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Technical Review of the Draft Staff Report/Substitute Environmental Document in Support of Potential Updates to the Water Quality Control Plan and Associated Modeling

PRESENTED BY: MBK ENGINEERS
455 UNIVERSITY AVENUE, SUITE 100
SACRAMENTO, CA 95825

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I. Overview

MBK was tasked with a technical review of the Draft Staff Report/Substitute Environmental Document in Support of Potential Updates to the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary for the Sacramento River and its Tributaries, Delta Eastside Tributaries, and Delta (DSR) and associated modeling. This report is a summary of the technical review and key findings.

Sections and Key Findings

This report is organized into four sections. The first section makes direct comparisons between results for the Agreements to Support Healthy Rivers and Landscapes (VA Alternative) and the 55% Unimpaired Flow (UIF) scenario. The "Agreements to Support Healthy Rivers and Landscapes" is the updated name and reference for the "Voluntary Agreements" or "VA's" as described and detailed in the DSR Chapter 9 and Appendix G. The comparisons use information from the DSR and the Sacramento Water Allocation Model (SacWAM) and temperature model results received from State Water Resources Control Board (SWRCB) staff. The DSR contains most of the results presented in the first section but summarizes the results in separate chapters and sometimes in different ways that make direct comparisons challenging. The key finding from the first section of this report is as follows:

Analysis contained in the DSR demonstrates that the VA Alternative provides more benefits with less impacts than the Proposed Plan Amendments.[1]

The second section of this report summarizes the results of independent modeling of the VA Alternative completed by the California Department of Water Resources (DWR) using the CalSim 3.0 model. Other than the use of different models, the key difference between the modeling conducted by DWR and the modeling presented in the DSR using SacWAM is that the DWR modeling contains consistent assumptions for the regulatory requirements governing Delta exports between the DWR baseline and the DWR VA Alternative. Maintaining consistent assumptions for areas that are not part of the alternative being analyzed is the standard practice in the engineering profession. The key finding from the second section of this report is as follows:

Separate modeling of the VA Alternative, performed by DWR, wherein the regulatory requirements remain consistent with those in the DWR baseline, show significantly more Delta outflow with the VA Alternative as compared to results set forth in the DSR. Analysis of the VA Alternative benefits that are based on Delta outflow are underestimated in the DSR. Our review of the CalSim 3.0 modeling does not indicate there would be any new or more severe environmental impacts of the VA Alternative than contained in the DSR.

[1] For purposes of this report, "Proposed Plan Amendments" (PPA) includes an inflow objective from the Sacramento River and Delta tributaries to the Delta at 55% of unimpaired flow, within an allowed adaptive range between 45 and 65% of unimpaired flow (DSR, 5-17). The PPA also includes a narrative cold-water habitat objective to ensure there are no redirected impacts on cold water habitat from the inflow and Delta outflow objectives and to address temperature management concerns on the tributaries (DSR, 5-22).

The third section of this report describes unavoidable impacts of UIF requirements with California's current hydrology and how those impacts will exacerbate the impacts of climate change. The key findings of the third section of the report are as follows:

There are significant, real-world adverse impacts that would result from implementation of an unimpaired flow requirement of 45 to 65%.

The real-world adverse impacts of an unimpaired flow requirement of 45 to 65% will exacerbate the effects of climate change and are not evaluated in the DSR.

The fourth section of this report describes key information that is missing from the DSR, in addition to the effects of climate change that were not evaluated as indicated above. The primary missing information is an implementation plan to describe how the PPA will be implemented in combination with the cold water habitat objective. The key findings of the fourth section of the report are as follows:

The lack of an implementation plan and the wide range of potential actions for the Proposed Plan Amendments make it extremely difficult to understand the impacts of the Proposed Plan Amendments on reservoir operations, river flows, water deliveries, and Delta outflow.

The DSR does not provide information on the impacts of UIF requirements during multi-year drought periods.

The DSR describes several modular alternatives but provides limited model results for only one modular alternative and relies on qualitative descriptions of effects for the other modular alternatives.

The final section is a summary of the findings of a technical review of SacWAM modeling for the UIF scenarios based on a review of the model results. Supporting information for the following key findings are contained in the final section of this report:

Differences in how the UIF requirements and narrative cold water habitat objective are modeled on different river systems within the Sacramento Valley result in disproportionate impacts within the Sacramento Valley, North and South of Delta, and between the CVP and SWP.

SacWAM model results demonstrate that UIF scenarios include model operations that are inconsistent with U.S. Bureau of Reclamation policies and contract obligations. A failure to accurately simulate Reclamation policies and contract obligations result in modeled water supply impacts and associated reservoir operations that are inconsistent with actual system operations.

Terminology

This report uses terms for specific model scenarios and alternatives. The term "VA Alternative" is used to describe a specific model simulation of the Agreements to Support Healthy Rivers and Landscapes. This is consistent with the terminology used in the DSR.

The PPA is the other primary alternative discussed in this report. As noted above, the PPA includes an inflow objective from the Sacramento River and Delta tributaries to the Delta at 55% of unimpaired flow, within an allowed adaptive range between 45 and 65% of unimpaired flow (DSR, 5-17). The PPA also includes a narrative cold-water habitat objective to ensure there are no redirected impacts on cold water habitat from the inflow and Delta outflow objectives and to address temperature management concerns on the tributaries (DSR, 5-22). The cold-water habitat objective would apply on all Sacramento/Delta tributaries that support or contribute to protection of salmonids and other native, cold-water fish species (DSR, 5-22).

There is no single model simulation that represents the PPA in the DSR. The DSR contains results from analyses of discrete UIF percentages across a range of 35 to 75% UIF, paired with other modeling assumptions to simulate the narrative cold water habitat objective. There is no single model simulation that includes a range of UIF requirements that is adaptive to different conditions or meeting different objectives. For comparison with the VA Alternative and to illustrate differences, results from the 55% UIF scenario are presented in this report because this scenario represents the default UIF requirement under the PPA.

Figures, tables, and text set forth in this report describe “changes,” “differences,” “increases,” and “reductions” that model results indicate will occur under alternatives analyzed in the DSR. These terms represent a comparison between the alternative and the baseline, calculated as alternative minus baseline, for a particular metric such as reservoir storage, river flow, water delivery, etc.

II. VA Alternative: More Benefits with Less Impacts

Analysis contained in the DSR demonstrates that the VA Alternative provides more benefits with less impacts than the Proposed Plan Amendments.

The DSR analyzes the benefits and impacts of the Agreements to Support Healthy Rivers and Landscapes as the "VA Alternative." Results for the VA Alternative are contained in DSR Chapter 9 and the Final Scientific Basis Report Supplement that is Appendix G2 to the DSR. The DSR also presents SacWAM and other model results of analysis of unimpaired flow requirements at discrete percentages in combination operational assumptions for the cold water habitat objective.

The DSR does not include direct comparisons of benefits and impacts for the VA Alternative and percent UIF scenarios. The following sections provide a direct comparison of results for these two alternatives. The figures and tables presented are results contained in the DSR and references to where the information can be found are provided. Results for the 55% UIF scenario are presented and assumed to be representative of the PPA because that scenario is described as the default flow requirement within the adaptive range. (DSR, 5-17).

Tributary Salmonid Habitat

The VA Alternative provides more salmonid benefits on the tributaries than the 55% UIF scenario, increases habitat to address limiting factors, and provides benefits across all water year types by making efficient use of existing flows and the VA flow assets.

The DSR includes a summary of results for both the VA Alternative and 55% UIF scenario for salmonid habitat on tributaries of the Sacramento River and Delta. This information is contained in Chapter 3, tables 3.14-8 (spawning) and 3.14-9 (rearing), for the UIF scenarios, and Chapter 9, tables 9.6-1 (spawning) and 9.6-2 (rearing), for the VA Alternative. For both the VA Alternative and UIF scenarios the analysis started with SacWAM modeling of flows and included subsequent analyses of depth, velocity, and temperature to evaluate suitable habitat during the seasons for each salmon run and habitat type. Results for the UIF scenarios are presented as median acres (figures) and percent change (tables) in habitat across 21 watersheds for fall-run Chinook salmon and four watersheds for spring-run Chinook salmon. Results for the VA Alternative are presented as median acres for the baseline and with VA. Results from the tables in Chapter 9 of the DSR were used to calculate the percent change in suitable habitat as acres with VA minus baseline acres divided by baseline acres for a direct comparison with UIF scenario results.

Figure 1 is the percent change in suitable salmonid spawning and rearing habitat for the VA alternative and the 55% UIF scenario on the Sacramento Valley rivers included in the VA Alternative.

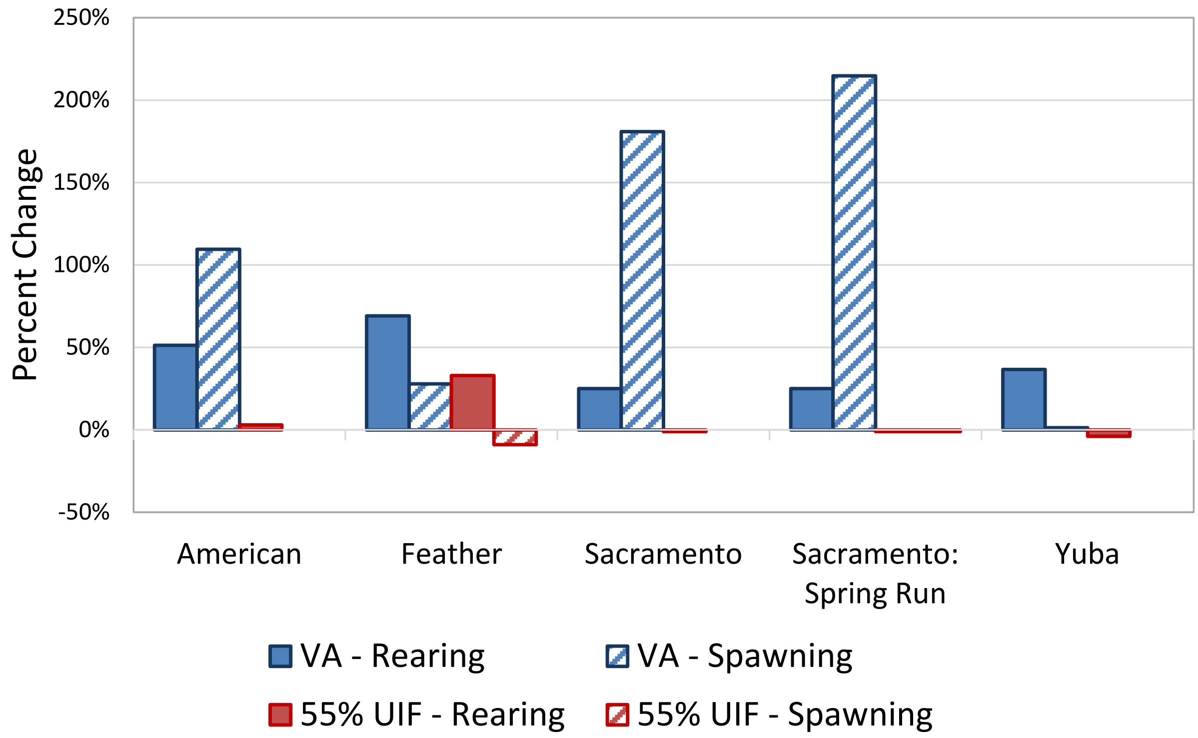

Figure 1. Change in Median Salmonid Spawning and Rearing Habitat with VA and 55% UIF Alternatives

Results in Figure 1 show larger percent changes in suitable salmonid spawning and rearing habitat on the American, Feather, Sacramento, and Yuba rivers with the VA Alternative as compared to the 55% UIF scenario. Spawning habitat more than doubles on the American River and approximately triples on the Sacramento River under the VA Alternative. Rearing habitat improvements under the VA exceed those under the 55% UIF scenario by at least a factor of two (Feather) and often significantly more (American, Sacramento, and Yuba). Figure 1 does not include changes on all watersheds included in tables for the UIF scenarios or across the range of UIF contained in the PPA. Moreover, Figure 1 does not include changes on the Calaveras River where the DSR results show the 55% UIF scenario would increase spawning and rearing habitat by 16% or on Clear Creek where rearing habitat increases by 4%. Additionally, the results for the VA Alternative do not include 20,000 acres of floodplain restoration in the Sutter Bypass that will provide rearing habitat for fish from the Feather and Sacramento rivers (DSR, 9-76).

The DSR provides additional details on the percent increases in tributary salmonid habitat with the VA Alternative in Appendix G2, the Supplement to the Scientific Basis Report, tables 6-1 and 6-2. Figure 2 and Figure 3 summarize the median percent increase from these tables for spawning and rearing habitat, respectively.

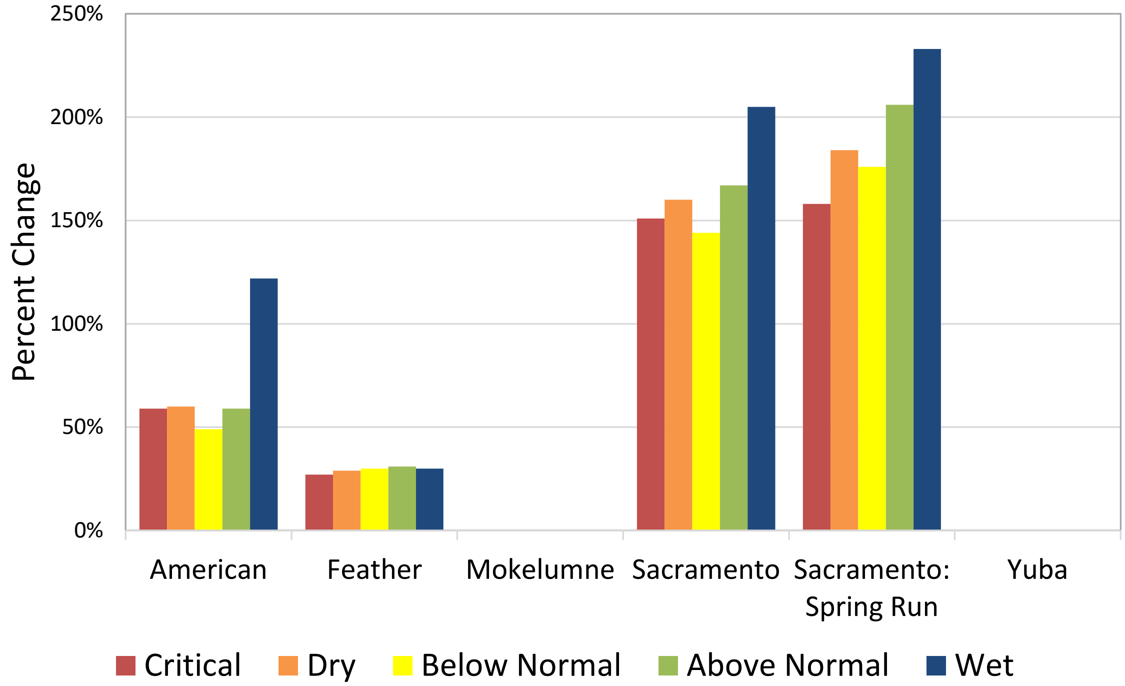

Figure 2. Percent Change in Tributary Spawning Habitat by Water Year Type with VA Alternative

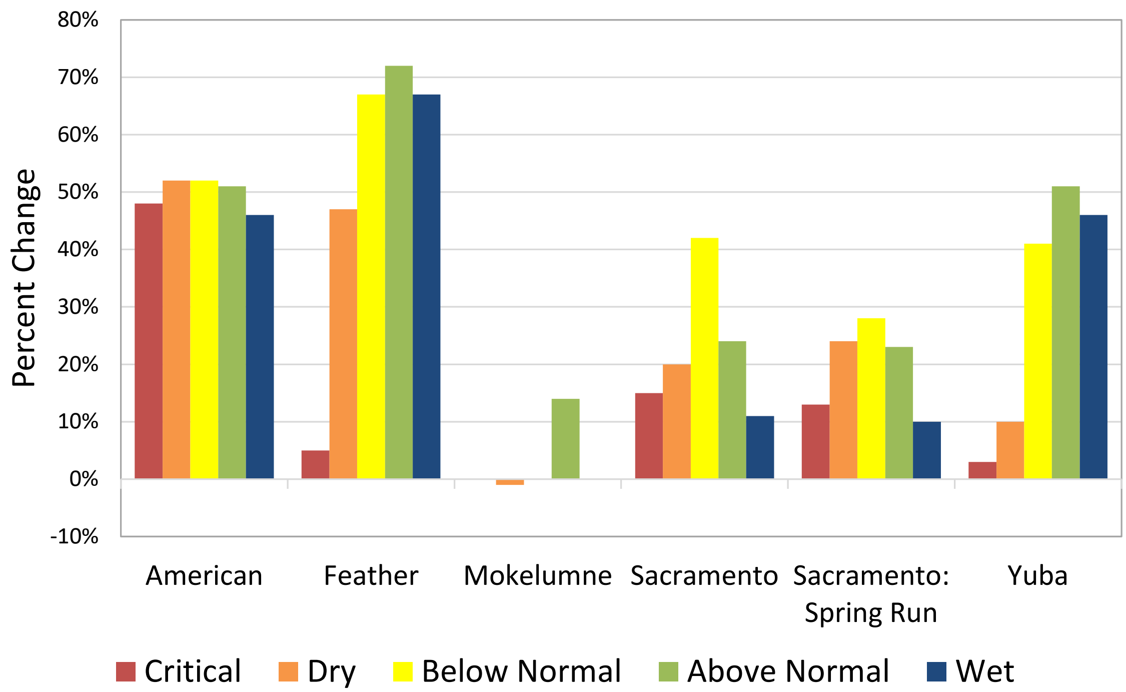

Figure 3. Percent Change in Tributary Rearing Habitat by Water Year Type with VA Alternative

Results summarized in these two figures illustrate two key points regarding the VA Alternative. First, the VA Alternative strategically addresses the specific needs of each tributary. For example, spawning habitat is not a limiting factor on the Yuba River and therefore VA habitat projects focus on additional rearing habitat on that system. Second, VA habitat projects provide benefits across the range of existing flows, including years without VA flow contributions. The result is an efficient use of existing flows to increase salmonid habitat in all years.

Temperature Management

The VA Alternative will have less impact on the ability to manage water temperature below reservoirs as compared to the 55% UIF scenario.

Summaries of the simulated changes in water temperature between the Baseline and UIF scenarios and the Baseline and VA Alternative are included in DSR Appendix A6 and DSR Appendix G3E, respectively. The model outputs summarized in these appendices for the Sacramento and Feather rivers were provided by SWRCB staff and used to generate the following figures. These figures illustrate the changes from the baseline in average monthly water temperature by water year type at locations on the Sacramento and Feather rivers downstream of the major reservoirs and regulating reservoirs on both rivers.

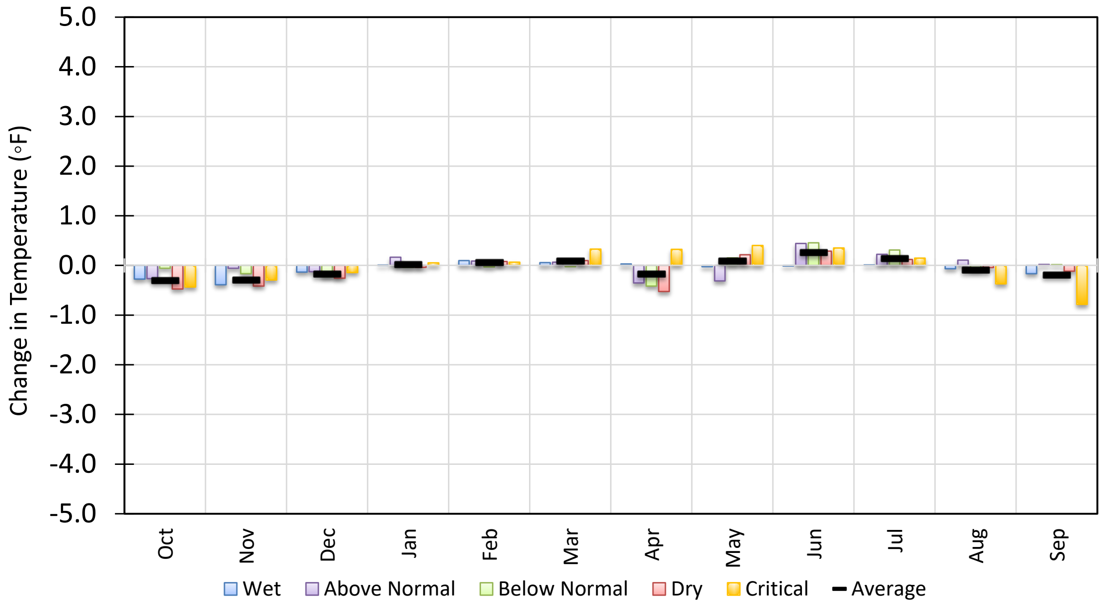

Figure 4. Average Monthly Change in Sacramento River above Clear Creek with VA Alternative

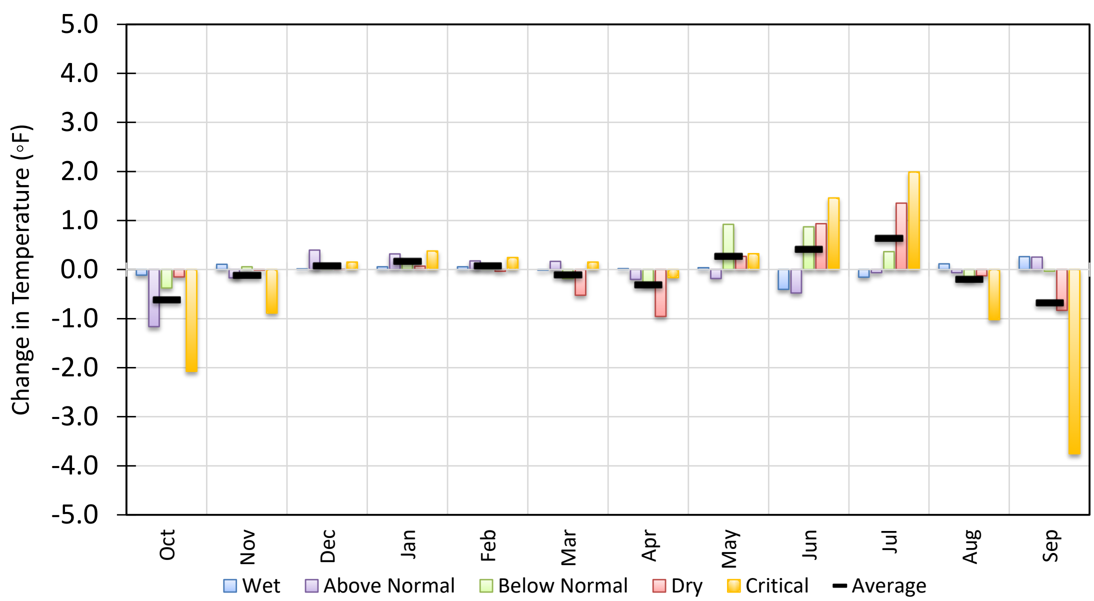

Figure 5. Average Monthly Change in Sacramento River above Clear Creek Water Temperature with 55% UIF Scenario

Comparison of the changes in water temperatures in Figure 4 (VA Alternative) with Figure 5 (55% UIF scenario) shows that temperature increases with the VA Alternative are less than 0.5 degrees Fahrenheit for all months and water year types. Increases in water temperature under the 55% UIF scenario are one to two degrees in June and July of dry and critical years. Under the 55% scenario, the water temperature increases occur despite simulated actions that reduce reservoir releases and downstream water supplies to implement the narrative cold water habitat objective.

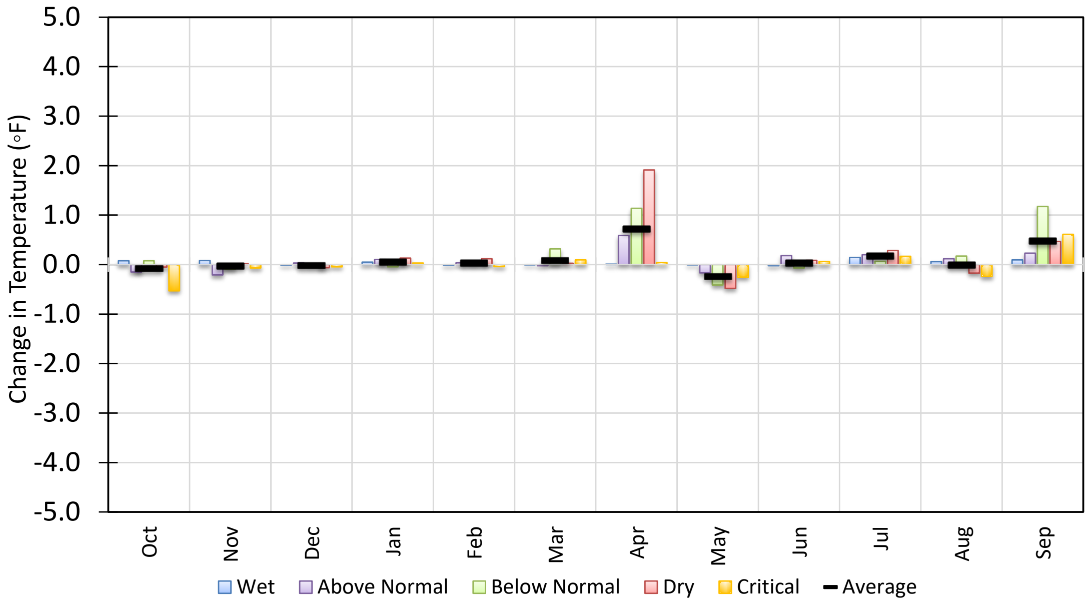

Figure 6. Average Monthly Change in Feather River at Gridley Water Temperature with VA Alternative

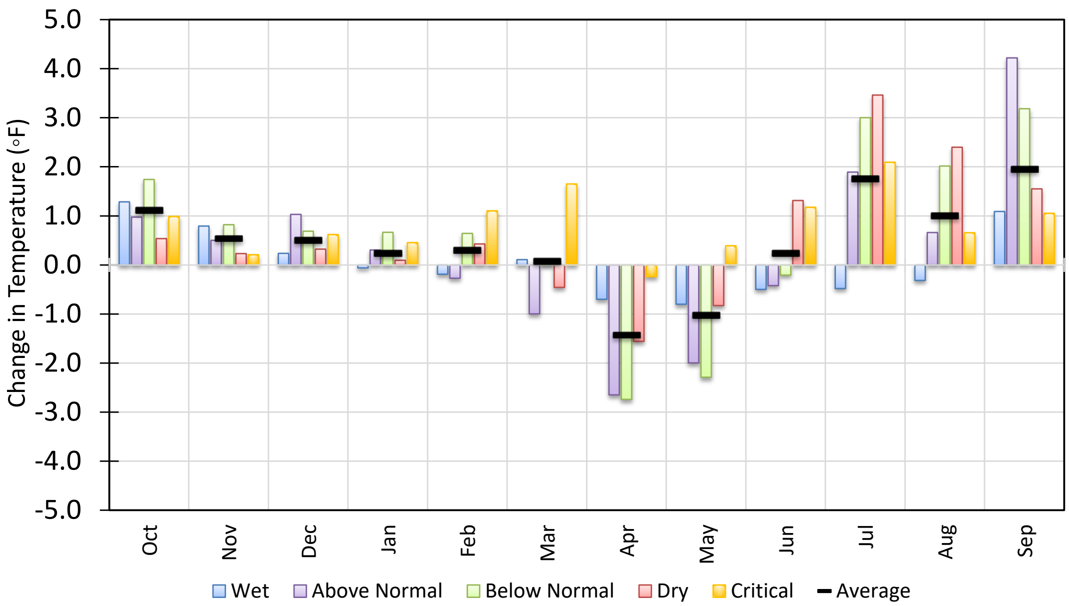

Figure 7. Average Monthly Change in Feather River at Gridley Water Temperature with 55% UIF Scenario

Comparison of the changes in water temperatures in Figure 6 (VA Alternative) with Figure 7 (55% UIF scenario) shows increases with the VA Alternative are minimal in most months and water year types, but up to one to two degrees Fahrenheit in April and September of some water year types. Increases in water temperature under the 55% UIF scenario are one to four degrees from June through October of several water year types.

Rice Acres and Wildlife Refuge Water Supply

The VA Alternative will have less impact on the acres of rice land in production in the Sacramento River Basin than the 55% UIF scenario and no impact on wildlife refuge water supplies, unlike the 55% UIF scenario.

The VA Alternative for the Sacramento River Basin will make water available by idling up to 35,000 acres of rice land[2] in above normal, below normal, and dry years. An estimate of the annual reduction in rice land in production under the 55% UIF scenario was developed based on reductions in SacWAM diversions to the primary rice growing areas of the Sacramento River Basin including the Sacramento River Settlement Contractors (SRSC); diversions from the Thermalito Afterbay on the Feather River; Yuba Water Agency diversions; and South Sutter Water District diversions from the Bear River. The combined reductions in simulated irrigation season diversions were divided by an approximate diversion duty of five acre-feet per acre to estimate the reduced rice acres each year. Figure 8 illustrates the annual reductions in Sacramento River Basin rice acres in production for the VA Alternative and 55% UIF scenario.

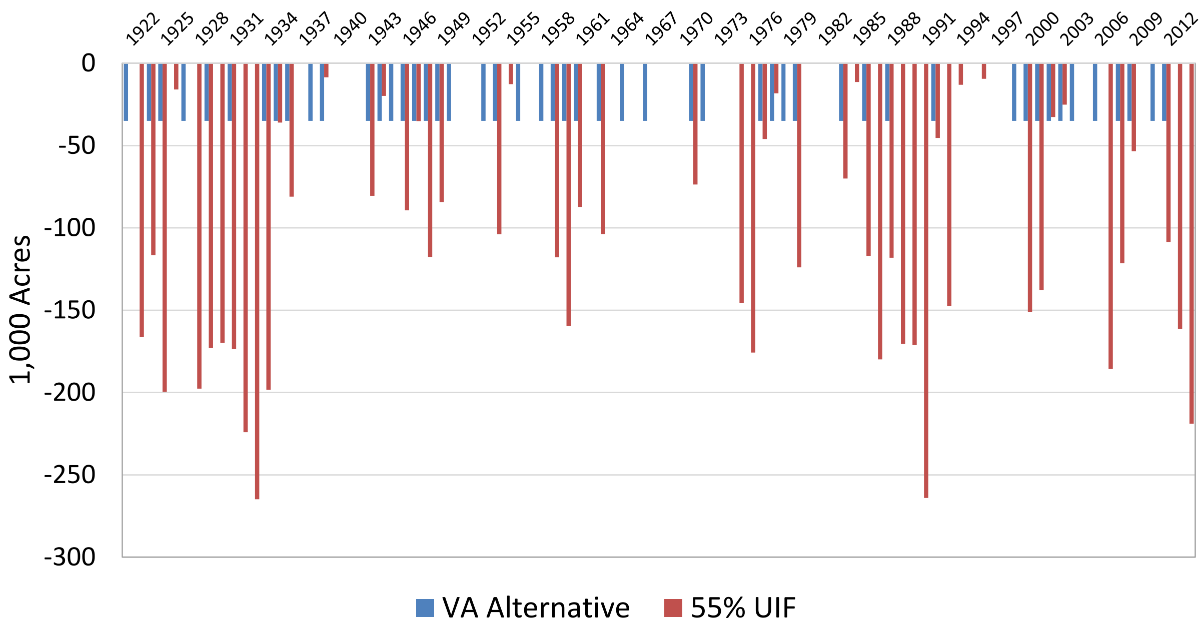

Figure 8. Estimated Annual Reductions in Sacramento River Basin Rice Acreage

Results summarized in Figure 8 show that, under the 55% UIF scenario, rice acreage will be reduced by 150,000 to 200,000 acres or more in multiple periods of consecutive years and may reach more than 250,000 acres, similar to the reductions that occurred in 2022 on the westside of the Sacramento River.

[2] See footnote 6 to Table 1a in the Memorandum of Understanding Advancing a Term Sheet for the Voluntary Agreements to Update and Implement the Bay-Delt Water Quality Control Plan, and Other Related Actions.

By comparison, under the VA Alternative the maximum reduction in rice acreage in production in the Sacramento River Basin in any one year is 35,000 acres.

Reductions in rice acreage reduce habitat for terrestrial species in the Sacramento Valley including waterfowl and giant garter snakes (DSR, 7.6.1-54). The DSR shows additional impacts to wildlife refuge water supply under the 55% UIF scenario. Figure 9 is an annual summary of the change in wildlife refuge water supply from SacWAM model results for refuges located north and south of the Delta. The DSR includes annual average changes in refuge water supply in Table 7.6.1-5.

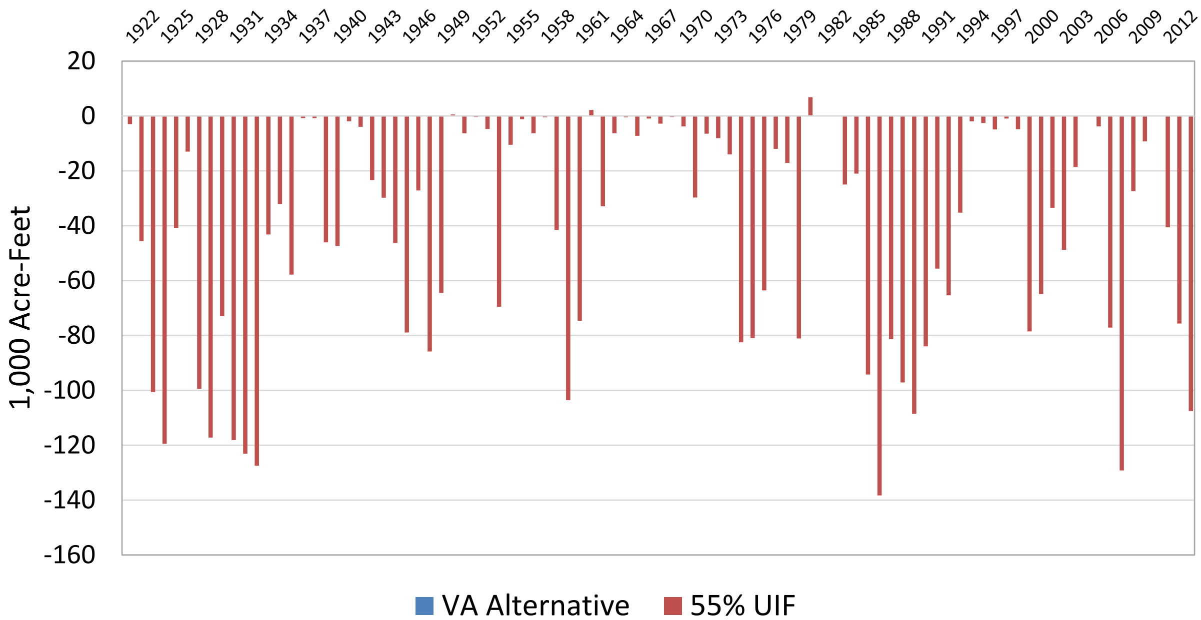

Figure 9. Annual Change in Wildlife Refuge Water Supply from SacWAM Results

Figure 9 shows that, under the 55% UIF scenario, annual reductions in refuge water supply can exceed 100 thousand acre-feet (TAF) in multiple periods of consecutive years. The VA Alternative does not result in any reductions in simulated refuge water supply. A comparison of Figure 8 and Figure 9 shows that, under the 55% UIF scenario, the largest reductions in rice acres occur in the same years as the largest reductions in wildlife refuge water supplies, compounding the impacts to terrestrial species in those years.

Reservoir Storage

The VA Alternative better maintains the ability of reservoirs to provide multiple benefits as compared to the 55% UIF scenario.

Figure 10 illustrates the probability of exceedance for end-of-May, simulated storage in Shasta, Oroville, Folsom, and New Bullards Bar reservoirs for the baseline, VA Alternative, and 55% UIF scenario. The end-of-May storage is the reservoir condition at the end of the spring period when both the VA Alternative and the 55% UIF scenario can require increased releases, and the start of the summer period when demands increase and reservoir storage is needed for water supply, temperature management, hydropower generation, and other uses.

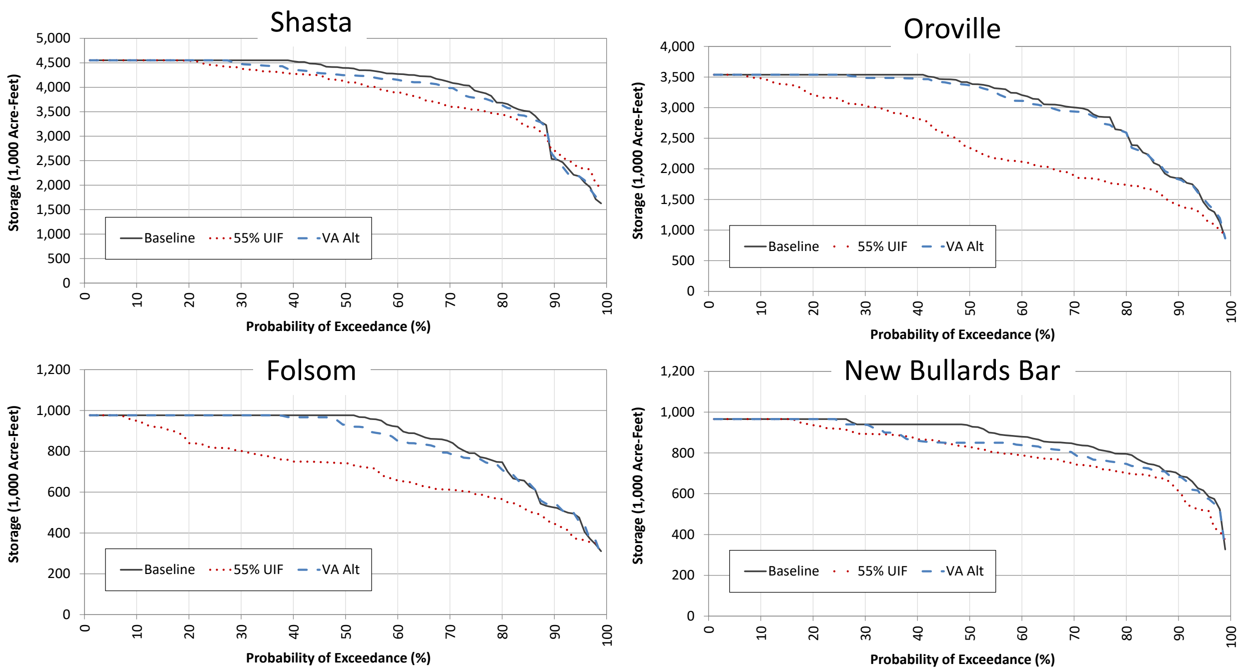

Figure 10. End-of-May Simulated Storage in Four Major Reservoirs in the Sacramento Valley

Results in Figure 10 show storage in the VA Alternative is higher at the end-of-May as compared to the 55% UIF scenario in three of the four reservoirs across the full range of conditions and approximately 90% of the time in Shasta. Under the 55% UIF scenario, end-of-May storage in both Oroville and Folsom is significantly lower than either the baseline or the VA Alternative. Tables in DSR Appendix A6 summarize the effects of higher spring releases on downstream water temperatures later in the summer. These tables include A6-25 for the Sacramento River above Clear Creek, A6-41 for the Feather River below the Thermalito Afterbay, and A6-47 for the American River at Watt Avenue. Under the 55% UIF scenario, temperature impacts on the Feather and American rivers are more pronounced with median temperatures higher than the baseline from June through February.

Figure 11 provides the same probability of exceedance for end-of-September, simulated storage in Shasta, Oroville, Folsom, and New Bullards Bar reservoirs for the baseline, VA Alternative, and 55% UIF scenario.

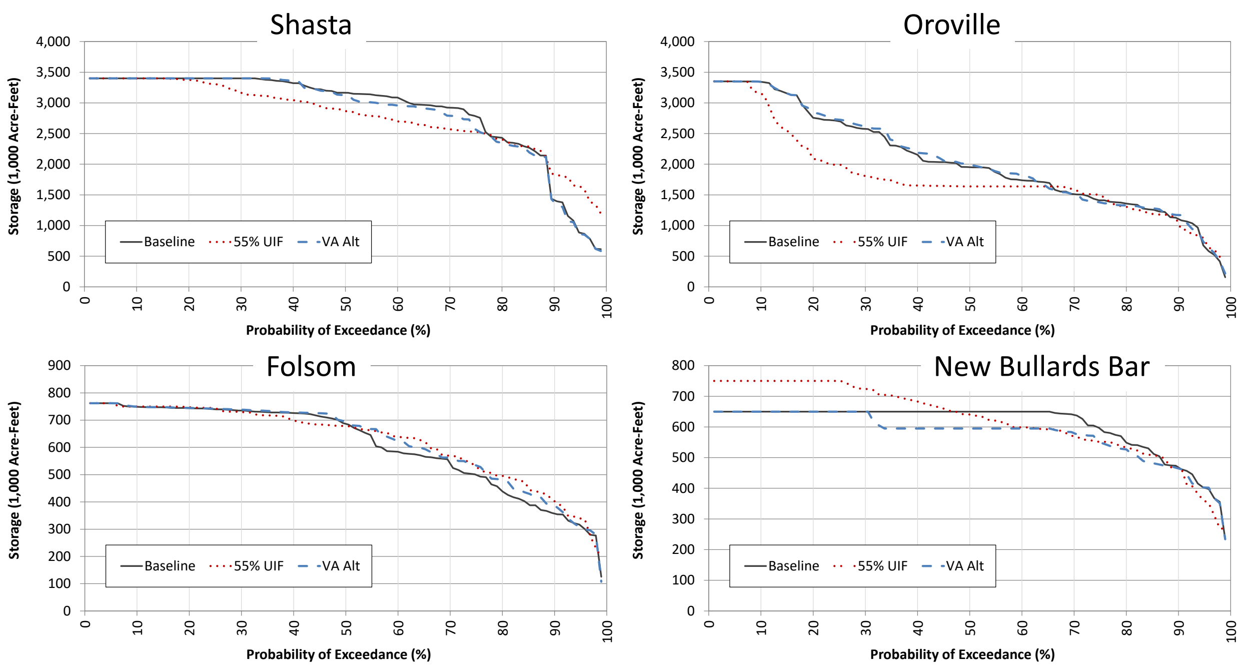

Figure 11. End-of-September Simulated Storage in Four Major Reservoirs in the Sacramento Valley

Results for end-of-September or carryover storage show differences across the four reservoirs. Carryover storage under the 55% UIF scenario is lower than the VA Alternative approximately 60% of the time in Shasta, but higher approximately 10% of the time because of the narrative cold water habitat objective. Carryover storage in Oroville is lower approximately 50% of the time under the 55% UIF scenario. Carryover storage in Folsom is similar to baseline under both the VA Alternative and 55% UIF scenario. Carryover storage in New Bullards Bar reflects a fundamental change in the operation of that reservoir with a carryover storage target of 750 TAF in the 55% UIF scenario compared to 650 TAF in the baseline and VA Alternative.

Water Supply

Water supply impacts of the VA Alternative are manageable and can be mitigated. The water supply impacts of the 55% UIF scenario are more than 2 million acre-feet in dry and critical years or approximately 23% of the baseline water supply in these years.

The DSR includes information to summarize the water supply impacts of both the UIF scenarios and VA Alternative. This information is contained in Chapter 6, Tables 6.4-2 for the UIF scenarios, and Chapter 9, Tables 9.5-45 for the VA Alternative. These tables include the surface water supply changes within the Sacramento River/Delta area and includes areas that may be affected by the alternatives evaluated in the DSR. This is the largest geographic area where results are summarized. The DSR includes more detailed, regional results and results by agricultural, urban, and wildlife refuge use.

Figure 12 compares the reductions in surface water supply under the VA Alternative and the 55% UIF scenario as reported in the DSR.

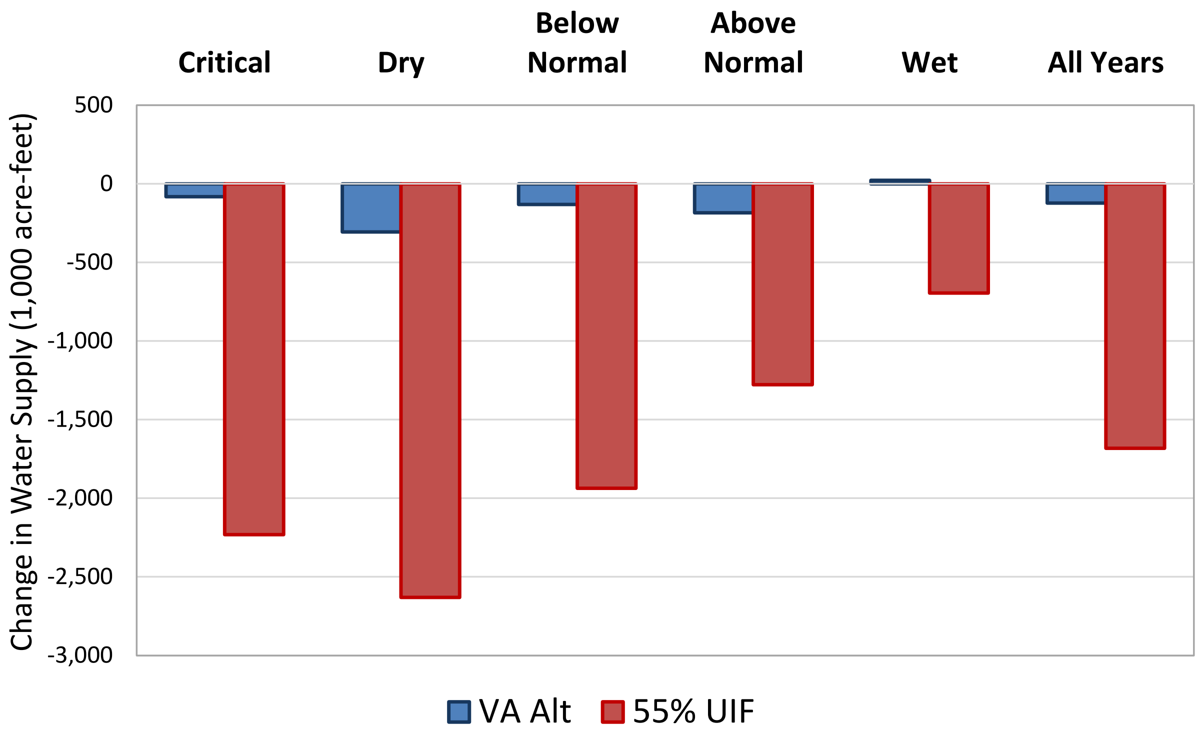

Figure 12. Average Annual Change in Water Supply by Water Year Type for VA Alternative and 55% UIF Scenario

As shown in Figure 12, the water supply impacts under the 55% UIF scenario exceed those under the VA Alternative by more than 2.1 million acre-feet (MAF) in critical and dry years, 1.8 MAF in below normal years, 1 MAF in above normal years, and 700 TAF in wet years.

Results are presented here for the largest geographic area because DSR Appendix A1 on the SacWAM model states the location of water supply impacts under the UIF scenarios may be different than SacWAM results though the overall magnitude of impacts is not expected to be substantially different (DSR Appendix A1, A1-19). Appendix A1 states the distribution between CVP and SWP contractors and areas located north and south of the Delta may be different (DSR Appendix A1, A1-19). The idea that the location of water supply impacts may be different than what was modeled is addressed in the subsequent section on the modeling of the UIF scenarios.

The magnitude of surface water supply impacts is understated in the DSR for both the VA Alternative and the 55% UIF scenario shown in Figure 12. The results for the VA Alternative shown in Figure 6 reflect changes in water supply from a baseline condition. Under the VA Alternative, the SacWAM model results show reductions in water supply in some areas and increases in Delta exports by the CVP and SWP, particularly in the months of April and May (see Figure 29 and Figure 31). This is an outcome of the different assumptions made with respect to regulatory requirements for the SacWAM Baseline and VA Alternative. These simulated increases in Delta exports are not part of the VA Alternative but offset a portion of the water supply impacts expected under the VA Alternative and result in the 22 TAF increase in wet year water supplies shown in Figure 12. As described in the following section that provides results of CalSim 3.0 modeling of the VA Alternative, the VA Alternative includes reductions in CVP and SWP

Delta export water supply (see Figure 30 and Figure 32). This means the surface water supply impacts for the VA Alternative are underestimated in the DSR.

The surface water supply impacts for the 55% UIF scenario are also underestimated in the DSR. Results reported in the DSR are developed from monthly model results of simulated water diversions in SacWAM. The SacWAM model calculates a monthly diversion requirement as the water necessary to meet crop evapotranspiration and maintain adequate soil moisture. If the simulated diversion is less than the diversion requirement, the SacWAM model simulated a soil moisture deficit that must be made up in future months if higher diversions are possible. The result is diversions that can exceed the baseline diversions in some months when prior month diversions were less than the simulated diversion requirement. Figure 13 illustrates this issue using monthly SacWAM diversions by all SRSC for the baseline and 55% UIF scenario.

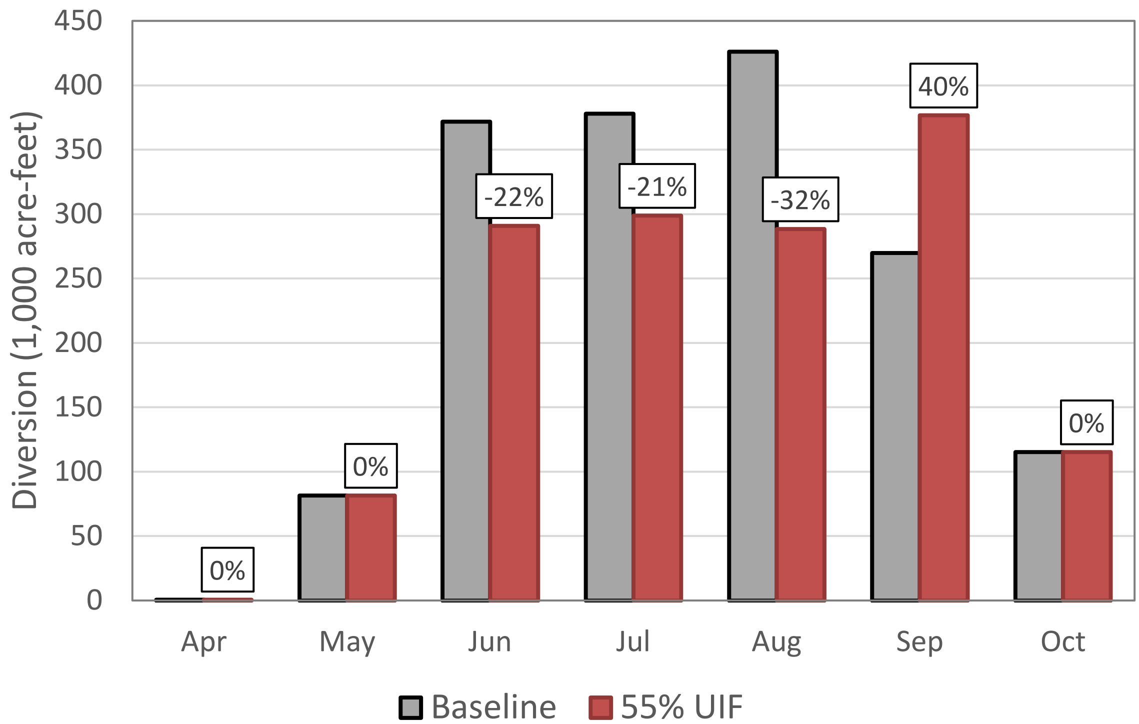

Figure 13. Example SacWAM Monthly Diversions by SRSC for Baseline and 55% UIF Scenario

Figure 13 shows reductions in the monthly SacWAM diversions by SRSC in the 55% UIF scenario as compared to the SacWAM Baseline in June, July, and August. The maximum percent reduction is 32% in August. The SacWAM diversions for September are 40% higher in the 55% UIF scenario than the baseline due to the soil moisture deficit from prior months. When aggregated for the purpose of summary tables in the DSR, the increased September diversions offset a portion of the decreased diversions in the prior three months. This results in an underestimate of the surface water supply impacts reported in the DSR because additional deliveries, above the baseline deliveries, in months that follow reductions, provide minimal benefit for agricultural water users following three months of 20-30% reductions. The 55% UIF scenario would result in a loss of approximately the same percentage of the planted crops as the maximum monthly percent reduction in the water supply, 32% in August.

Benefits and Adverse Impacts Comparison Summary

Analysis contained in the DSR demonstrates that the VA Alternative provides more benefits with less adverse impacts than the Proposed Plan Amendments.

Table 1 provides a summary of benefits and adverse impacts of the VA Alternative compared to the 55% UIF scenario for the resource metrics described in the previous sections.

Table 1. Summary of Benefits and Impacts of VA Alternative versus 55% UIF Scenario

Metric	VA Alternative	55% UIF Scenario
Tributary Salmonid Habitat	Benefits	Neutral
Terrestrial Habitat	Neutral	Adverse Impacts
River Temperatures	Neutral	Adverse Impacts
Reservoir Storage	Neutral	Adverse Impacts
Water Supply	Neutral*	Adverse Impacts

*The VA Alternative has impacts to water supply to provide the flow assets, but the impacts are manageable as compared to impacts under the 55% UIF scenario.

III. Separate Analysis of VA Alternative Shows Additional Delta Outflow

Separate modeling of the VA Alternative, performed by DWR, wherein the regulatory requirements remain consistent with those in the DWR baseline, show significantly more Delta outflow with the VA Alternative as compared to results set forth in the DSR. Analysis of the VA Alternative benefits that are based on Delta outflow are underestimated in the DSR. Our review of the CalSim 3.0 modeling does not indicate there would be any new, or more severe, environmental impacts of the VA Alternative.

This section provides a comparative analysis of VA Alternative modeling conducted by SWRCB Staff using SacWAM with the modeling conducted by DWR using CalSim 3.0. The VA Alternative flow asset assumptions for SacWAM and CalSim 3.0 are from the 2022 Memorandum of Understanding (MOU), Appendix 1, Table 1a and 1b. The flow assets explicitly simulated in each model are similar with differences in the frequency of implementation of the American River VA flow assets; simulation of the Friant VA flow assets in CalSim 3.0 but not SacWAM; and Sacramento VA flow assets in critical years in CalSim 3.0 but not SacWAM. Differences in flow assets simulated in each model are relatively small and not the primary cause for the differences in results.

Comparison of SacWAM and CalSim 3.0 Results

SacWAM modeling of the VA Alternative includes an assumption about changes in the regulatory requirements on Delta exports that is different from the assumption about such requirements contained in the SacWAM Baseline.

This section presents effects of the VA Alternative by comparing the changes in flows simulated by SacWAM and CalSim 3.0 models. Change in flows between the two models, calculated as the VA Alternative minus the respective baseline, are presented at key locations in the Sacramento Valley and Delta. Table 2 is a summary of average annual changes in flow and Delta exports under the VA Alternative as simulated in CalSim 3.0 and SacWAM. The SacWAM model outputs presented in this section correspond to the results reported in Appendix G3a of the DSR.

Table 2. Average Annual Flow Changes in TAF with CalSim 3.0 and SacWAM

	CalSim 3.0 Modeling			SacWAM		
Parameters	**Base**	**VA**	**Difference**	**Base**	**VA**	**Difference**
Sacramento River below Keswick	6,161	6,163	2	6,131	6,142	11
Sacramento River at Wilkins Slough	6,388	6,299	-89	6,566	6,512	-54
Yuba River near Marysville	1,467	1,495	27	1,461	1,462	1
Feather River at the confluence with Sacramento River	5,257	5,339	82	5,211	5,237	26
American River at Natomas	2,423	2,426	3	2,399	2,405	6
Yolo Bypass	2,342	2,321	-21	2,281	2,243	-38
Sacramento River at Hood	15,522	15,675	154	15,290	15,409	119
Banks Exports	2,608	2,551	**-57**	2,694	2,752	**58**
Jones Exports	2,475	2,421	**-54**	2,374	2,403	**28**
Delta Outflow	15,084	15,349	**264**	15,489	15,485	**-4**

Among the results summarized in Table 2, differences in Delta exports and Delta outflows between the two models are the most significant. CalSim 3.0 model results show an increase of 264 TAF per year of Delta outflow under the VA Alternative, while SacWAM model results show a reduction in Delta outflow of 4 TAF per year under the VA Alternative. These differences exist because of differences in assumptions about regulatory requirements contained in each model. SacWAM modeling of the VA Alternative includes an assumed change in the regulatory requirements for Delta exports from the regulatory requirements assumed in the SacWAM Baseline. This is a key difference and undermines the ability to understand the effects of the VA Alternative. The Agreements to Support Healthy Rivers and Landscapes do not include a change in regulatory requirements for Delta exports. Such regulatory requirements will be determined through other processes including the U.S. Bureau of Reclamation's (Reclamation) ongoing re-consultation regarding the long-term operations of the CVP and SWP. The Agreements to Support Healthy Rivers and Landscapes will provide additional Delta outflow on top of the Delta outflow that occurs as a result of all other applicable regulatory requirements.

Comparisons of the VA Alternative to a baseline with different underlying regulatory requirements is inappropriate and is contrary to standard industry practice in the engineering profession. In the engineering profession it is standard practice when performing technical analyses of an alternative to include only the components of that alternative in the analysis while keeping all other assumptions consistent with the baseline. Performing the analysis in this way ensures that the results of the analysis reflect only the changes attributable to the alternative. The addition of other changes to the model assumptions introduces confounding effects.

As described in DSR Appendix A1 describing the SacWAM modeling, the SacWAM results are intended to be used in a comparative analysis to understand the incremental effects between two scenarios (DSR Appendix A1, A1-3). Comparative analyses are the standard practice in the engineering profession for evaluating model results such as those presented in the DSR. However, it is critical to ensure that these comparisons, such as the change between an alternative and the baseline, represents only the changes associated with the alternative. All other assumptions and inputs not specifically part of the alternative should remain consistent with the baseline.

Unlike SacWAM, the CalSim 3.0 modeling performed by DWR adheres to standard industry practice in that the analysis reflects only the changes attributable to the VA Alternative. Under the VA Alternative scenario in the CalSim 3.0 modeling performed by DWR, the underlying regulatory requirements are the same as in the CalSim 3.0 baseline. In order to understand the impact of the change in regulatory requirements in the VA Alternative scenario as modeled in SacWAM, it is helpful to compare the SacWAM modeling results for the VA Alternative with the CalSim 3.0 modeling results for the VA Alternative. Because of the change to regulatory requirements in the VA Alternative in SacWAM, the CalSim 3.0 modeling of the VA Alternative is a more useful comparative tool for analysis of Delta outflow. Analysis of the VA Alternative benefits that are based on Delta outflow and represented as a change from the baseline are underestimated in the DSR. The underestimation of benefits does not affect the VA Alternative impact analysis. Our review of the CalSim 3.0 modeling did not identify any potential for new or more severe significant impacts of the VAs as modeled under CalSim 3.0, compared to the SacWAM modeling.

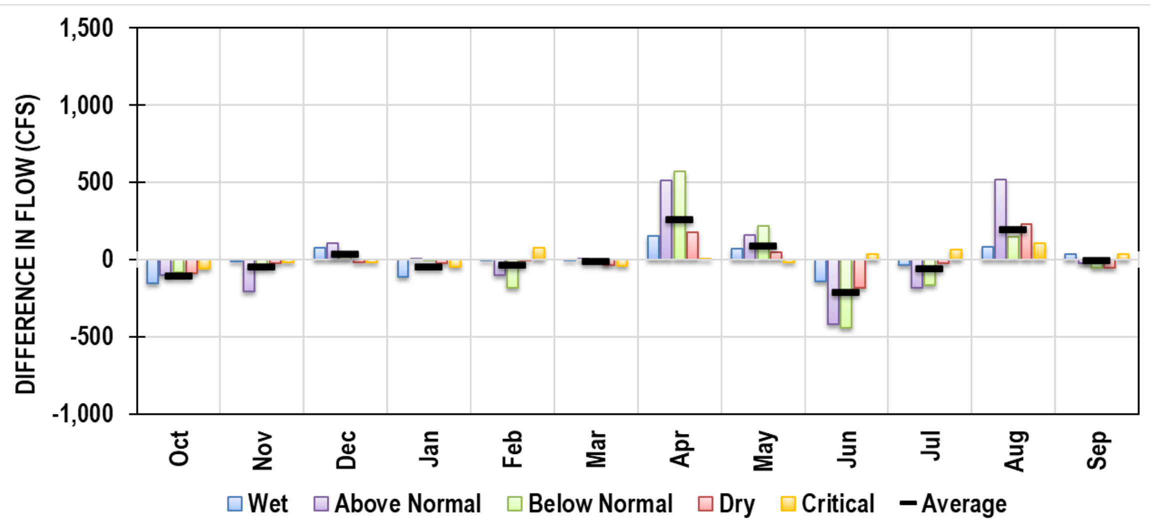

Figure 14. Average Monthly Changes in Sacramento River Flow below Keswick with VA Alternative in CalSim 3.0

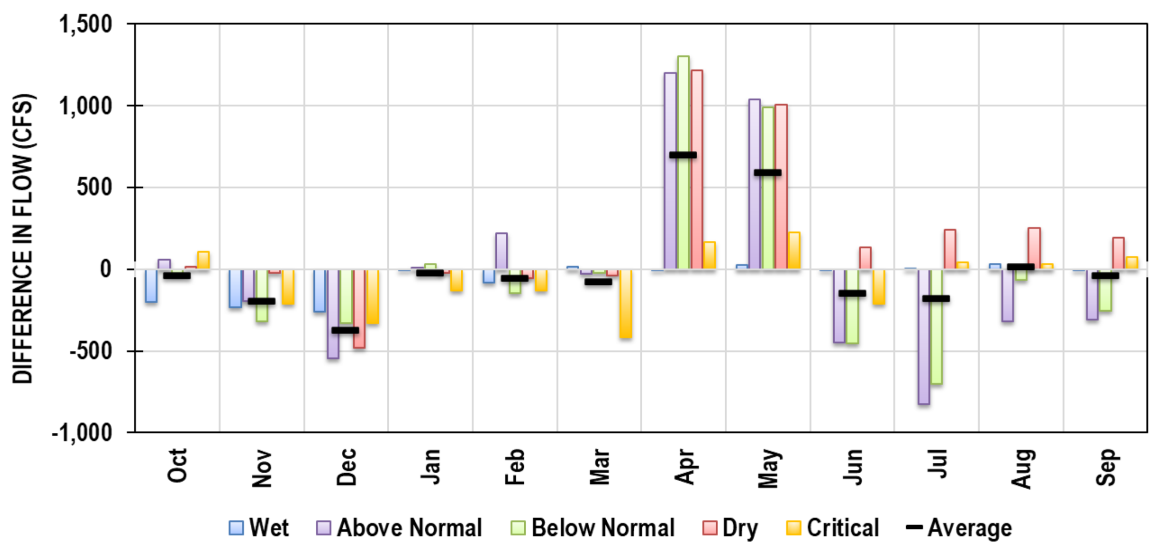

Figure 15. Average Monthly Changes in Sacramento River Flow below Keswick with VA Alternative in SacWAM

Figure 14 and Figure 15 compare changes in flows at Keswick with the VA Alternative from SacWAM and CalSim 3.0. The SacWAM model shows higher flows at Keswick in April and May under the VA Alternative as compared to CalSim 3.0. The large magnitude difference in SacWAM is because the SacWAM VA Alternative excludes the San Joaquin River inflow-to-export ration (SJR I/E) export restrictions in these months allowing greater release from Shasta for exports in April and May.

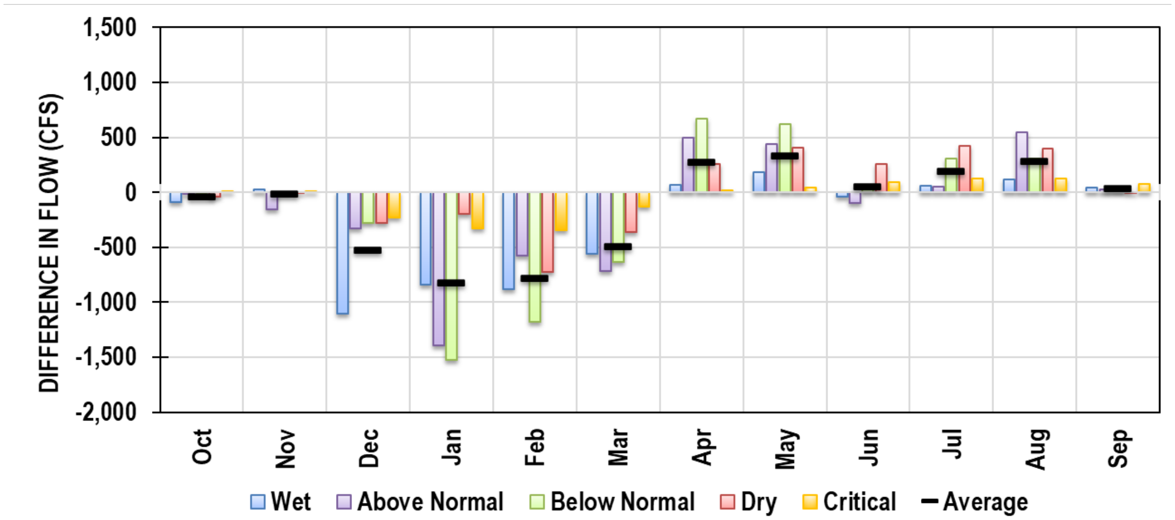

Figure 16. Average Monthly Changes in Sacramento River Flow near Wilkins Slough with VA Alternative in CalSim 3.0

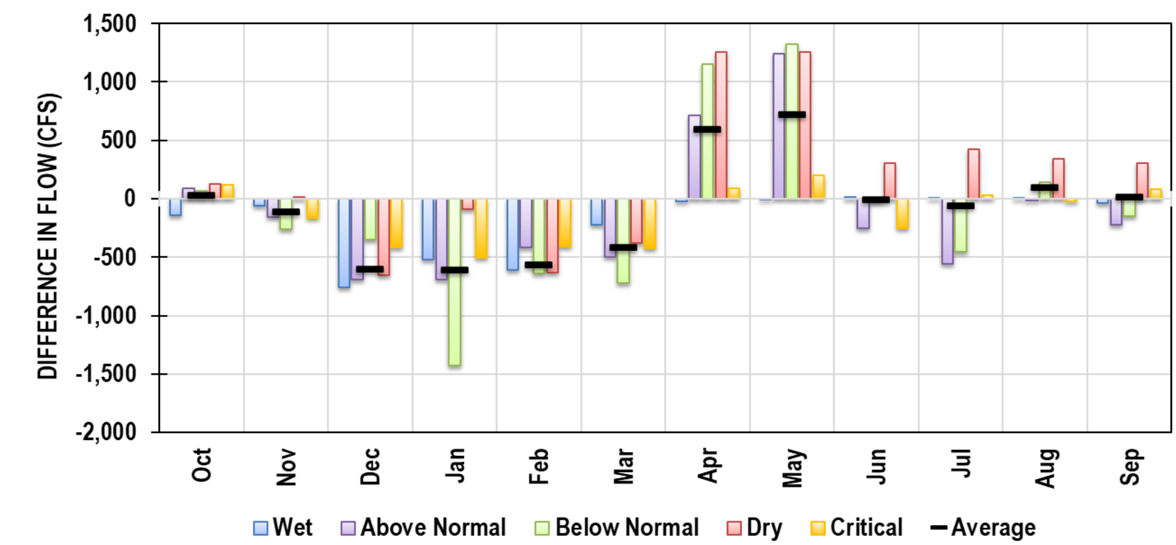

Figure 17. Average Monthly Changes in Sacramento River Flow near Wilkins Slough with VA Alternative in SacWAM

Figure 16 and Figure 17 depict the changes in flows at Wilkins Slough with the VA Alternative between SacWAM and CalSim 3.0. As observed at Keswick, the SacWAM model indicates larger magnitude flow changes in April and May under the VA Alternative due to increased releases from Shasta for CVP exports. The reductions in flow simulated in both models for the months of December through March are a result of the Tisdale Weir notch project under the VA Alternative.

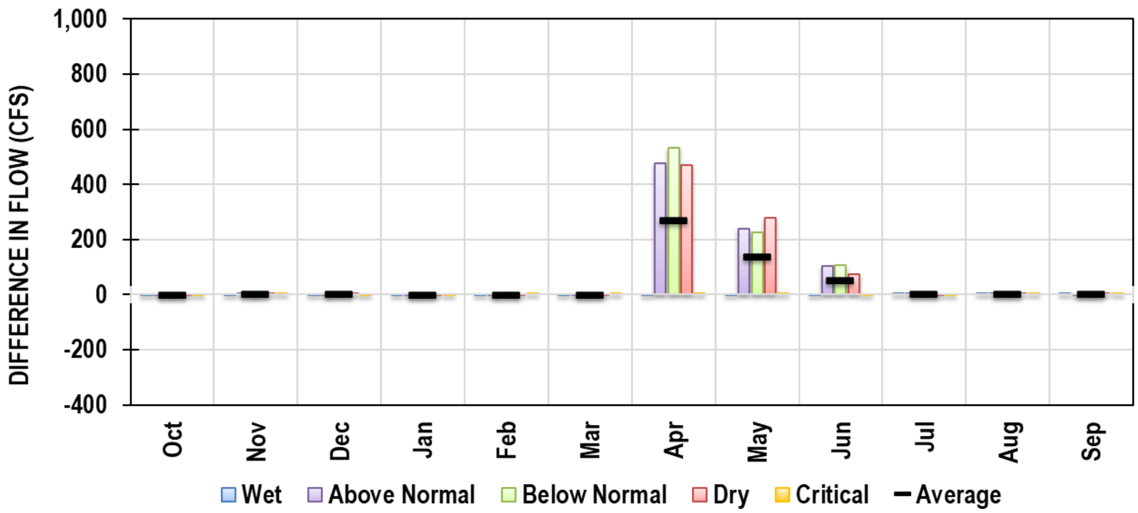

Figure 18. Average Monthly Changes in Yuba River Flow near Marysville with VA Alternative in CalSim 3.0

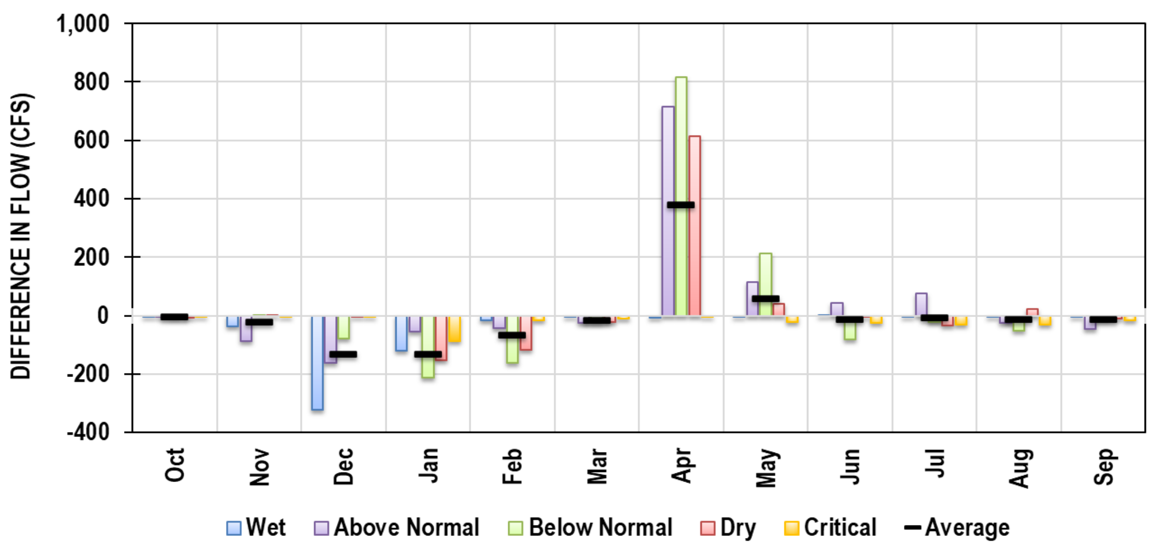

Figure 19. Average Monthly Changes in Yuba River Flow near Marysville with VA Alternative in SacWAM

Figure 18 and Figure 19 illustrate the changes in Yuba River inflows into the Feather River. In CalSim 3.0, Yuba VA flow assets are released in April, May, and June during above normal, below normal, and dry years. Conversely, in SacWAM, these flows are predominantly observed in April and May. Notably, SacWAM exhibits a decrease in Yuba River inflows between November and February.

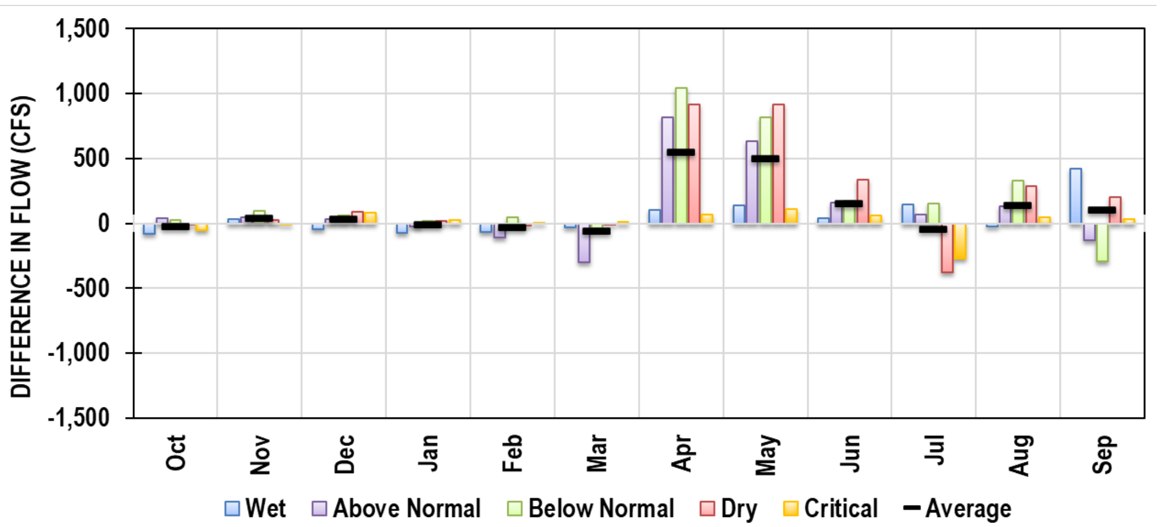

Figure 20. Average Monthly Changes in Feather River Flow at the Sacramento River Confluence with VA Alternative in CalSim 3.0

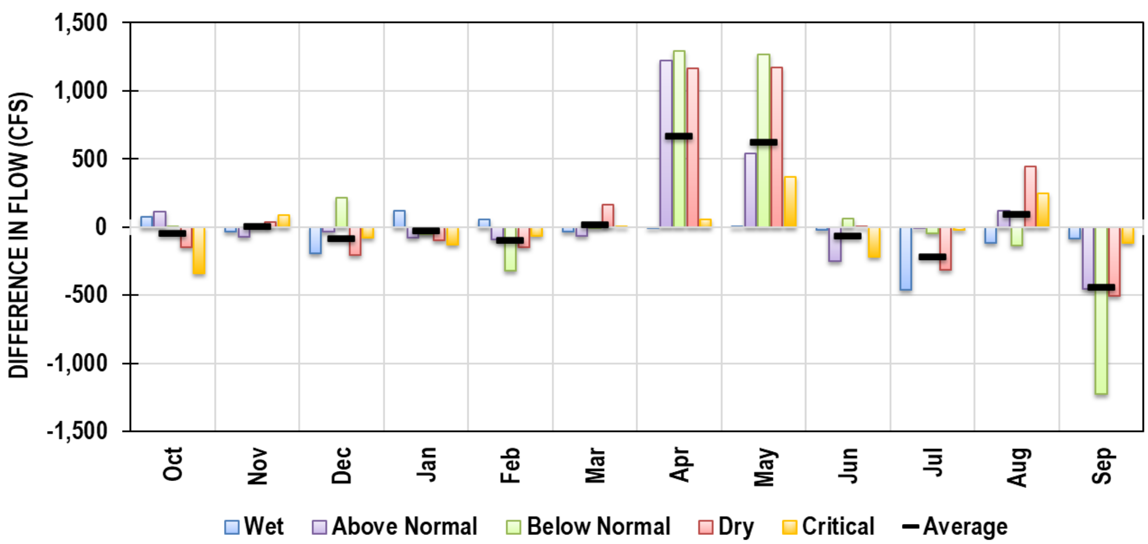

Figure 21. Average Monthly Changes in Feather River Flow at the Sacramento River Confluence with VA Alternative in SacWAM

Figure 20 and Figure 21 show changes in Feather River flows at the confluence with the Sacramento River with the VA Alternative. Average annual flows in the Feather River are greater in CalSim 3.0 by 56 TAF as compared to SacWAM due to differences in Oroville releases to the river and the Yuba River contribution. Changes in April and May flows in the three years with VA flow assets are typically higher in SacWAM, but reductions in other months exceed those in CalSim 3.0.

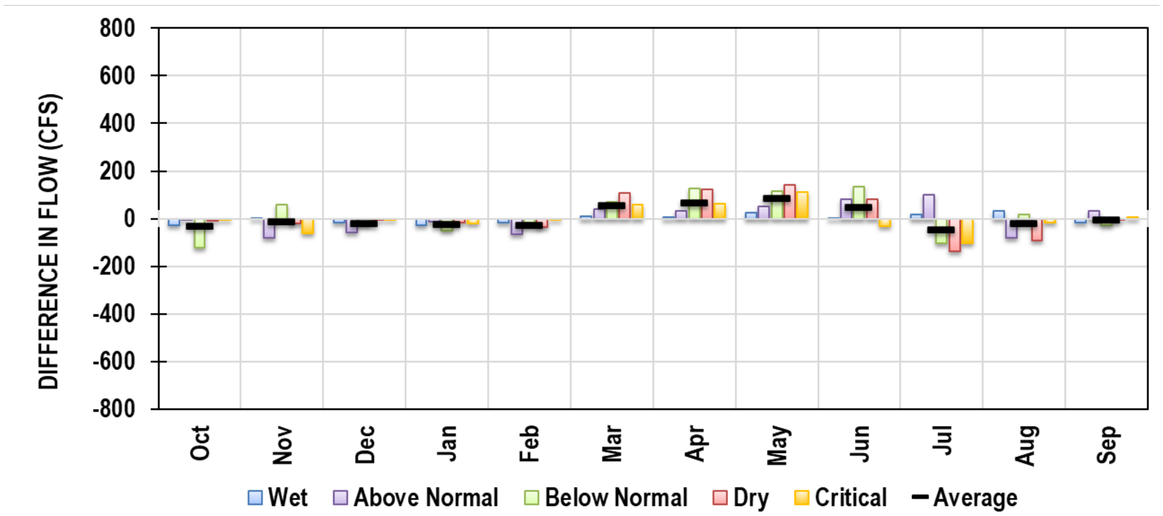

Figure 22. Average Monthly Changes in American River Flow at Natomas with VA Alternative in CalSim 3.0

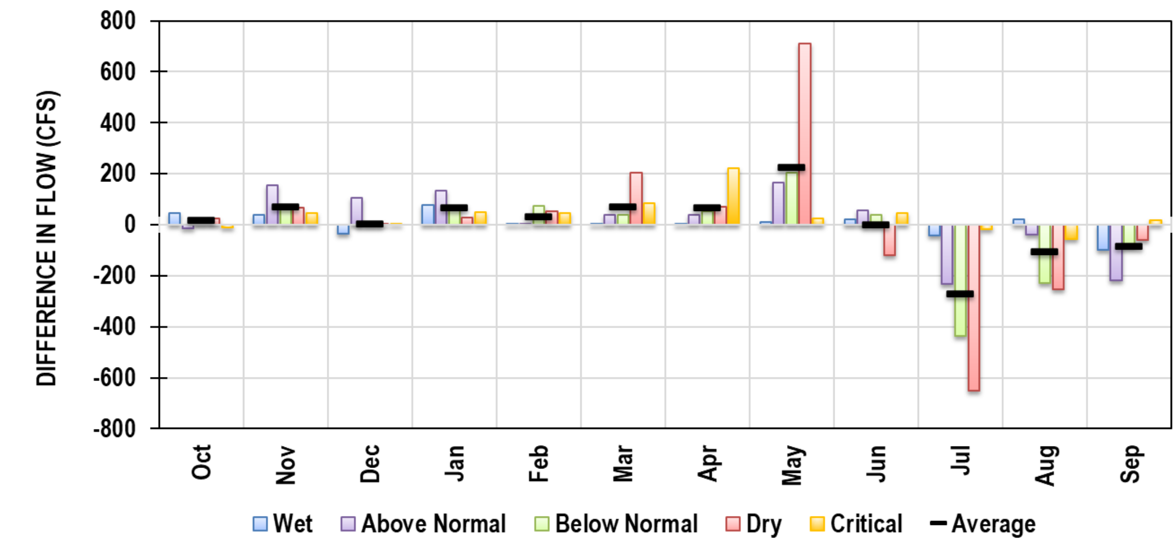

Figure 23. Average Monthly Changes in American River Flow at Natomas with VA Alternative in SacWAM

Figure 22 and Figure 23 shows changes in American River flows at Natomas between the two models with the VA Alternative. The magnitude of monthly flow changes under the VA Alternative in the CalSim 3.0 model are smaller than those simulated in SacWAM.

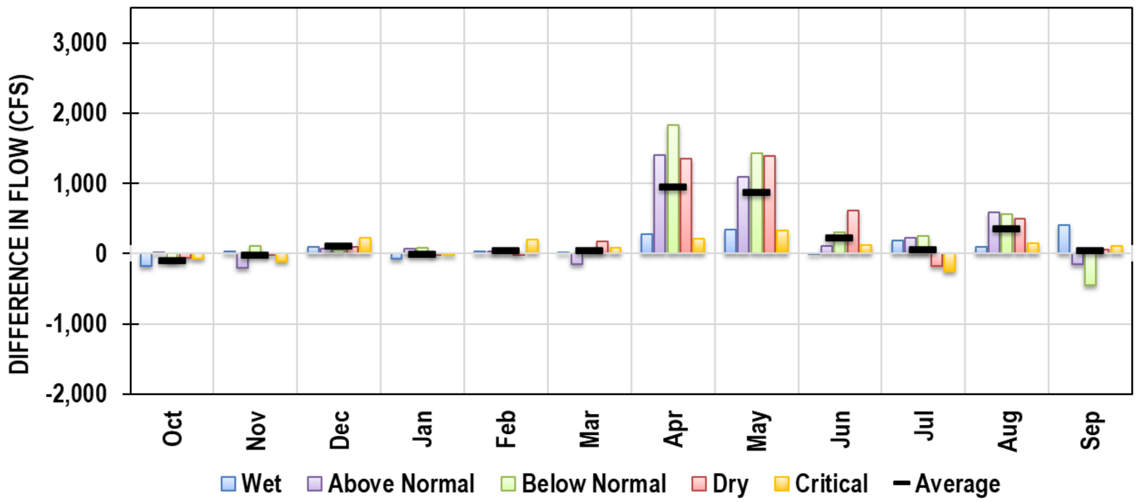

Figure 24. Average Monthly Changes in Sacramento River Flow at Hood with VA Alternative in CalSim 3.0

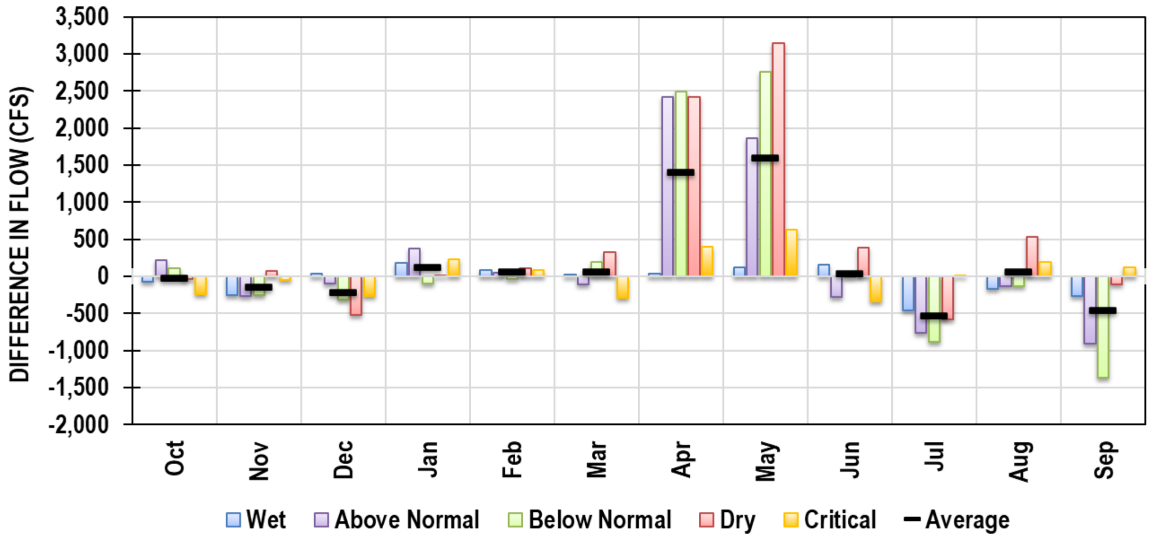

Figure 25. Average Monthly Changes in Sacramento River Flow at Hood with VA Alternative in SacWAM

Figure 24 and Figure 25 compare changes in Sacramento River inflow to the Delta with the VA Alternative from SacWAM and CalSim 3.0. The SacWAM model shows higher flows in April and May under the VA Alternative as compared to the CalSim 3.0 model for the reasons stated above relating to flows at Keswick and the Feather River. The CalSim 3.0 model shows increased flows in most months while the SacWAM model shows a mix of increased and decreased flows. On an average annual basis, CalSim 3.0 shows an approximately 35 TAF larger increase in the volume of Sacramento River inflow to the Delta in comparison to SacWAM.

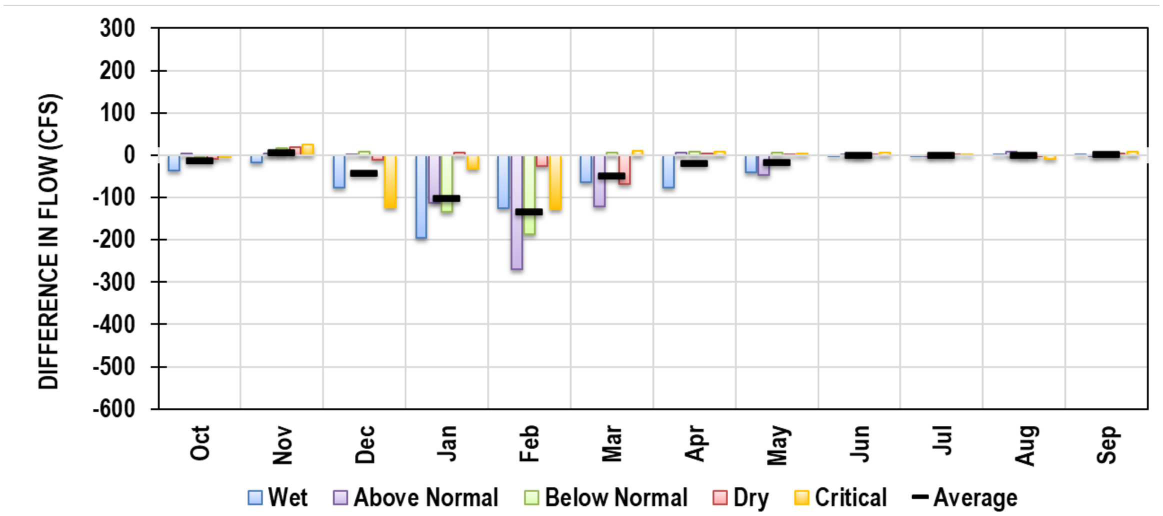

Figure 26. Average Monthly Changes in Yolo Bypass Flow with VA Alternative in CalSim 3.0

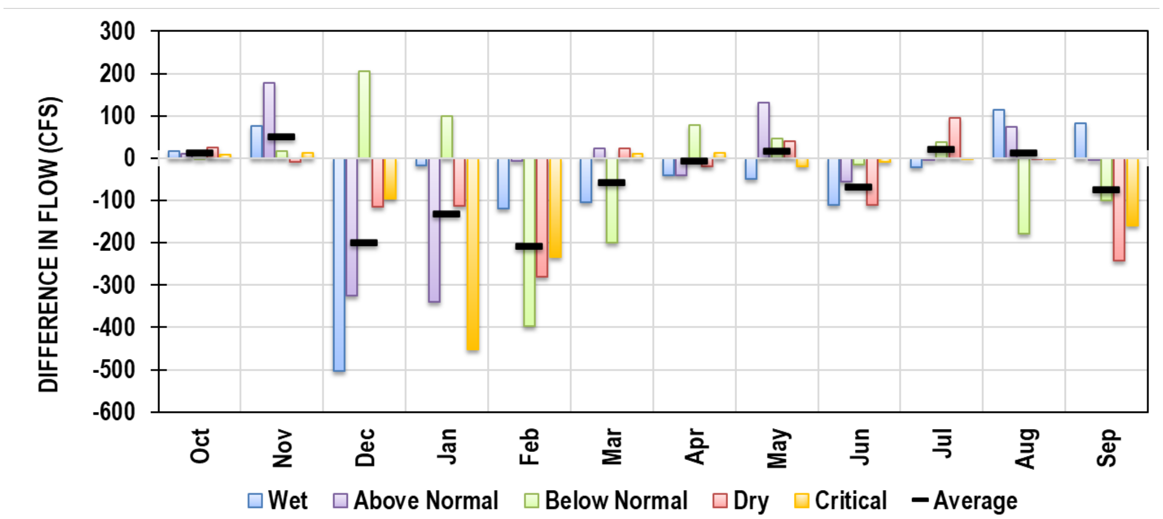

Figure 27. Average Monthly Changes in Yolo Bypass Flow with VA Alternative in SacWAM

Figure 26 and Figure 27 show changes in Yolo Bypass inflows into the Delta. Both models predict an average annual reduction in Yolo Bypass inflows under the VA Alternative, but the CalSim 3.0 modeling shows less of a reduction to such inflows than the SacWAM modeling.

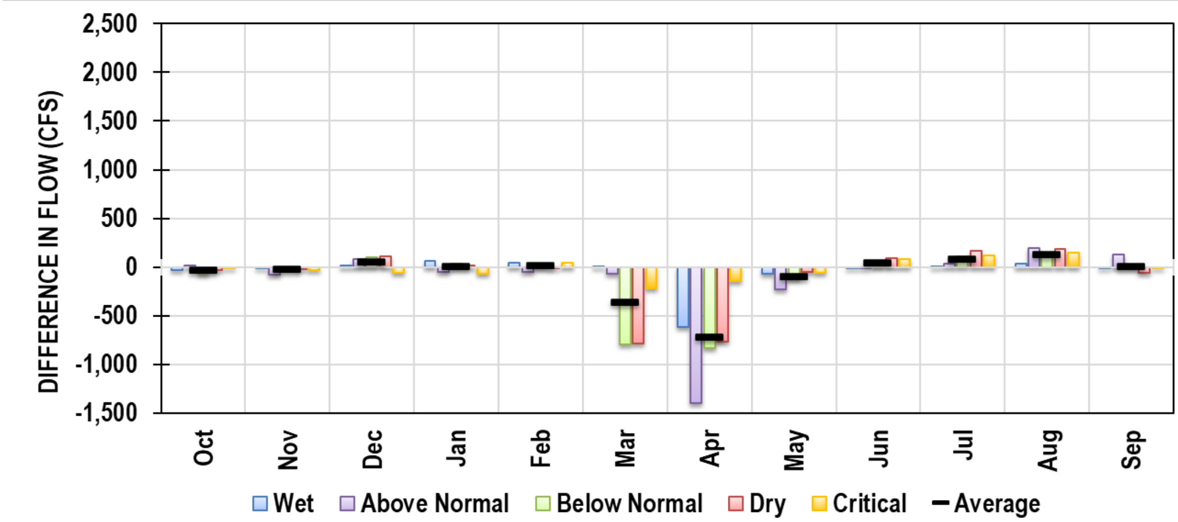

Figure 28. Average Monthly Changes in CVP Exports at Jones Pumping Plant with VA Alternative in CalSim 3.0

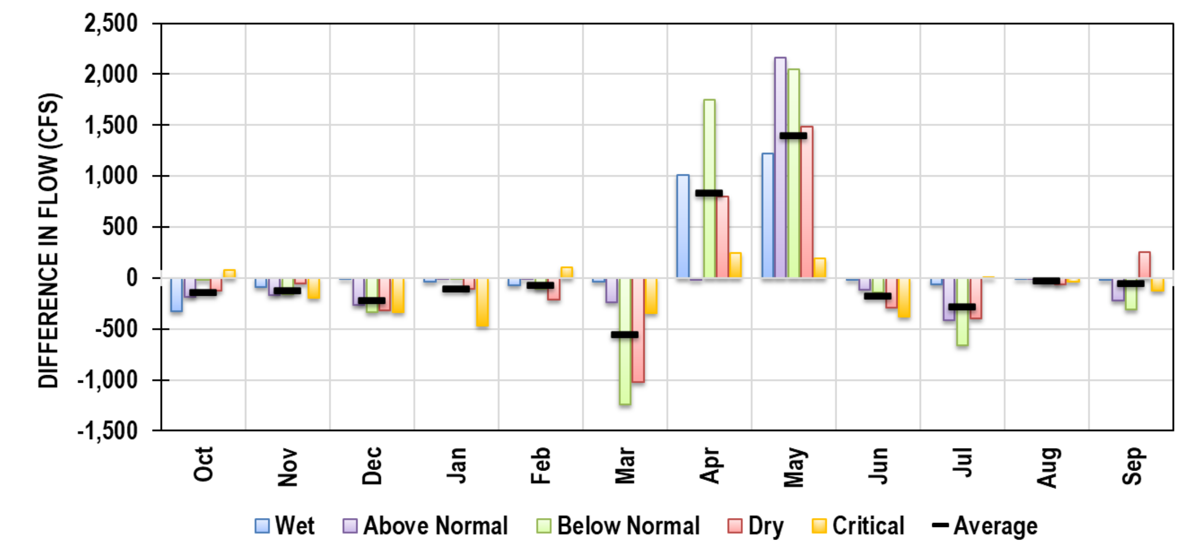

Figure 29. Average Monthly Changes in CVP Exports at Jones Pumping Plant with VA Alternative in SacWAM

Figure 28 shows a reduction in CVP exports under the VA Alternative as shown by the CalSim 3.0 modeling. Conversely, the SacWAM modeling shows an increase in CVP exports under the VA Alternative during April and May due to the assumed removal of SJR I/E restrictions as shown in Figure 29. The increased exports in April and May of most water year types under the VA Alternative, as modeled in SacWAM, is a result of an assumed change in regulatory restrictions on Delta exports contained in the SacWAM VA Alternative as compared to the SacWAM Baseline. Under the CalSim 3.0 modeling, average annual CVP exports are reduced by 57 TAF under the VA Alternative while CVP exports increase 58 TAF under the SacWAM modeling for the VA Alternative.

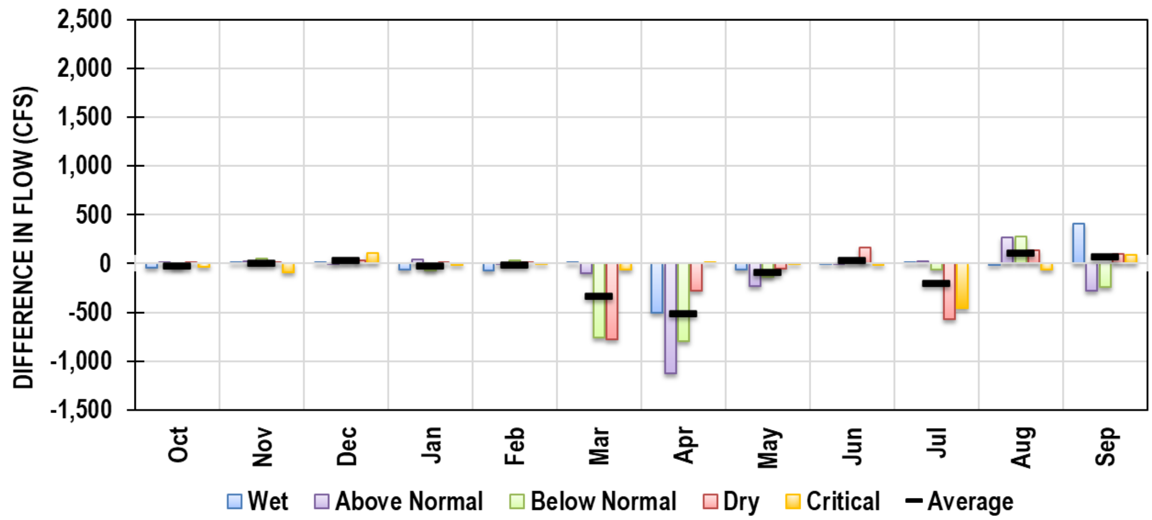

Figure 30. Average Monthly Changes in Exports at Banks Pumping Plant with VA Alternative in CalSim 3.0

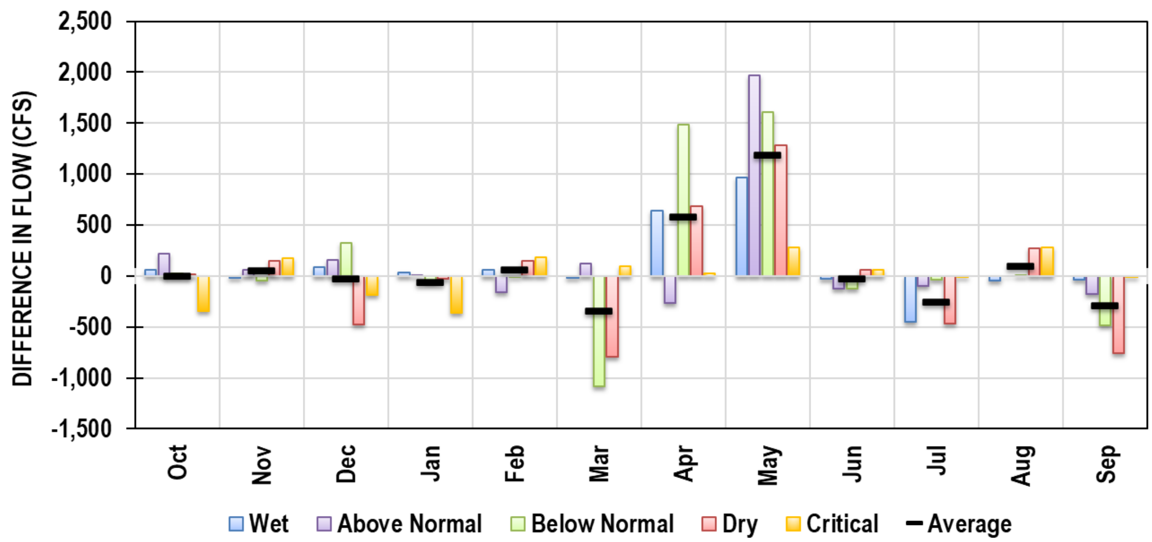

Figure 31. Average Monthly Changes in Exports at Banks Pumping Plant with VA Alternative in SacWAM

Figure 30 and Figure 31 show similar changes in Banks exports as shown above for CVP exports. The increased exports in April and May of most water year types under the VA Alternative in SacWAM is a result of the change in assumed regulatory restrictions on Delta exports in the SacWAM VA Alternative compared to the SacWAM Baseline. Average annual Banks exports in the CalSim 3.0 model are reduced 54 TAF under the VA Alternative while Banks exports increase 28 TAF in the SacWAM modeling.

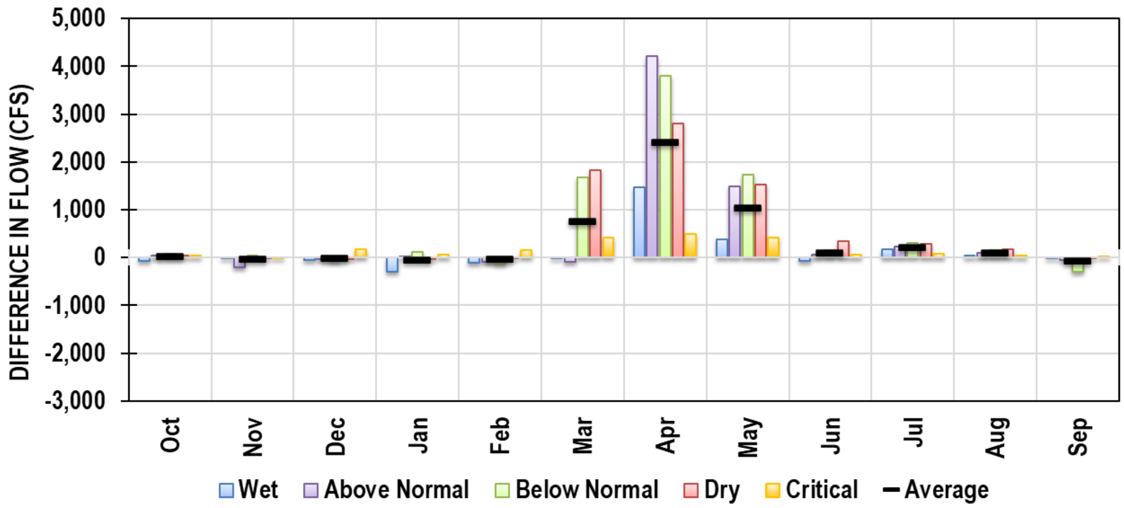

Figure 32. Average Monthly Changes in Delta Outflow with VA Alternative in CalSim 3.0

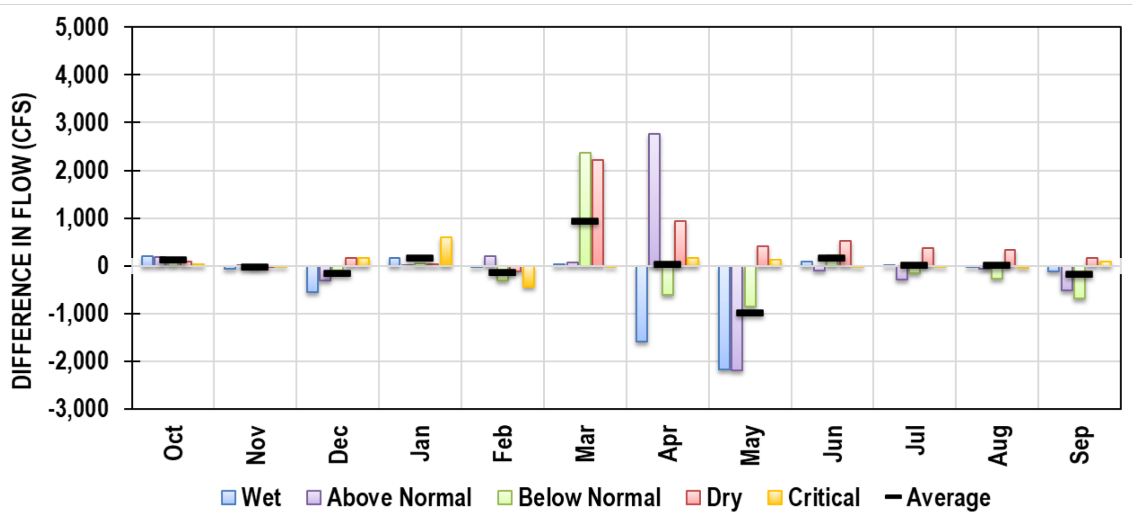

Figure 33. Average Monthly Changes in Delta Outflow with VA Alternative in SacWAM

Figure 32 and Figure 33 illustrate the changes in Delta outflow under the VA Alternative for the two models. CalSim 3.0 modeling shows an average annual increase in Delta outflow under the VA Alternative of 264 TAF, with approximately 154 TAF more inflow from the Sacramento Valley and 110 TAF less Delta exports. Conversely, SacWAM modeling shows an average annual <u>decrease</u> in Delta outflow under the VA Alternative of 4 TAF, with approximately 119 TAF more inflow from the Sacramento River offset by reductions in Yolo Bypass inflows and an 86 TAF increase in Delta exports due to the difference in assumed regulatory restrictions on Delta exports between the VA Alternative and the baseline in SacWAM, as discussed above.

Comparison of the VA Alternative to a baseline with different underlying regulatory requirements as occurred in the SacWAM modeling is inappropriate and confounds the understanding of the expected changes attributable to the VA Alternative, in this case underestimating the increases in Delta outflow attributable to that Alternative.

IV. Unavoidable Impacts of Unimpaired Flow Requirements

Current Conditions

There are significant, real-world adverse impacts that would result from implementation of an unimpaired flow requirement of 45 to 65%.

California water infrastructure, including the CVP, SWP, and local projects, were developed to address the state's seasonal contrast of wet winters and dry summers, lower winter demands and higher summer demand, and variable interannual precipitation. Figure 34 illustrates how storage facilities contribute to balancing water supply and demand. Runoff from late fall through early spring exceeds demand and allows a portion of the runoff to be diverted to storage in the state's existing reservoirs and aquifers. As runoff declines each spring and water demand increases, reservoirs transition from storing water to releasing water to meet the higher demand. This stored water meets a substantial portion of demand from late spring through early fall in most years, resulting in reduced water shortages. Currently, runoff peaks in early spring, just a few months before demand reaches its peak in early summer.

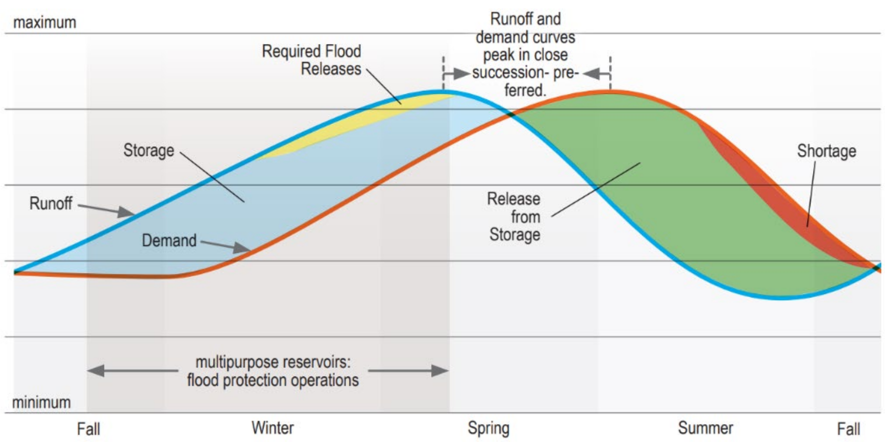

Figure 34. Current Conditions of California Water Supply, Demands, and the Role of Storage (DWR, 2015)

The unimpaired flow concept limits functionality of reservoirs to fulfill their intended purpose of shifting the availability of water in time and contradicts the fundamental principles of water supply management in California. UIF requirements at the levels of the PPA cannot be implemented in California without significant adverse impacts. Unimpaired flow requirements in the PPA will require higher flows during periods when demands are typically low, meaning the requirements can only be met by reducing diversions to storage in reservoirs. The impacts to reservoirs are shown in the SacWAM modeling results in Figure 10, most notably for Oroville and Folsom.

Figure 35 is an example to illustrate the relationship between unimpaired flow requirements, existing flows, and demands for water on the American River. Figure 35 shows average monthly information from the SacWAM model for unimpaired flow requirements covering the range of the PPA for the Lower American River, average monthly and average critical year monthly Lower American River flows from the SacWAM baseline, and average monthly modeled total American River diversions. Average UIF requirements of 55% are higher than existing flows during April and May by approximately 50 TAF per month. The total American River demands, primarily for M&I beneficial uses, during these same months are approximately 25 TAF. There is not enough American River demand to meet these flow requirements by reductions in deliveries; therefore, the only option is to reduce diversions to storage in Folsom. Although average existing flows are greater than unimpaired flow requirements from November through February and in June, there are many periods when diversions to storage must be reduced to meet unimpaired flow requirements.

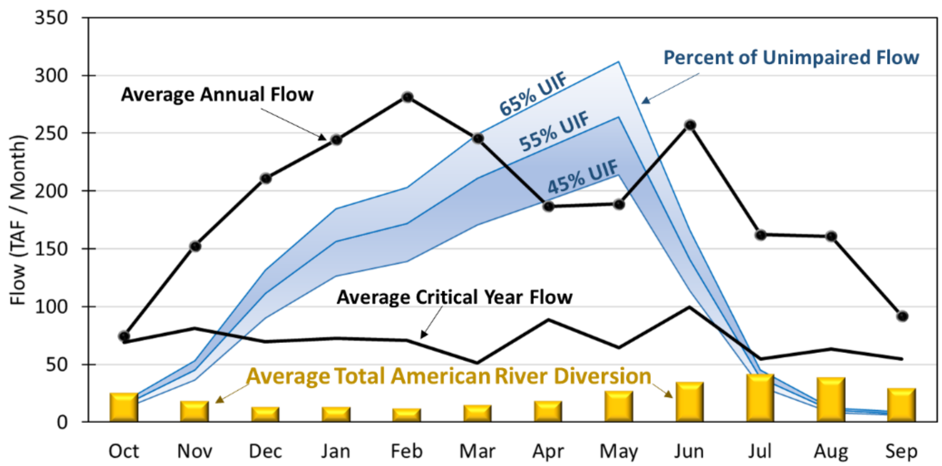

Figure 35. Average Monthly Lower American River Flow, Percent of Unimpaired Flow, and Baseline American River Diversions

Figure 36 shows the additional Folsom releases to the Lower American River flow that would be necessary to meet UIF requirements. These increases were calculated by the difference in American River flow for periods when releases were made specifically to meet the UIF requirements. These increased flows must be satisfied by bypassing water that would otherwise be diverted to storage in Folsom. The resulting average drawdown is shown in Figure 36. The reduction in Folsom storage to meet unimpaired flow is generally greater than the total annual American River diversions. This demonstrates that it is not possible to meet the UIF requirements solely through a reduction in diversions, and the UIF requirements will adversely impact reservoir storage.

In general, reduction in reservoir storage to meet UIF requirements will deplete cold water held in reservoirs, limit the ability to meet temperature objectives in the Lower American River, and reduce summertime hydropower generation. Similar impacts will occur at most reservoirs in the Sacramento River watershed.

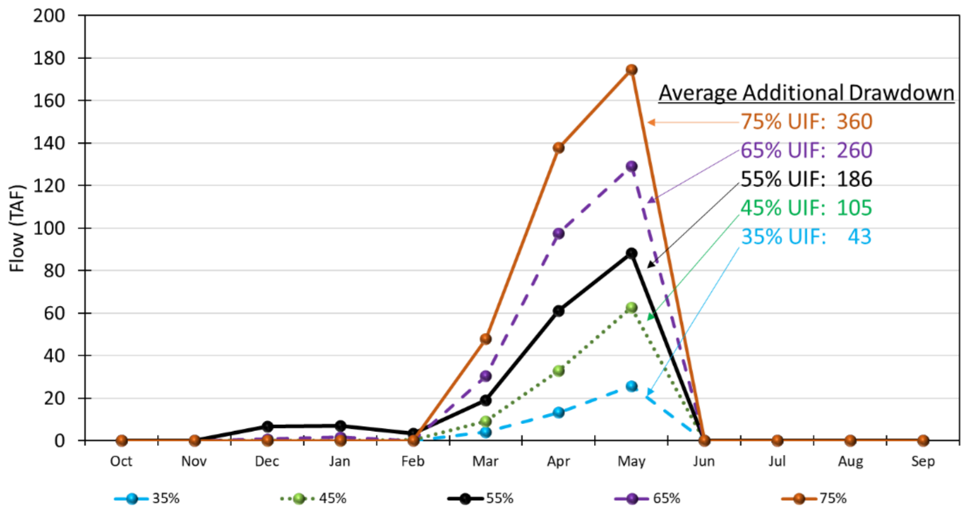

Figure 36. Additional Folsom Reservoir Release to Meet Unimpaired Flow Requirements (SacWAM Unimpaired Flow Scenarios minus SacWAM Baseline)

Future Climate Change

The real-world adverse impacts of an unimpaired flow requirement of 45 to 65% will exacerbate the effects of climate change and are not evaluated in the DSR.

California's water supply infrastructure is designed to bridge the seasonal disparity between supply and demand. Projected climate conditions indicate a shift in the timing of runoff that will limit the ability to capture winter flows and create challenges in meeting summer demands. Findings from a 2015[3] DWR paper illustrate the shift in the seasonal timing of runoff that is currently underway and expected to continue with climate change. "*The timing of runoff has changed in California's largest water-supply watershed, the Sacramento River System, shifting to earlier in the season. Snowmelt provides an annual average of 15-million acre-feet of water, slowly released by melting from about April to July each year. Much of the State's water infrastructure was designed to capture the slow spring runoff and deliver it during the drier summer and fall months*."

Figure 37 is another figure from the 2015 DWR report that illustrates the shift in runoff occurring with climate change and the general effects of that shift on storage, flood control releases, and water shortage.

[3] California Climate Science and Data for Water Resources Management, California Department of Water Resources (DWR) | 2015

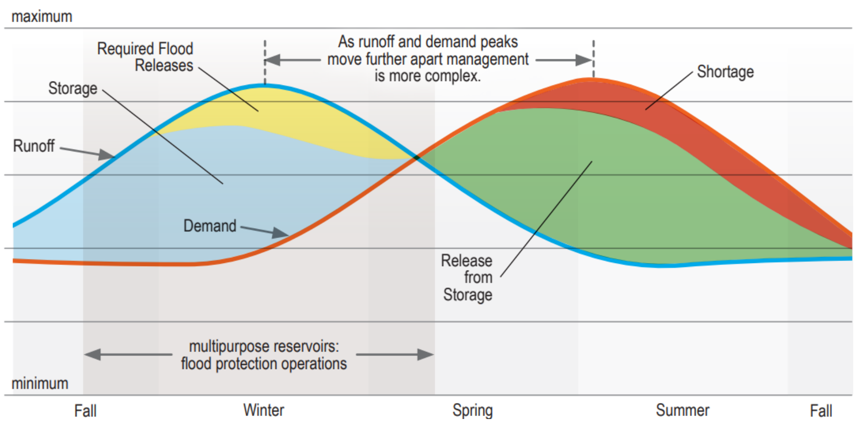

Figure 37. Future Conditions of California Water Supply, Demands, and the Role of Storage (DWR, 2015)

Figure 37 illustrates the hydrologic changes expected in response to a warming climate, adding extra strain to water supply systems. The effects of climate change are seen by comparing Figure 37 that illustrates future conditions with climate change and Figure 34 that represents our current conditions. As peak runoff shifts earlier in the year, more reservoir inflow occurs when reservoirs are operated for flood management and there is an increase in the releases of water for flood control. This is particularly applicable in wetter years with above average runoff. This results in lower peak reservoir storage and peak storage earlier in the year than peak demands. The result is increased shortage during the higher demand season with climate change than under current conditions and more challenges in managing water for beneficial uses.

These are many of the same water management challenges that will occur with UIF requirements at the levels in the PPA; higher spring releases, lower reservoir storage, and challenges managing water for all beneficial uses during the spring, summer, and fall seasons. With the timing of runoff under current conditions, there may be enough runoff in wetter years to meet UIF requirements and fill reservoirs, though the frequency of filling reservoir will be reduced. As shown in Figure 37, climate change will make filling reservoirs challenging in these wetter years such that the combination of both climate change and UIF requirements will create shortages and water management challenges in nearly all years.

The consequences of climate change in combination with UIF requirements are significant yet remain unanalyzed in the DSR. The DSR states, "*There is great uncertainty of how global change may affect the local climate in the study area. Changes in sea level, wind, temperature, and precipitation all may have large effects on the hydrology and available water supply. SacWAM modeling of climate change is not included at this time because of the uncertainty and lack of detailed climate change information required to produce inputs to the model*." While it is true that there is still considerable uncertainty regarding the magnitude and timing of future climate change, this is not an acceptable reason to not analyze the potential effects of such change. There are numerous technical approaches, regularly utilized by DWR, Reclamation, and others for incorporating the uncertainty of future climate change into the analysis of proposed projects. Several of these governmental bodies have developed detailed climate change information and utilized the information to produce inputs for other models such as CalSim 3.0.

The lack of a climate change analysis in the DSR raises fundamental questions about the adequacy of the DSR's analysis of the impacts that would result from implementation of the PPA. Climate change analysis has become an integral part of future planning in California as evidenced by Governor Newsom's Executive Order N-10-19 signed in 2019, to develop a “water resilience portfolio,” described as a set of actions to build a more climate-resilient future for California. The Executive Order states: "Historical hydrological patterns can no longer serve water managers as a trustworthy guide around which to plan, so climate science and projections have become increasingly important. Future conditions will continue to change and require ongoing adjustment and adaptation by water managers. By focusing on diversifying water sources, improving storage and management, and promoting conservation, the portfolio aims to build a more climate-resilient future for California and its water security." (California Water Resilience Portfolio, July 2020, DWR, page 15).

V. Key Deficiencies of DSR

Lack of Implementation Plan and Wide Range of Proposed Plan Amendments

The lack of an implementation plan and the wide range of potential actions for the Proposed Plan Amendments make it extremely difficult to understand the impacts of the Proposed Plan Amendments on reservoir operations, river flows, water deliveries, and Delta outflow.

The lack of an implementation plan is the primary deficiency in the analysis of impacts of the PPA contained in the DSR. The standard process to evaluate changes in requirements like the alternatives to update the Water Quality Control Plan is to define the project, including how it will be implemented or operated, and then perform the analysis to understand the impacts. The DSR provides a summary of potential impacts but fails to describe how the PPA will be implemented beyond stating that many aspects of the implementation plan will be left to the discretion of SWRCB staff (DSR, DSR 5-16). Without a defined implementation plan it is impossible to determine the true nature and extent of impacts associated with the PPA, including whether the projected impacts are occurring within the correct geographic region or even the correct resource area. This is acknowledged in Appendix A1 which states that the distribution of water supply between CVP and SWP contractors and areas located north and south of the Delta may be different than modeled (DSR Appendix A1, A1-19). This statement is made in the context of uncertainty regarding how the CVP and SWP may respond to an UIF requirement, but the statement is broadly applicable to the results of the SacWAM modeling summarized in the DSR. In other words, without an implementation plan the nature, extent and geographic focus of impacts associated with the PPA cannot be adequately analyzed.

The PPA includes a range of potential UIF requirements. The DSR contains results from analyses across an even wider range of UIF percentages. Results include changes in flow, reservoir storage, water supply, and other metrics for discrete UIF percentages, i.e. 45%, 55%, 65%. Results are presented at a relatively high-level with the main document in boxplots, exceedance curves, and annual averages by water year type, and in appendices as average monthly values by water year type and cumulative distributions of monthly flows. These results provide information regarding the effects of a single percent UIF requirement, but not the adaptive range defined as the PPA. Results show a wide range of potential outcomes within the system. For example, Figure 38 illustrates the reductions in water supply for the range of UIF scenarios included in the PPA. These same data are included in tabular form in DSR Table 6.4-2.

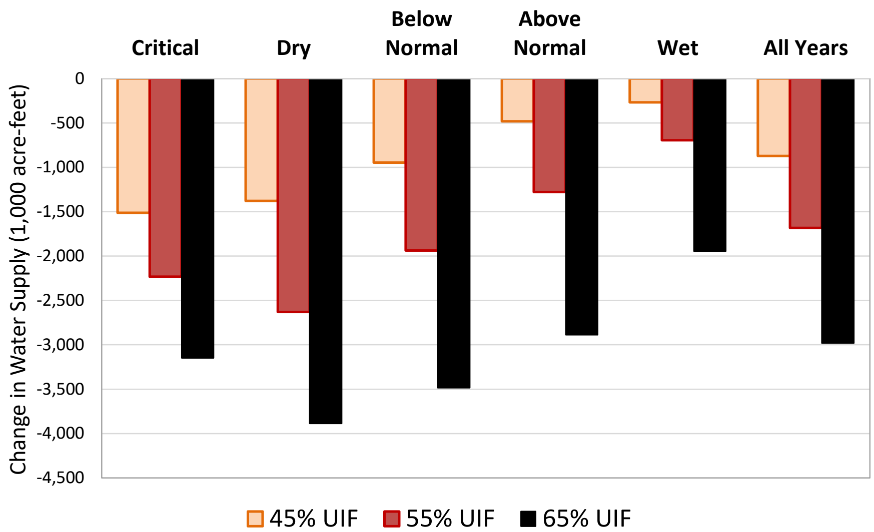

Figure 38. Range of Water Supply Impacts within Proposed Plan Amendment

Results in Figure 38 show the average annual water supply impact for the PPA is within a range of 871 to 2,981 TAF. Review of changes in average annual Delta outflow (DSR Appendix A1, Table A1-103) show a similar range of increased Delta outflow from 736 to 2,623 TAF.

The DSR provides some guidance regarding the decision-making process for determining what percentage of unimpaired flow may be required (DSR, 5-16). A lower percentage may be acceptable with voluntary implementation plans or if the State Board determines lower flows are needed to meet the narrative objective, including for reservoir storage. These statements do not provide sufficient detail to understand how to interpret the wide range of potential results or the criteria for how SWRCB staff will make their determinations.

Results of Drought Sequences

The DSR does not provide information on effects of UIF requirements during multi-year drought periods.

The DSR provides average water supply delivery changes by water year type and average changes in storage with exceedance probability charts, but this information is not adequate for understanding effects of the UIF scenarios during multi-year drought sequences. Statistics are helpful in providing high-level summaries of effects, but a detailed review of modeling is required to understand how the UIF scenarios may affect operations.

To analyze impacts of UIF requirements in a multi-year drought period, several time-series charts were developed from SacWAM model results to demonstrate how operation of CVP and SWP reservoirs are affected by UIF requirements and cold water habitat objectives. Figure 39 contains a chart of modeled monthly Shasta Lake storage for the SacWAM Baseline and 55% UIF scenario and a chart of annual changes in CVP North and South of Delta delivery for water year 1922 through 1939. The red line in the storage plot represents Shasta Lake storage in the 55% UIF scenario and the blue line represents Shasta Lake storage in the SacWAM Baseline. The red bar in Figure 48 represents changes in South of Delta

(SOD) CVP delivery and the orange bar represents changes in North of Delta (NOD) CVP delivery. During the second year of the simulation, water year 1923, Shasta Lake storage is reduced more than 800 TAF to satisfy 55% UIF requirements while there are no reductions in water supply. The drawdown of Shasta Lake in 1923 results in water supply impacts to both NOD and SOD CVP deliveries in 1924. During water years 1931 to 1935, Shasta Lake storage in the 55% UIF scenario is held higher than baseline, but large water delivery reductions are made to increase storage for the cold water habitat objective. These differences in modeled operations for multi-year droughts are not identified in the DSR.

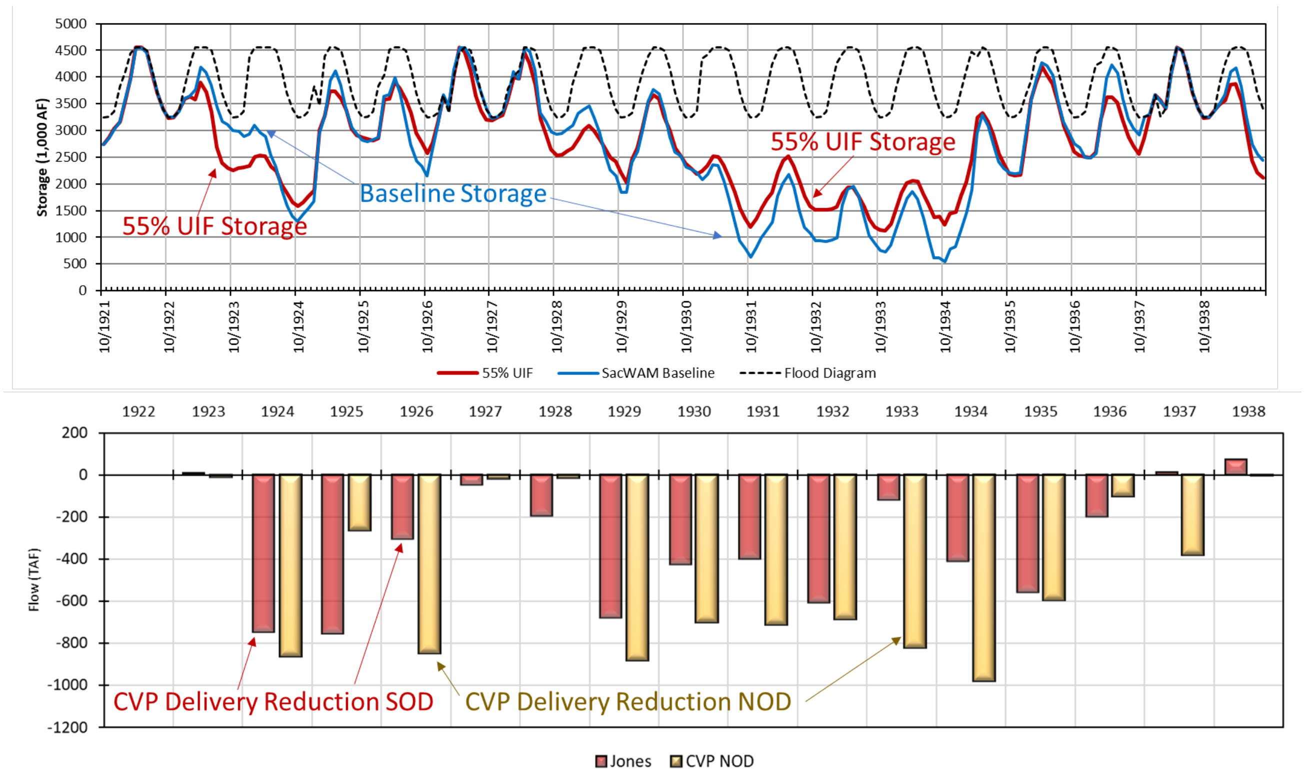

Figure 39. Shasta Lake Storage for SacWAM Baseline and 55% UIF and Annual CVP North and South of Delta Delivery Changes for SacWAM 1922-1938 Simulation Period

Figure 40 contains a chart of modeled monthly Oroville Reservoir storage for the SacWAM Baseline and 55% UIF scenario and a chart of annual changes in SWP NOD and SOD delivery for water year 1922 through 1939. The red line in the storage plot represents Oroville Reservoir storage in the 55% UIF scenario and the blue line represents Oroville Reservoir storage in the SacWAM Baseline. The red bar in the delivery chart represents changes in SOD SWP delivery and the orange bar represents changes in NOD SWP delivery. Oroville Reservoir storage in the 55% UIF scenario is almost always lower than the SacWAM Baseline. The average (1922-1938) monthly reduction in Oroville Reservoir is approximately 500 TAF and can be as large as 1.7 million acre-feet. The SacWAM operating criteria for Oroville Reservoir and the Feather River place higher priority on NOD SWP delivery than on storage, this results in prolonged periods of low storage in Oroville and annual reductions in SOD SWP deliveries of more than a million acre-feet. The DSR fails to identify or analyze these results in a multi-year drought.

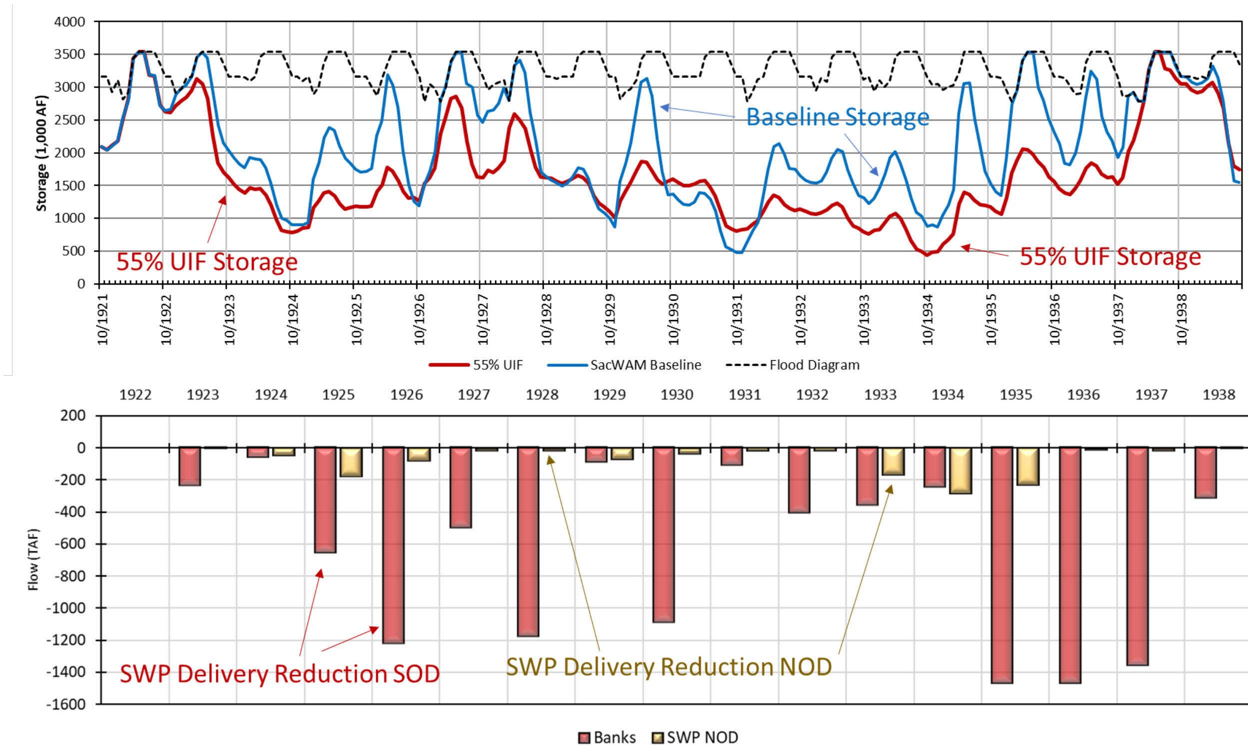

Figure 40. Oroville Lake Storage for SacWAM Baseline and 55% UIF and Annual SWP North and South of Delta Delivery Changes for SacWAM 1922-1938 Simulation Period

Figure 41 contains a chart of modeled monthly Folsom Lake storage for the SacWAM Baseline and 55% UIF scenario and a chart of annual changes in CVP NOD and SOD delivery for water year 1922 through 1939. The red line in the storage plot represents Folsom Lake storage in the 55% UIF scenario and the blue line represents Folsom Lake storage in the SacWAM Baseline. The red bar in the delivery chart represents changes in SOD CVP delivery and the orange bar represents changes in NOD CVP delivery, the CVP deliveries are the same as those in Figure 39. Folsom Lake storage is lower in the 55% UIF scenario than the baseline is almost all winter and spring periods during this multi-year drought period. The DSR fails to identify or analyze these results.

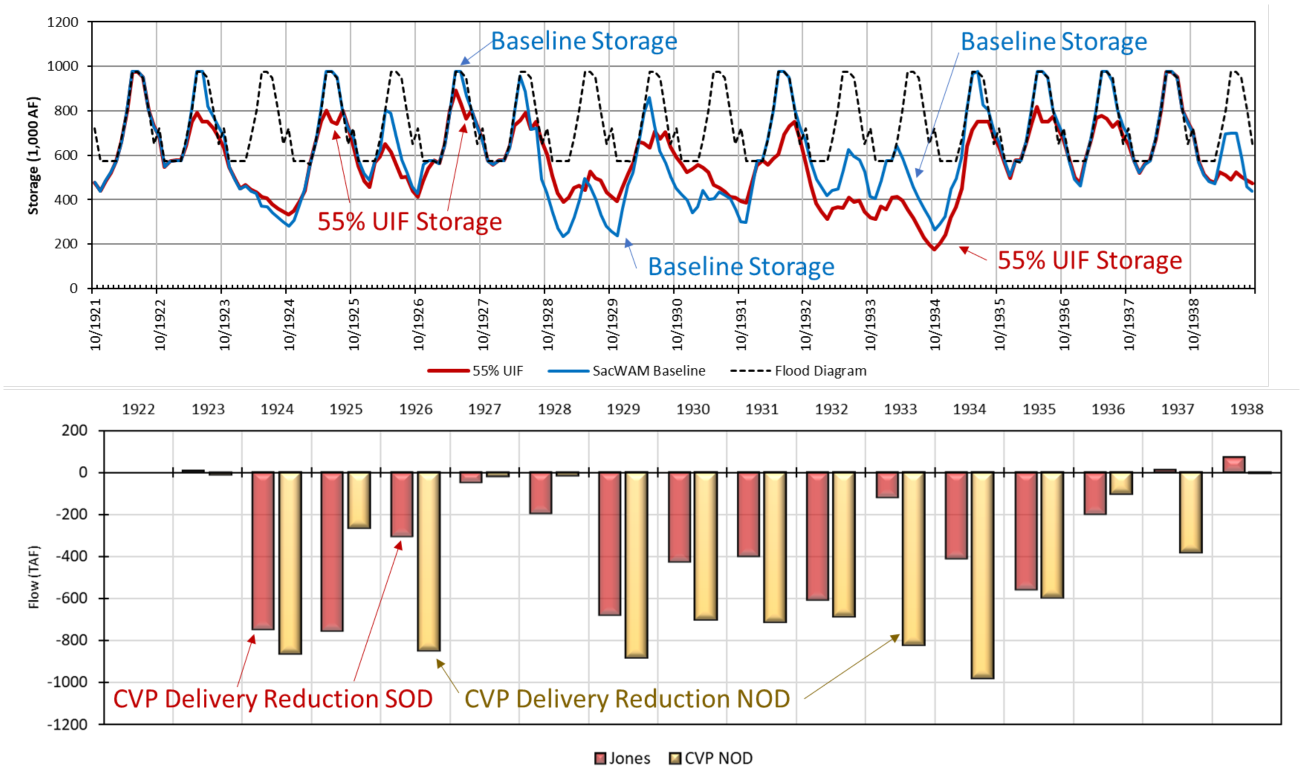

Figure 41. Folsom Lake Storage for SacWAM Baseline and 55% UIF and Annual CVP North and South of Delta Delivery Changes for SacWAM 1922-1938 Simulation Period

Figure 42 and Figure 43 contain changes in total annual CVP and SWP delivery in the 55% UIF scenario relative the SacWAM Baseline. Data in these figures are consistent with DSR Table A1-496 and Table A1-520. There are sequences of years with reductions in water deliveries that exceed a million acre-feet for each project and individual years when reductions exceed 1.5 million acre-feet. The DSR does not address the effects of these prolonged delivery reductions.

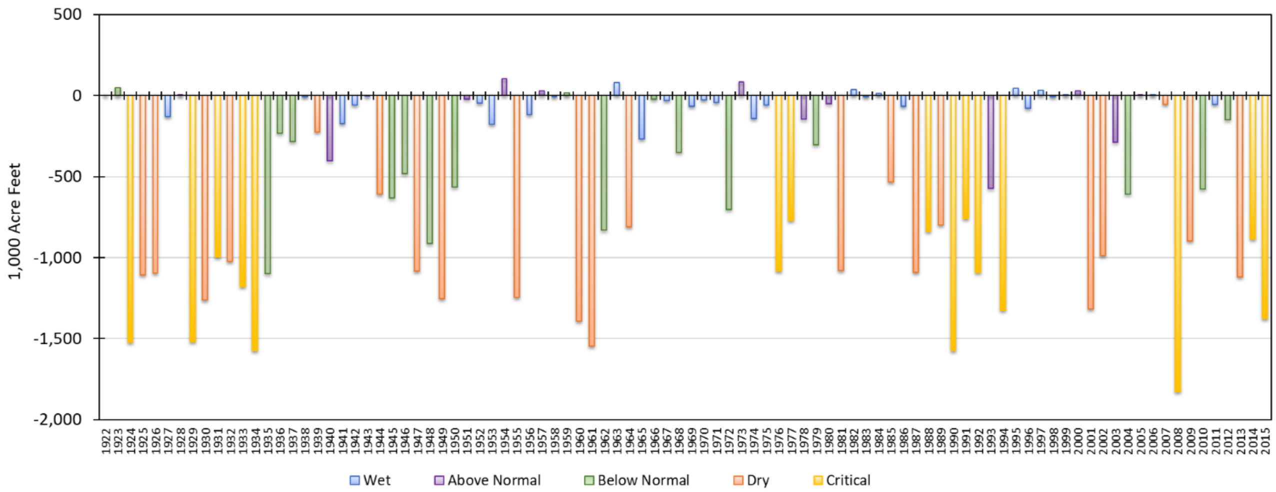

Figure 42. Change in Annual Total CVP Delivery under 55% UIF Scenario

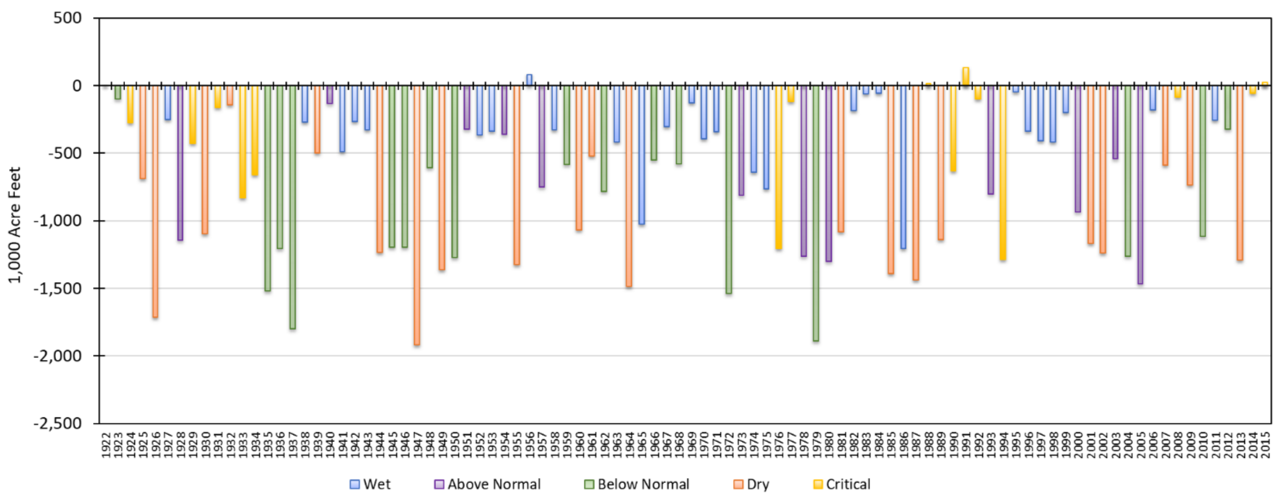

Figure 43. Change in Annual Total SWP Delivery under 55% UIF Scenario

Analysis for Modular Alternatives

The DSR describes several modular alternatives but provides limited model results for only one modular alternative and relies on qualitative descriptions of effects for the other modular alternatives.

The DSR includes descriptions of several modular alternatives in Chapter 7. Modular alternatives 4a, 4b, and 4c for interior flows/fall Delta outflow may be used in combination with the PPA or other flow alternatives (DSR, 7.24-34). Modular drought alternatives 5a and 5b could be adopted in combination with PPA, other flow alternatives, or the VA Alternative (DSR, 7.24-47). Modular alternative 6a is for the protection of VA flows and could be adopted with the VA Alternative (DSR, 9-199).

DSR sections 7.24 and 9.9 contain qualitative descriptions of the effects on flows, reservoir levels, water supply, and economics for the modular alternatives. Based on results presented in Tables 7.24-2 through 7.24-5, it appears modular alternative 4a was modeled in SacWAM to simulate the effects of removing the SJR I/E restriction on Delta exports. There are no other model results presented for any of the other modular alternatives and no explanation for why modular alternative 4a was modeled, but other modular alternatives were not modeled.

Modular alternative 4c, that would extend the SJR I/E restrictions on Delta exports from February through June, and the modular drought alternatives have significant implications to flow, reservoir levels, and water supply. For example, the limited model results for modular alternative 4a contained in Table 7.24-2 show the removal of the SJR I/E ratio in April and May would decrease average annual Delta outflow by 218 TAF from the SacWAM Baseline and increase Delta exports by 237 TAF (Table 7.24-4). Modular alternative 4c would extend the SJR I/E ratio to the months of February, March, and June but no model results are presented in the DSR for this modular alternative. Effects to water supply for modular alternative 4c are described as “potentially significant impacts” (DSR, 7.24-45). Modeling should be performed for this modular alternative to understand the impacts in combination with the alternatives that may include it.

There are no model results presented for the two modular drought alternatives, but the effects on water supply are described as “potentially significant impacts” (DSR, 7.24-49 and 7.24-51). Modeling and analysis are needed to understand the magnitude and location of these potential impacts because these modular alternatives are focused on actions during droughts periods of limited supply and may be adopted in combination with any of the alternatives in the DSR.

VI. Review of SacWAM Modeling of UIF Requirements

SacWAM model scenarios performed by SWRCB staff encompass a range of potential instream flow changes from 35 up to 75% unimpaired flow, in increments of 10%. Potential impacts due to imposition of UIF requirements throughout the Sacramento River Basin and Delta are assessed by comparing SacWAM UIF scenarios to the SacWAM Baseline. Although the DSR presents high level summaries of the comparison of UIF scenarios, many key effects due to imposition of UIF requirements cannot be determined from a high level summary. Therefore, MBK has conducted a detailed review of SacWAM scenarios to better understand the anticipated impacts. The detailed review of SacWAM UIF scenarios included review of water operations criteria based on simulation results including changes in reservoir operations, changes in water delivery, changes in flow through the Bay-Delta watershed, and other key water operation parameters.

Inconsistent Implementation of Proposed Plan Amendments on Different Rivers

Differences in how the UIF requirements and narrative cold water habitat objective are modeled on different river systems within the Sacramento Valley result in disproportionate impacts within the Sacramento Valley, North and South of Delta, and between the CVP and SWP.

There are differences in how the UIF requirements and narrative cold water habitat objectives are modeled in SacWAM for the Sacramento, Feather, and American rivers. The narrative cold water habitat objective is implemented more aggressively at Shasta Lake resulting in reductions in diversions to the SRSC to maintain water in storage while meeting the UIF requirements downstream of Shasta and Keswick. The narrative cold water habitat objective is less restrictive on the Feather and American rivers resulting in lower reservoir storage but fewer diversion reductions to Feather River service area diversions. Oroville storage in the 55% UIF scenario is approximately 615 TAF lower in May than the SacWAM baseline, while Shasta storage in the 55% UIF scenario is approximately 178 TAF lower in May than the SacWAM baseline (see Figure 10). Although temperature management is impacted in both the Sacramento and Feather rivers as shown above in Figure 5 and Figure 6, average storage reduction in Oroville storage is 437 TAF more than the reduction in Shasta storage. The lower storage in Oroville results, in part, in the reduced deliveries to SOD SWP contractors whereas most of the CVP water supply impacts are NOD.

To illustrate the difference in the modeled implementation of UIF requirements and the cold water habitat objective, Table 3 is a summary of the average annual change in water deliveries to different geographic regions of the CVP and SWP for the 45, 55, and 65% UIF scenarios. Table 4 provides the percent of the total changes that occur in regions NOD and SOD for each project.

Table 3. Average Annual Change in Water Delivery under Percent UIF Requirements Compared to SacWAM Baseline in TAF

	45% UIF	55% UIF	65% UIF
CVP North of Delta	-165	-296	-554
CVP South of Delta	-59	-218	-674
CVP Total	-230	-528	-1253
SWP Feather River Service Area	-7	-22	-59
SWP Table A North of Delta	-4	-7	-11
SWP Table A South of Delta	-397	-711	-1000
SWP Article 21 South of Delta	35	26	15
SWP Total	-370	-710	-1051

Table 4. Distribution of SacWAM Changes in CVP and SWP Water Delivery to North and South of Delta

	45% UIF	55% UIF	65% UIF
CVP North of Delta	72%	56%	44%
CVP South of Delta	26%	41%	54%
SWP North of Delta	3%	4%	7%
SWP South of Delta	98%	97%	94%

For example, the annual average reduction in NOD CVP deliveries in the 55% UIF scenario compared to the SacWAM Baseline is 296 TAF and the average annual reduction in CVP total delivery is 528 TAF; therefore, 56% of CVP water supply impact is NOD. By comparison, the annual average reduction in SWP NOD deliveries in the 55% UIF scenario is 29 TAF (22 TAF reduction to SWP Feather River Service Area plus 7 TAF reduction to SWP Table A NOD) and the average annual reduction in SWP total delivery is 710 TAF; therefore, 4% of SWP water supply impact is NOD.

Variation in the implementation of UIF requirements and cold water habitat objectives on upstream tributaries alters the burden of meeting UIF requirements in the Delta between the CVP and SWP. Although SacWAM operates each tributary independently to meet UIF requirements on each tributary, SacWAM applies the Coordinated Operations Agreement (COA) sharing percentages to allocate responsibility for meeting UIF requirements in the Delta to the CVP and SWP. The differences on where water supply impacts occur, whether NOD or SOD for each project, affects COA and the water supply of each project.

SacWAM Priorities and Operations Inconsistent with Policies and Contracts

SacWAM model results demonstrate that UIF scenarios include model operations that are inconsistent with U.S. Bureau of Reclamation policies and contract obligations. A failure to accurately simulate Reclamation policies and contract obligations result in modeled water supply impacts and associated reservoir operations that are inconsistent with actual system operations.

Real-time operation of the California water system is affected by myriad operating criteria from SWRCB, U.S. Fish and Wildlife Service, National Marine Fisheries Service, California Department of Fish and Wildlife, Divisions of Safety of Dam, U.S. Army Corps of Engineers, Federal Energy Regulatory Commission, and others. In addition to state and federal operating requirements, there are numerous contracts, policies, and agreements that govern distribution of water supply throughout the state and prioritize place of use, type of use (M&I, agriculture, hydropower, fish and wildlife, etc.), season of use, sharing of supply, responsibility for meeting requirements, and more. All these operating criteria, contracts, policies, agreements, and water distribution priorities affect operation of California's reservoirs, river flows, and water infrastructure to meet multiple beneficial uses.

Models of the California water system that intend to assess effects of proposed actions must operate in a manner that adheres to operating criteria, contracts, policies, agreements, and priorities governing the system. If models abide by these operating requirements, then models may be helpful in assessing effects of proposed actions and if models do not properly follow procedures governing actual operations then model results are unreliable for assessing effects of proposed actions.

Compliance with actual operating criteria when modeling proposed UIF requirements is essential to determining if model results are reliable; therefore, SacWAM model results are reviewed to assess if the model results are applicable to actual system operations. The following sub-sections provide three examples of how the SacWAM model operations are inconsistent with policies and operational criteria.

Sacramento Settlement Contract Reduced Diversions and CVP Water Service Cuts

Reclamation allocates water supplies based on their "Central Valley Project Municipal and Industrial Water Shortage Policy Guidelines and Procedures" (CVP M&I WSP). For analysis to adequately assess effects of UIF requirements, modeling must follow the priorities, contracts, policies, and procedures Reclamation uses in real-time operations. If simulated implementation of UIF requirements does not follow the CVP M&I WSP then modeled water delivery impacts and associated reservoir operations will be inconsistent with actual system operations. SacWAM water allocations and deliveries to various CVP water users was reviewed to assess compliance with actual operating contracts and policy. To review model compliance with current operating procedures, modeled deliveries to various CVP water users are compared in UIF scenarios.

Figure 44 contains annual CVP NOD water service contract deliveries (blue bars) and SRSC delivery changes (red bars) in the 55% UIF scenario. The 22 black arrows in Figure 44 indicate years when SRSC reductions are more than 20 TAF and water service contract deliveries exceed 40 TAF (which for purposes of this analysis represents an estimate of annual NOD public health and safety [PH&S] deliveries). In real-time operations, Reclamation operates to meet the SRSC before allocating water to CVP water service contractors, but there are years when SRSC deliveries are reduced while water service contract delivery is greater than PH&S amounts. This modeled inconsistency with actual operating criteria affects the integrated operation of the CVP and SWP and alters the location of water delivery impacts, reservoir operational changes, river flow changes, and environmental effects.

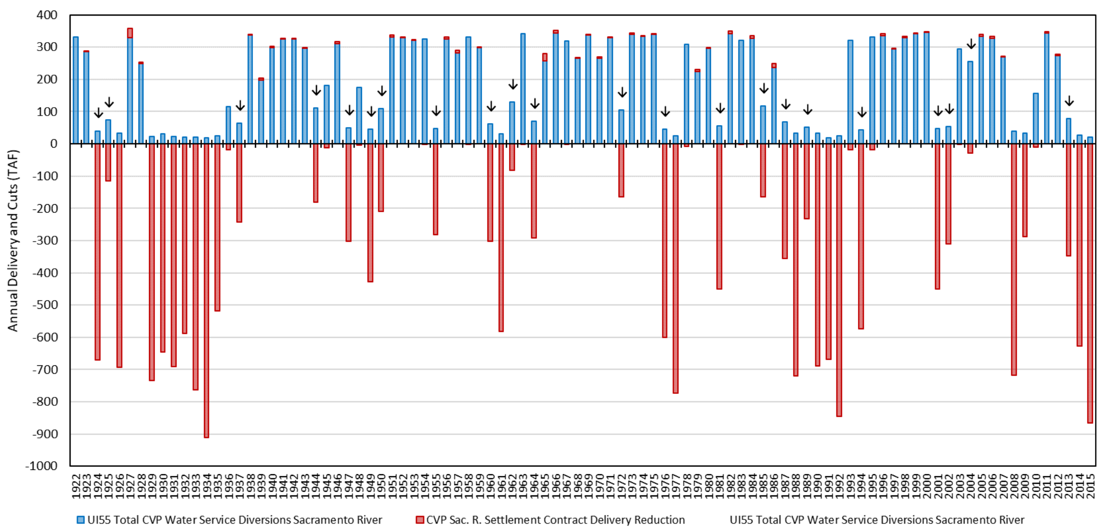

Figure 44. SacWAM Reductions in SRSC Diversions Due to 55% UIF Requirement and CVP NOD Walter Service Contract Delivery in 55% UIF Scenario

Sacramento Settlement Contract Reduced Diversions and Shasta Release for CVP Export

As shown in Figure 44, SRSC diversions are reduced by 100 TAF or more in 38 out of 94 years simulated in SacWAM under the 55% UIF scenario, or approximately 40% of years. In years when SRSC diversions are reduced, simulated releases from Shasta to support CVP Delta exports should be limited to releases necessary to maintain minimum PH&S exports.

An analysis was performed to calculate simulated Shasta releases to support CVP Delta exports by post-processing SacWAM results from the 55% UIF scenario. Figure 45 contains annual Shasta releases in excess of Sacramento River requirements that support CVP Delta export at Jones in the 55% UIF scenario (green bars), SRSC delivery reductions in the 55% UIF scenario (red bars), and the black tick marks are the difference between Shasta releases for export minus SRSC delivery reductions. Positive differences (black tick marks greater than zero) indicate that Shasta releases for export are greater than SRSC delivery reductions. In actual operations, Shasta releases for export would be reduced before reducing SRSC delivery. If differences are negative (black tick mark less than zero) then exports could be reduced by the difference between the red bar and the tick mark. These operating criteria tend to underestimate SOD CVP delivery reductions, overestimate SRSC delivery reductions, and have implications for SWP water supplies through COA.

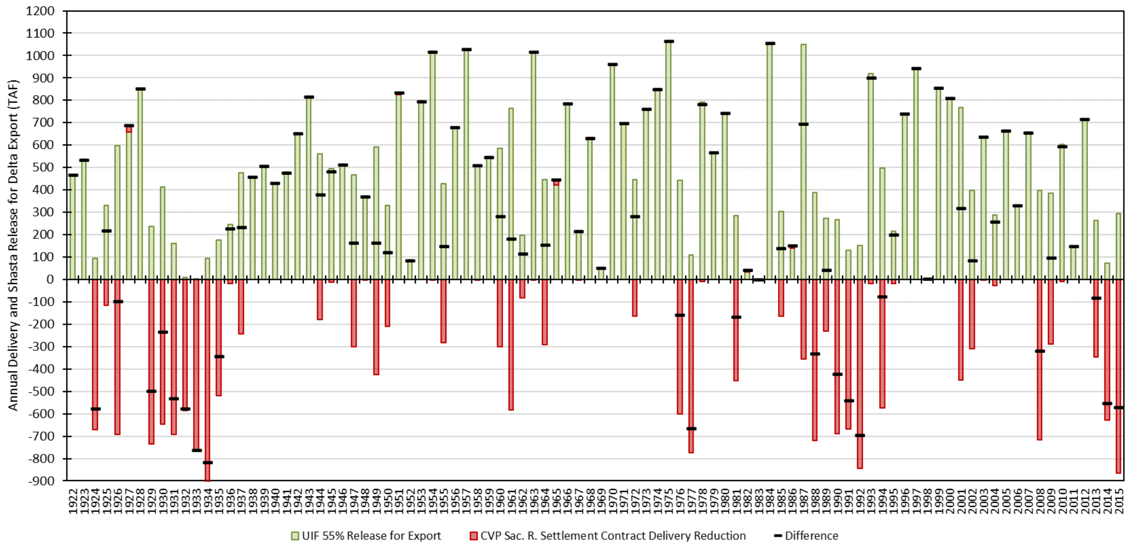

Figure 45. SacWAM Results from 55% UIF Scenario for Reduced SRSC Delivery and Shasta Lake Release for CVP Export

CVP South of Delta Operations and Allocations

Delta export service area CVP water deliveries are also subject to the CVP M&I WSP. This policy places higher water delivery priority on PH&S, San Joaquin River Exchange Contractors (Exchange Contractors), and delivery to wildlife refuges.

Figure 46 contains annual SOD CVP water service contract deliveries in the 55% UIF scenario (blue bars) and Exchange Contractors delivery reduction (red bars) in the 55% UIF scenario. Black arrows are shown in a total of 44 years and indicate when Exchange Contractor delivery reductions are more than 20 TAF and water service contractors are receiving more than 40 TAF.

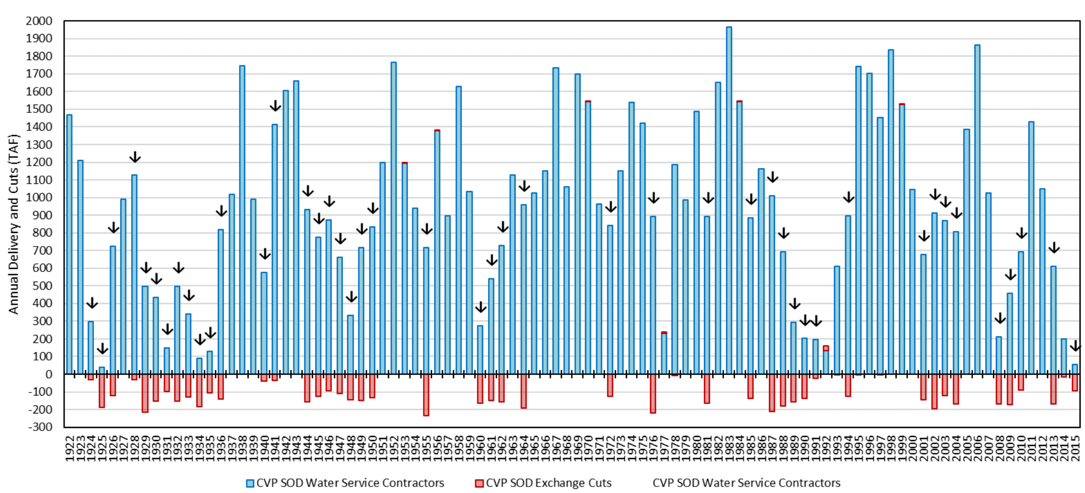

Figure 46. SacWAM Reductions in CVP Exchange Contract Diversions Due to 55% UIF Requirement and CVP SOD Walter Service Contract Delivery in 55% UIF Scenario

Exchange Contractor deliveries have a higher diversion priority than CVP water service contractors, but there are years when Exchange Contractors are reduced while water service contractor delivery is greater than assumed PH&S amounts. In these same years there are also reductions in simulated deliveries to SOD wildlife refuges while water service contractor delivery is greater than assumed PH&S amounts. This is inconsistent with actual CVP operational criteria. Inconsistency with Reclamation contracts and policy results in underestimating delivery impacts to the westside of the San Joaquin Valley and urban deliveries in the Santa Clara region. Reclamation contracts for Friant Division operations require releases from Friant Dam on the San Joaquin River to meet Exchange Contractor deliveries when Exchange Contracts cannot be met from the Delta. Therefore, when modeled deliveries to the Exchange Contractors do not follow contracts and policies it is not possible to assess the potential impacts to the CVP Friant Division Contractors. This inconsistency between the model and actual operating criteria alters the location of water delivery impacts.