MBK ENGINEERS

Water Resources • Flood Control • Water Rights

TECHNICAL MEMORANDUM

DATE: September 29, 2015

TO: Alan B. Lilly

FROM: Lee G. Bergfeld and Walter Bourez

SUBJECT: Technical Comments on Coordinated Long-Term Operation of the Central Valley Project and State Water Project Draft Environmental Impact Statement

This technical memorandum is a summary of MBK Engineers' (MBK) findings and opinions on the hydrologic modeling that the U.S. Bureau of Reclamation (Reclamation) performed for the draft environmental document for the Coordinated Long-Term Operation of the Central Valley Project and State Water Project (LT Ops DEIS).

This review focuses on water operations modeling using CalSim II. CalSim II is a computer program jointly developed by the California Department of Water Resources (DWR) and Reclamation. CalSim II presents a comprehensive simulation of State Water Project (SWP) and Central Valley Project (CVP) operations. CalSim II is widely recognized as the most prominent water management model in California, and it is generally accepted as a useful and appropriate tool for assessing the water delivery capability of the SWP and CVP. CalSim II estimates, for various times of the year, how much water will be diverted, how much will serve as instream flows, and how much will remain in reservoirs.

For the LT Ops DEIS, Reclamation applied CalSim II to analyze how CVP and SWP operations changed as a result of implementation of the Reasonable and Prudent Alternatives (RPAs) in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion (BO) on Delta smelt and the 2009 National Marine Fisheries Service (NMFS) Biological Opinion on Chinook salmon. The coding and assumptions included in the CalSim II model drive the results. Data and assumptions, such as the amount of precipitation runoff at a certain measuring station or the demand for water by specific water users are input into the model. Criteria used to operate the CVP and the SWP (including regulatory requirements such as biological opinions) are included in model assumptions. Because of the volume of water controlled and delivered by the CVP and SWP, these operational criteria significantly influence model results. Additionally, operational logic is coded into CalSim II to simulate how DWR and Reclamation would operate the system under circumstances for which there are no regulatory or otherwise definitive rules, e.g. when to move water from storage in reservoirs upstream of the Delta to reservoirs downstream of the Delta. This attempt to simulate the logic sequence and relative weighting that the CVP and SWP operators use as part of their "expert judgment" is a critical element of CalSim II.

The CalSim II model is the foundational model for analysis of the LT Ops DEIS, including effects and impacts analyses. Results from CalSim II are used to examine how water supply and reservoir operations are modified by the RPAs in both BOs and for each project alternative. CalSim II results are also used by subsequent models to determine physical and biological effects including water quality, water levels, water temperature, Delta flows, and fish response. Any errors or inconsistencies identified in the underlying CalSim II model are therefore present in subsequent analyses of environmental effects.

The following sections provide our comments on CalSim II analysis conducted for the LT Ops DEIS (LT Ops DEIS Model).

Climate Change

Analysis presented in the LT Ops DEIS attempts to incorporate the effects of climate change at a future date of approximately 2025 (LT Ops DEIS, page 5A.A-27). The methodology followed in the LT Ops DEIS is the same as used in analysis for the Bay-Delta Conservation Plan DEIS/EIR and the California Water Fix Revised DEIS/EIR. Analysis for the LT Ops DEIS is focused on an Early Long-Term (ELT) condition, as simulated in several different Global Climate Models under a range of future emissions conditions. These different Global Climate Model results, which vary significantly in their depictions of future temperatures and precipitation, are analyzed to determine a central tendency used to represent a potential future condition. The central tendency prediction of changes in temperature and precipitation is downscaled from large spatial grids used in Global Climate Models and input to the Variable Infiltration Capacity (VIC) hydrology model to generate simulated natural stream flows. These climate-influenced simulated stream flows on a watershed scale are then used to determine fractional changes from the historical, observed inflow patterns in CalSim II. Changes are then applied to the monthly historical reservoir inflows in CalSim II to depict a future, climate-changed hydrology.

Figure 1 illustrates the assumed average annual and monthly Folsom Reservoir inflows at the ELT condition, by water year type (historical Sacramento Valley Water Year Type), that were used for analysis of all alternatives in the LT Ops DEIS Model.

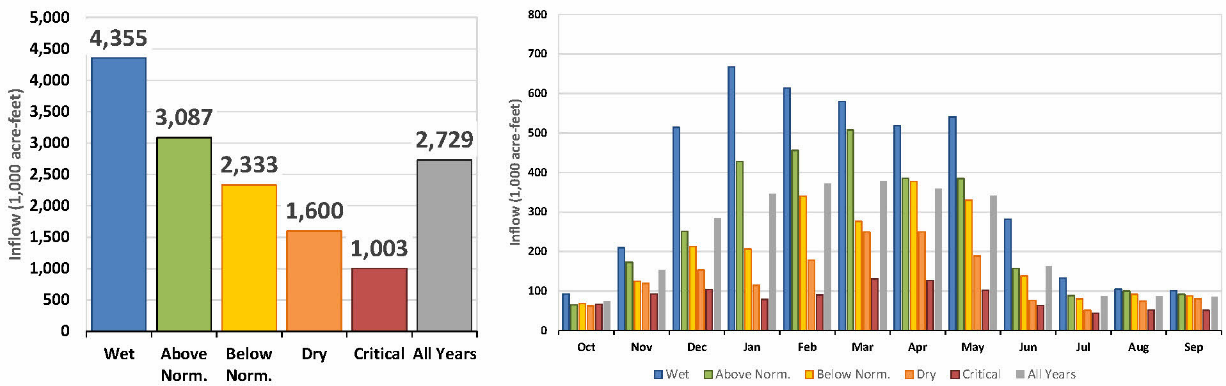

Figure 1: Average Annual and Monthly Inflow to Folsom in All Alternatives of LT Ops DEIS Model

Figure 2 shows the changes in the average annual and monthly Folsom inflows by water year type between the ELT condition used in the LT Ops DEIS Model and historically based inflows from a recent CalSim II study from Reclamation. The historically-based inflows were used for analysis of the CVP Municipal and Industrial (M&I) Water Shortage Policy Environmental Impact Statement released September 2015. Differences in Figure 2 show that while the average annual reduction in Folsom Reservoir inflow is only 9,000 acre-feet under the ELT assumptions, there are much higher reductions in drier year types, and seasonal shifts to higher inflows from November through March, and lower inflows from May through October.

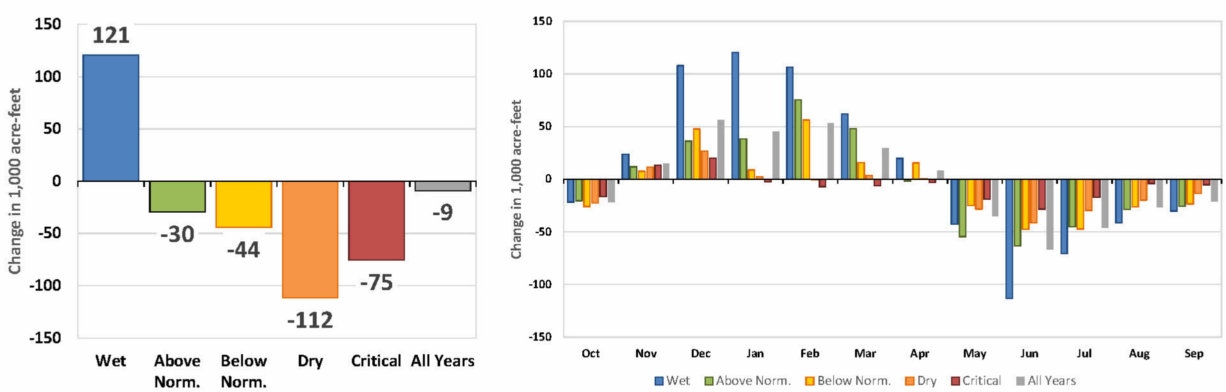

Figure 2: Average Annual and Monthly Change in Inflow to Folsom under ELT Climate Change Conditions included in All Alternatives of LT Ops DEIS Model

There is considerable uncertainty regarding the effects of climate change on future temperatures and precipitation. As described above, the LT Ops DEIS relied on one potential depiction of these effects. Analysis of only one potential future condition does not cover the range of potential future conditions and introduces inconsistent assumptions in the model. An example of these inconsistent assumptions occurs on the upper American River. The LT Ops DEIS assumed changes from historical inflow to Folsom based on potential change in future temperatures and precipitation and analysis with the VIC model to understand changes in natural stream flows. However, the American River watershed upstream from Folsom Reservoir is not expected to change in the same manner as a natural stream. There is significant storage capacity in Placer County Water Agency's (PCWA) Middle Fork Project and the Sacramento Municipal Utility District's (SMUD) Upper American River Project. Operations of these reservoirs directly affect Folsom inflow and operating criteria such as flood credit space. To produce acceptable modeling of Folsom Reservoir and the American River, there must be consistency in the hydrology used to model reservoirs upstream from Folsom and the hydrology used to model Folsom Reservoir. Changes in inflow and operations of these upstream projects should be considered to properly incorporate climate change into modeling of Folsom Reservoir. Alternatively, climate change analysis could be conducted as sensitivity analysis, as opposed to being included in all project alternatives. Standard practice for modeling CVP and SWP operations is to simulate the No Action and Project alternatives with historically-based hydrology. In our opinion, this is the preferred approach to avoid inconsistencies in model assumptions and over reliance upon results from one of many potential future climate-changed conditions.

Additionally, in examining possible effects of climate change, it is not appropriate to assume that current project operations will remain static and not respond to climate change. The analysis for the LT Ops DEIS assumes continued operations of the CVP and SWP without adaptations. This approach produces results that are not useful for dealing with the complex problem of climate change because it does not reflect the way in which the CVP and the SWP would actually operate, whether or not the RPAs are implemented. We recommend a sensitivity analysis be conducted to develop a better understanding of the range of possible responses to climate change by the CVP and SWP, and the regulatory structures that dictate certain project operations.

Climate Change Assumptions Result in Unrealistic Operations

Review of model output for the LT Ops DEIS No Action Alternative (NAA) reveals that the model is operated beyond its usable range. The purpose of CalSim II is to simulate how the CVP and SWP systems would be operated to meet regulatory requirements and water delivery objectives based on a certain amount of precipitation and runoff. When the precipitation patterns and resultant runoff were changed for the LT Ops DEIS Model with climate change, the logic regarding how the system is operated to meet the regulatory and water delivery objectives was not changed. The net effect is that during certain periods of the model simulation neither the regulatory criteria nor the delivery objectives are met.

With the predicted changes in precipitation and temperature implemented in the LT Ops DEIS Model, there is simply not enough water available in the simulation to meet all regulatory objectives and water user demands. Yet the LT Ops DEIS Model continues its normal routine until the modeled system essentially crashes and thus fails to meet its objectives. In this aspect, the LT Ops DEIS Model simply does not simulate reality. For example, if ELT conditions actually occur, the CVP and SWP would likely adapt to protect water supplies and the environment. Examples of adaptations to climate change would likely include: (1) updating operational rules regarding water releases for flood protection; (2) during severe droughts, emergency drought declarations could call for mandatory conservation, changes in some regulatory criteria, or even an inability to meet contractual obligations, similar to what has occurred during the current and previous droughts; and (3) if droughts become more frequent, the CVP and SWP would likely revisit the rules by which they allocate water during shortages and operate with lower deliveries during wetter years. The likelihood of an appropriate operational response to climate change is supported by the many modifications to CVP and SWP operations that were made during the winter and spring of 2014 and 2015 to respond to the current drought. Thus, while the LT Ops DEIS Model shows that difficult decisions will have to be made if ELT conditions occur, the LT Ops DEIS Model does not attempt to simulate the results of such decisions.

Under the climate change conditions, reservoir storage (particularly in the CVP system) is simulated to operate aggressively such that reservoirs are drawn down to an extremely low level. Simulated storage levels reach the model-defined dead pool, at which point no water can be released from reservoir storage – for fish, drinking water, or agriculture. CalSim II specifies dead pool in Folsom Reservoir as 90,000 acre-feet and storage reaches this level during approximately six percent of all years (see Figure 3). By comparison, since Folsom Reservoir became operational in 1955, the lowest storage level on record was 147,000 acre-feet at the end of September 1977. However, the LT Ops DEIS Model predicts that, with ELT climate change, reservoir storage will be approximately 90,000 acre-feet, nearly 40% lower than its historical low, during six percent of all years. Some municipalities, like the City of Folsom, the City of Roseville, and San Juan Water District, are almost entirely dependent on Folsom Reservoir releases for drinking water; and Folsom Reservoir's reaching 90,000 acre-feet could cut their municipal deliveries below the levels required to maintain public health and safety for over 500,000 people.

In reality, and to avoid such dire circumstances, the CVP and SWP would likely request that regulatory agencies modify the applicable standards so that the CVP and SWP could conserve storage. Conservation or rationing by water users would probably also occur. Similar steps were taken in spring 2014 and 2015 to reduce water diversions and reservoir releases for fishery needs and Delta requirements. Emergency measures such as these are not simulated in the model, so the LT Ops DEIS Model does not reflect reasonable future operations with climate change.

Modeling climate change, without adaptation measures, leads to results showing insufficient water supplies to meet all regulatory objectives and user demands. This modeling approach significantly limits the utility of the LT Ops DEIS Model results in analyzing the effects of implementing the RPAs, particularly during drought conditions. With future conditions modeled to be so dire, the modeled effects of the RPAs are reduced because it appears that conditions cannot get any worse; i.e., reservoir storage cannot be reduced below minimum levels. However, in reality, the future conditions will not be as depicted in the LT Ops DEIS Model. Operations during the current drought show that drawing reservoirs down to near minimum levels to meet regulatory and contractual requirements is not realistic. Instead, difficult decisions are made in an attempt to balance environmental conditions in reservoirs and rivers, while still meeting water supply needs. These real-world decisions create different environmental conditions than simulated in the LT Ops DEIS Model. Therefore, comparisons of results from alternatives simulated in the LT Ops DEIS Model do not capture the environmental effects during these drought periods. We recommend Reclamation, in cooperation with key agencies, develop more realistic operating rules for the hydrologic conditions expected over the next half-century, and incorporate those operating rules into any CalSim II model that includes climate change.

Effects of the Biological Opinions

The LT Ops DEIS states Reclamation was ordered by the Ninth Circuit Court to prepare the EIS to "*determine whether the acceptance and implementation of the RPA actions cause a significant effect on the human environment*" (LT Ops DEIS page ES-6). The LT Ops DEIS No Action Alternative (NAA) includes implementation of the RPA actions in the simulated operations of the CVP and SWP. Effects from the implementation of the RPA actions on the American River Basin are shown by comparison of the NAA with the Second Basis of Comparison (SBC). Reclamation developed the SBC, which does not include RPA actions, in response to scoping comments, and to provide a basis of comparison to determine effects of implementing RPA actions.

MBK previously analyzed the effects of implementing the 2008 USFWS and 2009 NMFS BOs on CVP and SWP operations without climate change. Overall, changes in simulated CVP/SWP operations contained in the LT Ops DEIS are generally consistent with previous studies conducted by MBK. Differences in the effects presented in the LT Ops DEIS, where they exist, are likely due to the inclusion of climate change.

An important assumption for the operation of Folsom Reservoir, as simulated for the LT Ops DEIS, is that both the NAA and the SBC include operations to meet the Lower American River Flow Management Standard (FMS). The FMS was one of the RPA actions in the 2009 NMFS BO; however, it also is included in the SBC. The inclusion of the FMS in both the NAA and SBC is important when comparing results of the two studies because none of the differences between the NAA and the SBC are the result of implementing the FMS. Additionally, the majority of the other RPA actions apply to areas outside of the American River Basin. Therefore, changes in Folsom Reservoir operations and deliveries in the American River Basin are a result of CVP operations to meet RPA actions outside of the basin.

For water users in the American River Basin, potential effects on the human environment are focused on the operation of Folsom Reservoir and water deliveries. Figure 3 illustrates the probability of exceedance for end-of-September (carryover) storage in Folsom Reservoir for the NAA with implementation of the BO RPA actions and the SBC without implementation of the BO RPA actions.

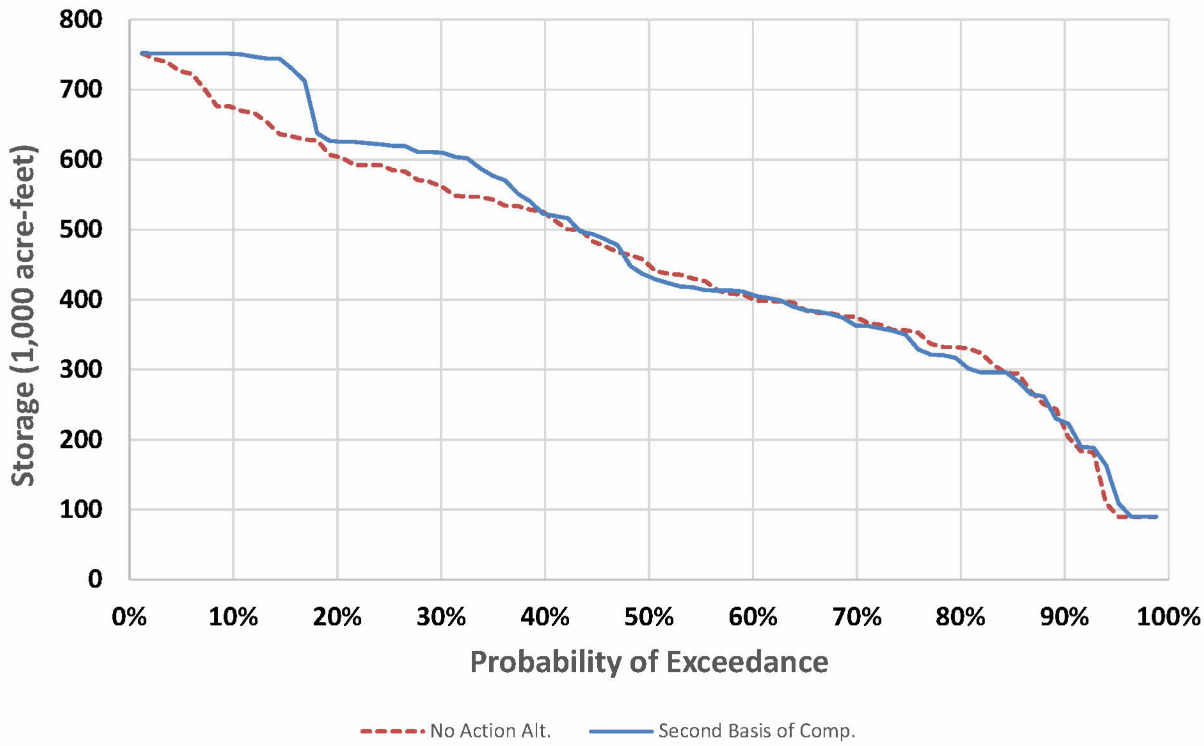

Figure 3: Probability of Exceedance for Folsom Reservoir End-of-September Storage

Results presented in Figure 3 illustrate one of the most significant effects of implementing the BO RPA actions on Folsom Reservoir. Folsom Reservoir carryover storage in wetter year types, i.e. below approximately the 40 percent exceedance level, is reduced as a result of additional releases to meet the fall X2 RPA action in the 2008 USFWS BO. In many years when Folsom Reservoir carryover storage is high, the reservoir will fill and spill in subsequent years. However, there are exceptions. Two examples included in the analysis are the years that preceded the 1976-1977 drought and the 1987-1992 drought. Both 1975 and 1986 are classified as wet water years by the Sacramento Valley Water Year Index and in both years carryover storage in Folsom Reservoir was reduced in the NAA by releases to meet the fall X2 RPA. Overall, the LT Ops DEIS lacks sufficient detail describing the effects of the different alternatives on CVP/SWP operations and the effects of implementing the BOs on the human environment. We recommend that more description of the operational changes and interpretation of the model results be included in the final EIS.

Changes in Folsom Reservoir storage can result in changes in CVP North-of-Delta (NOD) M&I water service contract allocations. Lower allocations result in less water deliveries to American River CVP contractors. Figure 4 illustrates the probability of exceedance for CVP NOD M&I allocations for the NAA and the SBC.

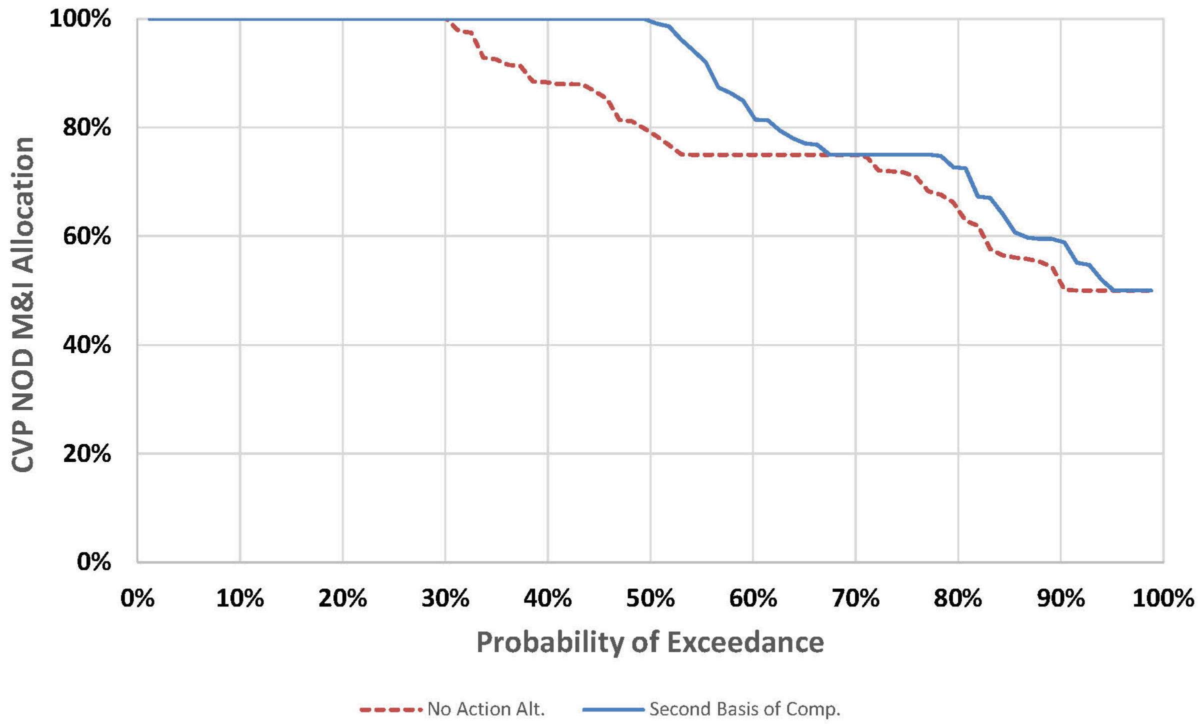

Figure 4: Probability of Exceedance for CVP NOD M&I Water Service Contract Allocations

Allocations illustrated in Figure 4 show a reduction in water available under CVP contracts as a result of implementing RPA actions contained in the BOs. The probability of receiving full allocations is reduced from approximately 50 percent to 30 percent, while the probability of receiving a 50 percent allocation is increased from approximately 5 percent to 10 percent. Changes in allocations are one parameter to understand the effects of implementing the BOs on American River water users. However, as described above, in the six percent of years when model results show that Folsom Reservoir would be drawn down to dead pool in both the NAA and SBC, there is not enough water in the simulation to meet the model allocations.

American River Basin Demands

Demand assumptions in CalSim II for a future level of development in the American River basin can vary. Table 1 is a summary of the average annual demands, by water purveyor, assumed in all alternatives for the LT Ops DEIS.

Table 1: Summary of American River Basin Water Purveyor Demands in LT Ops DEIS Model

Water Purveyor	Annual Demand (1,000 acre-feet)
Placer County Water Agency	65.0
PCWA – CVP Contract	35.0
City of Folsom	27.0
City of Folsom – CVP Contract	7.0
Folsom Prison	5.0
San Juan Water District (SJWD)	33.0
SJWD from PCWA	25.0
SJWD – CVP Contract	24.2
City of Roseville – from PCWA	30.0
City of Roseville – CVP Contract	32.0
Sac. Suburban Water District – from PCWA	0.0
El Dorado Irrigation District (EID)	0.0 or 17.0*
EID – CVP Contract	7.55
El Dorado County Water Agency (EDCWA) – CVP Contract	0.0 or 15.0*
So. Cal. Water Company/Arden Cordova Water Service	5.0
California Parks and Recreation	5.0
Sacramento Municipal Utilities District (SMUD)	15.0
SMUD – CVP Contract	30.0
City of Sacramento (Fairbairn and Sacramento River)	311.8
Carmichael Water District	12.0
Sacramento County Water Agency Total (SCWA)	109.7
SCWA – CVP Contract	45.0
East Bay Municipal Utilities District – CVP Contract	Up to 112.0

* These demands for EID and EDCWA are only included in sensitivity analyses performed for Alternatives 3 and 5.

The majority of the demands summarized in Table 1 approximate a buildout level of demand. One exception to this is for Sacramento Suburban Water District (Sac Suburban). There is no demand/diversion simulated for Sac Suburban for any of the alternatives evaluated in the LT Ops DEIS.

American River Basin Water Budget

Appendix 5B of the LT Ops DEIS describes the sensitivity analysis that was conducted to evaluate the effects of additional diversions from Folsom Reservoir. Alternatives 3 and 5 are described to include a potential future Warren Act Contract between Reclamation and El Dorado Irrigation District (EID) for the use of Folsom Reservoir to convey 17,000 acre-feet annually, and a M&I water service contract with El Dorado County Water Agency (EDCWA) for up to 15,000 acre-feet annually, subject to CVP M&I allocations. These two additional demands for water from Folsom Reservoir were not included in the modeling for Alternative 3 or Alternative 5. However, additional simulations were performed for the LT Ops DEIS for both alternatives that included the additional demands. The LT Ops DEIS states comparisons of these additional simulations that include the EID and EDCWA demands can be made to results for Alternatives 3 and 5, which do not include these demands, to understand the changes as a result of the additional 32,000 acre-feet of demand.

Review of these sensitivity studies shows an error in simulating the additional diversions in the context of the CVP/SWP system. Model studies correctly simulate the additional diversion of water from Folsom Reservoir, an annual average of approximately 17,000 acre-feet to EID and 12,000 acre-feet to EDCWA, after adjustment for CVP M&I allocations. Model studies also include an assumption that approximately 46 percent of the additional diversion returns to the system. The return flow appears to represent the monthly indoor M&I use of the additional demand being met from the surface water diversion. However, there is no additional depletion from the American River Basin, or Depletion Study Area (DSA) 70. Instead, the additional diversion from Folsom Reservoir results in: (1) increased return flows above the specified 46 percent, (2) reductions in other surface water diversions, and (3) a reduction in groundwater pumping within DSA 70. This change in groundwater pumping within DSA 70 is not a correct response of the model because the additional surface water diverted to EID and EDCWA under these two contracts would not be used to meet demands within DSA 70 that are currently being met from groundwater. Figure 5 illustrates the average annual change in different flow arcs in the CalSim II representation of the American River Basin/DSA 70.

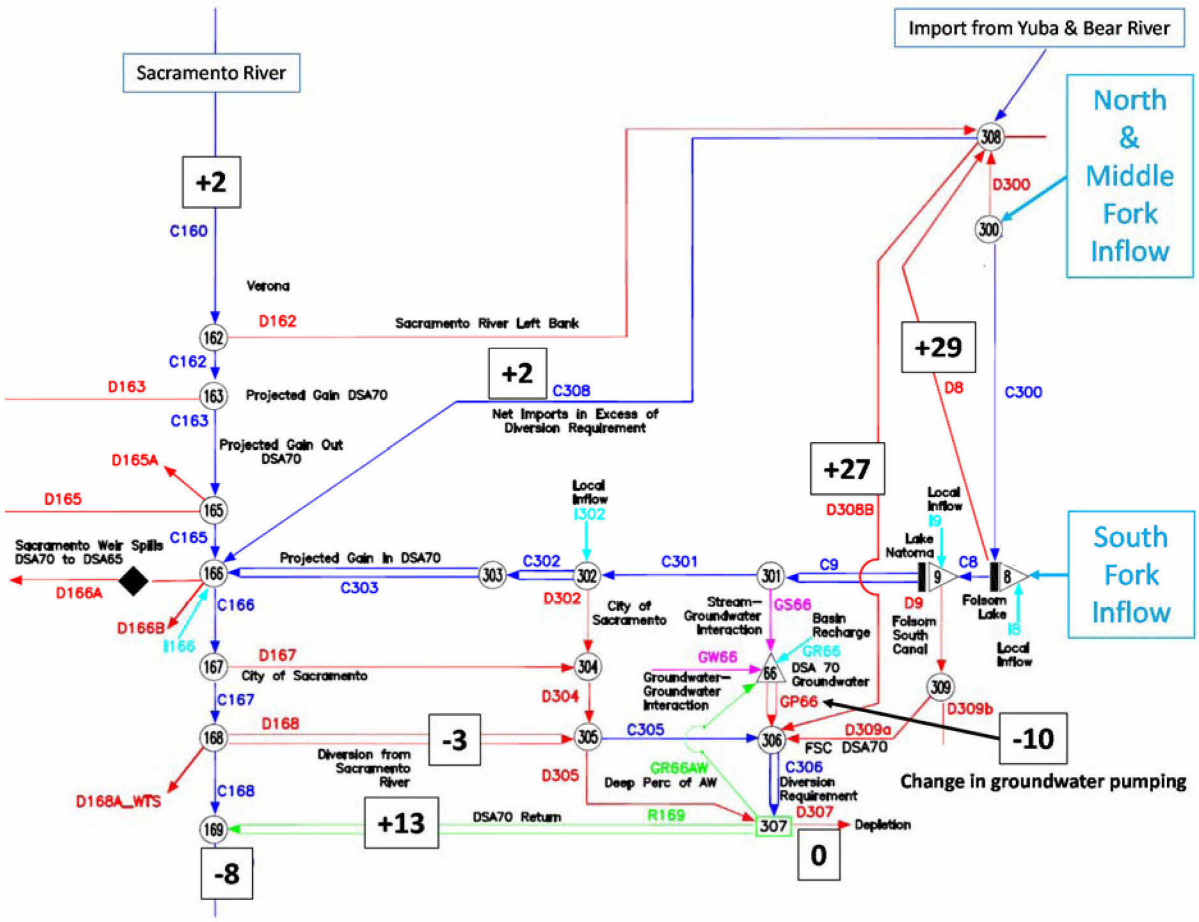

Figure 5: Average Annual Change in DSA 70 Water Budget for Sensitivity Analysis to Additional American River Basin Demands (1,000 acre-feet)

The result of these errors is to underestimate the potential environmental effects of these additional demands in Alternatives 3 and 5. Figure 5 illustrates that the reduction in Delta inflow is approximately 8,000 acre-feet on an average annual basis as a result of meeting up to 32,000 acre-feet of additional demand. Return flows are approximately 13,000 acre-feet of the 29,000 acre-feet diverted from Folsom Reservoir. Therefore, the remainder of the water should be depleted from the DSA 70 water budget, resulting in an average annual reduction in Delta inflow of approximately 16,000 acre-feet. However, instead of being depleted, the additional diversions from Folsom Reservoir increase return flow to the Sacramento River through arc C308, decrease Sacramento River diversions through arc D168, and reduce groundwater pumping through arc GP66. None of these changes should occur as a result of diverting additional water from Folsom Reservoir for delivery within EID and/or EDCWA. Additionally, there is no additional depletion of water from DSA 70 through arc D307. It is expected that some portion of the additional diversions under the two contracts would be depleted from the system. These model errors affect only the analysis of Alternatives 3 and 5 as presented in the sensitivity studies in Appendix 5B.

Lee Bergfeld, P.E.

LB/jw
1978-3/TECH MEMO COMMENTS ON LT OPS DEIS 2015-09-29