Appendix 4A

Attachment 8: Model Limitations

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4A-8.1 Introduction

Numerical models developed and applied for the Draft EIR are generalized and simplified representations of a complex water resources system. The models are not predictive models of project operations and results cannot be considered as absolute with a quantifiable confidence interval. The model results are only useful in a comparative analysis and can only serve as an indicator of conditions.

Due to the assumptions involved in the input data sets and model logic, care must be taken to select the most appropriate timestep for the reporting of model results. Sub-monthly (e.g., weekly or daily) reporting of raw model results is not consistent with how the models were developed, and results should be presented on a monthly or more aggregated basis.

All models include simplifications and generalizations compared to the "real-world" scenarios that they represent. Therefore, all models will have limitations to how accurately they can represent the real world. It is necessary to understand these limitations to correctly interpret results. Some of these limitations are discussed in general terms above, but because limitations are often model-specific, the following subsections further describe model-specific limitations and appropriate use of model results.

4A-8.2 CalSim 3 Model Limitations

CalSim 3 is a monthly model developed for planning-level analyses. The model is run using historical observed or reconstructed unimpaired runoff, but with 2020 level water demands, facilities, regulations, and operations criteria. Output from the 100-year simulation does not provide information about historical conditions, but does provide information about storage, flow, and water deliveries that could occur under the historical weather sequence.

4A-8.2.1 Calibration and Validation

Because CalSim 3 is partly a physically-based model and partly a management model, the model cannot be not fully calibrated and cannot be used in a predictive manner. CalSim 3 is intended to be used in a comparative manner; which is appropriate for California Environmental Quality Act and CESA analysis.

4A-8.2.2 Monthly Timestep

Simulated operational decisions in CalSim 3 are made on a monthly timestep. While there are certain components of the model that are downscaled to a daily timestep, such as north Delta diversion bypass flows, the results of those daily conditions are always averaged to a monthly timestep. For example, a certain number of days with and without the action is calculated and the monthly result is calculated using a day-weighted average based on the total number of days in that month. Operational decisions based on those components are again made on a monthly basis.

Use of CalSim 3 results to provide information at a sub-monthly timescale should include disaggregation methods that are appropriate for the given application, report, or subsequent model and recognize that the CalSim 3 operational decisions are always on a monthly timestep.

4A-8.2.3 Extreme Conditions

Appropriate use of model results is important. Despite detailed model inputs and assumptions, the CalSim 3 results differ from real-time operations under stressed water supply conditions. Such model results occur due to the inability of the model to make unique real-time policy decisions under extreme circumstances, as the actual (human) operators must do. Therefore, results that indicate severely low storage, or inability to meet flow requirements or senior water rights should only be considered an indicator of stressed water supply conditions under that scenario, and should not necessarily be understood to reflect literally what would occur in the future under that scenario. These conditions, in real-time operations, would be avoided by making policy decisions on other requirements in prior months. In actual future operations, as has always been the case in the past, the project operators would work in real time to satisfy legal and contractual obligations given then current conditions and hydrologic constraints.

4A-8.2.4 Extreme Operational Conditions and Regulatory Uncertainty

Continuing uncertainty in the regulatory environment makes the long-term planning of CVP and SWP operations challenging. The Baseline Conditions CalSim 3 model used to establish the modeling of the Proposed Project scenario assumes the full implementation of the operational actions of the 2020 ROD, 2020 SWP ITP and IOP. However, under full implementation of these operations, not all conditions of the operations may be met in a given month due to competing hydrologic, operational, and regulatory requirements. As a result, the simulation provides what is referred to as “extreme operational conditions”. Frequency of such conditions can increase in the future with climate change, if the hydrology is drier or with the occurrence of sea-level rise, without changes in the existing obligations of the CVP and SWP.

Extreme operational conditions are defined as simulated occurrences of storage conditions at CVP and SWP reservoirs in which storage is at “dead pool” levels. Reservoir storage at or below the elevation of the lowest outlet is considered to be at the dead pool level.

Under extreme operational conditions, CalSim 3 will utilize a series of rules within the specified priority to reach a numerically feasible solution to allow for the continuation of the simulation. The outcome of these types of solutions in CalSim 3 may vary greatly depending upon the antecedent conditions from the previous timestep result. The model may reach a numerical solution, but the results of the simulation may not reflect a reasonably expected outcome (i.e., an outcome which would require negotiation). In such cases, flows may fall short of minimum flow criteria, salinities may exceed standards, diversions may fall short of allocated volumes, and operating agreements may not be met, indicating a stressed water supply condition.

4A-8.2.5 Delta Salinity Compliance

CalSim 3 simulates Delta flows for a set of regulatory and operational criteria, including salinity standards, using a monthly timestep. CalSim 3 relies on the ANN for monthly averaged flow verses salinity relationships in the Delta. ANN emulates flow-salinity relationships derived from DSM2 for a given Delta channel configuration and sea level rise condition.

DSM2 application for analyzing the Baseline Conditions and Proposed Project uses the monthly CalSim 3 Delta inflows and diversions and exports results and simulates Delta hydrodynamics and salinity from WY 1922 to WY 2021, on a 15-minute timestep. Boundary conditions assumed in DSM2 modeling are based on monthly CalSim 3 outputs. The DSM2 inflows do not represent any sub-monthly operational adjustments that could occur to address any potential issues with salinity control in the Delta.

Monthly CalSim 3 salinity outputs and daily averaged salinity outputs from DSM2 simulations were used to evaluate compliance with D-1641 salinity requirements. CalSim 3 and DSM2 model results may indicate exceedances of D-1641 salinity standards. These exceedances are rare and result from limitations in the modeling process. In actual operations, DWR and Reclamation staff constantly monitor Delta water quality conditions and adjust operations of the SWP and CVP in real time, as necessary, to meet water quality objectives. These decisions are based on real-time conditions and many factors that the best available management models cannot represent or simulate. Under extreme conditions, negotiations and consultations with the State Water Board would occur in order to balance needs of protected resources, beneficial uses, and water rights. Such decisions under extreme conditions cannot be modeled.

4A-8.2.5.1 Partial Month Salinity Standards

In CalSim 3, the reservoirs and facilities of the SWP and CVP are operated to comply with regulatory flow and Delta water quality requirements. Meeting regulatory requirements, including Delta water quality objectives, is one of the highest operational priorities in the model.

Because CalSim 3 is a monthly timestep model and a number of daily D-1641 salinity standards are active during only portions of a month (e.g., April 1–June 20 and June 20–August 15), D-1641 standards are represented as a monthly weighted average in the model. The model attempts to meet these objectives on a monthly average basis, even though the objectives themselves are often transitioning within a month from one value to the other and may start or end in the middle of a month. When the monthly weighted average standards calculated for CalSim 3 are less stringent than the daily D-1641 EC standards, CalSim 3 adjusts SWP and CVP operations to release less flow to meet monthly weighted average EC standards instead of the flow needed to meet higher daily D-1641 EC standards. Therefore, within the months where the salinity standard is transitioning, there may be days where DSM2 inflows are less than the required flow to comply with the salinity standard, and more flow on other days. This results in a few days within such months where the modeled salinity exceeds the compliance standard. Importantly, however, in reality the SWP and CVP operations will be adjusted on day-to-day basis to meet the Delta standards.

4A-8.3 DSM2 Model Limitations

DSM2 is a one-dimensional model with inherent limitations in simulating hydrodynamic and transport processes in a complex estuarine environment such as the Delta. DSM2 assumes that velocity in a channel can be adequately represented by a single average velocity over the channel cross-section, meaning that variations both across the width of the channel and through the water column are negligible. DSM2 does not have the ability to model short-circuiting of flow through a reach, where a majority of the flow in a cross-section is confined to a small portion of the cross-section. DSM2 does not conserve momentum at the channel junctions and does not model the secondary currents in a channel. DSM2 also does not explicitly account for dispersion due to flow accelerating through channel bends. It cannot model the vertical salinity stratification in the channels.

DSM2 has inherent limitations in simulating the hydrodynamics related to the open water areas. Since an open water surface area (represented with a reservoir in the model) is constant in DSM2, it affects the stage in the reservoir and thereby affects the flow exchange with the adjoining channel. Due to the inability to change the cross-sectional area of the reservoir inlets with changing water surface elevation, the final entrance and exit coefficients were fine tuned to match a median flow range. This causes errors in the flow exchange at breaches (levee openings) during the extreme spring and neap tides. Using an arbitrary bottom elevation value for the reservoirs representing the proposed marsh areas to get around the wetting-drying limitation of DSM2 may increase the dilution of salinity in the reservoirs.

For open waterbodies DSM2 assumes uniform and instantaneous mixing over entire open water area. Thus, it does not account for the any salinity gradients that may exist within the open waterbodies. Significant uncertainty exists in flow and EC input data related to in-Delta agriculture, which leads to uncertainty in the simulated EC values. Caution needs to be exercised when using EC outputs on a sub-monthly scale, and therefore results are only presented at the monthly scale. Water quality results inside the waterbodies representing the tidal marsh areas were not validated specifically and because of the bottom elevation assumptions, preferably should not be used for analysis.

4A-8.4 Appropriate Use of Model Results

The modeling conducted to evaluate the Baseline Conditions and Proposed Project is a planning analysis. A planning analysis is conducted to understand long-term changes in the CVP and SWP system due to a proposed change. The models developed and applied in planning analysis are generalized and simplified representations of a complex water resources system. Even so, the models used are informative and helpful in understanding the performance and potential effects (both positive and negative) of the operation of a project and its interaction with the water resources system under consideration. Even though some of the models used in this planning analysis, such as DSM2, are calibrated and validated to represent physical processes, given the nature of the boundary conditions used (derived from CalSim 3, a generalized system model), DSM2 results would only tend to represent generalized long-term trends. Level of confidence in the results of any well calibrated predictive model is only as good as the level of confidence in the input boundary conditions used. Given the limitations of the planning analysis, a brief description of appropriate use of the model results to compare two scenarios or to compare against threshold values or standards is presented below.

4A-8.4.1 Absolute Versus Relative Analysis

The CalSim 3 and DSM2 results in a planning analysis are appropriately used as "comparative tools" to assess relative changes between the Baseline Conditions and Proposed Project. In a planning analysis, models used are not predictive models, and therefore the results cannot be considered as absolute with a quantifiable confidence interval. The model results are only useful in a comparative analysis and can only serve as an indicator of condition (e.g., compliance with a standard) and of trend or tendency (e.g., generalized impacts). Because CalSim 3 relies on generalized rules, a coarse representation of project operations, adjusted hydrologic conditions to reflect future demands and land use, and no specific operations in response to extreme events, results should not be expected to reflect what operators might do in real-time operations on a specific day, month, or year in the simulation period. In reality, the operators would be informed by numerous real-time considerations such as salinity monitoring.

4A-8.4.2 Appropriate Reporting Timestep

Due to the assumptions involved in the input data sets and model logic, care must be taken to select the most appropriate timestep for the reporting of model results. Sub-monthly (e.g., weekly or daily) reporting of model results is generally inappropriate for both models and the results should be presented on a monthly basis. There may be exceptions to this, and selected model results can be reported on a sub-monthly basis with adequate caution. An understanding of validity of the underlying operational conditions is critical in interpreting a sub-monthly result.

4A-8.4.3 Appropriate Reporting Locations

Due to the assumptions involved in the input data sets and model logic, care must be taken to select the most appropriate reference locations (and/or boundaries) for the reporting of model results. Each model assumes a simplified spatial representation of the water resource system and sub-systems. Reporting of model results inconsistent with the spatial representation of the model is inappropriate. Care must be taken in selecting the locations desired for reporting model results and whether or not the models are adequate for that purpose.

4A-8.4.4 Statistical Comparisons

Absolute differences computed at a point in time between model results from a scenario and a baseline to evaluate impacts is an inappropriate use of model results (e.g., computing differences between the results from a baseline and a scenario for a particular day or month and year within the period of record of simulation). Likewise, computing absolute differences between a scenario (or a baseline) and a specific threshold value or standard is an inappropriate use of model results. Statistics based on the absolute differences at a point in time (e.g., maximum of monthly differences) are an inappropriate use of model results. By computing the absolute differences in this way, an analysis disregards the changes in antecedent conditions between individual scenarios and distorts the evaluation of impacts of a specific action (e.g., project).

Reporting seasonal patterns from long-term averages and water year type averages is appropriate. Statistics based on long-term and water year type averages are an appropriate use of model results. Computing differences between long-term or water year type averages of model results from two scenarios is appropriate. Care should be taken to use the appropriate water year type for presenting water year type average statistics of model results (e.g., D-1641 Sacramento River 40-30-30 or San Joaquin River 60-20-20, and with or without climate modified conditions).

The most appropriate presentation of monthly and annual model results is in the form of probability distributions and comparisons of probability distributions (e.g., cumulative probabilities). If necessary, comparisons of model results against threshold or standard values should be limited to comparisons based on cumulative probability distributions. Information specific to a model calibration should be considered in using these types of comparisons.

4A-8.4.5 Model Output Metrics

The most appropriate format to present model results is:

- Long-term average summary and year type–based summary tables and graphics showing monthly and/or annual statistics derived from the model results.
- Cumulative exceedance probability monthly and/or annual model results shown only by rank/order or only by probability statistic.
- Comparative statistics based on these two types of presentations are generally acceptable.