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Common Response 9: Hydrologic Modeling and Approach

Overview

This Common Response addresses the common themes and topics raised in public comments related to the framework of hydrologic modeling and the hydrologic model (e.g., CalSim 3) used for multiple analyses contained in the Delta Conveyance Project Environmental Impact Report (EIR). Appendix 5A, *Modeling Technical Appendix*, Section A, *Modeling Overview*, in the section *Introduction*, describes the overall analytical framework and contains descriptions of the key analytical tools and approaches used in the quantitative evaluation of existing conditions, the No Project Alternative under the 2040 scenario, Delta Conveyance Project (project), and the project alternatives. Information from that appendix is referenced, summarized, and clarified in this Common Response.

This Common Response addresses comments with the following recurring themes.

- CalSim 3, best available tool for hydrologic analysis.
- CalSim 3 assumptions, uncertainties, and limitations.
- Appropriate use of CalSim 3 simulation results.
- Modeled representation of the California Environmental Quality Act (CEQA) baseline existing conditions.
- Modeled representation of No Project Alternative under the 2040 scenario.
- Modeled representation of proposed project and project alternatives.

Responses to common themes regarding water quality modeling and the use of DSM2, a water quality modeling tool, are provided in Common Response 10, *Surface Water Quality and Groundwater Resources*.

CalSim 3, Best Available Tool for Hydrologic Analysis

Comments did not suggest that CalSim 3 was the incorrect tool, nor did comments offer the use of an alternative tool for analytical purposes. Comments did suggest that some limitations of the CalSim 3 model may influence one or more simulations or add uncertainty to proposed specific project operations under the existing conditions, No Project Alternative under the 2040 scenario, or various project alternatives analyzed in the EIR. Those comments are addressed in later sections of this Common Response. This section of the response is intended to add clarification as to why CalSim 3 was selected as the best available tool despite limitations or uncertainty inherent in the CalSim 3 model itself as a planning tool.

The *Methods for Analysis* section of Chapter 5, *Surface Water*, describes the modeling tools used to identify potential changes as the basis for impact assessment in subsequent resource chapters of the EIR. Appendix 5A, Section A, in the section *Overview of Modeling Approach*, provides a detailed discussion of the overall analytical framework and contains descriptions of the key analytical tools and approaches used in the quantitative evaluation of existing conditions. The California Department of Water Resources (DWR) developed a suite of numerical modeling tools that are illustrated in Appendix 5A, Section A, with a figure titled *Modeling Framework Used to Assess*

Impacts of the Proposed Project and Project Alternatives. Central to this framework is CalSim 3, a planning model jointly developed by DWR and the Bureau of Reclamation (Reclamation) to simulate operations of the State Water Project (SWP) and Central Valley Project (CVP) over a wide range of hydrologic conditions. There is no other model that includes both the SWP and CVP facilities and operations that is used by both DWR and Reclamation to support their respective planning processes.

All models, including CalSim II and CalSim 3, by necessity are simplified representations of complex systems. The models are an imperfect representation of reality and contain some level of uncertainty in the internal assumptions and processes. The key to making these models useful is to reduce the uncertainty and limitations to an acceptable level and to present model results in a manner that is consistent with the level of uncertainty. The CalSim 3 model is the result of over 15 years of development by DWR and Reclamation to reduce uncertainty and limitations to an acceptable level and is used to support the long-term joint operational and facilities planning for the SWP and CVP—the two largest water supply projects in California, serving hundreds of thousands of acres of agriculture and providing millions of people with water for municipal and industrial uses.

For a number of years, CalSim II, the precursor to CalSim 3, has been accepted as an assessment tool by both federal (Reclamation) and California (DWR) water management agencies. For water projects throughout California, regulatory agencies such as the U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), California State Water Resources Control Board (State Water Board), and California Department of Fish and Wildlife (CDFW) have acknowledged through various environmental compliance processes and legal proceedings that CalSim II was an acceptable tool for conducting comparative impact (and not predictive) assessments. It has been adopted by other agencies as a planning tool for assessing impacts, including the Contra Costa Water District and Sites Project Authority. CalSim 3 was specifically developed from CalSim II to reduce uncertainty and limitations while improving its transparency and acceptability. Appendix 5A, Section B, *Hydrology and Systems Operations Modeling*, in the section *CalSim 3*, describes the additions and enhancements to CalSim II that were incorporated into CalSim 3. Most of these enhancements focus on hydrologic aspects of the model; CalSim 3 retains much of the CalSim II reservoir operations logic.

DWR and Reclamation have extensively reviewed CalSim 3 performance through comparison to CalSim II and to recent historical observed data. The latter included comparison of simulated and historical Sacramento River flows (1996–2015¹) at major gauge locations (Bend Bridge, Butte City, Wilkins Slough, Verona, and Freeport), comparison of river accretions between these gauges, weir spills, and comparison of diversions by SWP and CVP contractors, including diversions to the Feather River Service Area. As stated in Appendix 5A, Section B, in the section *CalSim 3*, “CalSim 3 is

¹ CalSim 3 simulates operations of water management infrastructure to meet current (2020) water demands under existing regulatory requirements and under a repeat of the historical weather sequence 1922–2015. Although CalSim 3 does not simulate historical operations, it is expected that many aspects of the model simulation would be reasonably close to what occurred in recent history. Model results will deviate more and more from the historical record of reservoir storage, river flows, and diversions the further back in time the period considered. The last 20 years of simulation, 1996–2015, was compared to historical data to validate the model’s representation of the Sacramento Valley and the water supplies and water use downstream from Shasta, Oroville, and Folsom dams. Under the Coordinated Operation Agreement (COA), the SWP and CVP have a joint obligation to meet “in-basin use.” Model validation through comparison to historical data confirms that the model accurately represents this obligation.

considered the best available tool for performing planning studies and supporting environmental review of projects and programs, including the proposed Delta Conveyance Project.”

CalSim 3 Assumptions, Uncertainties, and Limitations

Many commenters suggested that the assumptions used to develop, calibrate, or refine numerical models (e.g., CalSim 3) were inappropriate or unsupported. Appendix 5A, Section B, in the section *Model Limitations*, provides a detailed discussion of model limitations, while the *Appropriate Use of Model Results* subsection in Section B acknowledges how these limitations influence the use of the modeling tools developed for the EIR. Limitations include the use of assumptions for approximating the operations of various facilities and regulatory requirements, approximations of real-time daily or even hourly operational considerations in order to incorporate them into a monthly model, and additional uncertainty inherited from input data and modeling hydrologic processes.

Model Timestep

Similar to CalSim II, the monthly timestep in CalSim 3 is the standard for long-term planning efforts in California for a number of reasons. Use of a daily timestep would require development of daily input data for a large number of data sources, incorporation of stream routing to account for river travel time, a daily representation of climate change for long-term analysis, and generalized daily operation rules. This would greatly increase the effort required to prepare a simulation and add considerable uncertainty to final simulated operations, given the variability of datasets that are available on a daily basis. A daily timestep model of SWP and CVP operations is not currently available and would take significant investment of time and resources to develop. Such a model would require many additional simplifying assumptions and would not necessarily provide additional insight into effects of the project. Appendix 5A, Section B, in the section *Monthly Timestep*, acknowledges that while there are certain components of the model that are downscaled to a daily timestep, the results of those daily conditions are always averaged to a monthly timestep in recognition that CalSim 3 is intended to always support operational decisions on a monthly timestep.

Appendix 5A, Section B, in the section *Timestep and Period of Simulation*, describes adjustments that were made to the model to represent management operations at a daily timescale at several key locations along the Sacramento River. These include (1) daily representation of Sacramento River flows for the purpose of simulating flow over the Fremont and Sacramento Weirs, (2) adjustment of instream flow requirements on the Sacramento River at the Navigation Control Point to account for daily flow variation within the month, (3) daily representation of the Sacramento River flow at Wilkins Slough for triggering various Delta regulatory actions, and (4) for the proposed north Delta diversion, daily patterning of flows for the Sacramento River at Hood when applying bypass flow and low-level pumping requirements and simulating diversions. Inclusion of daily operations at these locations enables CalSim 3 to more accurately simulate short duration storms, pulse flows, and the amount of water that could potentially be diverted at the north Delta diversion over shorter timescales than one month.

Disaggregation is a temporal modification used to split time interval values to a smaller time interval using specific information on the characteristics of the shorter time intervals at the location. As described above, in CalSim 3, this is typically performed at a limited number of locations using a “pattern matching” technique to generate potential daily flows that add up to the original monthly

1 volume. Details on the specifics of this process can be found in Appendix 5A, Section B, in the section
2 *Incorporation of Sacramento River Daily Flow Variability*.

3 For various physical and biological analysis, temporal disaggregation drives model outputs used for
4 subsequent modeling efforts at monthly, daily, and in certain instances, sub-daily timesteps (e.g.,
5 DSM2-PTM). In many cases, sub-monthly results are reported as such, and in others, these results
6 are synthesized or summarized as applicable for documentation and comparative purposes; within
7 the Delta often using a 15-minute timestep. While not every analysis requires or can be informed by
8 this level of granularity, the relevant model outputs provide value when used for comparative
9 analyses.

10 **Model Validation**

11 CalSim 3 is a planning level model (i.e., not a real-time operations model) that uses a fixed,
12 generalized set of rules on a monthly timestep to simulate operations of the SWP and CVP. Because
13 CalSim 3 is partly a physically based model and partly a management model, the model cannot be
14 fully calibrated and cannot be used in a predictive manner. A physical model uses equations to
15 simulate a system response (e.g., the Navier-Stokes partial differential equations for the flow of
16 water). Parameter values in these equations can be adjusted so that the model is able to replicate
17 observed data. In contrast, a management model attempts to mimic human response to different
18 states of the system. For SWP and CVP operations, there is no complete set of rules governing how
19 project operators would respond to every situation. Rather CalSim 3 uses a set of objectives (e.g.,
20 water supply, flood control) to mimic project operations. These objectives and how they can be
21 achieved in the model have been developed over many years of discussions with DWR and
22 Reclamation water managers and project operators. Additionally, SWP and CVP project operations
23 are continually evolving in response to changes in regulatory requirements, new facilities, and
24 changing objectives.

25 Validation of CalSim 3 through comparison of model results for existing conditions to recent
26 observed historical data provides assurance that the model is correctly simulating the hydrology
27 and complex management of water resources in the Central Valley and rim watersheds. DWR has
28 undertaken a detailed comparison of simulated streamflows, diversions, and accretions to recent
29 historical data (WY 1996–2015). This includes comparison of historical and simulated inflows from
30 the Sacramento Valley to the Delta (California Department of Water Resources 2022). This
31 comparison provides an aggregate measure of the validity of rim inflows, surface runoff,
32 groundwater inflows to the stream system, surface water diversions, surface water return flows,
33 and storage regulation by local agencies. To provide an approximately constant regulatory basis for
34 the comparison of simulated to historical Delta inflows, simulated flows for the Sacramento River at
35 Freeport were adjusted to remove differences caused by CVP imports from the Trinity River via the
36 Clear Creek Tunnel, CVP storage regulation in Shasta and Folsom Lakes, and SWP storage regulation
37 in Lake Oroville. Average annual difference for the Sacramento River below Freeport (WY 1996–
38 2015) was +0.3% (simulated flow less historical flow). Seasonal differences in flow were -1.5% for
39 April through October and +1.7% for November through March. Average monthly differences
40 between simulated and historical flows varied from -9.2% to +5.7%.

41 There are many reasons that the CalSim 3 simulation of existing conditions does not match recent
42 historical streamflows. Land use in CalSim 3 is held constant, representing average conditions over a
43 recent 10-year period (2004–2013), historically cropping patterns, and the area of irrigated
44 agriculture in the Sacramento Valley has varied year to year. Similarly urban water demands are

held constant in CalSim 3, while historically these water demands have fluctuated substantially. CalSim 3 does not represent temporary, single-year water transfers. Nor does CalSim 3 represent water right curtailments by the State Water Board.

Artificial Neural Network

CalSim 3 uses an Artificial Neural Network (ANN)² algorithm developed by DWR to translate Delta water quality standards into flow equivalents that are to be met through SWP and CVP simulated operations. The ANN is a statistical model that mimics the Delta flow–salinity relationships as simulated in a Delta hydrodynamic and water quality model using a 15-minute timestep, known as DSM2. Please see Common Response 10 for additional discussion of the DSM2 model. The ANN provides a rapid transformation of this information into a form usable by CalSim 3. The development of the ANN for CalSim 3 is described by Jayasundara et al. (2020). The ANNs trained using a range of input flow that can be reliably used in operational models to simulate the salinity management in the Delta. Comparison of ANN-determined salinity with that of DSM2 showed that the new ANN in CalSim 3 is superior to the ANN used in CalSim II.

Runoff Forecasts

CalSim 3 uses imperfect forecasts of water year unimpaired runoff as the basis for SWP and CVP water allocations and designation of water year types and indices and associated regulatory requirements. For existing conditions, the forecast routines in CalSim 3 are designed to have a similar level of accuracy as DWR Bulletin 120 forecasts. For future (2040) conditions, simulated forecasts were found to be less accurate than for existing conditions. Therefore, some measure of perfect foresight was included in simulation of the No Project Alternative under the 2040 scenario to avoid significant error in model simulation. These issues are discussed in the Appendix 5A, Section B, subsection titled *Forecasting*.

Quantitative Measure of Uncertainty

Various comments question the level of accuracy in CalSim 3 modeling. As described in Appendix 5A, Section B, in the subsection titled *Model Precision in a Relative Analysis*, “model uncertainty and its influence on model results presented in the Draft EIR cannot be completely avoided. In addition to showing the potential effects of the project being analyzed, differences between two scenarios can sometimes include the unintended effects of model uncertainty.” These unintended effects may be caused by estimates of hydrologic input data, statistical routines such as the ANN, or generalized code that prescribe project operations under a broad range of conditions. DWR believes that, in general, model results may be subject to a 5% uncertainty. However, this low value of 5% applies only for a comparative analysis, not absolute values from a single model simulation, and when results are expressed in statistical terms such as average monthly values.

As stated in Appendix 5A, Section B, in the subsection titled *Model Precision in a Relative Analysis*, additional rule-of-thumb criteria have been used for considering the potential significance of a difference in modeling results from a comparative analysis. For example, changes in monthly flow and/or storage of less than 10 thousand acre-feet (TAF) are generally considered not significant.

² An ANN is a non-linear statistical data modeling tool that can be used to model complex relationships between inputs and outputs or to find patterns in data.

1 The threshold of 5% and 10 TAF are examples, and appropriate criteria varies depending on the
2 type of impact being analyzed.

3 DWR (2022) present results for validation of the hydrology data and hydrologic routines in CalSim
4 3. In addition to errors in the hydrology, CalSim 3 may not represent how SWP and CVP operators
5 would manage the projects under specific circumstances.

6 **Appropriate Use of CalSim 3 Simulation Results**

7 CalSim 3 is a “level of development” type model. The physical features, regulatory environment,
8 population, land use, and climate are set to a specific planning horizon and do not change during the
9 simulation. The hydrology, or the inflows to the system, are developed by adjusting historical
10 precipitation patterns to match the planning horizon, giving a set of possible water supply
11 conditions covering the anticipated range of hydrology at that planning horizon. The results can be
12 thought of as a “statistical” response of the system to varying hydrology at the planning horizon.

13 Appendix 5A, Section B, in the section *Level of Development*, describes output from the 94-year
14 simulation but does not provide information about historical conditions. Rather, it provides
15 information about storage, flow, and water deliveries that could occur under the historical weather
16 sequence. Similarly, as described in Appendix 5A, Section B, in the section *No Project Alternative*, the
17 No Project Alternative under the 2040 scenario simulation provides information about storage, flow,
18 and water deliveries that would occur under a repeat of the historical weather sequence
19 transformed for (1) climate change and (2) operations of water management facilities to account for
20 sea level rise, changes in land use and population, and associated water demands and water use.

21 Appendix 5A, Section B, in the section *Model Output Metrics*, explains that the most appropriate
22 presentation of monthly and annual model results (CalSim 3 results provided in Appendix 5A,
23 Section B, in the section *Presentation of Results*) are presented as exceedance or water year type
24 summaries instead of the magnitude of specific events. For comparative purposes, these statistical
25 metrics are used as applicable in the EIR. Appendix 5A, Section B, in the section *Absolute versus*
26 *Relative Analysis*, describes a key limitation of planning models; they are not intended to be
27 predictive nor provide results that should be considered absolute with a quantifiable confidence
28 interval. For comparative purposes, CalSim 3 is intended to assess relative changes between two
29 simulations. In a comparative analysis, model results are limited to providing an indicator of change
30 or representing a trend or tendency.

31 Many comments requested a “worst-case” scenario while others objected to the use of a worst-case
32 sea level rise scenario. CalSim 3 simulations, although not necessarily worst-case scenarios, do
33 include simulation of the extremes or bookends of proposed Delta Conveyance Project operations
34 (i.e., diversions up to the maximum physical capacity of the proposed north Delta diversion under
35 Sacramento River low flow conditions) while meeting project bypass criteria. However, infrequent
36 instances of extreme project operations do not drive overall model results relative to the much more
37 frequent occurrence of less extreme operations (i.e., higher Sacramento River flows and/or lower
38 north Delta diversion flows), and their affect is integrative.

39 CalSim 3 was developed using operational rules that require in-basin needs and regulatory
40 requirements to be met first while also meeting SWP and CVP delivery goals to the maximum extent
41 possible. Commenters suggested that the operational rules incorporated into the CalSim 3 model
42 were not representative of real-world conditions. The operational rules include requirements that
43 apply to either SWP or CVP, as well as shared requirements that apply to both projects, typically in

the Sacramento–San Joaquin Delta. The simulated SWP and CVP operational rules may be modified in a specific model run, if required, in order to meet system goals under different conditions (e.g., climate change) or project formulations (e.g., north Delta diversion). Model results are reviewed for each specific set of operational rules to check that the simulation is acceptable and meets in-basin demand and regulatory requirements, and reservoir storage and delivery targets.

Modeled Representation of CEQA Baseline Existing Conditions

A number of comments were received related to CalSim 3 and its application to development of the CEQA existing condition. Many of these comments focused on the documentation provided in relevant sections and attachments of Appendix 5A, with an emphasis on model development, operational criteria, assumptions, and limitations. Other comments focused on model outputs and analytical efforts that incorporated CalSim 3 outputs within the overall modeling framework described in Appendix 5A, Section A, in the section *Overview of Modeling Approach*. Several commenters relied on attachments or exhibits to their submittals that were essentially the same with respect to this topic, and in many cases similar comments are addressed under other Common Responses (e.g., Common Response 3, *Alternatives Development and Description*).

Section A of Appendix 5A provides an overview of the numerical models (e.g., CalSim 3) and supporting assumptions used for the EIR. It also explains the geographic scope of the analysis incorporated into the overall modeling framework as illustrated in the figure titled Modeling Framework Used to Assess Impacts of the Proposed Project and Project Alternatives. In addition to providing an overview of the modeling framework documented in various sections and attachments to Appendix 5A, this section of the appendix also contains a description of the tools and approaches used to characterize the existing conditions at the time the Notice of Preparation (NOP) was issued on January 15, 2020.

The existing conditions represented in the CalSim 3 model incorporated information associated with each of the following.

- Current regulatory requirements.
- Current facilities, programs, and operational criteria.
- Current water demands and water use.
- Runoff from the mountain and foothill watersheds derived from historical streamflow records.
- Valley floor surface and subsurface hydrology for current land use as either simulated by CalSim 3 preprocessors or determined internally by the model at runtime.

Inputs to the CalSim 3 model representing the existing condition include unimpaired inflows and rainfall runoff; agricultural, urban, and wetland water demands; return flows; and groundwater recharge from precipitation and irrigation.

As a planning tool, CalSim 3 outputs include river and stream flows, water diversions and return flows, reservoir storage, Delta channel flows, Delta diversions and exports, net Delta outflow, deliveries to SWP/CVP and non-project users, and controlling factors on proposed project operations. These were used to characterize existing conditions. Generally, results are presented using a monthly average by water year type. CalSim 3 computes water year types based on simulated runoff to date and forecasts of future inflows. For the presentation of results, water year type refers to the Sacramento Valley 40-30-30 hydrologic classification as defined in State Water

Board Water Right Decision 1641 (D-1641). The CalSim 3 May forecast of the water year type remains unchanged until the following February when a new forecast is made.

Appendix 5A, Section B, in the section *CalSim 3 Model Components*, documents the model components and input sources used to develop the CalSim 3 model. In addition to timeseries input data presented in the CalSim 3 Timeseries Input Data table in Appendix 5A, Section B, in the section *Introduction*, DWR's CalSimHydro model was used to develop hydrologic data inputs to CalSim 3, as explained in Appendix 5A, Section B, in the section *CalSimHydro*. Seven discrete upper watershed modules were developed to simulate water management facilities located in the Sierra Nevada to create the boundary conditions for the main body of the CalSim 3 model (see the CalSim 3 Upper Watershed Modules table).

Appendix 5A, Section B, in the section *Existing Conditions*, provides a detailed discussion of existing condition assumptions, including operational requirements, facilities, and programs that were in place at the time the NOP was issued on January 15, 2020.

A number of comments questioned the approach used to characterize hydrology that provides the basis for existing conditions. Appendix 5A, Section B, in the section *Hydrology*, describes the approach used to define hydrologic inputs (corrected for bias) to the CalSim 3 model for rim watersheds (e.g., more than 230 watersheds) and valley floor (using CalSimHydro) and Delta hydrology. For CalSim 3, the boundary of the Delta is as defined for the development of Delta Evapotranspiration of Applied Water and covers 679,699 acres. In addition to Delta channel accretions and depletion/consumptive use, the model also represents specific Delta channel flows (e.g., Delta Cross Channel, Old and Middle River) and south Delta pumping. The Net Delta Outflow Index is the regulatory representation of net Delta outflow, tidally filtered outflow from the Delta into Suisun Bay.

As explained in Appendix 5A, Section B, in the section *Water Demands and Water Use*, CalSim 3 input incorporates data related to agricultural water demands and users (see the table titled CalSim 3 Agricultural Water Demands in Appendix 5A, Section B, which lists more than 130 discrete demand units). The CalSim 3 Managed Wetland Water Demands table in this section summarizes the 18 demand units representing managed wetland water demands in the model. The model represents urban water demands based on historical annual production data for years 2016 through 2019 from more than 80 demand units, as summarized in the CalSim 3 Urban Water Demands table in that section. CalSim 3 also considers water contracts, including various types of SWP and CVP contracts and associated water deliveries.

As stated in Appendix 5A, Section B, in the section *Stream Diversions and Water Rights*, CalSim 3 is not a water rights model; however, it does simulate diversions by both SWP and CVP contractors upstream from the Delta consistent with SWP and CVP contracts and water rights. It also simulates diversions by water districts and entities that have signed settlement agreements with DWR (e.g., Feather River Service Area). CalSim 3 represents a limited number of diversions from the Sacramento River and American River by individuals or entities that do not hold CVP contracts (e.g., City of Sacramento). The model also represents diversions from minor tributaries to the Sacramento River.

There were a number of comments specific to operation and management of SWP and CVP facilities upstream from the Delta. Under the existing conditions, CalSim 3 simulates storage regulation in SWP and CVP reservoirs and also non-project reservoirs with active storage in excess of 50,000 acre-feet (though some smaller reservoirs are also included). Within each reservoir the model

identifies various storage zones (e.g., flood control space); each zone is assigned a different weight and is used to simulate water allocation for different purposes. The model also simulates operations of the U.S. Army Corps of Engineers Sacramento River Flood Control Project at eight key locations (five weirs and three overflow structures) on the Sacramento River using monthly timestep data. As described in Appendix 5A, Section B, in the section *Stream Diversions and Water Rights*, simulated flows over the Fremont and Sacramento Weirs are based on a disaggregation of the upstream monthly flow volume into daily flows. As described in Appendix 5A, Section B, in the section *Modeling Approach*, CalSim 3 simulated flows do not provide information on historical conditions, and simulated flows at stream gauges will differ from observed flows.

There were a number of comments specific to the assumptions and methods used to address regulatory requirements and how those were documented and presented in Appendix 5A, Section B, in the section *Regulatory Requirements*. This subsection explains how CalSim 3 incorporates the requirements that were in place when the NOP was issued. In addition to consideration of continuation of current operations of the SWP and CVP, the regulatory requirements included terms and conditions from the 2019 NMFS and USFW Biological Opinions for the Long-Term Operation of the CVP and SWP and the 2020 CDFW Incidental Take Permit for the Long-Term Operations of the SWP. It also included continued operations under the 2018 Coordinated Operation Agreement (COA) Addendum, D-1641.

As described in Appendix 5A, Section B, in the section *SWP and CVP Operational Assumptions and Modeling Guidelines*, during development of the model simulations, SWP and CVP operations were reviewed, and guidelines were developed in conjunction with DWR and Reclamation for both SWP (north and south of Delta) and CVP (north and south of Delta) to ensure that SWP and CVP operations in model simulations are a reasonable representation of how the system is and would be operated. The guidelines were developed to define uniform risk profiles and result in consistent operations across baseline and alternative models. Because CalSim 3 simulates SWP and CVP operations according to fixed operational rules, which do not include the day-to-day decisions and discretionary actions that occur in real operations, there is no single simulation that can meet all the guidelines. As a planning tool, CalSim 3 was used to refine simulations that meet the guideline to the greatest extent possible, while preventing severe violations of any one guideline.

Consideration of Extreme Drought Conditions and Temporary Urgency Change Petitions

The CEQA baseline *existing conditions* is represented by existing conditions modeling runs, not the historical data (Appendix 5A, Section B, in the section *Timestep and Period of Simulation*). The modeling and impact assessment for the EIR includes at least four relatively recent extreme drought year(s) and periods (e.g., 1976–1977, 1987–1992, 2008–2009, and 2014–2015). Therefore, the assessment includes the effects of the proposed project implementation under drought conditions. However, as described in Appendix 5A, Section B, in the section *Extreme Conditions*, despite detailed model inputs and assumptions, CalSim 3 results differ from real-time operations under stressed water supply conditions caused by drought. The model cannot represent the unique real-time policy decisions that SWP and CVP operators make in consultation with regulatory agencies under extreme circumstances and that deviate from standard operating policies. As described in Common Response 3, Temporary Urgency Change Petitions (TUCPs) are a reaction to extreme drought conditions in which DWR petitions the State Water Board to suspend or modify the water right permit and license conditions to operate the SWP. CalSim 3 is a rule-based simulation model and requires rules that are not arbitrary but are acceptable, legal, and applicable under all circumstances encountered during

the simulation period. As explained in Common Response 3, the Delta Conveyance Project would be unlikely to operate during a TUCP or Temporary Urgency Change Order issued by the State Water Board. As such, modeling of TUCPs is not required.

Modeled Representation of No Project Alternative Under the 2040 Scenario

Comments were received related to CalSim 3 and its application to development of the CEQA existing condition. Many of these comments focused on the documentation provided in relevant sections and attachments of Appendix 5A, with an emphasis on model development, operational criteria, assumptions, and limitations. These comments focused on topics including the use of historical climate information, future foreseeable regulatory environment, and concern that the No Project Alternative under the 2040 scenario masked impacts of project alternatives. There was also a wide array of comments on the use of the modeling framework to characterize and analyze the No Project Alternative under the 2040 scenario and compare it to project alternatives. In many instances these comments were similar to comments addressed through Common Response 6, *Climate Resilience and Adaptation*.

As described in Appendix 5A, Section B, in the section *No Project Alternative*, the CalSim 3 simulations for future conditions represents projected year 2040 conditions in the absence of the Delta Conveyance Project, including the facilities and programs that were incorporated into the model as part of the existing condition. The simulation of the No Project Alternative under the 2040 scenario acknowledges that water supplies and water demands differ, and the model represents projected changes in land use and urban growth, climate change, and sea level rise from the existing conditions. Common Response 6 provides additional discussion on sea level rise projections that were incorporated into CalSim 3 for 2040 and 2070. The CalSim 3 simulations for future conditions do not consider any special adaptation measures that would result in managing SWP and CVP facilities in a manner different to those under existing conditions other than (1) adjustments to reservoir releases to meet regulatory standards, including Delta outflow, under the changed environment; and (2) changes to discretionary project allocations based on future water supplies.

As described in Appendix 5A, Section B, in the section *Hydrology*, a number of considerations specific to hydrology were incorporated into the simulation of future conditions. A wide array of comments focused on climate change, changes in watershed inflow, and valley floor hydrology. The discussion of these topics in the referenced section provides a detailed explanation of how these topics were addressed consistent with the modeling framework. A more detailed discussion of climate change and sea level rise is provided later in this response.

Changes in water demands over time was a theme that a number of comments brought forward. Appendix 5A, Section B, in the section *Water Demands*, describes DWR's approach to simulate agricultural and managed wetlands water demands using CalSimHydro with revised climate data input consistent with the climate change scenario for 2040. For major water purveyors, urban water demands for future (2040) conditions were based on the projected 2040 water demand listed in their respective 2015 Urban Water Management Plans. For small unincorporated communities, water demands were based on per capita water use rates and population projections.

With the exception of two water management and control facilities, modeling assumptions used for the existing conditions simulation were the same as future conditions under the No Project Alternative under the 2040 scenario. The exceptions were the Yolo Bypass Salmonid Habitat

1 Restoration and Fish Passage Project and the Placer County Water Agency point of diversion for CVP
2 water that were approved and are expected to be implemented by the time the proposed project is
3 operating. Both of these exceptions are further described in Appendix 5A, Section B, in the section
4 *Water Management and Control Facilities*.

5 The CalSim 3 simulation for the No Project Alternative under the 2040 scenario incorporated the
6 same regulatory requirements as the existing condition, with the exception of hydropower projects
7 in the upper reaches of the Sierra Nevada watersheds. The nondiscretionary instream flow
8 requirements are incorporated into the No Project Alternative under the 2040 scenario as described
9 in the *Regulatory Requirements* subsection of Appendix 5A, Section B. Water transfers incorporated
10 into the No Project Alternative under the 2040 scenario are limited to those established in the
11 Lower Yuba River Accord.

12 DWR acknowledges that climate change poses significant challenges to Central Valley agriculture.
13 Potential effects include crop yield declines, increased pest and disease pressure, increased crop
14 water demands, and uncertain future sustainability of some vulnerable crops. California agriculture
15 is diverse, and crops respond to climate differently. Impacts on agriculture will also be influenced by
16 other social and economic factors such as commodity prices. CalSim 3 modeling of the No Project
17 Alternative under the 2040 scenario conditions includes adjustments to crop evapotranspiration
18 rates for changes in climate and modeling of soil moisture to account for changes in irrigation
19 demands. Further quantitative analysis of agricultural trends is beyond the scope of the EIR.

20 Climate Change

21 There were many comments on climate change and how it was addressed in the modeling
22 framework described in Appendix 5A, Section A. The comments fall into several categories: (1)
23 Selection of Climate Change Scenario for Input into Hydrologic Model, (2) Sea Level Rise, (3)
24 Stationarity, and (4) Downscaling. As described in Appendix 5A, Section B, in the section *Climate*
25 *Change Under Existing Conditions*, the inflow hydrology for the Existing Condition simulation is
26 based on the assumption of stationarity; however, DWR acknowledges that as climate continues to
27 warm, it is expected to increase the variability in precipitation.

28 Selection of Climate Change Scenario for Input into Hydrologic Model

29 Output from global climate models (GCM) cannot be used directly to inform CalSim 3. The spatial
30 resolution of these models is too coarse and insufficiently detailed to capture the variation of climate
31 and weather conditions over California's Coastal Range, Central Valley, and Sierra Nevada.
32 Downscaling of GCM output provides climate data at more local scales. The Localized Constructed
33 Analogs (LOCA) statistical method was used to downscale GCM output. LOCA uses the observed
34 pattern from past meteorological events to interpolate GCM output across the California landscape.

35 Two GCM scenarios were considered to address the uncertainty over the control and future
36 reduction of CO₂ emissions and other greenhouse gases and aerosols. Known as Representative
37 Concentration Pathways (RCP), RCP 4.5 is a "medium" emissions scenario that models a future
38 where societies attempt to reduce greenhouse gas emissions, while RCP 8.5 is more of a "business as
39 usual" scenario. These climate projections are the best available datasets for developing future
40 climate scenarios for California.

41 Of the available 64 downscaled bias-corrected climate datasets, 20 Coupled Model Intercomparison
42 Project Phase 5 (CMIP5) global climate projections were selected by DWR Climate Change Technical

Advisory Group (CCTAG) as the most appropriate projections for California water resources evaluation and planning (California Department of Water Resources CCTAG 2015). These 20 climate model projections were generated with 10 global climate models and two emission scenarios, RCP 4.5 and RCP 8.5.

The EIR analysis used a 2040 climate change scenario based on the Central Tendency of the 20 climate model projections selected by CCTAG. Data from all 20 projections were included and none were excluded as was suggested by a number of comments. Historical temperature and precipitation were adjusted based on climate model projections to represent future conditions with the quantile mapping approach. Adjustments to temperature and precipitation were calculated with cumulative distribution functions, mapped with the 20 downscaled CMIP5 global climate model (GCM) projections.

Recognizing the uncertainty inherent in the prediction of future climate change, a sensitivity analysis of potential change in impacts from alternative climate change scenarios (2040 Median) was completed and documented in Appendix 30A, *CalSim 3 Results Sensitivity to 2040 Climate Change and Sea Level Projections*. The Median scenario is based on 10 selected climate projections that are broadly representative of the 64 available climate projections for California. The results of this analysis showed that the potential impacts of the proposed project under the two different climate change scenarios (Central Tendency and Median) were similar and therefore impacts of the project in subsequent water quality and biological analysis would also be similar for the two climate change scenarios.

This sensitivity analysis was not performed to meet a specific CEQA requirement, and the results were not intended to support any future CEQA findings in the EIR. The intent of this analysis was to help support understanding of how the No Project Alternative under the 2040 scenario could differ under different assumptions of both climate change and sea level rise.

Global Climate Model Bias and Uncertainty

The CMIP5 GCM projections provide the best available climate data for water resources evaluation in California. The fidelity of a GCM at representing the large-scale climate beyond California was used as a first step to eliminate GCMs that were unlikely to provide reliable climate projections under future warming scenarios. Second, additional GCMs were eliminated in a series of steps based on local performance metrics. It is assumed that global models that better represent key aspects of climate during recent decades will perform better in representing global and regional climate in future decades.

The latest generation of GCMs (CMIP6) are now available, and these models are being reviewed and evaluated, and selected GCM projections are being downscaled to provide regional climate for evaluation of future conditions in California. Further data processing is subsequently required to provide data input for CalSim 3. CMIP6 data were not available when modeling for the Draft EIR was being conducted and was unavailable during the preparation of the Final EIR.

Various comments express concern over the reliability of GCM projections but offer no alternative source of future climate data. DWR agrees that use of an ensemble of downscaled bias-corrected GCM data provides the best method for confronting climate uncertainty. The Central Tendency scenario analyzed in the EIR is based on 20 downscaled projections of future climate. The Median scenario considered in Appendix 30A is based on an alternate set of 10 downscaled projections of future climate.

Downscaling

Global Climate Models represent the climate as discrete grids and layers that span the globe, with the geographic distribution of grid-cell centers typically separated by about 1 degree to more than 2.5 degrees of latitude and longitude. One degree of latitude and longitude in California equals approximately 100 kilometers (62 miles). Downscaling, as it relates to climate change in the EIR, refers to the process used to take the generalized climate data produced by GCMs and process it to apply to specific subbasins to match the CalSim 3 simulation areas. The need for developing downscaled climate projections arises because the scale of global climate modeling is too coarse to support local impacts assessment for many types of resources.

The statistically downscaled climate projections used in the EIR analysis are based on the LOCA dataset, which assumes stationarity (i.e., the statistical parameters of climate are independent through time). The LOCA dataset, which was developed, in part, for the Fourth California Climate Assessment, currently represents the climate projections of record for California and is overwhelmingly used to support climate change planning throughout the state. As such, LOCA represented the best available downscaled climate projection dataset to support the EIR at the time of the analysis. New climate projections using a hybrid downscaling technique that allow for a nonstationary climate are currently under development for the Fifth California Climate Assessment and, therefore, are not available for inclusion in the Final EIR.

The Variable Infiltration Capacity (VIC) model combined with the downscaled data from the global climate models is used to determine specific hydrologic (including runoff) and meteorological data based on the unique characteristics of each subbasin. This is a spatial analysis applying general trends to specific subbasins. Details on the specifics of this process can be found in Appendix 5A, Section B, Attachment 4, *Climate Change Development for Delta Conveyance Project*, in the section titled *VIC Model Simulations*.

Sea Level Rise

A number of comments focused on DWRs approach to incorporating sea level rise predictions into the No Project Alternative under the 2040 scenario part of the modeling framework and raised concerns that the climate change analysis was not representative of future climate change projections. In its State of California Sea-Level Rise Guidance 2018 Update, the California Ocean Protection Council recommends the H++ scenario for use on projects that could affect critical infrastructure or critical natural systems (California Natural Resources Agency and Ocean Protection Council 2018). For the use of specific climate scenarios under CEQA, per California Ocean Protection Council guidance, the H++ scenario is relevant to high-stakes, long-term decisions and for projects with a life span beyond 2050 that have a low risk tolerance. This extreme scenario was included given the potential for nonlinear acceleration of sea level rise driven by positive feedbacks of ice-sheet dynamics during the timeframe the project would be operational. The probability of the H++ scenario occurring is unknown.

The EIR analysis utilized the H++ scenario of 1.8-foot rise in sea level as representative of an upper bound of sea level rise and for compatibility with the design criteria for the facilities. Recognizing the uncertainty inherent in the prediction of future climate change, a sensitivity analysis of the potential change in impacts from a less extreme sea level rise alternative scenario using a smaller sea level rise of 0.5 feet for two climate change scenarios (Central Tendency and Median) was completed and documented in Appendix 30A. The results of these analyses showed that the changes

in impacts between the CalSim 3 simulations for the two different climate change scenarios were similar and therefore that any changes in impacts in subsequent analysis would also be similar. Additional information on this topic is also provided in Common Response 6.

Some comments questioned why the assessment of hydrologic and hydraulic conditions in the Delta did not assume that levees would fail because of sea-level rise. The assessment of water supply and water quality effects attributable to operation of the project alternatives described in Chapters 6 and 9, respectively, reflect the environmental conditions at the time DWR issued the NOP for the EIR, at which time Delta levees were in place and functioning. As noted above, the EIR includes an assessment of changes in hydrologic condition under a 2040 scenario and an assessment of two other sea level rise scenarios as described in EIR Appendix 30A (2040 Central Tendency 0.5 SLR and 2040 Median 1.8 SLR). Like existing conditions, the 2040 scenarios did not include speculation about levee failures. Sea level rise modeling for 2040 was undertaken using existing Delta geometry and Delta configuration. Including levee failures in the analysis would be speculative in the sense that it is not known with certainty the timing or location of potentially overtopped levees or the response that the state and local entities tasked with levee improvements, maintenance, and repairs would have to hydrologic conditions within the Delta characterized by sea level rise. Furthermore, excluding levee failures helped ensure a comparison among the three 2040 scenarios and existing conditions remained consistent. Analysis excluding levee failure or overtopping is considered to be conservative. A likely outcome of any increased inundation is a combination of a geometry-dependent local change in dispersion and a muting of tides upstream. Reverse flows that affect fish passage and propagation of salinity upstream from Rio Vista, would likely be smaller in a scenario with inundation as a result of levee failure or overtopping.

Existing Conditions and Stationarity

California experiences immense variability in hydrologic conditions. Precisely how this natural variability has and will continue to transform under climate change remains highly uncertain. Appendix 5A, Section B, in the section *Climate Change Under Existing Conditions*, acknowledges that changes in timing and quantity of runoff into both the Sacramento and San Joaquin Rivers with respect to fraction of snowmelt has declined over the past century. DWR also acknowledges that as climate continues to warm, an increased variability in precipitation is expected and runoff from snowmelt will occur earlier in the season, decreasing the SWP and CVP abilities to store this water for later use in the summer and fall.

Many comments suggested the assumption of stationarity in the development of unimpaired inflow input to CalSim 3 to represent existing conditions is outdated or inappropriate. None of the comments on this topic described assumptions that DWR should consider as alternatives to developing inflow input to CalSim 3. Because the precise effects of climate change remain uncertain, analysis for the EIR has continued the practice of using the historical flow record to represent existing conditions and a climate transformed historical flow record to represent future (2040) conditions. The CalSim 3 representation of existing conditions includes simulated SWP and CVP operations under a repeat of the driest 9-year period since the 1930s, water years 2007 through 2015.

CalSim 3 model results are generally presented as average monthly values by water year type or in terms of monthly exceedance charts in attachments to Appendix 5A. Figures illustrating monthly exceedance values should be interpreted as the range of conditions given natural variability of

climate and address the comment that “DWR’s operational results are not bracketed within a potential range but are instead presented as one set of results.”

Future Conditions and Stationarity

The EIR recognizes that climate conditions in California are nonstationary, and that past climate conditions and weather sequences are not good indicators of future (2040) conditions. Additionally, the analysis presented in the EIR assumes that the geometry of the Delta remains unchanged, while recognizing that the Delta levees are vulnerable to the effects of sea level rise. The Central Tendency scenario analyzed in the EIR transforms the historical climate for projected changes in temperature and precipitation. Historical runoff is transformed to incorporate the effects of changing precipitation, increased temperature, increased evaporative demand, and drier soil conditions. The Central Tendency scenario also includes the effects of a changing climate on reservoir evaporation, evaporation from the soil surface, and crop evapotranspiration. The Central Tendency scenario includes the projected change in the timing of runoff resulting from a greater fraction of precipitation falling as rain and earlier snowmelt. This temporal shift in runoff has a significant impact on SWP and CVP operations that is captured by the CalSim 3 modeling.

The analysis in the EIR preserves the historical sequence of wet and dry years. Several comments criticized the EIR analysis of No Project Alternative under the 2040 scenario conditions as preserving the historical frequency of drought events. However, CalSim 3 results should not be interpreted as what may occur in a particular year or a sequence of years. Attachments to Appendix 5A typically present results in the form of exceedance plots. Changing patterns of climate and runoff may lead to longer drought periods or increased frequency of drought periods. If this occurs, model results presented at the extremes (i.e., 10th and 90th percentiles) may be more representative of the future than model results presented for median conditions (i.e., 50th percentile). However, the EIR analyzed and discloses project effects at the extremes as well as under median conditions.

Extreme Events

Many comments expressed concern that CalSim 3 fails to take into account the potential for extreme heat events and recurring extreme storms. GCMs indicate that California may experience increasingly volatile, temporally concentrated, and extreme precipitation events. Larger, more frequent, and more intense, wildfires will change the runoff characteristics of rim watersheds. Comments acknowledge that the timing and sequencing of such extreme occurrences are all but impossible to predict or forecast.

The analytical framework and the use of a comparative analysis to identify potential project effects helps control for the lack of predictability of future climate and weather conditions. Extreme events will occur regardless of an alternative described in the EIR. The analysis presented in the EIR provides DWR with an assessment of the potential, and under what circumstances the Delta Conveyance Project would alter the trajectory of system response under a given event. The information presented in the EIR demonstrates that the Delta Conveyance Project would not meaningfully decrease the State’s ability to respond to extreme events, but conversely would likely enhance it.

Precipitation

The effects of the proposed project and project alternatives on flood protection are discussed in Chapter 7, *Flood Protection*.

CalSim 3 was not developed to analyze the effects of short duration, extreme precipitation events. With a few limited exceptions (weir flows, north Delta diversion bypass flows), the model assumes streamflows are uniform during each monthly timestep. A monthly timestep is inappropriate for flood control analysis.

Actual reservoir operations during flood conditions may be affected by short-term (e.g., 5-day weather forecasts). Accurate simulation of flood flows requires not only a short timestep but hydrologic routing of flood flows through reservoirs and along river reaches. CalSim 3 uses simple mass balance accounting and does not consider travel time. CalSim 3 simulations do not consider future climate change adaptation, which may require management of the SWP/CVP system in a different manner than today to reduce climate impacts. For example, future changes in reservoir flood control guidelines to better accommodate a seasonally changing hydrograph may be considered under future programs but are not considered in the EIR.

Extreme Heat

Extreme heat may affect the management of California's water resources in several ways, increasing evaporative losses and reducing runoff. CalSim 3 models the effects of a warming climate through reduced runoff and increased agricultural water demands. However, extreme heat events are outside the scope of the impact analysis presented in the EIR.

Modeled Representation of Proposed Project and Project Alternatives

Consideration of Carriage Water and Shifting

Several comments suggested changes in carriage water or shifting operations could affect SWP and CVP operations and water supply in the upstream Sacramento basin. As described in the *Assumed Available Water Transfer Supplies* subsection of Appendix 3H, *Non-Project Water Transfer Analysis for Delta Conveyance*, carriage water is the additional water needed for Delta outflow to compensate for the additional exports made on behalf of a water transfer to assure compliance with the water quality requirements of the SWP and CVP. Changes in flow can cause changes in salinity in the Delta. For example, an increase in reservoir releases that support additional Delta exports could cause exceedances in Delta salinity over acceptable limits, requiring additional reservoir releases in response to those changes. In CalSim 3, carriage water is considered an in-basin requirement and is shared between the SWP and CVP under the COA. The impact of these changes on reservoir storage and releases are reflected in the CalSim 3 modeling results as described in subsection titled *North Delta Diversion Operational Criteria* in Appendix 5A, Section B.

The proposed north Delta diversion as part of the Delta Conveyance Project would improve the flexibility of the SWP operations for meeting water quality requirements. In Chapter 3, *Description of the Proposed Project and Alternatives*, in the section titled *Integration of North Delta Intakes with South Delta Facilities*, DWR primarily defined shifting operations as balancing south Delta exports and the proposed north Delta diversion so that less water or Delta outflow would be required to meet the same water quality standards. The shifting that could occur is primarily defined by the summer and fall season. CalSim 3 simulates the shifting operation (from south to north) by minimizing carriage water, reducing it as much as possible, ideally to zero, unless other operational limits are reached first. Shifting can be limited by the following within the model: (1) total exports reach the export/import (EI) ratio export cap; (2) north Delta diversion exports reach the export

cap needed to maintain bypass flows; (3) all south Delta exports are shifted, or in July through September, south Delta exports are reduced to 3,000 cfs; and (4) all carriage water has been eliminated. All carriage water savings are split according to COA and are exported first, if possible, then backed up into north-of-Delta storage facilities. Shifting primarily occurs in CalSim 3 when salinity at Jersey Point is controlling carriage water requirements but can also occur occasionally when Rock Slough salinity is controlling carriage water requirements. Shifting does not occur when the required water quality standard for the Sacramento River at Emmaton is controlling carriage water requirements and flow in the Sacramento River must be maintained. The modeling process in CalSim 3 thus mimics how the SWP would use the north Delta diversion to make the overall operation more efficient, by shifting exports from south to north when Jersey Point to Rock Slough are controlling carriage water requirements.

Upstream Effects

This section addresses comments regarding Delta Conveyance Project effects upstream from the proposed north Delta diversion.

During development of CalSim 3 model simulations, SWP and CVP operations were reviewed and compared to specific operational guidelines in conjunction with DWR and Reclamation to ensure that model simulations of proposed project operations are a reasonable representation of how the system is and would be operated. Because the SWP and CVP in CalSim 3 operate according to fixed operational rules, which do not include the day-to-day decisions and discretionary actions that occur in real operations, it was not possible to meet all of the guidelines in all CalSim 3 simulations. Appendix 5A, Section B, in the section *SWP and CVP Operational Assumptions and Modeling Guidelines*, acknowledges that dead pool situations for both SWP and CVP reservoirs do occur, albeit infrequently.

Proposed project operations do not conflict with the operational criteria for Shasta, Trinity, or Folsom Reservoirs or any water storage facilities associated with the San Joaquin River and its tributaries. All the existing reservoir operation criteria will be met with the same frequency as conditions without the project. However, some changes in the seasonal release patterns at Oroville would occur under the project, primarily related to increased spring releases and reduced summer releases. However, this change in reservoir storage release patterns does not affect long-term storage and, as with the other reservoirs, does not conflict with existing applicable operational criteria.

Under extreme drought conditions when SWP and CVP reservoir storage is critically low, DWR and Reclamation may request a temporary change from water right and regulatory requirements, as occurred under recent drought conditions, and negotiate with their contractors for additional reductions in SWP and CVP water deliveries. Under this type of circumstance, there would be no storage withdrawals to support SWP and CVP exports other than to meet health and safety requirements. These types of emergency actions are not simulated in CalSim 3; the model maintains simulation of nondiscretionary regulatory and legal requirements through extreme drought conditions, which in some months leads to simulated storage at dead pool. However, this does not influence the modeled analysis presented in the EIR as the north Delta diversion would be expected to be non-operational during these times, unless real-time considerations under TUCPs indicate that north Delta diversions would help the efficient use of water to meet objectives. The EIR and CalSim 3 do not contain information about what speculative temporary measures the SWP and CVP might

seek to take during such unique and infrequent events and the relationship of those measures to upstream operations.

Term 91

Term 91 is a standard condition included in post-1965 water right permits and licenses that curtails these water right holder diversions when the Delta is in balanced conditions (i.e., the SWP/CVP are being operated to meet water quality standards in the Delta) and the SWP/CVP are releasing supplemental project water to meet in-basin entitlements. Supplemental project water is defined as water imported to the basin by the SWP/CVP and water released from SWP/CVP storage, which combined is in excess of project exports plus carriage water requirements. Term 91 is typically triggered in the late spring or summer and lifted in the fall or early winter. Term 91 has been triggered each year since 2012, except for 2017 when there were no curtailments.

CalSim 3 model results were post-processed to determine months when Term 91 would be imposed under existing conditions and under the project alternatives. Under existing conditions, Term 91 would be triggered in most years and be in place approximately 22% of the time. Under the project alternatives, the occurrence or frequency of Term 91 remained equal to approximately 22% under all project alternatives.

The duration of when Term 91 is in effect under the project alternatives increased in some years and decreased in other years compared to existing conditions, depending on hydrologic conditions and SWP/CVP operations in a particular year. Most of the changes in the timing of Term 91 occurred from late spring through late summer (May through September). Changes to when Term 91 is in effect during this period would not affect Sacramento River Settlement Contractors as CVP water may be delivered under their CVP contracts nor would it affect deliveries to the Feather River Service Area. In approximately 5% of years there were changes to the timing of Term 91 during the November through March period that could potentially affect diversion of winter water for flood-up of rice fields for rice straw decomposition or to provide duck habitat. However, the frequency of when Term 91 is in effect during the November through March period remained largely unchanged under the project alternatives compared to existing conditions.

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