.

Although the baselines have been labeled as the CEQA and NEPA baselines, respectively, the CEQA analysis presented in the various resources chapters frequently mentions the NEPA baseline in order to fully explain the results based on the CEQA baseline. Under NEPA, the effects of sea level rise and climate change are evident both in the future (2060) condition and in the effects of the action alternatives. Under CEQA, in contrast, the absence of sea level rise and climate change in Existing Conditions results in model-generated impact conclusions that include the impacts of sea level rise and climate change with the effects of the action alternatives. As a consequence, a CEQA analysis that reported these conclusions without qualification and explanation would either overstate the true effects of the action alternatives or would misleadingly suggest significant effects that are largely or exclusively attributable to sea level rise and climate change, and not to the action alternatives themselves. In the interest of informing the public of what DWR believes to be the true reasonably foreseeable impacts of the project alternatives, DWR has reported some of the CEQA effects with an explanation regarding the extent to which the impacts of sea level rise and climate change are reflected in the bare impact conclusions as modeled. To help explain these points, DWR has frequently pointed the reader to the NEPA conclusions, as those conclusions, which use the No Action Alternative as the baseline for comparison, allow for more of an "apples to apples" comparison, in that the results of both the No Action Alternative and the Action Alternatives include both sea level rise. Thus, although the CEQA analysis relies on Existing Conditions as a baseline, the CEQA analysis often points to the NEPA analysis as a way of helping readers to better understand the actual impacts of alternatives vis-à-vis Existing Conditions. This approach is fully consistent with CEQA as understood by the California Supreme Court, which in *Neighbors for Smart Rail v. Exposition Metro Line Construction Authority* (2013) 57 Cal. 4th 439, 454, held that "nothing in CEQA law precludes an agency…from considering both types of baseline—existing and future conditions—in its primary analysis of the project's significant adverse effects[.]" Although here DWR did not use dual baselines, it has relied in part on the NEPA baseline in clarifying the results of analyses based solely on the CEQA baseline.

4.2.1.2 Definition of Study Area

As noted in Chapter 1, *Introduction,* Section 1.5, the project area for the actions evaluated in this EIR/EIS is larger than the proposed BDCP Plan Area and Areas of Additional Analysis, because some of the effects of implementing the BDCP would extend beyond the boundaries of this region. Therefore, the project area analyzed in this EIR/EIS consists of the following three geographic regions, as shown in Figures 1-3 through 1-9.

- Upstream of the Delta.
- Delta (also referred to as the Plan Area and Areas of Additional Analysis).
- SWP and CVP Service Areas.

Areas downstream of the Delta (e.g., San Pablo Bay, San Francisco Bay south to Golden Gate and Bay Bridge) were considered and were not included as a part of the BDCP's analysis. For additional discussion on this, see Appendix 5.C of the BDCP, *Flow, Passage, Salinity, and Turbidity*, Section 5C.5.2 *Upstream Habitat Results*. Resource-specific study areas are defined in the introductions to the analyses in Chapters 5–30. The resource-specific study areas do not always correspond to the geographic regions in the overall project area. The Environmental Setting/Affected Environment section for each of the resource topics discussed in Chapters 5–30 defines the specific study area for the resource that might benefit or be affected by implementation of the BDCP alternatives.

4.2.1.3 Presentation of Existing Conditions

Chapters 5–30 also each identify and characterize existing resources and describe historic changes and trends affecting the subject resource. Existing information was used, when available, to describe Existing Conditions for each resource. Further, where possible, this information was supplemented through site-specific assessment(s). DWR has attempted to gain access to certain private properties in an effort to conduct further studies and to gather additional relevant information; however, several areas were not accessible and other methods of data collection were used to assess Existing Conditions. For a detailed discussion of DWR's efforts to obtain legal access to inaccessible portions of the Plan Area, see Appendix 4A, *Summary of Survey Data Collection*. In some situations, where data from 2009 or immediately following 2009 was unavailable, could not be projected, or would be overly speculative, the most recent official data was used as a proxy for Existing Conditions.

4.2.2 Regulatory Setting

Chapters 5–30 each include a regulatory setting section describing the laws, regulations, and policies that affect the resource or the assessment of impacts on the specific resource. The regulatory framework for the analysis in each resource chapter is established in this section. CEQA and NEPA and their regulations are not described in the resource-specific Regulatory Setting sections. Refer to Chapter 1, *Introduction*, for a brief discussion of CEQA and NEPA and other pertinent laws, regulations, and policies, particularly Table 1-1.

4.2.3 Methods for Analysis

Chapters 5–30 each include a description of the methods for analysis describing the resource-specific approach methodology used to identify and assess the potential environmental impacts that may result from implementation of the BDCP alternatives. For those resource topics utilizing modeling output, a brief overview of the modeling tools and outputs is provided in Section 4.3, *Overview of Tools, Analytical Methods, and Applications.*

In choosing the models used in this EIR/EIS, the Lead Agencies selected widely accepted and frequently utilized tools which provide reliable outputs regarding the environmental effects of the proposed action alternatives and the extent to which future conditions would differ as between various alternatives. While advances in some of the modeling used may have been made since the time these analyses began, the models used in support of this document reflect consensus amongst lead agencies' expert staff and consultants at the time assessment methods were chosen. These models and associated limitations are further described in the individual resource chapters, as applicable. Discussion of key modeling efforts include those for Chapter 5, Water Supply (Section 5.3.1.1. *Quantitative Analysis of SWP and CVP Water Supply Impacts*; Appendix 5A, *BDCP EIR/EIS Modeling Technical Appendix*, Section D); Chapter 6, Surface Water (Section 6.3.1.1. *Quantitative Analysis of Surface Water Resources*; Appendix 5A, *BDCP EIR/EIS Modeling Technical Appendix*); Chapter 11, Fish and Aquatic Resources (BDCP Effects Analysis Appendix 5.B *Entrainment*, *Section B.5 Methods of Biological Analysis*); Chapter 12, Terrestrial and Biological Resources (Section 12.3.2.3. *Methods Used to Assess Species Effects*, BDCP Effects Analysis Appendix 2.A, *Covered Species Accounts*; BDCP Effects Analysis Appendix 5.J, *Effects on Natural Communities, Wildlife, and Plants*); Chapter 16, Socioeconomics (Section 16.2.1.2. *Delta Regional Employment and Income*); Chapter 22, Air Quality and Greenhouse Gases (Section 22.3.1. *Methods for Analysis*; Appendix 22A, *Air Quality Analysis Assumptions*).

4.2.4 Consideration of Seismic Risks and Climate Change on Action Alternatives

All of the BDCP Alternatives other than No Action would involve the construction of new infrastructure that would be designed and engineered in anticipation of sea level rise and the potential for major seismic events. For the No Action Alternative, seismic risk and climate change are specifically analyzed. For the other alternatives, the issues are generally discussed in the following portions of this EIR/EIS:

- Appendix 3B, *Environmental Commitments* (see Commitments 3.B.1, Perform Geotechnical Studies, and 3B.1.2 Conform with Applicable Design Standards and 36 Building Codes
- Appendix 3C, *Construction Assumptions*
- Appendix 3E, *Potential Seismic and Climate Change Risks to SWP/CVP Water Supplies*
- Appendix 3H, *Forebay Location Analysis*
- Appendix 3I, *BDCP Compliance with the 2009 Delta Reform Act*
- Chapter 5, *Water Supply* (discussion of No Action Alternative)
- Appendix 5B, *Responses to Reduced South of Delta Water Supplies*
- Chapter 6, *Surface Water* (6.3.1–6.3.3)
- Chapter 9, *Geology and Seismicity* (9.1.1.1.4.1–9.1.1.4.6, 9.2, 9.2.2.4, 9.3, 9.3.1.1, 9.3.3, 9.3.3.2)
- Chapter 29, *Climate Change*

As discussed in Appendix 3E, climate change and expected changes in precipitation patterns could affect the frequency and magnitude of extreme storms and storm-related flooding in the Delta. In addition, rising sea levels are expected to raise water levels in the Delta, placing additional stress on fragile Delta levees. These levees protect not only farmland but maintain hydrodynamic conditions in the Delta.

Chapter 29 discusses how the BDCP alternatives affect the resiliency and adaptability of the Plan Area to the effects of climate change. In this context, resiliency and adaptability mean the ability of the Plan Area to remain stable or flexibly change, as the effect of climate change increases, in order to continue providing water supply benefits with sufficient water quality and supporting ecosystem conditions that maintain or enhance aquatic and terrestrial plant and animal species. As climate change impacts many other resources areas analyzed in this EIR/EIS, Table 29-1 shows the linkages between these other resources/chapters and potential climate change effects.

As Chapter 29 explains, all of the BDCP alternatives would provide important added resilience and adaptability by creating new facility components that will offer options and flexibility in conveying water. Alternatives 1A through 8 would provide additional adaptability to catastrophic failure of Delta levees by providing an alternate conveyance route around the Delta. Alternative 9 adds additional resiliency to the Delta by strengthening and reinforcing levees critical to the through-Delta conveyance route. If the Delta were temporarily disrupted by levee failure, these alternatives would provide conveyance and interties that would enable continued water deliveries to SWP/CVP contractors and to local and in-Delta water users.

Within Chapter 5, *Water Supply*, the first portions of the discussion of the No Action Alternative address the following topics, among others: Potential for Abrupt Disruptions of South of Delta Water Supplies; Seismically Induced Levee Failures; Flood-Related Failures; and Potential Effects on the Export of Delta Water Supplies from Levee Failures. These are among the problems that the BDCP action alternatives, to varying degrees, are intended to address.

Chapter 6, *Surface Water*, evaluates flood management concerns, as well as surface water conditions due to construction and operation of conveyance facilities in the Delta. Each alternative was studied to determine the potential for causing 10 different flood management impacts. The analysis includes determination of the effects and the mitigation approaches for each alternative. Where alternatives could result in significant or adverse impacts to runoff patterns, drainage, and potential exposure to risks to people or structures, the analysis identified mitigation measures to reduce or prevent negative effects.

Chapter 9, *Geology and Seismicity*, describes the existing geologic and seismologic conditions and associated potential geologic, seismic and geotechnical hazards in the Sacramento-San Joaquin Delta and Suisun Marsh area. The hazards include surface fault ruptures (section 9.1.1.4.1), earthquake ground shaking (section 9.1.1.4.2), liquefaction (section 9.1.1.4.3), slope instability (section 9.1.1.4.4), ground failure and seismic-induced soil instability (section 9.1.1.4.5), and tsunami and seiche risks (section 9.1.1.4.6). Chapter 9 also sets forth the federal, state, and local regulatory structure for mapping, monitoring, regulating, and managing these public safety concerns. (Chapter 9, section 9.2.) State and federal design codes will regulate construction of the many structures that are part of the BDCP. These codes and standards establish minimum design and construction requirements, including design and construction of concrete and steel structures, levees, embankment dams, tunnels, pipelines, canals, buildings, bridges and pumping stations. The codes and standards are intended to ensure structural integrity and to protect public health and safety.

The EIR/EIS evaluates the potential effects that could result from project construction, operation, and maintenance due to geologic and seismic-related conditions and hazards. The evaluation considers the potential for these hazards to affect the constructed and operational elements of the alternatives and the potential for the elements of the alternatives to increase human health risk and loss of property or other associated risks.

DWR has also developed Conceptual Engineering Reports (CERs) for the conveyance facilities associated with each alternative alignment. The CERs describe the existing geologic conditions (based on available data), seismic hazards, and potential flood risks including sea-level rise due to climate change that the conveyance facilities will be subjected to. The CERs also describe the design criteria, government codes and safety standards that will be applied to insure that the new conveyance facilities will be able to withstand design level catastrophic events. These criteria include the ability to withstand a 6.75 magnitude earthquake (based on peak ground accelerations ranging from 0.23–0.57) and 200-year flood events combined with sea-level rise. (Appendix A of the CERs provides detailed discussion on regional and localized geology, seismic information, as well as, climate change impacts.)

4.2.5 Environmental Consequences

Chapters 5–30 each include an evaluation of the direct and reasonably foreseeable indirect impacts associated with implementation of the BDCP alternatives. Under NEPA, the purpose of an EIS is to describe and disclose the impacts of the alternatives. Under CEQA, however, the significance of the impact needs to be described. A "significant effect on the environment" is defined as a substantial, or potentially substantial, adverse change in the environment (CEQA Public Resources Code Section 21068). Therefore, to facilitate both CEQA and NEPA reviews, the Environmental Consequences sections in Chapters 5–30 document and describe potential resource-specific impacts, including for CEQA adequacy, a threshold of significance, mitigation that would reduce significant impacts, and a statement of each impact's significance before and after mitigation. Chapter 31, *Other CEQA/NEPA Required Sections*, addresses significant irreversible and irretrievable changes, short-term uses versus long-term productivity, selection of the environmentally superior alternatives, and a summary of significant and unavoidable impacts under CEQA.

Throughout the EIR/EIS, impacts are identified as temporary or permanent. These terms apply differently to different resources and are defined, where relevant, in each individual resource chapter (Chapters 5–30). Due to the nature of the impact, in some cases, impacts are treated as permanent, even though the impact mechanism would end following construction[4] of water conveyance facilities. For example, impacts to terrestrial biological resources that would end following construction activities are nonetheless treated as permanent impacts for the purposes of impact analysis where the resource would be removed or lost and would not be replaced at its original site. Even where the resource would be replaced, these impacts were characterized as being permanent due to the length of time between the loss of the resource and the first opportunity to restore or replace the resource. In this manner, such a definition represents a conservative characterization of the impact. For other resources, however, such as noise, when construction

[4] For the purposes of this EIR/EIS, the construction period for water conveyance facilities is generally assumed to be nine years. However, socioeconomic analyses based upon annual expenditures for labor, equipment, and materials reflect an eight-year construction period for these facilities, since these estimates were developed from a slightly older construction schedule. The differences between these schedules, for the purposes of these analyses, are minor because the final months of construction would require relatively small expenditures in comparison to those estimated for the peak construction periods.

ceases, so do related impacts associated with construction. In these cases, impacts are characterized as temporary.

Each of the action alternatives involves implementation of a specific operational scenario. However, due to the fact that over the past decades there has been considerable uncertainty and disagreement over the causes and the relative importance of various factors contributing to the decline of many Delta aquatic species, the Proposed Project (which implements Scenario H) includes a mechanism by which additional scientific information will be obtained and applied prior to commencement of operations of new and existing diversion and conveyance infrastructure. As described in Chapter 3, *Description of Alternatives*, Scenario H includes two decisions and each decision tree has two possible outcomes. Because the environmental effects resulting from each of these scenarios may differ, in some resource chapters, Scenario H is divided into four scenarios and the range of environmental effects that could result from these four scenarios of the decision trees is presented. However, the range captures the full extent of what the effect could be.

4.2.5.1 Resource-Specific Study Areas

For some resources, the types of changes anticipated would occur only in one of the defined geographic regions that make up the overall project area; in others, changes would occur in more than one region (i.e., Upstream of the Delta, Delta (corresponding to the BDCP Plan Area and Areas of Additional Analysis), and SWP and CVP Export Service Areas). Chapters 5–30 each describe the rationale for evaluating specific geographic regions in their introductory Environmental Setting sections. The study area defined in the setting for each resource considers the geographic areas involved in implementation of all the BDCP alternatives.

4.2.5.2 Cumulative Effects Analysis

An EIR must discuss impacts that are cumulatively considerable, meaning that "the incremental effects of the individual project are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects." (CEQA Guidelines Section 15065(a)(3)). Under CEQA, cumulative impacts are "two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts" (State CEQA Guidelines Section 15355; Public Resources Code Section 21083[b]). The focus under CEQA Cumulative Impacts is on whether the Proposed Project's incremental contribution to any significant cumulative impact is cumulatively considerable and thus significant in and of itself. (CEQA Guidelines, section 15065(a)(3).) CEQ's regulations for implementing NEPA define a cumulative effect as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7).

For this EIR/EIS, cumulative impacts were identified based on: (1) assumptions developed as part of CALSIM II water supply modeling, (2) information extracted from existing environmental documents or studies for the resource categories potentially affected by each project, (3) investigation of future project plans by other agencies and private entities, and (4) knowledge of expected effects of similar projects (CEQA Guidelines, section 15130, subdivision (a)(1).). Each resource chapter contains an analysis of the cumulative effects specific to that resource that would potentially result due to implementation of the BDCP and other cumulative projects. The analysis of cumulative climate change effects included quantitative and qualitative assessment approaches. Quantitative assessment approaches were applied to those resource topics that depended in whole or in part on CALSIM II modeling. These resource topics included water supply, surface water, water quality, fish and aquatic resources, recreation, energy, and growth inducement. The remaining resource topics assessed in the EIR/EIS evaluated the effects of climate change in a qualitative fashion. Potential cumulative effects are analyzed both quantitatively and qualitatively in this EIR/EIS.

In many cases, the resource-specific cumulative analysis is primarily qualitative and considers the contribution of the BDCP to other programs, projects and policies as identified in Appendix 3D, *Defining Existing Conditions, the No Action/No Project Alternative, and Cumulative Impact Conditions*, as well as assumptions for climate change and sea level rise. Appendix 5A, *BDCP EIR/EIS Modeling Technical Appendix*, describes how changes due to climate change and sea level rise were selected and integrated into the modeling in Section A.7, *Climate Change and Sea Level Rise Scenarios*. Chapters in which water-related impacts are more prominently discussed include a quantitative analysis of cumulative effects of the implementation of the BDCP including effects of climate change and sea level rise combined with qualitative assessments of other cumulative projects.

As provided for under CEQA (14 CCR 15130[b]) and consistent with NEPA (40 CFR 1508.7), the analysis of cumulative impacts is evaluated at a level of detail sufficient for the Lead Agencies to use as a reasonable basis for decision making in selecting between the alternatives.

4.2.5.3 Mitigation Approaches

Specific measures are proposed when necessary to avoid, reduce, minimize, or compensate for adverse environmental effects of the BDCP alternatives. Mitigation is also presented to meet CEQA's specific requirement that whenever possible, agency decision makers adopt feasible mitigation available to reduce a project's significant impacts to a less-than-significant level. Although NEPA does not impose a similar procedural obligation on federal agencies, this practice is consistent with NEPA's intent that mitigation be discussed in sufficient detail to ensure that environmental consequences have been fairly evaluated. Under Section 10 of the ESA, an applicant must minimize and mitigate the impacts of the taking of listed species, to the maximum extent practicable. Mitigation measures included in the EIR/EIS are considered to be potentially feasible; however, the ultimate determination of feasibility can be made only by state and federal lead agency decision makers. The EIR/EIS addresses whether the mitigation presented would reduce the impact to a less-than-significant level, based on the threshold of significance presented in each resource chapter. The term *mitigation* is specifically applied in this EIR/EIS to designate measures required to reduce residual environmental impacts, after considering the application of all environmental commitments (discussed below), as described for each resource in Chapters 5–30.

The mitigation actions in this EIR/EIS typically assign responsibility to "BDCP proponents." This term should be understood to mean different responsible parties in different contexts. DWR will implement actions associated with construction of *CM1 Water Facilities and Operation.* With respect to water operations-related conservation measures, DWR and Reclamation will coordinate implementation of actions associated with *CM1 Water Facilities and Operations* and water operations aspects of *CM2 Yolo Bypass Fisheries Enhancement*. In general, mitigation related to restoration and other activities in CM3–CM22 shall be the responsibility of a larger group of agencies (including DWR and Reclamation) as set forth in relevant portions of the BDCP. The responsibility changes for various reasons, including the jurisdiction of a particular agency, as defined for various BDCP proponents. Responsibilities for particular measures will be described in the Mitigation Monitoring and Reporting Program to be issued in connection with the Final EIR/EIS.

Certain elements have been incorporated into the alternatives and would be carried out as environmental commitments during project implementation. “Environmental commitments” is used here to refer to design features, construction methods, and other BMPs that have been incorporated as part of the project description to preclude the occurrence of environmental effects that could arise without such commitments in place. These environmental commitments tend to be relatively standardized and are often already compulsory; they represent sound and proven methods that can avoid or reduce the potential effects of an action—for example, installation of sedimentation barriers and other stormwater protections during grading—in contrast to mitigation measures that would be necessary to be included as part of project approval to offset the environmental effects of the proposed action. The rationale behind including environmental commitments is that the BDCP proponents (see discussion in preceding paragraph) commit to undertake and implement these measures as part of the project in advance of impact findings and determinations in good faith to improve the quality and integrity of the project, streamline the environmental analysis, and demonstrate responsiveness and sensitivity to environmental quality. Environmental commitments that are incorporated into the alternatives are detailed in Appendix 3B, *Environmental Commitments*.

4.3 Overview of Tools, Analytical Methods, and Applications

Several models and analytical methods were used to characterize and analyze the operational changes in water operations in the SWP and CVP systems under each alternative. These tools represent the best available technical tools for purposes of conducting the analyses at issue. The overall flow of information between the models and the general application and use of outputs for the resource evaluations are shown in Figure 4-1. Table 4-1 provides a description of the various modeling tools represented in Figure 4-1.

The models were used to compare and contrast the effects among various operating scenarios. The models incorporated a set of base assumptions; the assumptions were then modified to reflect the operations associated with each of the alternatives. The output of the models is used to show the comparative difference in the conditions among the different alternative scenarios. The model output does not predict absolute conditions in the future; rather, the output is intended to show what type of changes would occur. This type of model is described as comparative rather than predictive. Because of the comparative nature of these models, these results are best interpreted using various statistical measures such as long-term and year-type averages and probability of exceedance. Additionally, results from one model cannot be quantitatively compared to results from another model; therefore, comparisons between alternatives must be based on results that are derived from a consistent modeling approach.

In general, CALSIM II is used to simulate the operations of the SWP and CVP. The output of this model is then used by the DSM2 model to simulate the hydrodynamics, water quality, and particle tracking. With the information generated from these models, the water supply, flows, and water quality can be compared under different operating scenarios. The output from these models are then used by a variety of other models to support the comparative analysis of various other resources, such as land use, economics, energy, temperature, and other water quality characteristics.

In addition, resource-specific models were used to inform and support the impact analyses for several resources under each proposed alternative. These models, as well as the models used to characterize and analyze the changes in water operations for the SWP and CVP are described in Table 4-1. An overview of how these models were applied for the environmental consequences analyses is provided in the Methods for Analysis section of each applicable resource chapter. For additional information on species life-cycle models used in our analysis, please refer to the BDCP Effects Analysis, Appendix 5.G, *Fish Life Cycle Models*.

Table 4-1. Overview of BDCP EIR/EIS Modeling Tools[a]

Model Name	Description of Model
Artificial Neural Network (ANN) for CALSIM II	An ANN has been developed for CALSIM II that attempts to mimic the flow-salinity relationships in the Delta, as simulated in DSM2. It provides a rapid transformation of this information into a form usable by the CALSIM II operations model. The ANN is implemented in CALSIM II to constrain the operations of the upstream reservoirs and the Delta export pumps in order to satisfy particular salinity requirements. The ANN attempts to statistically correlate the salinity results from a particular DSM2 model run to the various peripheral flows (Delta inflows, exports and diversions), gate operations and an indicator of tidal energy. The ANN is calibrated or trained on DSM2 results to represent historical or future conditions in the Delta using a full circle analysis. The ANN requires retraining whenever the flow – salinity relationship in the Delta changes.
CALSIM II	CALSIM II simulates operations of the SWP, CVP and areas tributary to the Sacramento-San Joaquin Delta. The model, based on inputted priorities and constraints, determines monthly river flows and diversions, Delta flows and exports, reservoir storage, deliveries to project and non-project users, and controls on project operations. Inputs to CALSIM II include system connectivity and capacities information, regulatory requirements, as well as, water diversion requirements (demands), stream accretions and depletions, rim basin inflows, irrigation efficiencies, return flows, non-recoverable losses, and groundwater operations. Sacramento Valley and tributary rim basin hydrologies are developed using a process designed to adjust the historical sequence of monthly stream flows over an 82-year hydrologic period (1922 to 2003) to represent a sequence of flows at a future level of development. CALSIM II's output—monthly flow volumes (often converted to cfs) and end-of-month storage volumes—provides the basis for multiple other hydrologic, hydrodynamic, and biological models and analyses. CALSIM II results are used to determine water quality, hydrodynamics, and particle tracking in the DSM2 model.
Central Valley Hydrologic Model (CVHM)	CVHM is a three-dimensional numerical groundwater flow model that simulates subsurface and limited surface hydrologic processes (surface water flows, groundwater flows, and land subsidence in response to stresses from water use and climate variability) over the entire Central Valley at a uniform grid-cell spacing of 1 mile over a 20,000-square-mile area and in 10 vertical layers of various depths from 50 feet to 750 feet. It uses the USGS MODFLOW-2000 groundwater flow model code combined with the USGS Farm Process (FMP) module to simulate groundwater and surface water flow, irrigated agriculture, and other key processes in the Central Valley on a monthly basis from April 1961–September 2003. CVHM uses results from CALSIM II calibrated using a combination of trial-and-error and automated methods. An autocalibration code, USGS UCODE-2005 helps assess the ability of CVHM to estimate the effects of changing stresses on hydrologic systems. The Delta exports simulated by CALSIM II were used as inputs into CVHM to assess impacts on groundwater levels due to changes in surface water deliveries. Because CALSIM II assumes the same deliveries for the different types of conveyance per alternative, CVHM also used only one delivery time series per alternative.

Model Name	Description of Model
Central Valley Hydrologic Model - Delta (CVHM-D)	CVHM-D simulates hydrologic processes in the Delta region at a more refined grid-cell spacing of 0.25 mile (compared to the grid-cell spacing of 1 mile with CVHM). Four fundamental modifications were made to CVHM to develop CVHM-D: (1) the model domain extent of CVHM was reduced to include only the Delta region; (2) the model grid-cell spacing was reduced from 1-mile to 0.25 mile centers; (3) additional streams, sloughs, and canals were incorporated; and (4) boundary conditions in the Delta region were refined to allow for more precise simulation of water routing.
MODFLOW-2000	MODFLOW is a flow model that simulates three-dimensional groundwater flow through a porous medium by using a finite-difference method. MODFLOW-2000, an update of MODFLOW, simulates steady and nonsteady flow in an irregularly shaped flow system in which aquifer layers can be confined, unconfined, or a combination of confined and unconfined. Flow from external stresses, such as flow to wells, areal recharge, evapotranspiration, flow to drains, and flow through river beds, can be simulated.
Farm Process (FMP) Module	FMP allocates water, simulates processes, and computes mass balances for 21 defined subregions of the model domain. FMP was developed for MODFLOW-2000 to estimate irrigation water allocations from conjunctively used surface water and groundwater; it is designed to simulate the demand components representing crop irrigation requirements and on-farm inefficiency losses, and the supply components representing surface water deliveries and supplemental groundwater pumpage. FMP also simulates additional head-dependent inflows and outflows such as canal losses and gains, surface runoff, surface water return flows, evaporation, transpiration, and deep percolation of applied water.
Delta Simulation Model II (DSM2)	DSM2 is a one-dimensional mathematical model that simulates hydrodynamics, water quality, and particle tracking throughout the Delta based on flow data generated from CALSIM II outputs. It describes the existing conditions in the Delta as well as performs simulations for the assessment of incremental environmental effects caused by facilities and operations. The model can be used to calculate stages, flows, velocities, mass transport processes for conservative constituents, and transport of individual particles. DSM2 is based on a 16-year hydrologic period of record (1976–1991) and is simulated on a 15-minute time step to address the changing tidal dynamics of the Delta system; the likely effects of anticipated sea-level rise were included in the modeling of tidal variations. DSM2 currently consists of three separate components or modules: HYDRO, QUAL, and PTM. HYDRO simulates one-dimensional hydrodynamics including flows, velocities, depth, and water surface elevations. HYDRO provides the flow input for QUAL and PTM. QUAL simulates one-dimensional fate and transport of conservative water quality constituents given a flow field simulated by HYDRO. PTM simulates pseudo three-dimensional transport of neutrally buoyant particles based on the flow field simulated by HYDRO.
Impact Analysis for Planning (IMPLAN)	IMPLAN is a computer database and modeling system used to create input-output models for any combination of United States counties on an annual timestep. IMPLAN is the most widely used input-output model system in the United States. It provides users with the ability to define industries, economic relationships, and projects to be analyzed. It can be customized for any county, region, or state, and used to assess the "ripple effects" or "multiplier effects" caused by increasing or decreasing spending in various parts of the economy. IMPLAN includes (1) estimates of county-level final demands and final payments developed from government data; (2) a national average matrix of technical coefficients; (3) mathematical tools that help the user formulate a regional model; and (4) tools that allow the user to change data, conduct analyses, and generate reports.

Model Name	Description of Model
Delta Simulation Model II (DSM2) Particle Tracking Model (PTM)	PTM simulates fate and transport of conservative and non-conservative water quality constituents throughout the Sacramento-San Joaquin Delta given a flow field simulated by HYDRO. The model uses velocity, flow, and stage output from DSM2-HYDRO. Time intervals for these hydrodynamic values can vary but are on the order of 15 minutes. Outputs are used to estimate the effects of hydrodynamic changes on the fate and transport of larval fish, other covered species, and toxics through the Delta, as well as entrainment of larval fish at various locations. It allows assessment of particle fate, transport, and movement rate from numerous starting points to numerous end points. It provides information on movement of planktonic larval fish, such as delta and longfin smelt, in a tidal environment and is used extensively in Central Valley fishery assessments.
DSM2-HYDRO	DSM2-HYDRO is a one-dimensional hydraulic model used to predict flow rate, stage, and water velocity in the Delta and Suisun Marsh at a 15-minute timestep.
DSM2-QUAL	DSM2-QUAL simulates multiple conservative and non-conservative constituents including dissolved oxygen, carbonaceous BOD, phytoplankton, organic nitrogen, ammonia nitrogen, nitrate nitrogen, organic phosphorus, dissolved phosphorus, TDS and temperature. The model is used to predict water temperature, dissolved oxygen, and salinity in the Delta and Suisun Marsh at a 15-minute timestep.
MIKE21	MIKE21 is modeling software used to develop a two-dimensional hydrodynamic model that predicts water surface elevation, flow, and average velocity in the Yolo Bypass.
Delta Passage Model	The Delta Passage Model simulates migration and mortality of Chinook salmon smolts entering the Delta from the Sacramento, Mokelumne, and San Joaquin Rivers through a simplified Delta channel network, and provides quantitative estimates of relative Chinook salmon smolt survival through the Delta to Chipps Island on a daily timestep.
SALMOD	The SALMOD model integrates the effects of water temperature, flow, fish density, and distribution on all lifestages present in the river upstream of Red Bluff to predict effects on habitat quality and quantity for all races of Chinook salmon in the Sacramento River on a weekly timestep.
Reclamation Egg Mortality Model	The Reclamation Egg Mortality Model predicts temperature-related proportional losses of Chinook salmon eggs due to operational changes on a daily timestep. Temperature-exposure mortality criteria for three life stages (pre-spawned eggs, fertilized eggs, and pre-emergent fry) are used along with the spawning distribution data and output from the river temperature models to compute percents of salmon spawning losses.
Delta Recreational Ecosystem Restoration Implementation Plan (DRERIP)	The DREIP is a conceptual model that is used to assess the importance of stressors by assigning these stressors a level of certainty and magnitude, develop methods, and aid in qualitative assessments of preliminary proposal actions in the Plan Area.
Habitat Suitability Models (HSM)	Habitat suitability modeling (HSM) is a tool for predicting the suitability of habitat for a given species based on known affinities with environmental parameters. This technique was chosen for this project to provide a synoptic view of habitat suitability for specific species as well as assess habitat suitability for species assemblages. BDCP Species Habitat Suitability Models are formulated primarily using vegetation data from existing GIS data sources, as well as other environmental variables. Habitat suitability for each species is determined on the basis of whether or not the area being studied is likely to be occupied based on the species' habitat requirements as described in the species account. The models are not formulated on the basis of species occurrence data, which is incomplete for most covered species in the Plan Area. Instead, species occurrence data are used to verify the habitat models and, as necessary, revise the input data.

Model Name	Description of Model
Yolo Bypass Fry Growth Model	Yolo Bypass Fry Growth Model is used to estimate the differences in growth of Chinook salmon fry in the Yolo Bypass compared to the mainstem lower Sacramento River.
BDCP Bioenergetics Model	The BDCP Bioenergetics Model estimates the relative consumption of BDCP-covered fish species by striped bass based on water temperature, striped bass size, number of striped bass present, and the density and size of prey encountered.
Reclamation Temperature Model	The Reclamation Temperature Model uses CALSIM II flow and climatic model output to predict monthly mean vertical water temperature profiles and release temperatures in the Trinity, Whiskeytown, Shasta, Folsom, New Melones, and Tulloch Reservoirs. The reservoir component of the model simulates one-dimensional, vertical distribution of reservoir water temperature using monthly input data on initial storage and temperature conditions, inflow, outflow, evaporation, precipitation, radiation, and average air temperature. The reservoir is divided into horizontal layers of uniform thickness. Each layer is assumed to be isothermal. Volume of the cold-water pool would be able to be estimated at a gross level (in layers).
RMA Bay-Delta Model	The RMA Bay-Delta Model is a full-featured hydrodynamics/water quality modeling system of the full Bay-Delta estuary. The computational time step used for modeling the depth-averaged flow and EC transport in the Delta is 7.5 minutes, and output from each model is saved every 15 minutes.
Upper Sacramento River Water Quality Model (USRWQM)	USRWQM predicts the effects of operations on water temperature in the Sacramento River and Shasta and Keswick reservoirs. The model is a daily timestep and provides water temperatures for each day of the 82-year hydrologic period (1922 to 2003) used in CALSIM II. The USRWQM was developed using the HEC-5Q model to simulate mean daily (using 6-hour meteorology) reservoir and river temperatures at key locations on the Sacramento River. Daily timestep allows for more accurate simulation of real-time operation strategies and more biologically meaningful assessment of temperature effects. Monthly flows from CALSIM II for the 82-year period are used as input after being temporally downsized to daily average flows.
Mercury Bioaccumulation	The output from the DSM2 model (expressed as percent inflow from different sources) was used in combination with the available measured waterborne methylmercury concentrations for those sources to model concentrations of methylmercury at locations throughout the Delta. These modeled waterborne methylmercury concentrations were used with mathematical relationships of waterborne methylmercury to fish-tissue methylmercury to estimate bioaccumulation of methylmercury in fish. Two bioaccumulation models/relationships to convert between water and fish tissue concentrations of methylmercury were used: 1. Linear regression between DSM2 output of methylmercury concentrations in water (modeled) and bass tissue mercury concentrations (measured) using either annual average or quarterly water values. This model was developed specifically for this analysis and is described in detail in Appendix 8I. 2. The Central Valley Regional Water Quality Control Board (CVRWQCB) Total Maximum Daily Load (TMDL) model was based on the concentration averages of measured fish mercury and water concentrations of methylmercury over broad areas of the Delta. The CVRWQCB model was used in addition to the above described here as a separate predictive tool to link to DSM2 model output.

Model Name	Description of Model
Selenium Bioaccumulation	The output from the DSM2 model (expressed as percent inflow from different sources) was used in combination with the available measured waterborne selenium concentrations for those sources to model concentrations of selenium at locations throughout the Delta. These modeled waterborne selenium concentrations were used in the relationship model to estimate bioaccumulation of selenium in whole-body fish. Selenium concentrations in whole-body fish were calculated using ecosystem-scale models developed by Presser and Luoma (2010). The models were developed using biogeochemical and physiological factors from laboratory and field studies; information on loading, speciation, and transformation to particulate and the lowest tropic levels (e.g., suspended particulates and algae); bioaccumulation in invertebrates; and trophic transfer to predators. Important components of the methodology included (1) empirically determined environmental partitioning factors from water to particulates and the lowest trophic levels that quantify the effects of dissolved speciation and phase transformation; (2) concentrations of selenium at the base of the food web; and (3) selenium trophic transfer factors that quantify the bioaccumulation from the base of the food web to consumer organisms and from prey to their predators. Modeled selenium concentrations in whole-body fish were used to estimate selenium concentrations in fish fillets for evaluation of human exposure through fish consumption.
Traffic Noise Model Lookup (TNM)	TNM is a Federal Highway Administration (FHWA) program that estimates average noise levels at fixed distances from the roadway centerline based on estimated traffic volumes for automobiles and medium- and heavy-duty trucks, vehicle speeds, and a designated noise drop-off rate. The model was programmed to produce a conservative, worst-hour estimate of traffic-generated noise levels due to heavy truck and increased commuter trips associated with construction of project and program components. The model does not account for shielding effects from topographical features and buildings.
California Emissions Estimator Model (CalEEMod)	CalEEMod analyzes the type of construction activity and the duration of the construction period to estimate emissions (GHGs and criteria pollutants).
EMission FACtors (EMFAC 2011)	The EMFAC model is used to calculate emission rates from all motor vehicles, such as passenger cars to heavy-duty trucks, operating on highways, freeways and local roads in California
AERSCREEN	AERSCREEN is a screening model based on the American Meteorological Society/EPA Regulatory Improvement Committee model (AERMOD). AERSCREEN was used to estimate pollutant concentrations of diesel particulate matter (DPM) and particulate matter 2.5 microns or less in diameter (PM2.5)of each water conveyance alternative to determine if a more detailed modeling was warranted for the BDCP Health Risk Assessment for Construction Emissions (URS Corporation Americas, Inc. 2012) for the air quality impact analysis. AERSCREEN uses a set of worst case (non site-specific) met data consisting of worst case wind speeds and wind direction. AERSCREEN also allows the user to only estimate emissions from one emission source at a time. AERSCREEN estimates concentrations at set distances from the emission source being modeled.
AERMOD	AERMOD is a steady-state (i.e., no variability in meteorological parameters over a 1-hour time period), multiple-source, Gaussian dispersion model designed for use with emission sources situated in terrain where ground elevations can exceed the release heights of the emission sources (i.e., complex terrain). AERMOD was used to estimate DPM (including particulate matter 10 microns or less in diameter [PM10] diesel exhaust and PM2.5 emissions impacts in situations where AERSCREEN was determined to be unrepresentative.

Model Name	Description of Model
IOS (Interactive Object-Oriented Simulation)	The Interactive Object-Oriented Simulation Model (IOS) is a stochastic life-cycle simulation model for winter run Chinook salmon in the Sacramento River, CA. The winter run IOS model provides a quantitative tool for resource managers to compare the relative impact of future water use activities on the winter run population and to select relevant life-stages and environmental variables to address as recovery actions. It is used for comparing the relative impact of different flow, temperature, and water export scenarios on the winter-run Chinook population which spawns in the upper reaches of California's Sacramento River, migrates downriver and through the Sacramento-San Joaquin Delta to the Pacific Ocean, and returns to the upper Sacramento River to spawn. In IOS is a life-cycle model that simulates all life stages of winter-run Chinook salmon and models individual daily cohorts of fish through their entire life cycle. Individual life stages are modeled using functional relationships, whose form and parameters values are informed by the best available information from literature. These functional relationships for each life stage are then linked together to form a complete life cycle model that estimates the daily number of eggs for each brood year and progresses them through life stage transitions until spawning at age 3, 4, or 5, where the process begins again for the next generation. Uncertainty is explicitly modeled in the IOS model by incorporating environmental stochasticity and estimation error where data is available.
OBAN (Oncorhynchus Bayesian Analysis)	OBAN is a statistical life cycle model that includes all winter-run and spring-run Chinook salmon life stages based on a Beverton-Holt stock-recruitment function. OBAN defines the transition from one life stage to the next in terms of survival and carrying capacity. Unlike the mechanistic models, OBAN does not represent the timing of movement between stages or habitats. Survival and carrying capacity parameters are determined by a set of time-varying covariates. The weighting terms for the influence of environmental covariates on the Beverton-Holt stock-recruitment relationship is derived by fitting the model to spawner and recruit data. The OBAN model has been informally reviewed by state and federal resource agencies, water users, and the environmental community.
SacEFT (Sacramento River Ecological Flows Tool)	The SacEFT system is a database-centered software system for linking flow management actions to changes in the physical habitats for the species of interest. The model uses daily temperature and flow outputs from the SRWQM. SacEFT employs a set of functional relationships to generate habitat-centered performance measures for the species of interest that change in response to flow-management scenarios. SacEFT operates on a daily time step.

[a] This table is not intended to provide an exhaustive list of all analytical tools (qualitative and quantitative) used in the impact analyses in this EIR/EIS. Rather, it is meant only to provide a summary, including descriptions, of the models used in the analyses.

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