5. Guide to the Resource Analyses

5.1 Introduction

This chapter is included to help readers understand how the impact analyses are presented for the resource discussions in Chapters 6 through 31. The resource chapters included in this EIR/EIS were prepared by a multi-discipline team of resource specialists using data from site visits, field surveys, and technical studies conducted for the Project; and information obtained from published environmental and planning documents, books, websites, journal articles, and communications with technical experts.

Chapters 6 through 31 of this EIR/EIS are organized by environmental resource area. Each chapter discusses the Environmental Setting[1]/Affected Environment[2], the Environmental Impacts[1]/Environmental Consequences[2] (short- and long-term impacts/direct and indirect impacts,) of implementing the No Project[1]/No Action[2] Alternative and the three action alternatives (Alternatives A, B, and C), and, where appropriate, Mitigation Measures. Also discussed for each environmental resource area are the assumptions considered and methodologies used, the regulatory setting, and the references that were consulted during the preparation of the resource analyses.

Chapters 6 through 31 are organized into the following resource areas:

- Chapter 6: Surface Water Resources
- Chapter 7: Surface Water Quality
- Chapter 8: Fluvial Geomorphology and Riparian Habitat
- Chapter 9: Flood Control and Management
- Chapter 10: Groundwater Resources
- Chapter 11: Groundwater Quality
- Chapter 12: Aquatic Biological Resources
- Chapter 13: Botanical Resources
- Chapter 14: Terrestrial Biological Resources
- Chapter 15: Wetlands and Other Waters of the U.S.
- Chapter 16: Geology, Minerals, Soils, and Paleontology
- Chapter 17: Faults and Seismicity
- Chapter 18: Cultural Resources
- Chapter 19: Indian Trust Assets
- Chapter 20: Land Use
- Chapter 21: Recreation Resources
- Chapter 22: Socioeconomics
- Chapter 23: Environmental Justice
- Chapter 24: Air Quality
- Chapter 25: Climate Change and Greenhouse Gas Emissions
- Chapter 26: Navigation, Transportation, and Traffic
- Chapter 27: Noise
- Chapter 28: Public Health and Environmental Hazards
- Chapter 29: Public Services and Utilities

[1] This terminology is applicable to the California Environmental Quality Act (CEQA).
[2] This terminology is applicable to the National Environmental Policy Act (NEPA).

- Chapter 30: Visual Resources
- Chapter 31: Power Production and Energy

For some of these resource areas, an appendix has been prepared. All appendixes are listed in the EIR/EIS Table of Contents, and are included at the end of this EIR/EIS.

5.1.1 Approach to the Resource Analyses

5.1.1.1 CEQA and NEPA Requirements

The California Environmental Quality Act (CEQA) and the State *CEQA Guidelines* §15125(a) indicate that "the description of the environmental setting shall be no longer than is necessary to an understanding of the significant effects of the proposed project and its alternatives."

CEQA Guidelines §15126 indicates that "all phases of a project must be considered when evaluating its impact on the environment: planning, acquisition, development, and operation". *CEQA Guidelines* §15126.2(a) indicates that "an EIR shall identify and focus on the significant environmental effects of the proposed project. Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due consideration to both the short-term and long-term effects. State *CEQA Guidelines* §15126.4 requires that an EIR describe feasible measures which could minimize significant adverse impacts, and sets forth mitigation measure considerations.

The Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act (NEPA) specify that an "EIS shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives. Data and analyses in a statement shall be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced" (Title 40, Section 1502.15 of the Code of Federal Regulations [40 CFR 1502.15]).

40 CFR 1502.16 indicates that, for the environmental consequences analysis, "the discussion will include the environmental impacts of the alternatives including the proposed action." It shall include "any environmental effects which cannot be avoided should the proposal be implemented." It shall also include discussions of: direct effects and indirect effects and their significance; possible conflicts between the proposed action and the objectives of federal, regional, State, and local (and in the case of a reservation, Indian tribe) land use plans, policies, and controls for the area concerned; and the means to mitigate adverse environmental impacts. "40 CFR 1502.14(f) requires the inclusion of "appropriate mitigation measures not already included in the proposed action or alternatives".

DWR and Reclamation prepared this EIR/EIS in accordance with the above-listed regulations.

5.1.1.2 Establishment of the Environmental Setting/Affected Environment Baseline Date

In determining the "Environmental Setting/Affected Environment " baseline date for environmental analyses in this EIR/EIS, DWR and Reclamation consulted the *CEQA Guidelines* and the CEQ NEPA regulations (40 CFR Part 1500).

CEQA Guidelines §15125(a) indicates than "an EIR must include a description of the physical environmental conditions in the vicinity of the project as they exist at the time the Notice of Preparation

(NOP) is published, or if no NOP is published, at the time environmental analysis is commenced, from both a local and regional perspective. The environmental setting will normally constitute the baseline physical conditions by which a Lead Agency determines whether an impact is significant.

CEQA Guidelines §15126.2(a) indicates that "the lead agency should normally limit its examination to changes in the existing physical conditions in the affected area as they exist at the time the NOP is published, or where no NOP is published, at the time environmental analysis is commenced."

The CEQ regulations do not specify a baseline physical condition time period.

The NOP for the Project was published on November 5, 2001, and the Notice of Intent (NOI) for the Project was published on November 9, 2001. Lead agencies have the discretion, where appropriate, to fully or partially update baseline physical conditions beyond the time of the issuance of the NOP and NOI. Because the preparation of this environmental document has occurred over several years, it is appropriate to delay the Environmental Setting/Affected Environment date to include programs, projects, or policies that have been implemented during the document's preparation. Changes in the regulatory environment since November 2001, such as the regulations discussed below, preclude using November 2001 as the baseline for environmental analyses in this EIR/EIS.

The December 2008 U. S. Fish and Wildlife Service (USFWS) and June 2009 National Marine Fisheries Service (NMFS) Biological Opinions (BOs) for the Operations Criteria and Plan (OCAP) established a new regulatory framework for water management and operations within the Sacramento Valley and the Sacramento-San Joaquin Delta. These BOs fundamentally changed State and federal project operations, which affected water supply reliability and substantially increased water supplies dedicated to environmental enhancement purposes. For these reasons, June 2009 (following the release of NMFS' BO) was selected as the Project's Environmental Setting/Affected Environment (i.e., Existing Conditions) date.

The environmental and social conditions in June 2009 within the Project's three study areas[3] that could be affected by the three action alternatives were used to establish the Environmental Setting/Affected Environment that is presented in each of the environmental resource evaluations (Chapters 6 through 31). The information necessary to characterize the setting was obtained from technical studies performed for the Project, information that was obtained from published environmental and planning documents, books, websites, journal articles, field surveys, site visits, and communications with technical experts. In addition, the resources analyses considered regulations that are in effect; descriptions of the regulations for each resource are provided in Chapter 4 Environmental Compliance and Permit Summary.

[3]The three study areas for the EIR/EIS analyses are the Extended, Secondary, and Primary study areas. They are discussed in Chapter 1 Introduction. The data presented in the various resource chapters for the three study areas were presented at a level of detail that was appropriate for each individual discussion.

5.1.1.3 Project Facilities Evaluated

Analysis of the action alternatives within each resource area included consideration of each of the following Project facilities that are components of the alternatives:

- Sites Reservoir Inundation Area (1.27-MAF reservoir or 1.81-MAF reservoir)
- Sites Reservoir Dams (Golden Gate Dam, Sites Dam, and saddle dams)
- Recreation Areas (Antelope Island, Lurline Headwaters, Stone Corral, Peninsula Hills, Saddle Dam[4])
- Road Relocations and South Bridge
- Sites Pumping/Generating Plant
- Sites Electrical Switchyard
- Tunnel from Sites Pumping/Generating Plant to Sites Reservoir Inlet/Outlet Structure
- Sites Reservoir Inlet/Outlet Structure
- Field Office Maintenance Yard
- Holthouse Reservoir Complex
- Holthouse Reservoir Electrical Switchyard
- Glenn-Colusa Irrigation District Canal Facilities Modifications
- Glenn-Colusa Irrigation District Canal Connection to the Terminal Regulating Reservoir
- Terminal Regulating Reservoir
- Terminal Regulating Reservoir Pumping/Generating Plant
- Terminal Regulating Reservoir Electrical Switchyard
- Terminal Regulating Reservoir Pipeline
- Terminal Regulating Reservoir Pipeline Road
- Delevan Transmission Line
- Delevan Pipeline
- Delevan Pipeline Electrical Switchyard
- Delevan Pipeline Intake Facilities
- Delevan Pipeline Discharge Facility
- Project Buffer

Combinations of these Project facilities were used to create action Alternatives A, B, and C. In the resource chapters, DWR and Reclamation described the potential impacts associated with the construction, operation, and maintenance of each of the Project facilities listed above for each of the three action alternatives.

5.1.1.4 Alternatives Analysis

For this analysis, DWR and Reclamation defined the No Action Alternative as the conditions that existed as of June 2009 (known as the Existing Conditions, and characterized in Chapters 6 through 31 as the Environmental Setting/Affected Environment), plus the programs that were adopted and the facilities that were permitted or are being constructed during the early stages of development of the EIR/EIS. As indicated in Chapter 3, the No Project Alternative (for CEQA) and the No Action Alternative (for NEPA) are the same alternative. Thus, in this EIR/EIS, it is called the No Project/No Action Alternative.

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[4] Although five recreation areas were evaluated in this EIR/EIS, fewer than five recreation areas may be developed if the Project is approved.

For every resource discussion presented in Chapters 6 through 31, for the purpose of CEQA compliance:

- The No Project Alternative (CEQA term) was compared to the Environmental Setting (known as Existing Conditions)
- Alternatives A, B, and C were compared to the Environmental Setting (known as Existing Conditions)

For every resource discussion presented in Chapters 6 through 31, for the purpose of NEPA compliance:

- Alternatives A, B, and C were compared to the No Action Alternative (NEPA term).

To reduce redundancy in the analyses of Alternatives A, B, and C, the analysis for Alternative A was presented first in the discussion, and then the analyses for alternatives B and C indicate if their impacts would be the same, or similar to, Alternative A. If they were not similar, those analyses then described how they differed from Alternative A.

The analysis of each resource began with an examination of the Existing Conditions that may be affected by implementation of the alternatives. The effects of the alternatives, pursuant to CEQA, were defined as the changes to Existing Conditions that were attributable to construction, operation, and/or maintenance of the alternatives.

In conducting the analysis for this EIR/EIS, the authors considered the comments that were received during the Project's scoping period, relied on available published studies and reports, and conducted independent investigations, as needed. The specific documents considered and relied upon are cited for each resource in Chapter 37 References.

Each identified impact has been numbered in accordance with the naming convention presented in Table 5-1. Included in each impact discussion is the reasoning indicating *whether* and *why* there would be an impact and the level of significance of each impact, when compared to Existing Conditions and the No Project/No Action Alternative.

Table 5-1
Impact Naming Convention for each of the Resources Evaluated

Resource Area	Impact Numbering*
Surface Water Resources	Impact SW Res-#
Surface Water Quality	Impact SW Qual-#
Fluvial Geomorphology and Riparian Habitat	Impact Geom-#
Flood Control	Impact Flood-#
Groundwater Resources	Impact GW Res-#
Groundwater Quality	Impact GW Qual-#
Aquatic Resources	Impact Aquat-#
Botanical Resources	Impact Bot-#
Terrestrial Biological Resources	Impact Wild-#
Wetlands and Other Waters of the US	Impact Wet-#
Geology, Minerals, Soils, and Paleontology	Impact Geol-#
	Impact Min-#
	Impact Soils-#
	Impact Paleo-#
Faults and Seismicity	Impact Seis-#
Cultural Resources	Impact Cul-#

Table 5-1
Impact Naming Convention for each of the Resources Evaluated

Resource Area	Impact Numbering*
Indian Trust Assets	Impact ITA-#
Land Use	Impact Land-#
Recreation Resources	Impact Rec-#
Socioeconomics	Impact Socio-#
Environmental Justice	Impact Env Jus-#
Air Quality	Impact Air Qual-#
Climate Change and Greenhouse Gas Emissions	Impact Climate-#
	Impact GHG-#
Navigation, Transportation, and Traffic	Impact Trans-#
Noise	Impact Noise-#
Public Health and Environmental Hazards	Impact Pub Health-#
Public Services and Utilities	Impact Services-#
Power Production and Energy	Impact Power-#
Visual Resources	Impact Visual-#

*Each resource impact is numbered, with the first impact numbered "1".

5.1.1.5 Types of Impacts

Mechanisms that could cause impacts are discussed for each resource. General categories of impact mechanisms are construction and future operation and maintenance. Project-related impacts are categorized as follows, to describe the intensity or duration of the impact:

- **A temporary impact** would last less than three to four years and typically would occur only during Project construction. Construction impacts would occur during the defined construction period and include all activities that would occur to construct each Project facility. For the purposes of this analysis, the initial filling of Sites Reservoir and Project access road construction was considered a construction-related impact. The construction disturbance area includes each Project facility footprint plus the land area around that footprint that would be used for materials laydown, soil stockpiling, equipment storage, construction vehicle parking, equipment/vehicle maintenance, spoil disposal, construction debris, batch plants, materials delivery, access roads, actual construction activity disturbance, and any other activity conducted during the construction period for a Project purpose that would cease after the Project facilities are built. The total construction disturbance area is larger than the permanent long-term disturbance area that is caused by each Project facility footprint.

- **A short-term impact** would occur during Project construction and could last from the time construction ceases to within three to five years after Project construction.

- **A long-term impact** would last longer than five years after the completion of Project construction. In some cases, a long-term impact could be a permanent impact. Project operational and maintenance impacts include any activities that must occur to operate and maintain each Project facility. These activities and their associated impacts are long-term and permanent. Operation activities include those related to the movement of water (such as Sites Reservoir level fluctuations, or the intake or release of water through the Delevan Pipeline Intake or Discharge facility), the generation/transmission of electricity, the use of roads during operation and maintenance activities, and the recreation activities that would be associated with operation of the reservoir. Maintenance activities include the upkeep of all of the facilities.

- **A direct impact** is an impact that would be caused by an action and would occur at the same time and place as the action.
- **An indirect impact** is an impact that would be caused by an action but would occur later in time or at another location, yet is reasonably foreseeable in the future.

5.1.1.6 Determination of Significance of Impacts

CEQA Guidelines §15382 define the term “significant effect on the environment” as “a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic or aesthetic significance.” The *CEQA Guidelines* further state that the determination of whether a project could have a significant effect on the environment requires careful judgment on the part of the public agency involved and that this judgment should be based, to the extent possible, on “scientific and factual data” [§15064(b)]. CEQA also states that there is no predetermined definition of “significant effect” because the significance of an activity can vary with the setting. For example, an activity that might not have a significant effect in an urban area could be considered significant in a rural area [§15064(b)].

For the purposes of the analyses conducted in this EIR/EIS of Alternatives A, B, and C, a combination of the CEQA Appendix G Environmental Checklist Form criteria were used, along with professional judgment that considered current regulations, standards, and/or consultation with agencies, knowledge of the area, and the context and intensity of the environmental effects, as required pursuant to NEPA. The specific criteria for determining impact significance are listed within the impact discussion in each resource chapter.

The level of significance of the impacts for Alternatives A, B, and C was classified based on the following impact definitions:

- **Potentially Beneficial Effect:** The alternative would potentially improve the environment. No mitigation is required.
- **Beneficial Effect:** The alternative would improve the environment. No mitigation is required.
- **No Impact:** No change in the environment would result from implementing the alternative. No mitigation is required.
- **Less-than-Significant Impact:** No substantial adverse change in the environment would result from implementing the alternative. No mitigation is required.
- **Potentially Significant Impact:** A substantial adverse change in the environment may result from implementing the alternative; however, additional information is needed regarding the extent of the impact. For CEQA purposes, a potentially significant impact is treated as if it were a significant impact. Mitigation measures are identified, when feasible, to reduce effects to the environment.
- **Significant Impact:** A substantial adverse change in the physical conditions of the environment would result from implementing the alternative. Significant impacts are identified by the evaluation of project effects using specified significance criteria. Mitigation measures are identified, when feasible, to reduce effects to the environment.

5.1.1.7 Mitigation Measure Development and Implementation

Mitigation measures were presented, where feasible, to avoid, minimize, rectify, reduce, or compensate for significant and potentially significant impacts of the alternatives, in accordance with §15126.4 of the *CEQA Guidelines* and NEPA regulations (40 CFR 1508.20). To aid the reader, each mitigation measure was identified numerically to correspond with the number of the impact being mitigated by the measure.

When “significant” or “potentially significant” impacts were identified, feasible mitigation measures were formulated to eliminate or reduce the intensity of the impacts and focus on the protection of sensitive resources. The effectiveness of a mitigation measure was subsequently determined by evaluating the impact remaining after the application of the mitigation, and reaching one of two conclusions: (1) the mitigation reduced the impact to a less-than-significant level; or (2) no feasible mitigation exists to reduce the impact to a “less-than-significant level,” and therefore, the impact was determined to be “significant and unavoidable”. No mitigation measures were needed or proposed when an impact was determined to be “less than significant.” Implementation of more than one mitigation measure may be needed to reduce an impact below a level of significance. The mitigation measures recommended in this EIR/EIS are identified within each resource chapter (Chapters 6 through 31) and are presented in the Mitigation Monitoring Plan (Appendix 1A).

5.1.1.8 Topics Eliminated from Further Analytical Consideration

CEQA and the State *CEQA Guidelines* provide for the identification and elimination from detailed study the effects that are not significant or that have been covered by prior environmental documentation (Public Resources Code, §21002.1; State *CEQA Guidelines*, §15143). The NEPA regulations provide similar provisions (40 CFR 1501.7(a)(3)).

During initial scoping with the public and governmental agencies, and based on information obtained through literature review, agency correspondence, consultations, and field data collection, it was determined that no resources were able to be eliminated from detailed study. Therefore, analysis of all resources required by CEQA and NEPA is included in this Draft EIR/EIS.

However, during preparation of the impact analyses, it became evident that some of the CEQA significance criteria were not applicable to the Project, or that some discussions were not relevant to the analysis. DWR and Reclamation described those situations in a “Topics Eliminated from Further Analytical Consideration” subsection in the appropriate resource chapters.

5.1.1.9 Tools, Analytical Methods, and Applications

Each resource chapter includes a description of the methodology used to identify and assess the potential environmental impacts that would result from implementation of the alternatives. For those resources that used modeling output, a brief overview of the modeling tools and output is provided below.

Several modeling tools and analytical methods were used to characterize and analyze the changes in water operations in the SWP and CVP systems for each alternative. These tools represent the best available technical tools for purposes of conducting the analyses. The overall flow of information between the models and the general application and use of output for the resource evaluations are shown in Figure 5-1. Table 5-2 provides a description of the various modeling tools and an overview of how they were used for the impact analyses.

The models were used to compare and contrast the effects among alternatives with 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 was 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 water year-type averages, and probability of exceedance.

The output from these models supports the comparative analysis of various resources, such as water quality, land use, economics, and energy. Additional detailed discussions of the modeling tools and assumptions are provided in the appendixes that are mentioned in Table 5-2.

Table 5-2
Overview of NODOS EIR/EIS Modeling Tools, Analytical Methods, and Applications

Model Name	Description of Model
Surface Water Resources	
SWP and CVP Hydrology and System Operations Model (CALSIM II)	Simulates operations of the SWP, CVP, and other facilities in the Central Valley and approximates changes in storage reservoirs, river flows, and exports from the Delta. Inputs describe assumptions of hydrology at projected levels of land and water use, existing and proposed facilities, and riverine and Delta regulatory conditions. SWP and CVP operations are consistent with the Biological Assessment on the Continued Long-term Operations of the Central Valley Project and the State Water Project (U.S. Bureau of Reclamation. 2008) as modified by the December 2008 USFWS BiOp (U.S. Fish and Wildlife Service. 2008) and the June 2009 NMFS BiOp (National Marine Fisheries Service. 2009). The model and assumptions are described in Appendixes 6A and 6B.
Artificial Neural Network (ANN)	Mimics the flow-salinity relationships as modeled in the Delta Hydrodynamics and Salinity Model (DSM2), and provides a rapid transformation of this information into a form usable by the Statewide CALSIM II model. ANN is implemented in CALSIM II to inform the operations of the upstream reservoirs and the Delta export pumps to satisfy particular salinity requirements.
Upper Sacramento River Daily Operations Model (USRDOM)	Simulates daily reservoir operations and daily river flows for the upper Sacramento River from Shasta Dam to Knights Landing, including the facilities and tributaries within this region; includes the Trinity River section of the Central Valley Project, the Sutter Bypass region (and other bypasses), and the conveyance and storage facilities of the proposed Project. Uses CALSIM II outputs. The model is described in Appendix 6C.
Surface Water Quality	
Upper Sacramento River Water Quality Model (USRWQM)	Simulates the temperature regime of the Upper Sacramento River. The USRWQM, as modified for use in the NODOS Investigations, extends from Keswick Dam to Knights Landing and includes the Sacramento River, Sacramento River at Red Bluff Diversion Dam, Black Butte Dam, Stony Creek, T-C Canal, GCID Canal, Colusa Basin Drain, a proposed Delevan pipeline, the proposed Holthouse Reservoir, and the proposed Sites Reservoir. Provides estimate of daily average riverine temperature conditions. Uses USRDOM outputs. The model is described in Appendix 7E.
Preliminary Sites Reservoir Discharge Temperature Model	Simulates the temperature regime in the proposed Sites Reservoir and the discharge of flows to the Sacramento River. Provides simulated daily average temperature conditions of discharge and blended flow in the Sacramento River. Uses USRDOM and USRWQM outputs. The model is described in Appendix 7E.

Table 5-2
Overview of NODOS EIR/EIS Modeling Tools, Analytical Methods, and Applications

Model Name	Description of Model
Reclamation Monthly Temperature Models (Reclamation Temperature)	Simulates the temperature regime in the Trinity, Feather, American, Lower Sacramento, and Stanislaus river basins and upstream reservoirs. Provides simulated monthly reservoir and stream temperatures used for evaluating the effects of operations on mean monthly water temperatures in the basin. Uses CALSIM II outputs. The model is described in Appendix 7E.
Delta Hydrodynamics Model (DSM2 HYDRO)	Simulates one-dimensional hydrodynamics of the Sacramento–San Joaquin Delta; models Delta channel flows, stages, and cross-section average velocities under tidal conditions. DSM2 is simulated on a 15-minute time step to address the changing tidal dynamics of the Delta system; however, one-dimensional and simplified boundary conditions limit use of results to monthly statistics. Uses outputs from CALSIM II. The model is described in Appendix 7D.
Delta Salinity Model (DSM2 QUAL)	Simulates salinity based on Electrical Conductivity (EC) calibration; one-dimensional and simplified boundary conditions limit use of results to monthly statistics. Uses outputs from DSM2 HYDRO. The model is described in Appendix 7D.
Fluvial Geomorphology and Riparian Habitat, Botanical Resources, and Terrestrial Biological Resources	
Sedimentation and River Hydraulics - Capacity (SRH-Capacity)	Simulates water and sediment budgets of the river system at the watershed scale. The model links sediment sources and transport with geomorphic change and accounts and predicts the sediment loads from tributaries and sediment balance in the main stem of the river. The study area is the Sacramento River from River Mile 295 (downstream of Keswick Dam) to River Mile 80 (near Knights Landing). The study area has been divided into 23 sub-reaches based on hydraulic conditions and river slope. Hydraulics conditions are averaged in each reach and then transport capacity in each reach is computed using the sediment size fraction. SRH-Capacity uses daily flow data from 19 tributaries and computes sediment load in these reaches to estimate sediment balance in the mainstem. Uses outputs from USRDOM. The model is described in Appendix 8A.
Sedimentation and River Hydraulics – Meander (SRH-Meander)	Simulates the bed topography, flow field, and bank erosion rate in curved channels with an erodible bed. In each time step, SRH-Meander first calculates the flow field. It then computes the channel bank erosion rate. Finally, the channel alignment is updated with the erosion rate, followed by a channel cutoff if needed. The model can be used to predict the channel migration in meandering rivers. Uses outputs from USRDOM. The model is described in Appendix 8A.
Sedimentation and River Hydraulics - Vegetation (SRH-1DV)	Simulates river hydraulics, sediment transport, erosion, deposition, and vegetation growth. Cottonwood growth and survival at different cross-sections along the Sacramento River is simulated between Keswick Dam and Colusa. The river is divided into five reaches. SRH-1DV uses groundwater data at several locations and river stage data at River Mile 183 and River Mile 193. Flow rates for the model are required at Hamilton City and Ord Ferry. Uses outputs from USRDOM. The model is described in Appendix 8A.
Riparian Habitat Establishment Model (RHEM)	Simulates the growth of riparian vegetation on point bars. Integrates the simultaneous effects of river stage, precipitation, evaporation, and plant transpiration on soil water content in the root zone. Uses these results to determine the plant survival by simulating the plant's ability to maintain sufficient transpiration to support continued root and shoot growth from germination through the initial establishment stage. Uses outputs from USRDOM and SRH. The model is described in Appendix 8A.

Table 5-2
Overview of NODOS EIR/EIS Modeling Tools, Analytical Methods, and Applications

Model Name	Description of Model
Sacramento River Ecological Flows Tool (SacEFT)	A decision analysis tool that incorporates physical models of the Sacramento River with biophysical habitat models for three species that use riparian habitats along the Sacramento River to evaluate the ecological consequences of management-related changes in flow regime and channel restoration activities. Includes flow and habitat relationships for bank swallows and channel erosion/migration for large woody debris deposition and removal, western pond turtle, and Fremont cottonwood. The model is described in Appendix 8B.
Aquatic Biological Resources	
Reclamation Mortality Models (Reclamation Mortality and SacSalMort)	Estimates the fraction of population lost each year for winter-, spring-, fall-, and late-fall-run Chinook salmon due to thermal conditions only. Uses reach level empirical degree-day equations for the Trinity, Sacramento, Feather, American, and Stanislaus rivers. Uses monthly average outputs from Reclamation Temperature Model. Customized version for the Sacramento River (SacSalMort) uses daily outputs from USRWQM. The model is described in Appendix 12J.
Salmonid Population Model (SALMOD)	Simulates dynamics of freshwater life history of anadromous and resident salmonid populations using streamflow, water temperature, and habitat type. Provides potential fish production values reflecting the suitability of riverine habitat for winter-, spring-, fall-, and late-fall-run Chinook salmon. Simulates salmon habitat conditions in the Sacramento River between Keswick Dam and Bend Bridge. Uses outputs from USRDOM and USRWQM. The model is described in Appendix 12K.
Winter Run Chinook Life Cycle Model (IOS)	Simulates multiple life stages of winter-run Chinook salmon within the Sacramento River system. Life-cycle model provides a quantitative framework to evaluate the effects of flow, temperature, diversions, and habitat conditions on individual cohorts and overall population of winter-run Chinook salmon. The IOS model tracks daily salmon numbers from six different life stage categories (eggs, alevins, fry, smolts, subadults, and adults). The model is spatially explicit including detailed reaches of the Sacramento River, Delta migratory corridors, and the Pacific Ocean. Uses outputs from USRDOM, USRWQM and DSM2. The model is described in Appendix 12L.
Delta Passage Model (DPM)	Simulates detailed accounting of migratory pathways and reach-specific mortality for four runs (winter-, spring-, fall-, and late-fall) of Chinook salmon smolts traveling through a simplified network of reaches and junctions in the Delta. The DPM operates on a daily time step using simulated daily average flows and Delta exports as model inputs. The DPM does not attempt to represent sub-daily flows or diel salmon smolt behavior in response to the interaction of tides, flows, and specific channel features. The DPM for winter-run Chinook salmon is incorporated as a module of the IOS model. Uses outputs from DSM2. The model is described in Appendix 12M.
Sacramento River Ecological Flows Tool (SacEFT)	A decision analysis tool that incorporates physical models of the Sacramento River with biophysical habitat models for three Sacramento River fish species to evaluate the ecological consequences of management-related changes in flow regime and channel restoration activities. Includes flow and habitat relationships for Chinook salmon, steelhead, and green sturgeon. Constituent focal species “sub-models” provide performance measures specific to the species evaluated. Multi-year roll-ups of annual performance allow users to quickly zoom in on the much smaller set of performance measures, which differ significantly across management scenarios. Uses outputs from CALSIM II, USRDOM, and USRWQM. For fisheries analyses in the NODOS Investigations, the SacEFT was used to evaluate potential impacts on steelhead and green sturgeon. The model is described in Appendix 8B.

Table 5-2
Overview of NODOS EIR/EIS Modeling Tools, Analytical Methods, and Applications

Model Name	Description of Model
Recreation Resources	
Recreation-Day Benefit Values	Benefit values combine two equally weighted factors: (1) variety and quality of recreation, and (2) aesthetic qualities of the site. Factors considered in determining the variety and quality of recreation at a reservoir include the types of activities available, quality of the experience, quality of development, and operation and maintenance of the facilities and area. Aesthetic factors include reservoir operation, geologic, topographic, aquatic, vegetative, climate, and other environmental factors. Based on guidelines described in DWR's Economics and Recreation Planning Manuals and in Supplementary Procedures for Application of DWR's Guidelines for Evaluation of General Recreation, developed jointly by DWR and DPR (California State Parks, 1967).
Socioeconomics	
Statewide Agricultural Production (SWAP) model	Simulates the decisions, production, and economics of agricultural producers in California's Central Valley. The model includes up to 27 crop production regions in the Central Valley and 20 categories of crops. Surface water supplies are estimated by hydrologic models and groundwater use and pumping lift are estimated based on assumptions about groundwater availability. SWAP model versions consider responses under average hydrologic conditions and responses during drought. The model maximizes the producer and consumer surplus to determine an optimal market solution. Uses outputs from CALSIM II. The model is described in Appendix 22E.
Least Cost Planning Simulation Model (LCPSIM)	Simulation/optimization model that assesses the economic benefits and costs of increasing urban water service reliability (supply/demand balance) at the regional level. The total cost of the optimized regional water management plan is used in a comparative analysis to determine the potential economic benefit or cost of a proposed action. Models are available for the South Bay and South Coast regions. Uses outputs from CALSIM II. The model is described in Appendix 22D.
Other Municipal Water Economics Model (OMWEM)	Urban water supply valuation for other urban areas using assumptions associated with availability of surface and groundwater supplies. Uses outputs from CALSIM II. The model is described in Appendix 22D.
Lower Colorado River Basin Water Quality Model (LCRBWQM)	Assesses the regional economic effects of water salinity within the SWP system and Colorado River Aqueduct throughout the urban coastal region of southern California. Assesses the benefit of a change in average annual regional salinity costs based on demographic data; water deliveries; TDS concentration; and costs for typical household, agricultural, industrial, and commercial water uses. Uses mathematical functions that define the relationship between TDS and items in each affected category, such as the useful life of appliances, specific crop yields, and costs to industrial and commercial customers. Uses long-term volume and salinity load information based on CALSIM II and DSM2 results. The model is described in Appendix 22E.
Bay Area Water Quality Economics Model (BAWQM)	Assesses the benefit of a change in average annual regional salinity costs based on households in the South Bay region. Uses mathematical functions that define the relationship between TDS and items in each affected category, such as the useful life of appliances. Uses long-term volume and salinity load information based on CALSIM II and DSM2 results. The model is described in Appendix 22E.
IMPLAN	IMPLAN develops input-output estimates of the economic impacts of various activities. For water resources planning, IMPLAN estimates the income and employment effects upon local communities from water project construction and the regional effects of water transfers. Uses outputs from SWAP. The model is described in Appendix 22C.

Table 5-2
Overview of NODOS EIR/EIS Modeling Tools, Analytical Methods, and Applications

Model Name	Description of Model
Reporting Metrics Tool (RMT)	Developed for the NODOS Feasibility Report and EIR/EIS, RMT is a spreadsheet model that reports system operations and economics metrics. The reports are a summary of system specifications for scenarios evaluated, modeled operations, and modeled economics impacts at a range of detail. The reported system operations metrics include yield and water supply, water quality, and hydropower. The reported economics metrics include Project costs, agricultural and M&I water supply, and M&I water quality. The system operations metrics are characterized by user type, and because the modeled economics metrics do not include the entire modeled operations metrics, extensions are made in the RMT to provide estimates for these reporting gaps. Uses outputs from SWAP, LCPSIM, OMWEM, LCRBWQM, BAWQM and other Project-specific information. The model is described in Appendix 22B.
Air Quality and Greenhouse Gas Emissions	
Off-Road Emissions Model (OFFROAD 2007)	The OFFROAD Model estimates the relative contribution of gasoline-, diesel-, compressed natural gas, and liquefied petroleum gas-powered vehicles to the overall emissions inventory of the state. The model is described in Appendix 24A.
Emissions & Generation Resource Integrated Database (eGRID)	The eGRID is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States. These environmental characteristics include air emissions for nitrogen oxides, sulfur dioxide, carbon dioxide, methane, and nitrous oxide; emissions rates; net generation; resource mix; and many other attributes. Uses outputs from Reclamation Long Term Generation (LT-GEN), State Water Project Power Model (SWP Power) and Project Power. The model is described in Appendix 24A.
URBan EMISsions (URBEMIS 2007)	URBEMIS 2007 estimates air pollution emissions from a wide variety of land use projects. The model uses the California Air Resources Board's EMFAC2007 model for on-road vehicle emissions and the OFFROAD2007 model for off-road vehicle emissions. The model is described in Appendix 24A.
EMission FACtors (EMFAC 2007)	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. The model is described in Appendix 24A.
Power Production and Energy	
Reclamation Long Term Generation (LT-GEN)	Computes the power generation and capacity for CVP power plants and project use (pumping plant demand) for CVP pump stations at a monthly time step based on the operations defined by a CALSIM II simulation. Simplified factors are used to separate peak and non-peak generation and load. Includes calculations of transmission losses. Net-revenue is estimated based on price forecasts. Uses outputs from CALSIM II. The model is described in Appendix 31B.
State Water Project Power Model (SWP Power)	Computes the power generation and capacity for SWP power plants and project use (pumping plant demand) for SWP pump stations at a monthly time step based on the operations defined by a CALSIM II simulation. Simplified factors are used to separate peak and non-peak generation and load. Net-revenue is estimated based on price forecasts. Uses outputs from CALSIM II. The model is described in Appendix 31B.
NODOS Power	Computes the power generation and capacity for proposed Project power plants and use (pumping plant demand) for proposed Project pump stations at a monthly time step based on the operations defined by a CALSIM II simulation. Simplified factors are used to separate peak and non-peak generation and load. Net-revenue is estimated based on price forecasts. Uses outputs from CALSIM II. The model is described in Appendix 31B.

Table 5-2
Overview of NODOS EIR/EIS Modeling Tools, Analytical Methods, and Applications

Model Name	Description of Model
DWR-PARO Optimization Modeling	A DWR-PARO Power Planning Study was completed to analyze the current/designed components, and operational scenarios of the Project from a power planning perspective. The Study was aimed at optimizing Project operations to maximize its power portfolio's value (revenues-obligations). The Study is implemented using current power market information and regulations, and available power portfolio models/tools to better evaluate energy costs and revenues of the Project. The Study considered short time step pump-generation operations in addition to long-term water operations. Uses outputs from CALSIM II. The model is described in Appendix 31A.

5.1.1.10 Limitations of the Modeling Tools and Analytical Methods

All modeling tools and analytical methods used in the environmental consequences analyses have limitations. The limitations related to the modeling tools are documented in each of the Appendixes referenced in Table 5-2. There are other uncertainties reflected in the EIR/EIS analyses presented in this document from conducting the environmental studies associated with a large, complex, and evolving project over a period of many years. Biological and cultural resource surveys were conducted over a period of many years. These surveys have limitations in that survey access was not obtained for all parcels for all resource surveys. These surveys are adequate for impact assessment, but some surveys may need to be updated to meet regulatory agency guidelines to confirm final mitigation.

5.1.1.11 Sensitivity Analysis

One limitation of the environmental consequences analyses is that the water operations in the SWP and CVP systems for each alternative were evaluated only at the 2009 climate and sea level conditions. A sensitivity analysis was prepared to evaluate the potential impact of climate and sea level conditions on the results of the surface water models, CALSIM II, and test the conclusions of the environmental consequences analyses subject to the findings of this sensitivity analyses (Appendix 25B).

5.2 References

California Department of Parks and Recreation (California State Parks). 1967 (with Revisions to 1971). Water Project Recreation Planning Manual. Measurement of Benefits, Sections 6400-6411.14.

National Marine Fisheries Service. 2009. Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project. June 4. Southwest Region. Long Beach, CA.

U.S. Bureau of Reclamation. 2008. Biological Assessment on the Continued Long-term Operations of the Central Valley Project and the State Water Project. Mid-Pacific Region. Sacramento, CA.

U.S. Fish and Wildlife Service. 2008. Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP). December 15. Region 8. Sacramento, CA.

Figure

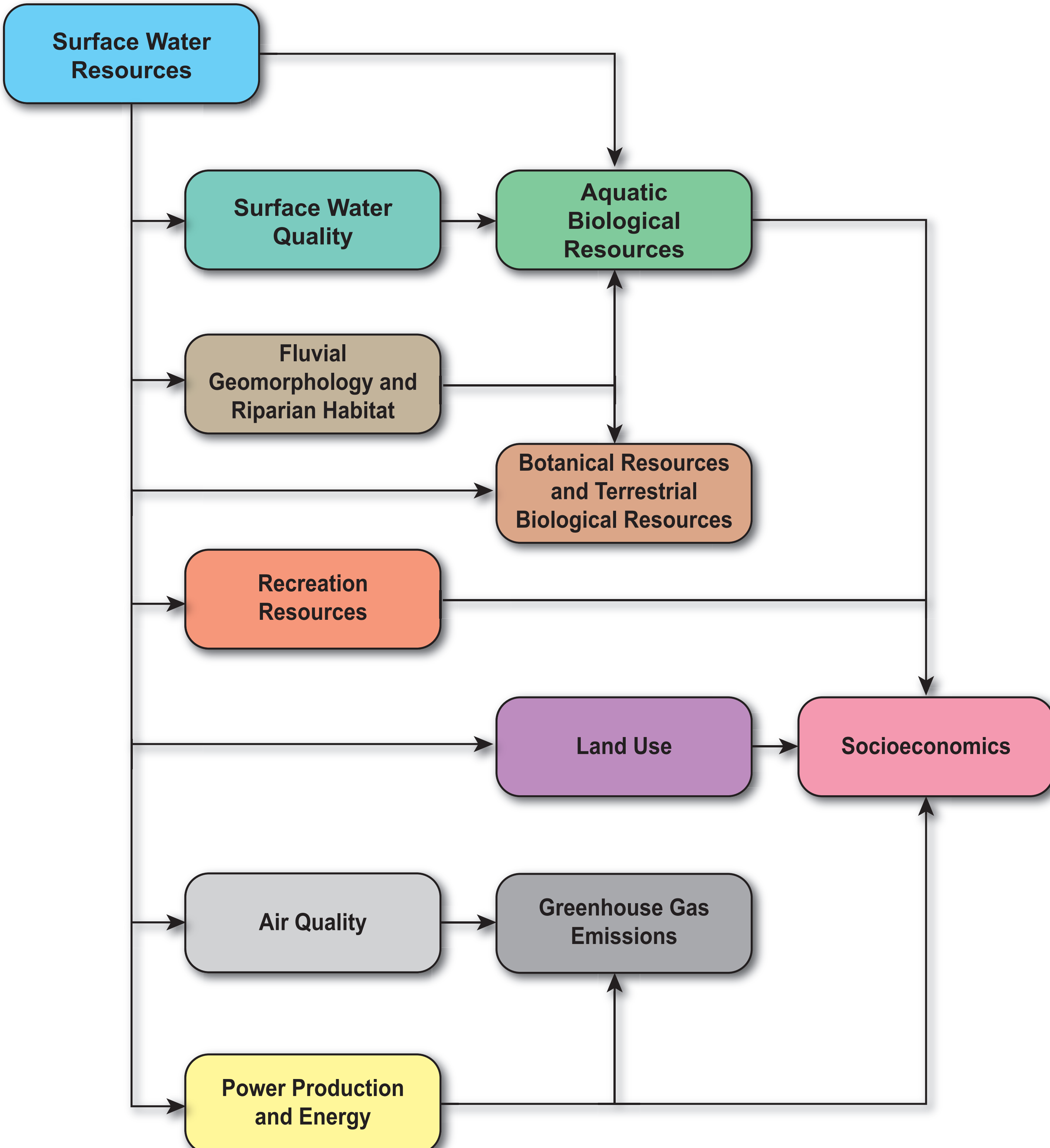

FIGURE 5-1
Overview of Influences between NODOS EIR/EIS Modeling Tools, Analytical Methods, and Applications
North-of-the Delta Offstream Storage Project