APPENDIX G

MODELING TECHNICAL MEMORANDUM

(CALSIM MODELING)
Supplemental Water Rights Project
Modeling Technical Memorandum

Prepared for
El Dorado Water & Power Authority

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Supplemental Water Rights Project
Modeling Technical Memorandum

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List of Acronyms

af  acre feet
BA  Biological Assessment
Bay-Delta  San Francisco Bay/Sacramento-San Joaquin Delta Estuary
CALSIM II  DWR and Reclamation Simulation
CDFG  California Department of Fish and Game
CEQA  California Environmental Quality Act
cfs  cubic feet per second
COA  Coordinated Operations Agreement
CVP  Central Valley Project
CVPIA  Central Valley Project Improvement Act
D-1641  SWRCB Decision-1641
D-893  SWRCB Decision-893
Delta  San Joaquin-Sacramento Delta
DSM2  DWR Delta Simulation Model 2
DSS  Data Storage System
DWR  California Department of Water Resources
E/I  export-to-inflow
EBMUD  East Bay Municipal Water District
EDW&PA  El Dorado Water & Power Authority
EIR  Environmental Impact Report/Environmental Impact Statement
ESA  Endangered Species Act (federal)
EWA  Environmental Water Account
FERC  Federal Energy Regulatory Commission
GATAER  Graphical and Tabular Analysis for Environmental Resources
JPOD  Joint Point of Diversion
MAF  million acre-feet
M&I  municipal and industrial
NEPA  National Environmental Policy Act
NMFS  National Marine Fisheries Service
NPS  National Park Service
OCAP  Operations Criteria and Plan
PCWA  Placer County Water Agency
PEIS  Programmatic Environmental Impact Statement
ppt  parts per thousand
Reclamation  Bureau of Reclamation
ROD  Record of Decision
SDIP  South Delta Improvement Program
SVWMP  Sacramento Valley Water Management Program
SWP  State Water Project
SWRCB  State Water Resources Control Board
SWRP  EDW&PA Supplemental Water Rights Project
TAF  thousand acre-feet
TUs  temperature units
USFWS  U.S. Fish and Wildlife Service
USGS  United States Geological Survey
VAMP  Vernalis Adaptive Management Plan
X2  2 parts per thousand near bottom salinity isohaline
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SECTION 1 INTRODUCTION
This memorandum provides detailed information regarding the modeling tools, primary modeling assumptions, model inputs, and methodologies that are used to evaluate potential effects on reservoir operations, stream flow, water quality, water temperature, and salmon mortality under the various scenarios that are analyzed in the El Dorado Water & Power Authority Proposed Supplemental Water Rights Project (Proposed EDW&PA SWRP) Environmental Impact Report (EIR), and in support of the necessary federal regulatory requirements associated with Endangered Species Act (ESA) compliance. Implementation of one of these scenarios could result in changes in operations of: (1) the California Department of Water Resources (DWR) State Water Project (SWP); (2) U.S. Bureau of Reclamation’s (Reclamation) Central Valley Project (CVP); and (3) CVP/SWP Sacramento San Joaquin-Delta (Delta) facilities.

This memorandum is included as an appendix to the Draft EIR.

SECTION 2 IMPACT ANALYSIS FRAMEWORK
This section describes the impact analysis framework to evaluate potential flow and water temperature related changes on surface water supplies, surface water quality, hydropower, and aquatic and riparian habitat utilized by listed species that would be expected to occur with implementation of the various alternatives analyzed in the Draft EIR for the Proposed EDW&PA SWRP.

Modeling scenarios were developed to represent existing and future hydrologic conditions with and without implementation of the alternatives considered for the Proposed EDW&PA SWRP (i.e., EDW&PA SWRP Alternatives and Reduced Diversion Alternatives) to enable an evaluation of potential environmental impacts pursuant to CEQA.


Comparison of model results for the different scenarios is used in the discussions of environmental effects in the Draft EIR. Comparison of model results for the scenarios is used to support the CEQA process for the Proposed EDW&PA SWRP.

2.1 IMPACT ANALYSIS APPROACH
The impact analysis compares modeling outputs from one modeling scenario with outputs from another scenario to determine the potential for changes in hydrologic and environmental conditions. Parameters represented by the modeling outputs include: reservoir storages and
water surface elevations, river flows, reservoir and river water temperatures, early life stage Chinook salmon mortalities, and Delta water quality.

The alternatives considered involve changes in surface water management within the American River basins, changes in operations of the CVP and SWP, and modifications of CVP/SWP export operations in the Delta. In addition, changes in San Luis Reservoir storage also are evaluated for certain resources, as appropriate.

The evaluation of environmental impacts is performed using the impact indicators and significance criteria developed for each resource topic (presented in resource chapters of the EIR). Simulation comparisons to be evaluated in the Draft EIR are presented in Table 2-1.

For purposes of addressing potential impact considerations to satisfy CEQA requirements, modeling simulations for the Proposed EDW&PA SWRP alternatives are compared to the Existing Condition Alternative (Table 4-1).

Cumulative impact analyses are required by CEQA regulations and are an important component of the environmental documentation and approval process. The Future Cumulative Condition without the Proposed EDW&PA SWRP Alternative “A” is compared to the Future Cumulative Condition.

2.2 STUDY AREA

The study area is described in three regions: (1) the Folsom Reservoir and American River Region; (2) the CVP/SWP Upstream of the Delta Region; and (3) the Delta Region. Operations of the Trinity River and Clear Creek will not be affected by implementation of the alternatives considered, as discussed below. Simulation of these facilities is not included in the comparative impact analysis.

2.2.1 CHARACTERIZATION OF TRINITY RIVER AND CLEAR CREEK OPERATIONS

The CVP consists of seven divisions located within the Central Valley Basin and two out-of-basin divisions (i.e., the Trinity River Division and the San Felipe Division). The Trinity River Division is the only out-of-basin division that imports water into the Central Valley (i.e., the Sacramento River Basin). Water is transported from the Trinity River Basin via the Clear Creek Tunnel to Whiskeytown Reservoir. From Whiskeytown Reservoir, Trinity River water can be transported either via a second tunnel (i.e., Spring Creek Conduit) to Keswick Reservoir or released into Clear Creek, which flows into the Sacramento River. Reclamation conducts integrated operations between the CVP Trinity River and Shasta divisions.

The Trinity River does not naturally flow into the Sacramento River Basin but is connected by the Clear Creek Tunnel and the Spring Creek Conduit to the Sacramento River system and contributes to CVP water supply. Trinity River flows enter the Sacramento River below Keswick Dam via Clear Creek, however, Sacramento River flows below Keswick Dam do not influence or re-enter the Trinity River Basin. The Trinity River and Clear Creek systems are unlike other river systems (e.g., the Sacramento, Feather, and lower American) evaluated by CALSIM II modeling because project-related changes in flow, water temperature, or reservoir storage in those systems do not alter conditions affecting the availability, rate, timing, magnitude or duration of flows in the Trinity River Basin. The flow regime established in the Trinity River ROD is the only requirement for CVP water downstream of Lewiston Dam and is not altered by the Proposed EDW&PA SWRP. Diversions from the Trinity River to the
Sacramento River occur at Lewiston Lake and CVP operators have expressed their intent to maintain diversions consistent in magnitude and temporal distribution with those that have occurred historically.

Based on the CVP system configuration described above, and upon confirmation that the Proposed EDW&PA SWRP does not directly or indirectly affect Trinity River resources through review of hydrologic and water temperature modeling results, the Trinity River system will not require detailed study in the Draft EIR. However, Trinity, Whiskeytown, and Folsom reservoirs are included in the water temperature modeling because including them is necessary to assess Sacramento River water temperatures.

SECTION 3 MODELS USED FOR THE IMPACT ANALYSIS
Computer simulation models of water systems provide a means for evaluating changes in system characteristics such as reservoir storage, stream flow, and hydropower generation, as well as the effects of these changes on environmental parameters such as water temperature, water quality, and early-life stage Chinook salmon survival. The models and post-processing tools used to simulate conditions with and without implementation of the Proposed EDW&PA SWRP include the following:

- Reclamation and DWR simulation model of the integrated CVP and SWP system operations (CALSIM II);
- Reclamation Trinity, Shasta, Whiskeytown, Oroville, and Folsom reservoir water temperature models;
- Reclamation Feather, and Sacramento river water temperature models;
- Reclamation Feather, and Sacramento river early life stage Chinook salmon mortality models;
- Graphical and Tabular Analysis for Environmental Resources (GATAER) Tool; and
- CVP and SWP (Project) Hydropower Production and Delta Export Pumping Power Demand Analysis
Table 3-1 Summary of Comparative Scenarios to be Evaluated

<table>
<thead>
<tr>
<th>Statute</th>
<th>Base Scenarios</th>
<th>Compared Scenarios</th>
<th>Purpose of Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEQA</td>
<td>Run 1 Existing Condition</td>
<td>Run 2 Proposed Project AlternativeRun 3</td>
<td>To evaluate potential effects of the Proposed Project relative to the Existing Condition</td>
</tr>
<tr>
<td></td>
<td>Run 1 Existing Condition</td>
<td>Run 4 Alternative 2 Reduced DiversionRun 5</td>
<td>To evaluate potential effects of the Reduced Diversion Alternative relative to the Existing Condition</td>
</tr>
<tr>
<td></td>
<td>Run 1 Existing Condition</td>
<td>Run 2 Alternative 3 New Long-Term Water TransferRun 3</td>
<td>To evaluate potential effects of the Long-Term Water Transfer Alternative relative to the Existing Condition</td>
</tr>
<tr>
<td></td>
<td>Run 1 Existing Condition</td>
<td>Run 2 Alternative 4 New Storage FacilitiesRun 3</td>
<td>To evaluate potential effects of the New Storage Facilities Alternative relative to the Existing Condition</td>
</tr>
<tr>
<td></td>
<td>Run 1 Existing Condition</td>
<td>Run 2 Alternative 8 Groundwater Banking/ Conjunctive UseRun 3</td>
<td>To evaluate potential effects of the Groundwater Banking/ Conjunctive Use Alternative relative to the Existing Condition</td>
</tr>
<tr>
<td></td>
<td>Run 7 Future Cumulative W/O Proposed project</td>
<td>Run 6 Proposed Action ESA Cumulative Condition with Proposed Project</td>
<td>To evaluate the incremental contribution of the Proposed Project to the overall potential cumulative effects</td>
</tr>
</tbody>
</table>
The CALSIM II model provides baseline monthly simulation of the CVP and SWP water operations (reservoir inflows, releases, and storage; river flow; and other operating parameters such as CVP/SWP pumping and Delta operations) with and without implementation of the Proposed EDW&PA SWRP.

The CALSIM II output databases are used to generate the inputs required for the water temperature, fish salvage, and power models. The water temperature models’ output is subsequently used to generate the inputs to the early life stage Chinook salmon mortality models. The output or results, of all these models is used to generate a model simulation database. Finally, the GATAER tool is used to generate the information needed for the impact analysis in the form of tables and graphs of model results. These models and related post-processing tools are described in detail in the following sections.

A diagram of the modeling and post-processing applications is presented in Figure 3-1.

### 3.1 CALSIM II MODEL

CALSIM II was jointly developed by Reclamation and DWR for planning studies relating to CVP and SWP operations. The primary purpose of CALSIM II is to evaluate the water supply reliability of the CVP and SWP at current or future levels of development (e.g. 2001, 2020), with and without various assumed future facilities, and with different modes of facility operations. Geographically, the model covers the drainage basin of the Delta, and SWP exports to the San Francisco Bay Area, Central Coast, and Southern California.

CALSIM II typically simulates system operations for a 73-year period using a monthly time-step. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over this period, representing a fixed level of development (e.g., 2001 or 2020). The historical flow record of October 1921 to September 1994, adjusted for the influence of land use change and upstream flow regulation, is used to represent the possible range of water supply conditions. It is assumed that past hydrologic conditions are a good indicator of future hydrologic conditions. Major Central Valley rivers, reservoirs, and CVP/SWP facilities are represented by a network of arcs and nodes. CALSIM II uses a mass balance approach to route water through this network.

The model simulates one month of operation at a time, with the simulation passing sequentially from one month to the next, and from one year to the next. Each determination that the model makes regarding stream flow is the result of defined operational priorities (e.g. delivery priorities to water right holders, and water contractors), physical constraints (e.g., storage limitations, available pumping and channel capacities), and regulatory constraints (flood control, minimum instream flow requirements, Delta outflow requirements). Certain decisions, such as the definition of water year type, are triggered once a year, and affect water delivery allocations and specific stream flow requirements. Other decisions, such as specific Delta outflow requirements, vary from month to month. CALSIM II output contains estimated flows and storage conditions at each node for each month of the simulation period. Simulated flows are mean flows for the month, reservoir storage volumes correspond to end-of month storage.

CALSIM II models a complex and extensive set of regulatory standards and operations criteria. Descriptions of both are contained in Chapter 8 of the OCAP BA (Reclamation 2004), and in the Benchmark Studies Assumptions Document (Reclamation and DWR 2002).

CALSIM II simulates monthly operations of the following water storage and conveyance facilities:
• Trinity, Lewiston, and Whiskeytown reservoirs (CVP);
• Spring Creek and Clear Creek tunnels (CVP);
• Shasta and Keswick reservoirs (CVP);
• Oroville Reservoir and the Thermalito Complex (SWP);
• Folsom Reservoir and Lake Natoma (CVP);
• New Melones Reservoir (CVP);
• Millerton Lake (CVP);
• C.W. "Bill" Jones (CVP), Contra Costa (CVP) and Harvey O. Banks (SWP) pumping plants; and
• San Luis Reservoir (shared by CVP and SWP).

To varying degrees, nodes also define CVP/SWP conveyance facilities including the Tehama-Colusa, Corning, Folsom-South, and Delta-Mendota canals and the California Aqueduct. Other non-CVP/SWP reservoirs or rivers tributary to the Delta also are modeled in CALSIM II, including:

• New Don Pedro Reservoir;
• Lake McClure; and
• Eastman and Hensley lakes.

For this EIR, CALSIM II is used to establish baseline flow conditions in the Sacramento River, Feather River, American River, and Delta, and the availability of pumping capacity at Banks and C.W. “Bill” Jones pumping plants. CALSIM II output includes average monthly X2 (2 parts per thousand [ppt] near bottom salinity isohaline) location, Net Delta Outflow, and Delta export-to-inflow (E/I) ratio.

CALSIM II modeling undertaken for Reclamation’s 2008 OCAP BA is used to provide the foundation for CVP/SWP system-wide baseline conditions (stream flow, storage, and diversions) used to represent the Existing Condition and the Future Cumulative Condition. OCAP model simulations were rerun (OCAP Study 7 and OCAP Study 8) with updated inputs for South Fork American River inflow to Folsom Dam (diversion at White Rock penstock), diversions at the American River Pump Station near Auburn, and diversions from Folsom Reservoir.

3.2 BUREAU OF RECLAMATION WATER TEMPERATURE MODELS

Reclamation has developed water temperature models for the Sacramento, Feather, and American rivers. The models have both reservoir and river components to simulate water temperatures in five major reservoirs (Trinity, Whiskeytown, Shasta, Oroville, and Folsom); four downstream regulating reservoirs (Lewiston, Keswick, Thermalito, and Natoma); and three main river systems (Sacramento, Feather, and American).

The following sections provide additional detail regarding the reservoir and river components of the water temperature models, respectively. Additional details regarding Reclamation’s water temperature models are well documented in the Central Valley Project Improvement Act (CVPIA) Draft Programmatic EIS (PEIS) Technical Appendix, Volume Nine (Reclamation 1997). These water temperature models also are documented in the report titled: U.S. Bureau of Reclamation Monthly Temperature Model Sacramento River Basin, (Reclamation 1990).
Figure 3-1 Modeling and Post-Processing Procedures

INPUT

CALSIM II
CVP/SWP System
Reservoir and
Rivers
CVP/SWP System
Operations

Temperature
Models
Reservoirs
Rivers

Salmon
Mortality
Models

Delta
Fish
Salvage

RESULTS

Graphic and
Tabular Analysis
for
Environmental
Resources
(GATAER)
Tool

ANALYSIS
FINDINGS

Hydrology
Water Supply
Water Quality
Hydropower
Flood Control
Fisheries
Terrestrial
Recreation
Visual
Cultural
Delta
Delta X2
Inflow/Outflow
Delta Exports
3.2.1 **BUREAU OF RECLAMATION’S RESERVOIR WATER TEMPERATURE MODELS**

Reclamation’s reservoir models simulate monthly water temperature profiles in five major reservoirs: Trinity, Whiskeytown, Shasta, Oroville, and Folsom. The vertical water temperature profile in each reservoir is simulated in one dimension using monthly storage, inflow and outflow water temperatures and flow rates, evaporation, precipitation, solar radiation, and average air temperature. The models also compute the water temperatures of dam releases. Release water temperature control measures in reservoirs, such as the penstock shutters in Folsom Reservoir and the temperature control device in Shasta Reservoir, are incorporated into the models.

Reservoir inflows, outflows, and end-of-month storage calculated by CALSIM II and post-processing applications are input into the reservoir water temperature models. Additional input data include meteorological information and monthly water temperature targets that are used by the model to select the level from which reservoir releases are drawn. Water temperature control devices, such as the outlet control device in Shasta Dam, the temperature curtains in Whiskeytown Dam, and the penstock shutters in Folsom Dam are incorporated into the simulation. Model output includes reservoir water temperature profiles and water temperatures of the reservoir releases. The reservoir release water temperatures are then used in the downstream river water temperature models, as described in the next section.

Trinity, Whiskeytown, and Folsom reservoirs are included in the modeling application because they are required to assess Sacramento River water temperatures; however, these reservoirs are not individually analyzed because there would be no change in CVP/SWP project operations due to implementation of the alternatives considered for the Proposed EDW&PA SWRP, relative to the bases of comparison.

3.2.2 **BUREAU OF RECLAMATION’S RIVER WATER TEMPERATURE MODELS**

Reclamation’s river water temperature models utilize the calculated temperatures of reservoir releases, much of the same meteorological data used in the reservoir models, and CALSIM II and post-processing application outputs for river flow rates, gains and water diversions. Mean monthly water temperatures are calculated at multiple locations on the Sacramento, Feather, and American rivers.

Reservoir release rates and water temperatures are the boundary conditions for the river water temperature models. The river water temperature models compute water temperatures at 52 locations on the Sacramento River from Keswick Dam to Freeport, and at multiple locations on the Feather and American rivers. The river water temperature models also calculate water temperatures within Lewiston, Keswick, Thermalito, and Natoma reservoirs. The models are used to estimate water temperatures in these reservoirs because they are relatively small bodies of water with short residence times; thereby, on a monthly basis, the reservoirs act as if they have physical characteristics approximating those of riverine environments.

3.3 **BUREAU OF RECLAMATION’S EARLY LIFE STAGE CHINOOK SALMON MORTALITY MODELS**

Water temperatures calculated for specific reaches of the Sacramento and Feather rivers are used as inputs to Reclamation’s Early Life Stage Chinook Salmon Mortality Models (Salmon Mortality Models) to estimate annual mortality rates of Chinook salmon during specific early life stages. For the Sacramento River analyses, the model estimates mortality for each of the
four Chinook salmon runs: fall, late fall, winter, and spring. For the Feather River and American River analyses, the model produces estimates of fall-run Chinook salmon mortality.

The Salmon Mortality Models produce a single estimate of early life stage Chinook salmon mortality in each river for each year of the simulation. The overall salmon mortality estimate consolidates estimates of mortality for three separate Chinook salmon early life stages: (1) pre-spawned (in utero) eggs; (2) fertilized eggs; and (3) pre-emergent fry. The mortality estimates are computed using output water temperatures from Reclamation’s water temperature models as inputs to the Salmon Mortality Models. Thermal units (TUs), defined as the difference between river water temperatures and 32°F, are used by the Salmon Mortality Models to track life stage development, and are accounted for on a daily basis. For example, incubating eggs exposed to 42°F water for one day would experience 10 TUs. Fertilized eggs are assumed to hatch after exposure to 750 TUs. Fry are assumed to emerge from the gravel after being exposed to an additional 750 TUs following hatching.

Because the models are limited to calculating mortality during early life stages, they do not evaluate potential impacts to later life stages, such as recently emerged fry, juvenile out-migrants, smolts, or adults. Additionally, the models do not consider other factors that may affect early life stage mortality, such as adult pre-spawn mortality, instream flow fluctuations, redd superimposition, and predation. Because the Salmon Mortality Models operate on a daily time-step, a procedure is required to convert the monthly water temperature output from the water temperature models into daily water temperatures. The Salmon Mortality Models compute daily water temperatures based on the assumption that average monthly water temperature occurs on the 15th of each month, and interpolate daily values from mid-month to mid-month. Output from the Salmon Mortality Models provide estimates of annual (rather than monthly mean) losses of emergent fry from egg potential (i.e., all eggs brought to the river by spawning adults) (Reclamation 2003).

A similar water temperature based mortality model for steelhead in the Sacramento, Feather and American rivers currently is not available. However, because the temporal and spatial spawning distributions of steelhead and late fall-run Chinook salmon are similar, it can be assumed that water temperature changes and resultant losses of steelhead eggs and fry would be similar to those estimated for late fall-run Chinook salmon using the Salmon Mortality Models, where available.

3.3.1 OTHER SALMON MORTALITY MODEL CONSIDERATIONS

Three separate reviews of the NMFS October 2004 Biological Opinion on the Long-Term Central Valley Project (CVP) and State Water Project (SWP) Operations Criteria and Plan (OCAP) (NMFS 2004) have been conducted to determine whether NMFS (NMFS 2004) used the best available scientific and commercial information (California Bay-Delta Authority 2005).

McMahon (McMahon 2006) acknowledged that a lack of information on how water operations related habitat alterations affect Central Valley salmonid populations exists. In this context, McMahon (McMahon 2006) concluded that, “…the Biological Opinion (BO) appears to be based on best available information with regards to temperature effects on survival of salmonid embryos and early fry in the upper Sacramento River and major tributaries…”.

Maguire (Maguire 2006) reported two general concerns related to the salmon mortality model. First, Maguire (Maguire 2006) stated, “The mean monthly temperature may in fact be of little predictive value for mortality estimation without knowing (using) the variability and duration of variability.” Second, Maguire (Maguire 2006) suggested that the salmon mortality model is of
limited usefulness because it does not evaluate potential impacts on emergent fry, smolts, juvenile emigrants, or adults, and the model only considers water temperature as a source of mortality.

With respect to the application of the salmon early life stage mortality model in NMFS (NMFS 2004), three concerns were reported within the California Bay-Delta Authority (CBD) report (California Bay-Delta Authority 2005). First, CBD (California Bay-Delta Authority 2005) questioned the use of water temperature predictions that were developed by linear interpolation between monthly means without accounting for variation. Second, water temperature at the time of spawning was taken as an index of pre-spawning water temperature exposure, which reportedly may be an unsatisfactory approach for spring-run Chinook salmon, which may hold in the river throughout the summer. Lastly, and reportedly the expert panel's most serious concern, “...the data used to develop the relationships between temperature and mortality on eggs, alevins, and especially gametes was not the best available.”

To address these three concerns, the expert panel recommended that NMFS should: (1) perform a thorough analysis of the data, relationships, and calculations of the salmon mortality model; (2) investigate how variation around monthly mean water temperatures would affect salmon mortality model results; and (3) suggest or make improvements to the model. It is uncertain whether NMFS will accept these recommendations and undertake these efforts to address the concerns raised with technical details of the salmon mortality model. At this time, this process has not been undertaken and salmon mortality model improvements have not been identified and incorporated into the model. Therefore, the existing salmon mortality model is the best available model for comparing the potential water temperature related effects of the Proposed Project/Action and alternatives on Chinook salmon early life stages to those of the basis of comparison.

3.4 GRAPHIC AND TABULAR ANALYSIS OF ENVIRONMENTAL RESOURCES TOOL

The GATAER Tool produces figures and tables for the analysis of output from CALSIM II, the water temperature models, salmon mortality models, and other post-processing applications. Data are loaded from these models into a DSS database, which is then used as input to a series of spreadsheets that generate the figures and tables for use in the environmental resource analyses. The figures and tables generated for the evaluation of specific resource topics and impacts is included in Appendix H, Graphical and Tabular Analysis of Environmental Resources – Summary and Technical Output, of the Draft EIR.

3.5 SACRAMENTO-SAN JOAQUIN DELTA FISH SALVAGE EVALUATION

The CVP and SWP export facilities (including the John E. Skinner Fish Protection Facility and the Tracy Fish Collection Facility) that pump water from the Delta can directly affect fish mortality in the Delta through entrapment and associated stresses resulting from CVP/SWP export pumping operations. This section describes the methodology and assumptions that is used to evaluate these potential impacts. The evaluation uses historical fish salvage data from the CVP and SWP pumping plants to evaluate the overall effect of changes in Delta exports.

3.5.1 SALVAGE

Salvage operations at the CVP and SWP export facilities are performed to reduce the number of fish adversely affected by entrapment (direct loss). Salvage estimates are defined as the
number of fish entering a salvage facility and subsequently returned to the Delta through a trucking and release operation. Because the survival of species that are sensitive to handling is believed to be low for most fish species, increased salvage is considered an adverse impact and decreased salvage is considered a beneficial impact on Delta fisheries resources.

Historical salvage records provide data for delta smelt, Chinook salmon, steelhead, and striped bass at both the CVP and SWP facilities. These data were used to develop estimates of salvage loss. During the historical period, 1993 to 2003, the CVP and SWP facilities were operated under Delta water quality, flow, and export constraint requirements that varied over the period and were different than the Delta requirements in place today. This suggests that the historical fish salvage was likely higher than it would be if the 1993 to 2003 period reoccurred with the CVP/SWP facilities operated under today’s Delta requirements, as is assumed in this analysis.

Consistent with prior Reclamation assumptions (Reclamation 2004b), it is assumed that changes in salvage are directly proportional to changes in the amount of water pumped (i.e., doubling the amount of water exported doubles the number of fish salvaged). Salvage analyses are performed for winter-run Chinook salmon, spring-run Chinook salmon, steelhead, striped bass, and delta smelt to develop estimates of the relative impacts of CVP and SWP pumping operations under the various modeling scenarios. The evaluation uses historical fish salvage data from the CVP and SWP pumping plants to evaluate changes in Delta exports (increased pumping) and the resultant changes in salvage for various fish species in the Delta. The available historical salvage data extends from 1993 to 2003 for delta smelt, Chinook salmon, steelhead, and striped bass. The salvage data prior to 1993 does not sufficiently represent the current conditions in the Delta due to operational changes. Since 1993, the salvage data provides daily densities, in numbers of fish salvaged per thousand acre-feet pumped at the CVP C.W. “Bill” Jones Pumping Plant and the SWP Banks Pumping Plant.

Populations of some of the listed species, such as winter-run Chinook salmon, are continuously variable and the geographical and temporal distribution of the population can be different today from what they were during the 1993 to 2003 period. Because of this, neither the timing, duration, nor the quantity of water needed for most export curtailments can be accurately estimated until shortly before an action is scheduled.

In response to NMFS issuance of a final rule (71 FR 17757) listing the Southern Distinct Population segment of North American green sturgeon as threatened under the Endangered Species Act (ESA), Reclamation is in the process of developing a methodology for calculating green sturgeon salvage estimates at the CVP and SWP export pumping facilities in the Delta. If a methodology is developed prior to completion of the Draft EIR for the Proposed EDW&PA SWRP, it is anticipated that salvage estimates for green sturgeon also would be conducted.

3.5.2 MODELING

Salvage analyses is performed to develop an indication of the relative changes in CVP and SWP pumping operations under the various modeling scenarios evaluated in the Draft EIR and information used to support the ESA consultation process. Salvage densities are developed for the purposes of evaluating the incremental effects of potential operations on the direct losses at the Delta export facilities. Calculations of salvage at the CVP and SWP facilities, as a function of changes in the seasonal volume of water diverted, have been used as an indicator of potential effects resulting from changes in water project operations. The magnitude of direct salvage resulting from export operations is a function of the magnitude of monthly water exports from each facility and the density (number per acre-foot) of fish susceptible to entrainment at the facilities.
Data selected for use in these analyses extended over a period from 1993 to 2003. The salvage densities are derived using historic records of species-specific salvage at the CVP and SWP facilities, which are used to calculate average monthly density (number of fish per thousand acre-feet), and then are multiplied by the calculated CVP and SWP monthly exports (in thousand acre-feet) obtained from the hydrologic modeling output to estimate direct salvage. The salvage estimates are calculated separately for the CVP and SWP export operations for all modeling scenarios.

Average monthly salvage densities for each species are calculated from daily salvage records over the period from 1993 to 2003 (pers. comm. M. Chotkowski, Reclamation in (Reclamation 2004a). Based on the daily salvage, expanded for sub-sampling effort, a daily density estimate is calculated using the actual water volume diverted at each of the two export facilities. The daily density estimates are averaged to calculate an average monthly density. For consistency, the average monthly density of each of the individual target species are used to calculate the estimated salvage using hydrologic modeling results for each modeling scenario. After calculating the monthly salvage estimates for each species, the baseline (or basis of comparison scenario) estimate are subtracted from the monthly salvage estimate for each species to determine the net difference in salvage estimates for the various scenarios.

Results of the hydrologic modeling provide estimates of the average monthly Delta export operations for both the CVP and SWP. Because hydrologic conditions may affect salvage densities, the average salvage densities are calculated separately for wet years (i.e., wet and above normal water years using the Sacramento Valley 40-30-30 Index) and dry years (i.e., below normal, dry, and critical water years using the Sacramento Valley 40-30-30 Index). Estimates of direct salvage from CVP and SWP facilities are calculated for Chinook salmon, steelhead, delta smelt, and striped bass, and then are used to determine the incremental benefits (reduced salvage) and impacts (increased salvage) calculated for each modeling scenario.

Despite the inaccuracies within the analyses caused by assuming historical fish salvage at the pumping plants, the evaluations are performed to provide an approximate quantification of the overall potential impacts with implementation of the alternatives, using the best available data. Without some quantification, the discussion and analyses of potential changes in fish salvage and the cost of exporting water would have to be qualitative and based solely on scientific opinion. Therefore, the results provided by the analyses must be considered as only part of the information (quantitative and qualitative) that are used to evaluate the potential effects in the Delta.

3.6 PROJECT HYDROPOWER PRODUCTION AND DELTA EXPORT PUMPING POWER DEMAND EVALUATION

CVP project hydropower impacts are assessed using the LongTermGen Model, which is a CVP power model developed to estimate the CVP power generation, capacity, and project use based on the operations defined by a CALSIM II simulation. Created using Microsoft’s Excel spreadsheet with extensive Visual Basic programming, the LongTermGen Model computes monthly generation, capacity, and project use (pumping power demand) for each CVP power facility for each month of the CALSIM II simulation.

The LongTermGen model does not compute hydropower production for Oroville Reservoir or pumping power use for SWP pumping plants. To assess any changes in Oroville power production, equations were developed relating reservoir storage and release to generation and
capacity, using historical data. These relationships were incorporated into an Excel 2000 spreadsheet that uses CALSIM II (or post-processing tool) output data as input.

Although the LongTermGen Model can calculate export pumping power demand for the CVP pumping plant at the C.W. “Bill” Jones Pumping Plant, it does not calculate SWP export pumping power demand at the Banks Pumping Plant. Water pumped at Banks Pumping Plant can gravity flow to O’Neill Forebay, but water pumped at C.W. “Bill” Jones Pumping Plant requires an additional lift at O’Neill Pumping Plant. The combined pumping power requirement at C.W. “Bill” Jones and O’Neill is approximately equal to that of Banks Pumping Plant. For this reason, and because CVP or SWP water may be pumped at either Delta export facility, the Banks, and C.W. “Bill” Jones plus O’Neill, pumping power demand was calculated using a plant requirement of 298 kilowatt-hours/acre-foot times the volume of water pumped at either facility. An Excel spreadsheet is used to calculate the resultant pumping power demand using input from the CALSIM II (or post-processing tool) simulations.

3.7 MODEL LIMITATIONS

Reclamation’s 2008 OCAP Biological Assessment (BA) outlines the limitations of three of the models that were used in the assessment conducted for the most recent Section 7 consultations on the OCAP, which led to NMFS and USFWS biological opinions (BOs) for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Southern Distinct Population Segment (DPS) of North American green sturgeon, Southern Resident killer whales, and delta smelt. These models (i.e., CALSIM II, water temperature, and salmon mortality) are the same models used to conduct the modeling analysis presented in the Draft EIR for the Proposed EDW&PA SWRP. The following discussion regarding the model limitations used in the modeling analysis is taken directly from the CVP and SWP OCAP BA.

“The main limitation of CALSIM II and the temperature models used in the study is the time-step. Mean monthly flows and temperatures do not define daily variations that could occur in the rivers due to dynamic flow and climatic conditions. However, monthly results are still useful for general comparison of alternatives. The temperature models are also unable to accurately simulate certain aspects of the actual operations strategies used when attempting to meet temperature objectives, especially on the upper Sacramento River. To account for the short-term variability and the operational flexibility of the system to respond to changing conditions, cooler water than that indicated by the model is released in order to avoid exceeding the required downstream temperature target. There is also uncertainty regarding performance characteristics of the Shasta TCD [temperature control device]. Due to the hydraulic characteristics of the TCD, including leakage, overflow, and performance of the side intakes, the model releases are cooler than can be achieved in real-time operations; therefore, a more conservative approach is taken in real-time operations that is not fully represented by the models.

The salmon model is limited to temperature effects on early life stages of Chinook salmon. It does not evaluate potential direct or indirect temperature impacts on later life stages, such as emergent fry, smolts, juvenile out-migrants, or adults. Also, it does not consider other factors that may affect salmon mortality, such as in-stream flows, gravel sedimentation, diversion structures, predation, ocean harvest, etc. Since the salmon mortality model operates on a daily time-step, a procedure is required to utilize the monthly temperature model output. The salmon model computes daily temperatures based on linear interpolation between the monthly temperatures, which are assumed to occur on the 15th day of the month.
CALSIM II cannot completely capture the policy-oriented operation and coordination of the 800,000 of dedicated CVPIA 3406(B)(2) water and the CALFED EWA. Because the model is set up to run each step of the 3406(B)(2) on an annual basis and because the WQCP and ESA actions are set on a priority basis that can trigger actions using 3406(b)(2) water or EWA assets, the model will exceed the dedicated amount of 3406(b)(2) water that is available. Moreover, the 3406(b)(2) and EWA operations in CALSIM II are just one set of plausible actions aggregated to a monthly representation and modulated by year type. However, they do not fully account for the potential weighing of assets versus cost or the dynamic influence of biological factors on the timing of actions. The monthly time-step of CALSIM II also requires day-weighted monthly averaging to simulate minimum instream flow levels, VAMP actions, export reductions, and X2-based operations that occur within a month. This averaging can either under- or over-estimate the amount of water needed for these actions.

Since CALSIM II uses fixed rules and guidelines results from extended drought periods might not reflect how the SWP and CVP would operate through these times. The allocation process in the modeling is weighted heavily on storage conditions and inflow to the reservoirs that are fed into the curves mentioned previously in the Hydrologic Modeling Methods section beginning on page 8-1 and does not project inflow from contributing streams when making an allocation. This curve based approach does cause some variation in results between studies that would be closer with a more robust approach to the allocation process” (Reclamation, 2004).

Model assumptions and results are generally believed to be more reliable for comparative purposes than for absolute predictions of conditions. All of the assumptions are the same for both the with-project and without-project model runs, except assumptions associated with the action itself, and the focus of the analysis is the differences in the results. For example, model outputs for the Proposed Project can be compared to that of the No Project simulation. Results from a single simulation may not necessarily correspond to actual system operations for a specific month or year, but are representative of general water supply conditions. Model results are best interpreted using various statistical measures such as long-term and year-type average, and probability of exceedance.

SECTION 4 MODEL SCENARIOS

The full suite of modeling scenarios developed to represent existing and future hydrologic conditions expected to occur with and without implementation of the alternatives considered for the Proposed EDW&PA SWRP and evaluated in the Draft EIR is presented in Table 4-1. Details on the assumptions included in each of the scenarios are included in footnotes after the table.

4.1 FOUNDATION STUDIES

The foundations studies are CALSIM II planning studies that have been developed by Reclamation in association with DWR for the 2008 OCAP BA. These studies are used as the basis for all hydrologic modeling.

4.1.1 2008 OCAP STUDY 7

The Existing Condition represents the current conditions at the time a project is proposed. For CEQA purposes, the Existing Condition is defined as the time at which the notice of preparation is published (CEQA Guidelines Section 15125). The Existing Condition represents the current
regulatory and physical conditions, which are used as a baseline to evaluate the significance of potential impacts associated with implementation of the alternatives considered in the Draft EIR.

2008 OCAP Study 7 was developed by Reclamation as part of the 2008 OCAP BA to evaluate the existing CVP/SWP operations (Reclamation 2008). This study forms the model to compare proposed operations. OCAP Study 7.0 describes existing water demands, facilities, and water project operational policy, to the extent possible. It represents the today condition (a 2005 level of land use development).

4.1.2 2008 OCAP STUDY 8
The Cumulative Condition focuses on reasonable foreseeable actions that may occur at a future time during the life of the project.

OCAP Study 8, “Future EWA” was developed by Reclamation as part of the 2008 OCAP BA to evaluate future CVP/SWP operations, and was used to evaluate the effects of projects and actions included in the consultation (Reclamation 2008). This study represents assumed water demands and policy for the future. It represents the future condition (a 2030 level of land use development). OCAP Study 8 accounts for future foreseeable projects/actions, and therefore most correctly characterizes the modeling assumptions applied to modeling scenarios evaluated in the Draft EIR. OCAP Study 8 did not include the EDW&PA SWRP Proposed Project, therefore, to appropriately describe the Future Cumulative Condition, OCAP Study 8 was modified to include the EDW&PA SWRP Proposed Project “A”.

4.2 SCENARIOS
For CEQA purposes, model scenarios are based on 2008 OCAP Study 7, modified as necessary to create simulations for the Existing Condition (Run 1), EDW&PA SWRP Proposed Project “A” (Run 2), EDW&PA SWRP Proposed Project “B” (Run 3), EDW&PA SWRP Reduced Project “A-2” (Run 4), EDW&PA SWRP Reduced Project “B-2” (Run 5).

4.2.1 EXISTING CONDITION (RUN 1)
This simulation represents current hydrologic, operational and regulatory considerations within the Study Area as described in the Chapter 2, Description of Environmental Setting and Existing Conditions, of the Draft EIR.

4.2.2 EDW&PA SWRP PROPOSED PROJECT “A” (RUN 2)
This simulation represents current hydrologic, operational and regulatory considerations within the Study Area, modified to represent inclusion of the EDW&PA SWRP Proposed Project “A”. Proposed Project “A” is a 40,000 af annual diversion characterized as an annual 30,000 af diversion from Folsom Reservoir, and an annual 10,000 af inflow reduction into Folsom Reservoir to reflect an assumed diversion at or near the American River Pump Station on the North Fork American River.
## Table 4-1: EDW&PA SWRP CEQA AND NEPA Modeling Scenario Assumptions Matrix

### Supplemental Water Rights Project Modeling Assumptions Matrix

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<th>PROPOSED PROJECT &quot;B&quot;</th>
<th>REDUCED DIVERSION &quot;A-2&quot;</th>
<th>REDUCED DIVERSION &quot;B-2&quot;</th>
<th>FUTURE CUMULATIVE CONDITION</th>
<th>FUTURE CUMULATIVE CONDITION WITHOUT PROPOSED PROJECT &quot;A&quot;</th>
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#### Supplemental Water Rights Project Modeling Assumptions Matrix

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### Table 4-3 (continued). EDW&PA SWRP CEQA AND NEPA Modeling Scenario Assumptions Matrix

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<td>191</td>
<td>Feather River</td>
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<td>192</td>
<td>Minimum flow below Thermalito Diversion Dam</td>
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<td>193</td>
<td>Minimum flow below Thermalito Access Point</td>
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<td>Yuba River</td>
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<td>195</td>
<td>Minimum flow below Daggett Point Dam</td>
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<td>196</td>
<td>Lower Sacramento River</td>
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<td>197</td>
<td>Mokelumne River</td>
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<td>198</td>
<td>Upper Sacramento River</td>
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<td>199</td>
<td>Minimum flow below Camanche Dam</td>
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<td>200</td>
<td>Minimum flow below Woodbridge Diversion Dam</td>
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<td>Stanislaus River</td>
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<td>202</td>
<td>Minimum flow below Goodwin Dam</td>
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<td>203</td>
<td>Minimum flow below Van Arsdale Dam</td>
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<td>Tuolumne River</td>
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<td>205</td>
<td>Minimum flow at La Grange Bridge</td>
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<td>Merced River</td>
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# Supplemental Water Rights Project Modeling Assumptions Matrix

## Table 4-5 (continued). EDW&PA SWRP CEQA and NEPA Modeling Scenario Assumptions Matrix

<table>
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<tr>
<th>Row</th>
<th>Run Number</th>
<th>Description</th>
<th>BASE CONDITION</th>
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<th>PROPOSED PROJECT 'B'</th>
<th>REDUCED DIVERSION 'A'-2'</th>
<th>REDUCED DIVERSION 'B'-2'</th>
<th>FUTURE CUMULATIVE CONDITION</th>
<th>FUTURE CUMULATIVE CONDITION WITHOUT PROPOSED PROJECT 'A'</th>
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<td>River-specific Operations Criteria</td>
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<td>Flow objective for navigation (Wilkins Slough)</td>
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<td>3,250-5,000 cfs based on CVP water supply condition</td>
<td>3,250-5,000 cfs based on CVP water supply condition</td>
<td>3,250-5,000 cfs based on CVP water supply condition</td>
<td>3,250-5,000 cfs based on CVP water supply condition</td>
<td>3,250-5,000 cfs based on CVP water supply condition</td>
<td>3,250-5,000 cfs based on CVP water supply condition</td>
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<td>Variable 400/670 flood control diagram without outlet modifications</td>
<td>Variable 400/670 flood control diagram without outlet modifications</td>
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<td>Variable 400/670 flood control diagram without outlet modifications</td>
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<td>San Joaquin River</td>
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<td>228</td>
<td>CVP Water Allocation</td>
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<td>229</td>
<td>CVP Settlement and Exchange</td>
<td>100% (75% in Shasta critical years)</td>
<td>100% (75% in Shasta critical years)</td>
<td>100% (75% in Shasta critical years)</td>
<td>100% (75% in Shasta critical years)</td>
<td>100% (75% in Shasta critical years)</td>
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<td>230</td>
<td>CVP Refuges</td>
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<td>100% (75% in Shasta critical years)</td>
<td>100% (75% in Shasta critical years)</td>
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<td>231</td>
<td>CVP Agriculture</td>
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<td>50% (50% based on supply)</td>
<td>50% (50% based on supply)</td>
<td>50% (50% based on supply)</td>
<td>50% (50% based on supply)</td>
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<td>232</td>
<td>CVP Municipal and Industrial</td>
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<td>50% (50% based on supply)</td>
<td>50% (50% based on supply)</td>
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<td>SWP Water Allocation</td>
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<tr>
<td>235</td>
<td>South of Delta (including North Bay Aqueduct)</td>
<td>Based on supply; equal prioritization between Ag and M&amp;I based on Monterey Agreement</td>
<td>Based on supply; equal prioritization between Ag and M&amp;I based on Monterey Agreement</td>
<td>Based on supply; equal prioritization between Ag and M&amp;I based on Monterey Agreement</td>
<td>Based on supply; equal prioritization between Ag and M&amp;I based on Monterey Agreement</td>
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<td>CVP-SWP Coordinated Operations</td>
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### Table 4-6 (continued). EDW&PA SWRP CEQA AND NEPA Modeling Scenario Assumptions Matrix

#### Supplemental Water Rights Project Modeling Assumptions Matrix

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<thead>
<tr>
<th>Row</th>
<th>Run Number</th>
<th>Description</th>
<th>BASE CONDITION</th>
<th>PROPOSED PROJECT A</th>
<th>PROPOSED PROJECT B</th>
<th>REDUCED DIVERSION A-2</th>
<th>REDUCED DIVERSION B-2</th>
<th>FUTURE CUMULATIVE CONDITION</th>
<th>FUTURE CUMULATIVE CONDITION WITHOUT PROPOSED PROJECT A</th>
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</table>
4.2.3 EDW&PA SWRP PROPOSED PROJECT “B” (RUN 3)

This simulation represents current hydrologic, operational and regulatory considerations within the Study Area, modified to represent inclusion of the EDW&PA SWRP Proposed Project “B”. Proposed Project “B” is a 40,000 af annual diversion characterized as an annual 40,000 af inflow reduction into Folsom Reservoir to reflect an assumed diversion at or near the White Rock Penstock on the South Fork American River.

4.2.4 EDW&PA SWRP REDUCED PROJECT “A-2” (RUN 4)

This simulation represents current hydrologic, operational and regulatory considerations within the Study Area, modified to represent inclusion of the EDW&PA SWRP Reduced Project “A-2”. Reduced Project “A-2” is a 20,000 af annual diversion characterized as an annual 15,000 af diversion from Folsom Reservoir, and an annual 5,000 af inflow reduction into Folsom Reservoir to reflect an assumed diversion at or near the American River Pump Station on the North Fork American River.

4.2.5 EDW&PA SWRP REDUCED PROJECT “B-2” (RUN 5)

This simulation represents current hydrologic, operational and regulatory considerations within the Study Area, modified to represent inclusion of the EDW&PA SWRP Reduced Project “B-2”. Proposed Project “B-2” is a 20,000 af annual diversion characterized as an annual 20,000 af inflow reduction into Folsom Reservoir to reflect an assumed diversion at or near the White Rock Penstock on the South Fork American River.

4.3 CUMULATIVE EFFECTS

Cumulative effects are impacts on the environment that result from the incremental impacts of a proposed project or action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Such impacts can result from individually minor but collectively significant actions taking place over time (40 CFR 1508.7). Cumulative impact analyses are required by both CEQA and NEPA regulations and are an important component of the environmental documentation and approval process. The baseline condition of the resource of concern shall include a description of how conditions have changed over time and how they are likely to change in the future without the proposed action (Emphasis added) (CEQ 1997).

Cumulative impacts related to surface water supply and management, hydropower, surface water quality, fisheries and aquatic resources, terrestrial resources, recreation, visual resources, and cultural resources and Indian trust assets are evaluated quantitatively utilizing model data output from CALSIM II.

4.3.1 EDW&PA SWRP FUTURE CUMULATIVE CONDITION (RUN 6)

For analytical purposes, the Future Cumulative Condition with EDW&PA SWRP Proposed Project “A” was modeled as OCAP Study 8 modified to include EDW&PA SWRP Proposed Project “A”. Additional changes to OCAP Study 8 are shown in Table 4-1.
4.3.2 **FUTURE CUMULATIVE CONDITION WITHOUT PROPOSED PROJECT “A” (RUN 7)**

To identify effects of the Proposed Project in the future condition, OCAP Study 8 serves as the basis for comparison for the without project condition. OCAP Study 8 was modified as shown in Table 4-1 to maintain consistency with Run 6 except for the proposed project.

**SECTION 5 REFERENCES**


Reclamation. 2004b. Long-Term Central Valley Project Operations Criteria and Plan (CVP-OCAP).

Reclamation. 2003. CVP-OCAP, Temperature and Salmon Mortality Model Description.


