Evaluation of California Water Fix Boundary Analysis Modeling

August 31, 2016

MBK ENGINEERS

Overview

This technical memorandum describes the MBK Engineers (MBK) review of the boundary analysis modeling (Boundary Analysis) performed by the California Water Fix (CWF) proponents. Exhibit DWR-515 for this hearing, *Table 4: Key CalSim II CWF No Action Alternative, H3, H4, CPOD Boundary 1 and CPOD Boundary 2,* lists some of the modeling assumptions that the CWF proponents made for the five CalSim II scenarios they modeled for the Boundary Analysis.

As discussed in Exhibit DWR-51, page 10, lines 10-11, the CWF proponents assert that the Boundary Analysis provides "a broad range of operational criteria and the initial operating criteria will fall within this range." The CWF proponents assert that these boundaries "are sufficiently broad so as to assure the State Water Board that any operations considered within this change petition proceeding have been evaluated with regard to effects on legal users of water. These boundaries are described below as boundary 1 and boundary 2." (Exh. DWR-51, p. 10, lines 11-14.)

The Boundary Analysis includes four different Cal WaterFix CalSim II model simulations and the No Action Alternative (NAA). The CWF proponents state that the Boundary 1 scenario reflects a hypothetical future condition with less regulatory requirements for Delta outflow and Delta exports and the Boundary 2 scenario reflects a hypothetical future condition with more regulatory requirements for Delta outflow and Delta exports. The CWF proponents further state that Alternatives H3 and H4 represent the initial operational range of the CWF.

This report discusses these five modeling scenarios and also discusses comparisons to the CWF Biological Assessment (BA) preferred alternative, Alternative 4A, scenario. This additional scenario is included in this discussion because it was our understanding that the modeling conducted for the CWF BA would be the basis for the SWRCB CWF Project Hearing[1].

Conclusions

I. Based on our review of the USBR/DWR model files and results, the Boundary Analysis fails in its purported purpose of bounding the range of potential effects of the CWF.

The Boundary Analysis alters Delta outflow requirements and Delta export restrictions that currently apply to the South Delta Diversion (SDD) to create a range of changes in Delta outflow, compared to the NAA. However, the Boundary Analysis does not evaluate a range of potential operations of the Central Valley Project (CVP) and State Water Project (SWP) with the CWF, or the additional capacity to convey water across the Delta that would be provided by the North Delta Diversion (NDD), even though this additional conveyance capacity is the primary purpose of the CWF. The Boundary Analysis fails to meet

[1] As stated in the March 11, 2016 letter from DWR and the United States Bureau of Reclamation to Hearing Chair Tam Doduc and Hearing Officer Felicia Marcus, "…the modeling conducted for the BA is the basis of the information that will be used in the case-in-chief in the Hearing Process."

its purported purpose because it does not consider this additional capacity or the flexibility it would provide to the operations of the CVP and SWP.

A true boundary analysis for the CWF would focus on the operational boundaries of the CVP and SWP with the CWF. The following is an initial list of operational parameters that should be included in a true boundary analysis of CWF.

- Flexibility for meeting Delta salinity standards by use of the NDD or SDD
    - This flexibility was specifically mentioned in the hearing testimony of John Leahigh, of DWR
- Flexibility to convey surplus upstream storage
    - This flexibility was specifically mentioned in the hearing testimony of John Leahigh, of DWR
- Priorities for use of the NDD between the CVP and the SWP
- Expanded use of Joint Point of Diversion (JPOD) by the CVP that would be made possible by the NDD
- Changes in upstream CVP and SWP reservoir operations that may occur with the additional Delta export capacity provided by CWF and the NDD
- Potential sharing of obligations to satisfy increases in Delta outflow requirements under the Coordinated Operating Agreement (COA)
- Potential variations in the NDD bypass criteria
    - NDD bypass criteria used for modeling are complex and may be altered when an operations plan is developed or actual operations begin. Analyses should be performed to demonstrate how sensitive CWF and CVP/SWP operations are to changes in NDD bypass requirements.

II. Four of the key conclusions in MBK's Modeling Review Report, Exhibit SVWU 107, and the evidence supporting those conclusions also apply to the USBR/DWR studies for the Boundary Analysis.

Based on statements made in the March letter[1] from DWR and the United States Bureau of Reclamation (Reclamation or USBR), MBK Engineers focused their modeling review on the CWF BA modeling, and specifically the preferred alternative, Alternative 4A H3+ (Alternative 4A). Review, analysis, and conclusions regarding Alternative 4A are discussed in Exhibit SVWU 107. The conclusions in that report that apply to the Boundary Analysis and are summarized here, but then not discussed further in this report:

1. **DWR/USBR Boundary Analysis Alternatives do not consider additional capacity that would be made available with the NDD when making allocations to South of Delta CVP and SWP contractors.**

Although the NDD would provide increased ability to convey water from upstream reservoirs, export estimates used to calculate south-of-Delta (SOD) CVP water service contract allocations and SWP Table A contract allocations in the Boundary 1 and H3 scenarios are set the same as those in the DWR/USBR BA NAA, and the export estimates in Boundary 2 and H4 are set significantly *lower* than those in the DWR/USBR BA NAA. These model assumptions artificially limit the modeled ability of

DWR and USBR to increase CVP and SWP SOD allocations and their use of the NDD. The ability to convey water through the Delta has restricted CVP SOD allocations in approximately two out of every three years since the Old and Middle River (OMR) requirements were imposed on the CVP and SWP in 2008. Therefore, these model assumptions have the potential to significantly affect model results. These assumptions tend to artificially and incorrectly keep modeled storage in north-of-Delta (NOD) CVP and SWP reservoirs higher under the Boundary Analysis Alternatives, as compared to the No Action Alternative, than probably would occur under actual operations.

2. DWR/USBR Boundary Analysis Alternatives include artificial limits on the use of Joint Point of Diversion (JPOD).

DWR/USBR Boundary Analysis modeling limits JPOD to remaining Banks SDD permitted capacity[2] regardless of whether the water is conveyed through SDD or NDD. This assumption limits the CVP's modeled ability to use JPOD to convey through the NDD both excess Delta outflow (outflow in excess of existing regulatory requirements) and water stored in upstream CVP reservoirs. This model assumption tends to artificially and incorrectly keep storage in NOD CVP reservoirs higher under the DWR/USBR Boundary Analysis Alternatives as compared to the No Action Alternative.

3. DWR/USBR Boundary Analysis Alternatives change NOD/SOD reservoir balancing criteria so that less stored water is modeled as being conveyed from North of Delta (NOD) reservoirs to San Luis Reservoir during summer months.

CalSim II balances Sacramento Valley CVP and SWP reservoir storage with storage in San Luis Reservoir by setting target storage levels in San Luis Reservoir. These operations criteria, in conjunction with CVP and SWP SOD contract allocations, govern how much stored water will be released from upstream reservoirs and exported from the Delta. DWR/USBR BA Alternative 4A increased San Luis Reservoir target storage levels in winter and spring months, and then decreased target storage levels during summer months, as compared to the NAA. When combined with Parameter 1 above, and related to export estimates and SOD contract allocations, the result of this model assumption is a modeled decrease in release and conveyance of previously stored water from NOD reservoirs. This assumption tends to artificially, and incorrectly, keep modeled storage in NOD CVP and SWP reservoirs higher under DWR/USBR BA Alternative 4A, as compared to the No Action Alternative.

4. CalSim II does not address effects on many types of water users.

CalSim II is used for this modeling analysis, and although CalSim II simulates changes in Delta exports, Delta outflows, river flows, and CVP and SWP reservoir storage levels, it does not model any changes in water deliveries to Sacramento River Settlement Contractors, Feather River Settlement Contractors, wildlife refuges, CVP Exchange Contractors, or non-Project water right holders. Because all CVP and SWP Settlement Contractor deliveries and all non-Project water user deliveries are "Hard Coded", the model is forced to meet these deliveries unless it runs out of water. For the purposes of CalSim II, the model runs out of water when a reservoir reaches dead pool.

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[2] "Remaining permitted capacity" means the capacity to use the SDD under the permit issued by the U.S. Army Corps of Engineers under Section 10 of the Rivers and Harbors Act minus the portion of this capacity that is used by DWR for SDD.

> Because CalSim II does not reduce water use by non-Project water right holders or reduce deliveries to Settlement Contractors as necessary to comply with regulatory requirements, effects on these water users must be determined by evaluating the model outputs. Lower actual storage during spring of dry and critical years would likely result in operational changes to protect cold water in Shasta Reservoir. The lower storage may cause the SWRCB, CVP, or SWP to reduce deliveries to the Sacramento and Feather River Settlement Contractors to meet regulatory requirements.

III. The USBR/DWR CWF modeling that was performed is impractical and unsatisfactorily executed.

In each of the Boundary Analysis Alternatives, modeled exports are unrealistically curtailed, modeled allocations are unreasonably suppressed, and modeled water storage remains in North of Delta CVP and SWP reservoirs, and San Luis Reservoir. These modeling results occur despite the increased ability to convey the water through the Delta that would be provided by the CWF and the ability to deliver water already in San Luis Reservoir. Given the lack of a true boundary analysis, as discussed in Conclusion I above, and the listed modeling issues and defects described in Conclusion II above, the results of the Boundary Analysis are inadequate to draw any accurate conclusions concerning the impacts that CWF actually would have on legal users of water.

Model Results and Details

In addition to the issues common to all Boundary Analysis Alternatives described above, operational details for each alternative are described in the sections below. Model results for each alternative used for the Boundary Analysis are compared, and observations are presented, in the sections below.

The main parameter that is varied in the Boundary Analysis is required Delta outflow. While Alternative 4A H3+t (he CWF BA preferred alternative) was not included in the Boundary Analysis, it was configured to maintain average March through May Delta outflows, as simulated in the NAA, by constraining total exports (NDD and SDD) to the San Joaquin River Inflow to Export ratio (SJR IE). Annual average Delta outflow in the various alternatives, as compared to the NAA, varies over a range of more than 2.3 million acre-feet (MAF), from a reduction of 1.26 MAF to an increase of 1.073 MAF, as shown in **Figure 1**. Alternatives H3 and 4A both would reduce overall Delta outflow, but not by as much as Boundary 1. H4 would maintain approximately the same average annual Delta outflow as the NAA. Although the Boundary Analysis modeling shows a range of changes in Delta outflow, if the issues described above were to be addressed, then this range would likely be different.

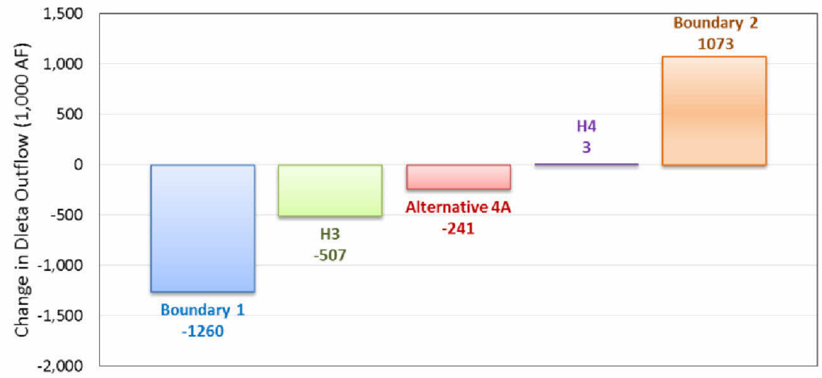

Figure 1. Average Annual Changes in Delta Outflow (Alternative minus USBR/DWR NAA)

Change in annual average Delta outflow is one metric for a boundary analysis, but changes in that metric do not describe or bound other possible changes in CVP and SWP operations due to the CWF. It is also important to analyze *when* Delta outflow is changing to better understand CVP and SWP operational changes. **Figure 2** shows average monthly changes in Delta outflow for each alternative, as compared to the NAA.

Boundary 1 does not include the Fall X2 requirement, which explains the reductions in September, October, and November Delta outflow under that scenario. The removal of the Fall X2 requirement reduces releases from NOD CVP and SWP reservoirs, and increases storage levels. Therefore, increased Delta outflow in December, under Boundary 1, is due to increases in reservoir spills. Boundary 1 and H3 show average monthly reductions in Delta outflow in April and May, between 2,000 and 4,000 cubic feet per second (cfs). This is explained by the removal of SJR IE Delta export restrictions in both studies.

Boundary 2 results in lower average monthly Delta outflow in April and May. Boundary 2 includes Delta outflow targets in all months that range from 25,000 cfs in dry and critical years, to 44,500 cfs in wet, above normal, and below normal years. Boundary 2 modeling inputs are designed to meet Delta outflow targets by cuts in Delta exports; however, results show a decrease in average monthly April and May Delta outflows. Boundary 2 increases in Delta outflows, from December to March, are partly generated from a combination of December through March cuts in Delta exports, but a significant portion of the increased Delta outflow in these months is due to cuts in exports in previous years that did not go to Delta outflow, but were instead held in NOD CVP and SWP reservoirs and then spilled, in subsequent months.

High spring Delta outflow was a goal of H4, and preservation of spring Delta outflow was a goal of Alternative 4A. As shown in **Figure 2**, H4 does generate higher average monthly Delta outflows from March through May. In fact, H4 is the only alternative with higher average monthly Delta outflows in April and May. Alternative 4A preserves April and May Delta outflows by restricting total Delta exports to the SJR IE, the same as Delta exports are restricted in the NAA. Therefore, there is essentially no change in average monthly Delta outflow under this alternative.

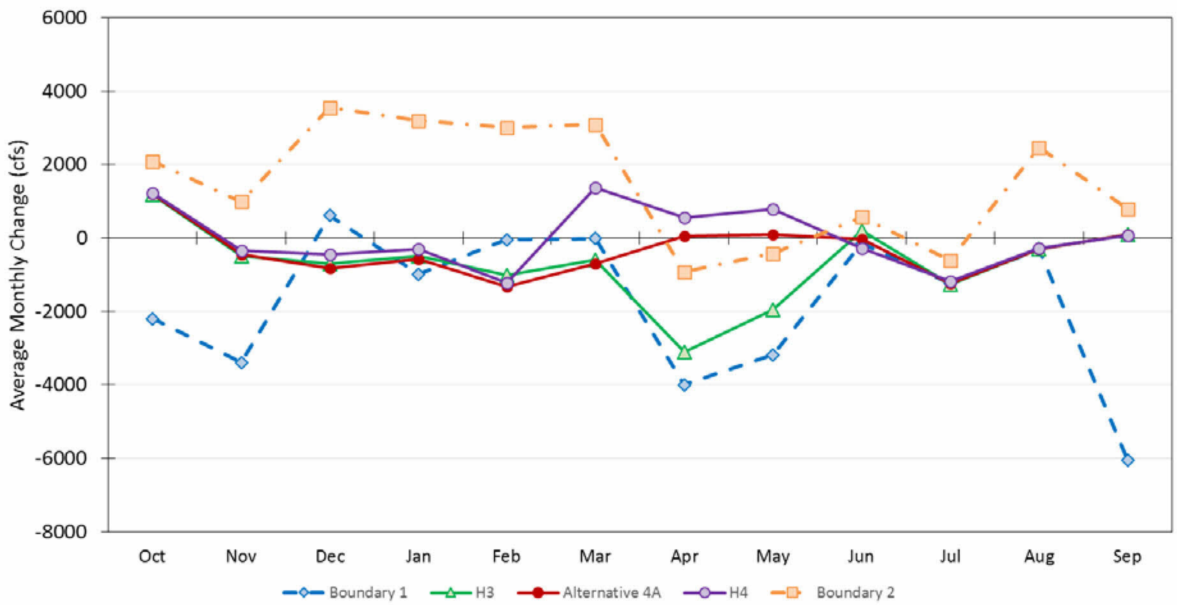

Figure 2. Average Monthly Changes in Delta Outflow (Alternative minus USBR/DWR BA NAA)

Figure 3 shows average monthly changes in combined NDD and SDD Banks exports for each alternative as compared to the NAA. Banks exports are lower in every alternative during September, and August export is lower in every alternative, with the exception of Alternative 4A, where it is the same as the NAA. Reductions in Banks exports in these two months are caused by changes in reservoir operational rules that balance storage in Oroville and the SWP portion of San Luis Reservoir and often coincide with lower reservoir releases from Oroville and higher storage. Except for Boundary 2 and Alternative 4A, average exports during the March through May period are generally higher.

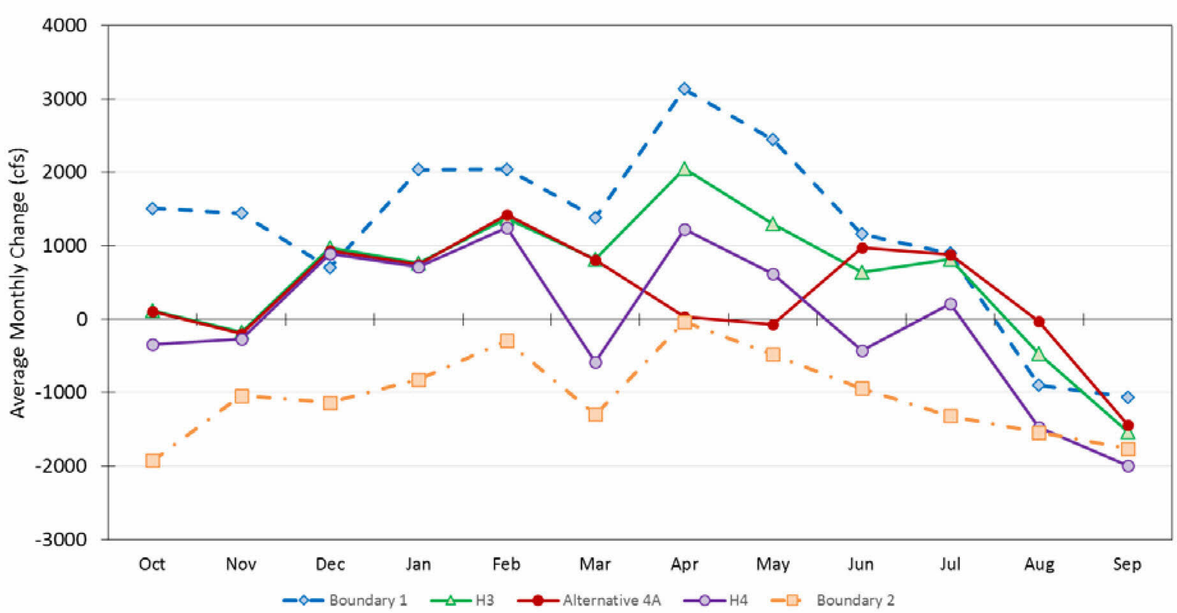

Figure 3. Average Monthly Changes in Banks Pumping (Alternative minus USBR/DWR BA NAA)

Figure 4 shows average monthly changes in combined NDD and SDD Jones exports for each alternative as compared to the NAA. Except for Boundary 1, Jones exports are lower in every alternative from September through November. Reductions in Jones exports in these months are caused by changes in reservoir operational rules that balance storage in NOD CVP reservoirs (Shasta, Trinity, and Folsom) and the CVP portion of San Luis Reservoir, and often coincide with lower reservoir releases from NOD CVP reservoirs and higher storage in those reservoirs. Average monthly April through June Jones exports are higher in every alternative. This often coincides with decreases in Delta outflow or increases in upstream reservoir releases.

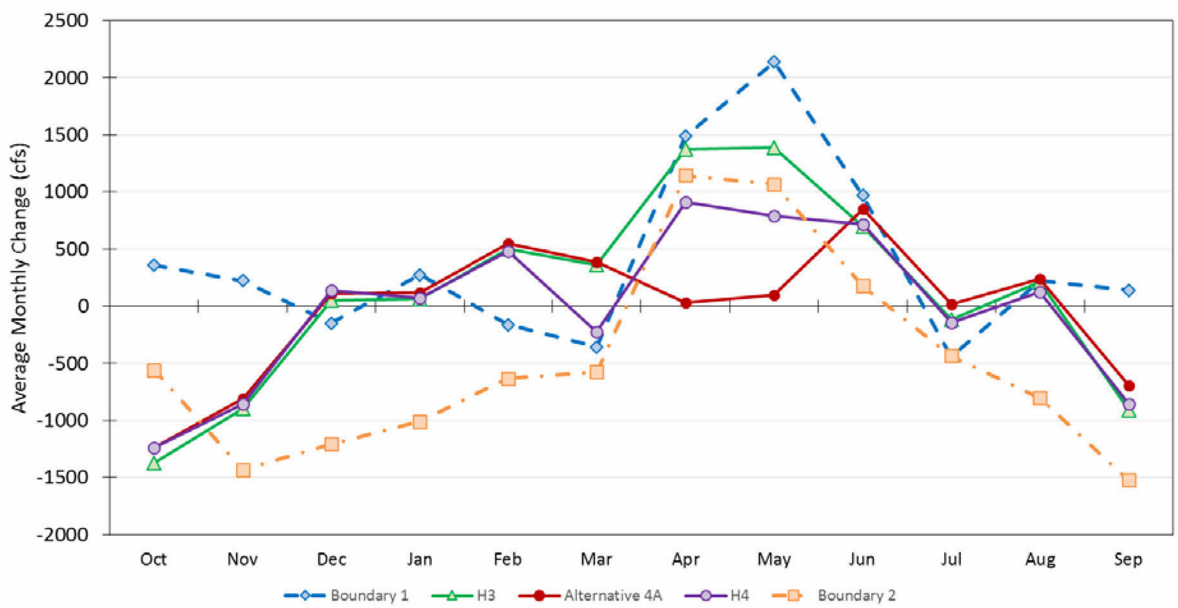

Figure 4. Average Monthly Changes in Jones Pumping (Alternative minus USBR/DWR BA NAA)

Figure 5 shows average monthly changes in Oroville storage for each alternative as compared to the NAA. Modeled Oroville storage is higher in every alternative during the September through March period, primarily due to changes in reservoir operational and balancing rules, and without consideration of additional capacity made available with the NDD when allocations are made to South of Delta SWP contractors. The effects of reservoir operating rules and export estimates cause average monthly Oroville storage to be higher in every month in Boundary 1 and Boundary 2, with September carryover being about 270 thousand acre-feet (TAF) higher in Boundary 1, and nearly 500 TAF higher in Boundary 2. Although Boundary 1 and Boundary 2 were intended to bound the range of potential CVP and SWP operations with CWF, both of these scenarios have higher average monthly storage in Oroville Reservoir, even though there would be significant additional capacity to convey water across the Delta. These results do not reflect a true boundary analysis.

Although Oroville storage is drawn down in H4 to meet increases in Delta outflow, model assumptions are set to reduce releases of stored water from June through September, even when Oroville storage is above levels needed to satisfy upstream requirements. Increases in spring Delta outflow requirements in H4 would result in a 200 TAF reduction in Oroville storage followed by higher carryover storage due to changes in reservoir operating and balancing rules.

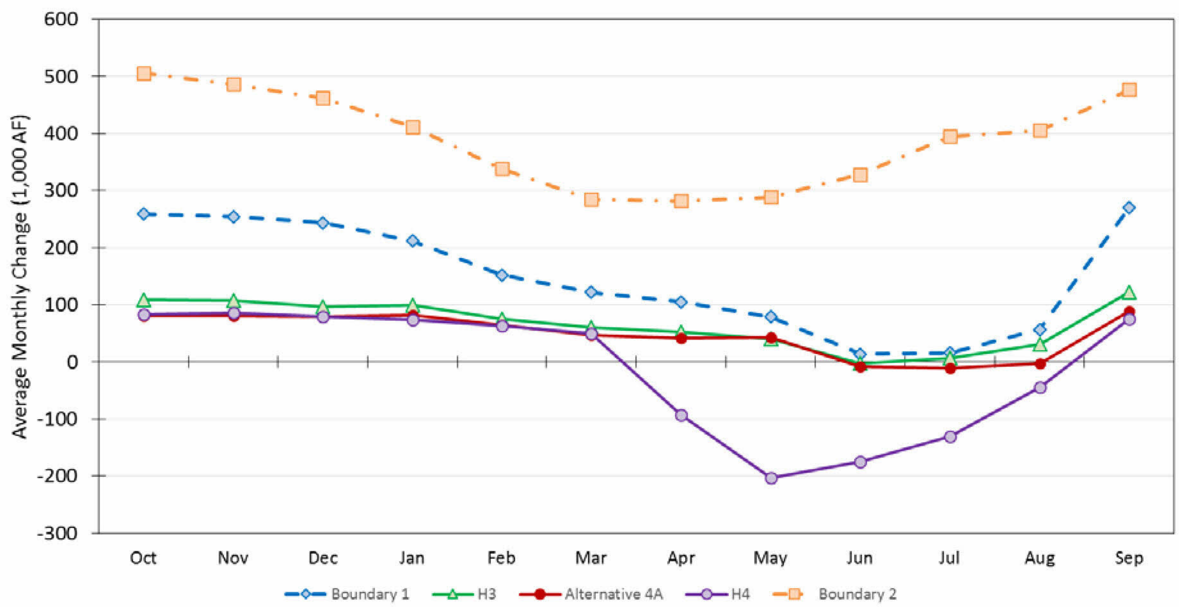

Figure 5. Average Monthly Changes in Oroville Storage (Alternative minus USBR/DWR BA NAA)

Figure 6 shows average monthly changes in SWP San Luis Reservoir storage for each alternative as compared to the NAA. The NDD would increase the ability to capture the surplus Delta outflow that typically occurs in winter and spring months and to use diversions of this water to increase San Luis storage. However, this water is not simulated as being allocated to SWP contractors, so there are higher SWP San Luis Reservoir storage levels from May through August in all scenarios. Modeled SWP San Luis storage is higher from May through August in every alternative, and then is reduced in September. This modeled operation is primarily due to changes in reservoir operational modeling rules and does not consider the additional capacity that would be made available by the NDD when making modeled allocations to South of Delta SWP contractors.

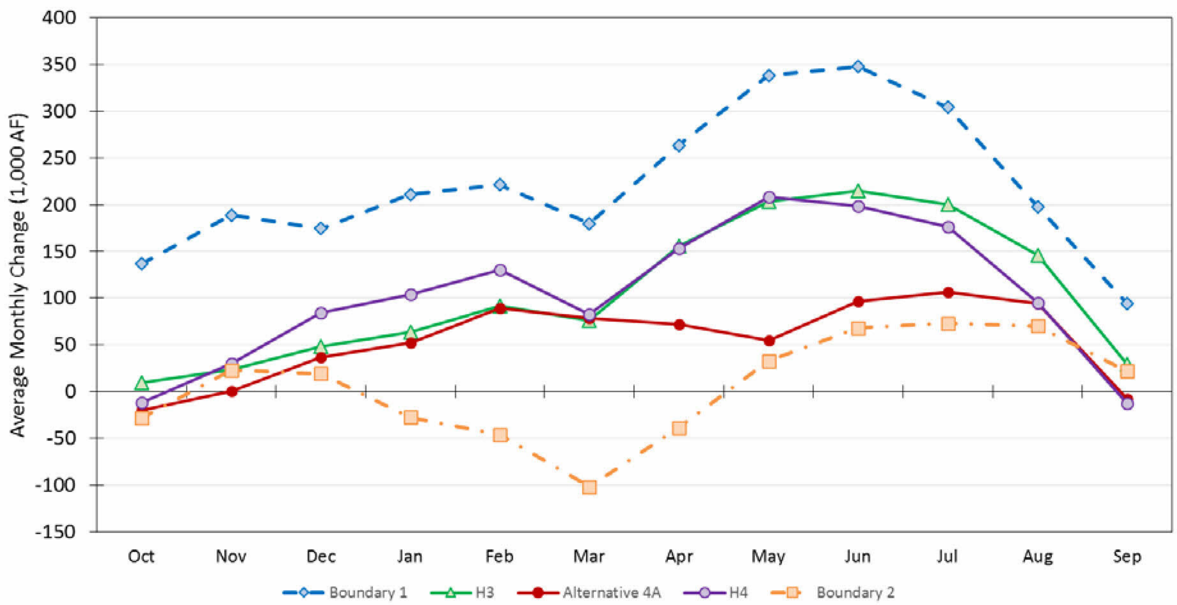

Figure 6. Average Monthly Changes in SWP San Luis Reservoir Storage (Alternative minus USBR/DWR BA NAA)

Figure 7 shows average monthly changes in Shasta storage for each alternative as compared to the NAA. Modeled Shasta storage is higher in every alternative during the September through April period. This is primarily due to changes in modeled reservoir operational rules, and does not consider the additional capacity that would be made available by the NDD when making model allocations to South of Delta CVP contractors. Average Keswick releases to the Sacramento River are increased from December through June in every alternative (**Figure 8**). Increased releases cause Shasta storage to be less than the NAA in June in all alternatives other than Boundary 2. However, if reservoir operating and balancing rules were appropriately modeled, and if modeled export estimates considered the additional Delta export capability that would be provided by the CWF when making modeled CVP allocations in Boundary 2, then Shasta storage in Boundary 2 would likely be lower in June. Reductions in Keswick releases in September through November affect Shasta storage and may affect the modeled ability to satisfy upstream flow requirements.

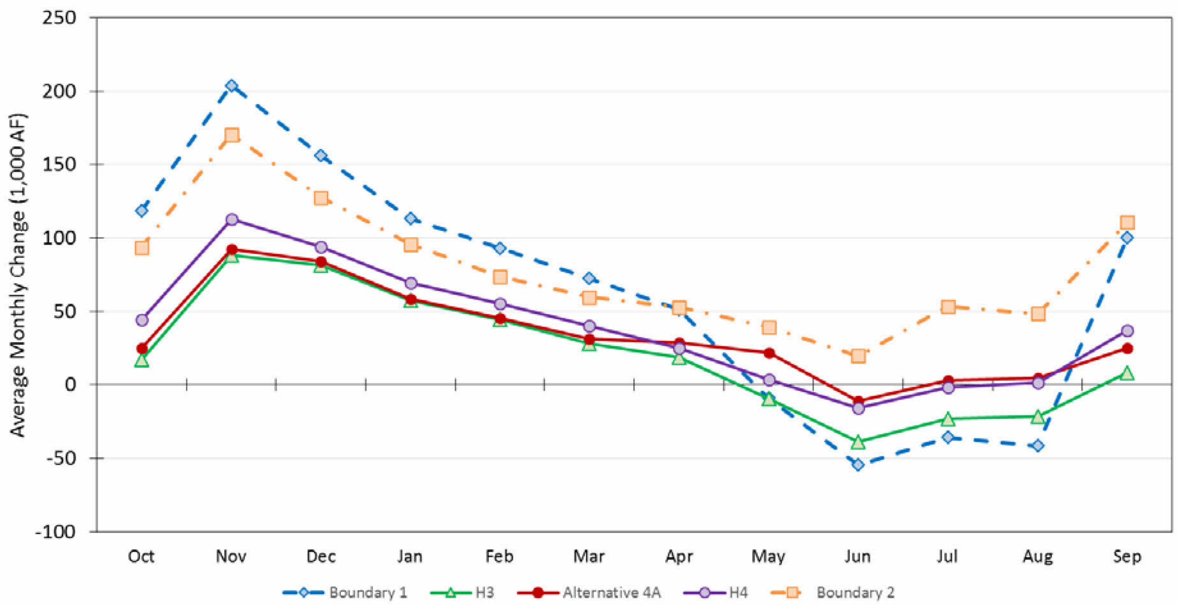

Figure 7. Average Monthly Changes in Shasta Reservoir Storage (Alternative minus USBR/DWR BA NAA)

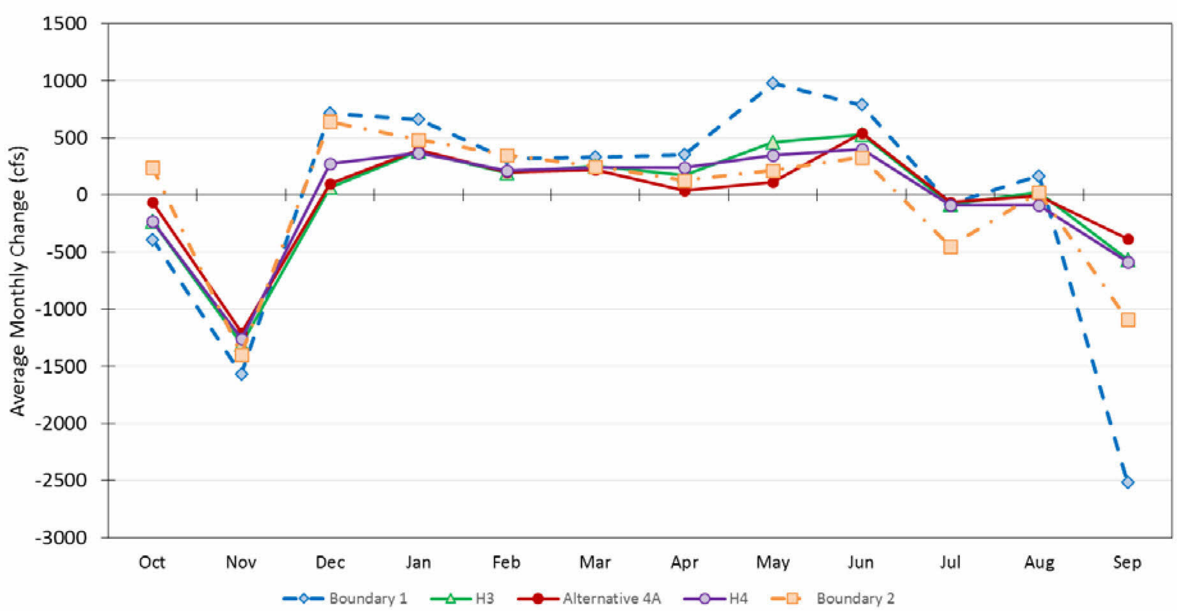

Figure 8. Average Monthly Changes in Keswick Release to Sacramento River (Alternative minus USBR/DWR BA NAA)

Figure 9 shows average monthly changes in Folsom storage for each alternative, as compared to the NAA. Folsom storage is drawn down in June in every alternative. If the Boundary Analysis covers the entire range of potential operations due to the CWF, then results show that Folsom storage is expected to be lower in June with the CWF. In all alternatives, with the exception of Boundary 2, Folsom storage is lower in July and August and there are reductions in releases from Folsom in September, which increase storage. **Figure 10** shows Nimbus releases to the American River. Average monthly releases are increased in June, and then decreased in July and September, in each alternative. In Boundary 2, there is an average monthly reduction in Nimbus release of approximately 15 percent in July, and an increase of approximately 17 percent in August. These changes in Folsom storage and releases would be likely to affect environmental conditions and water deliveries along the American River.

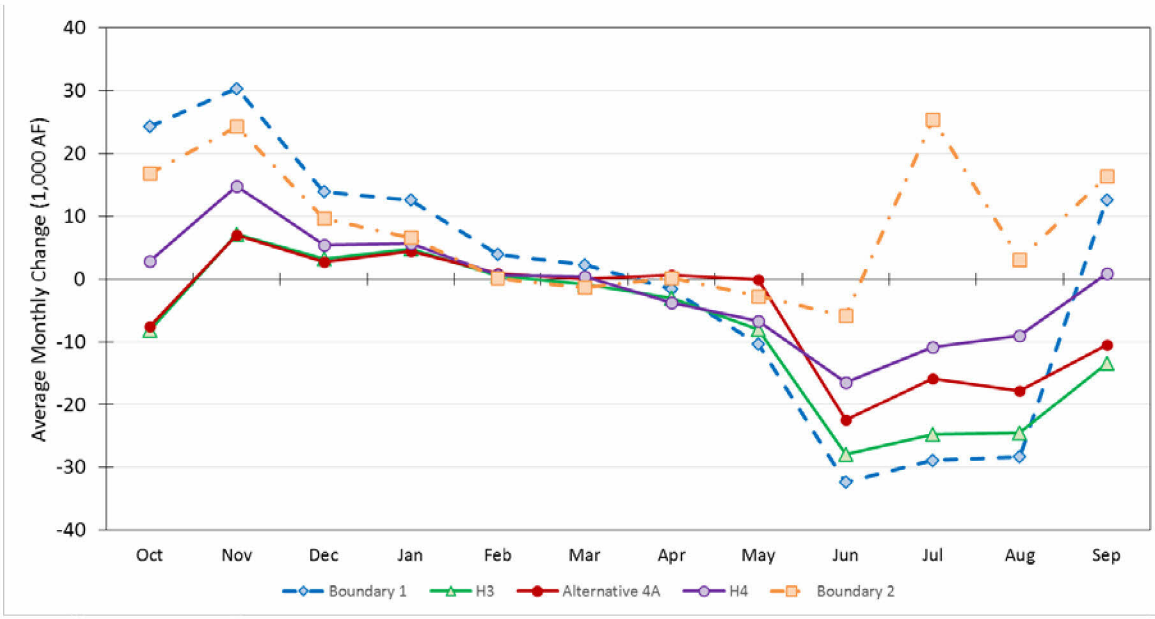

Figure 9. Average Monthly Changes in Folsom Reservoir Storage (Alternative minus USBR/DWR BA NAA)

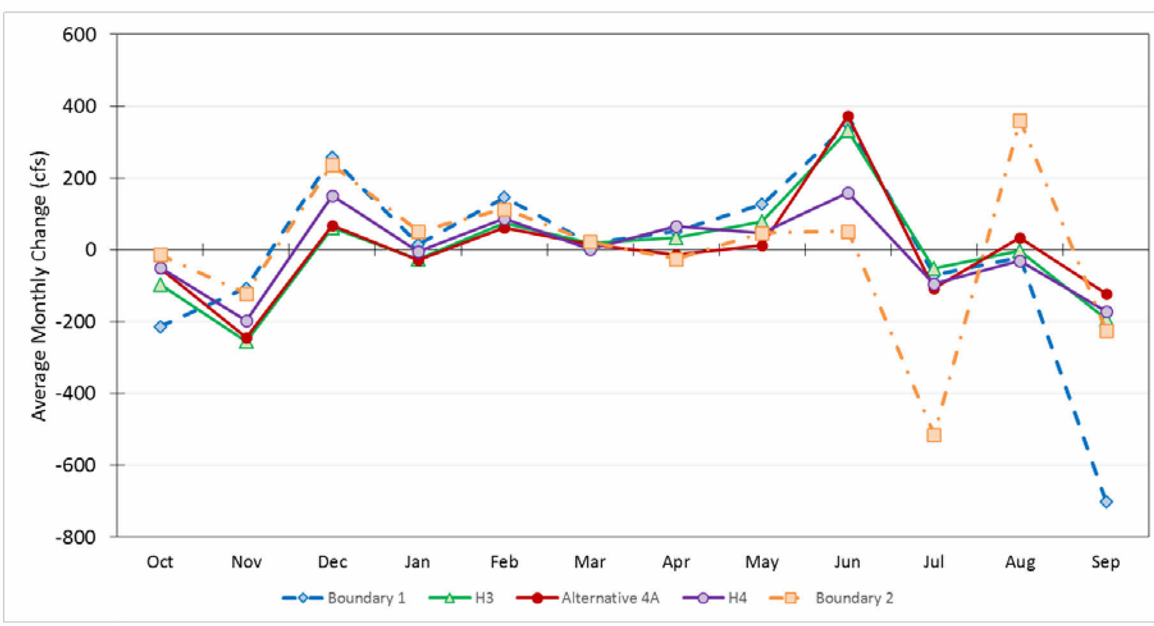

Figure 10. Average Monthly Changes in Nimbus release (Alternative minus USBR/DWR BA NAA)

Figure 11 shows average monthly changes in CVP San Luis storage for each alternative as compared to the NAA. Modeled CVP San Luis storage is higher from April through September in every alternative. Higher storage in these months is primarily due to changes in reservoir operational rules and Delta export estimates that fail to consider the additional capacity to convey water through the Delta that would be made available with the NDD when making modeled allocations to South of Delta CVP contractors.

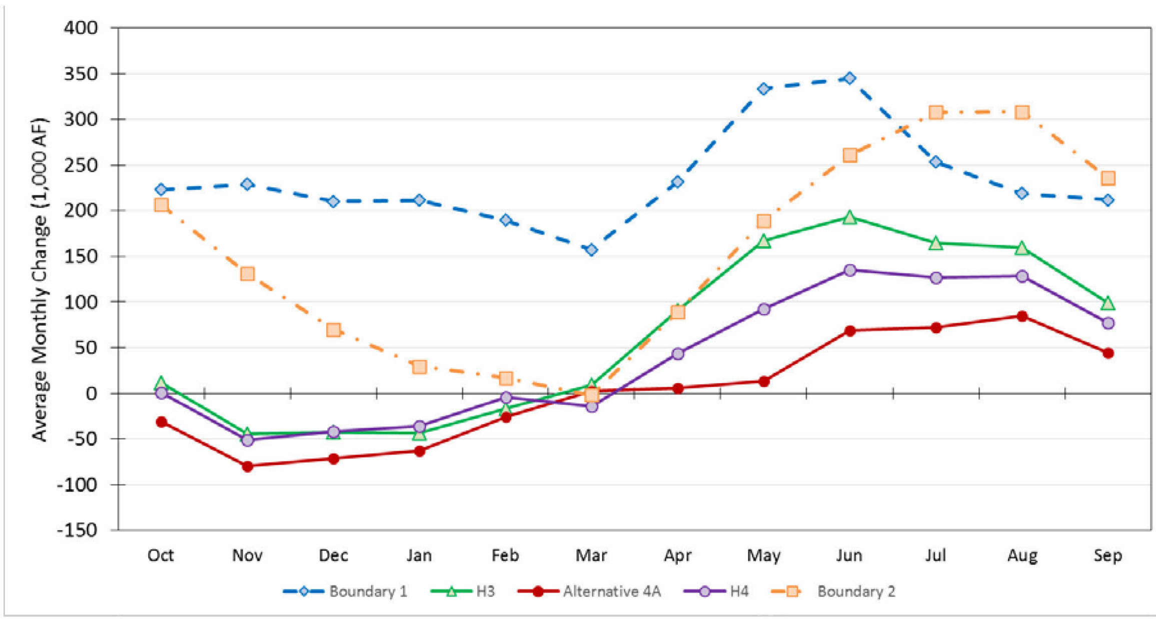

Figure 11. Average Monthly Change in CVP San Luis Reservoir Storage (Alternative minus USBR/DWR BA NAA)

User Input Export Estimates to Boundary Analysis Alternatives

As stated in Conclusion I, DWR/USBR Boundary Analysis Alternatives do not consider the additional capacity that would be made available by the NDD, when making modeled allocations to SOD CVP and SWP contractors. The CalSim II CVP and SWP allocation logic in the Boundary Analysis Alternatives depends on user input to properly bound allocations so that allocations of water to SOD contractors do not exceed the available export capacity to convey water through the Delta. These inputs are export estimates found in two CalSim input tables. Table "ExportEstimate_SWP" bounds SWP Table A allocations, and table "ExportEstimate_CVP" bounds CVP SOD water service contractor allocations.

To compare the export estimates in each Boundary Analysis Alternative to the export estimates in the BA NAA, the "ExportEstimate_SWP" and "ExportEstimate_CVP" values are listed in **Table 1** through **Table 5** below by project (SWP or CVP), alternative (BA NAA, Boundary 1, H3, H4, or Boundary 2), and by hydrologic condition (non-Wet San Joaquin River [SJR], Wet SJR, or Flood SJR). Non-Wet SJR is defined as a critical, dry, below normal, or above normal year, as determined by *Water Quality Control Plan San Joaquin Valley Water Year Hydrologic Classification* (60-20-20 Index). Wet SJR is a wet year as

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determined by the same classification. Flood SJR implies very high flows on the San Joaquin River. This condition is triggered by average monthly flows at Vernalis exceeding 16,000 cfs in either March, April, or May, and Flood SJR supersedes Wet SJR and non-Wet SJR for purposes of selecting an export estimate.

Table 1, **Table 2**, and **Table 3** show SWP export estimates for Non-Wet SJR, Wet SJR, and Flood SJR conditions respectively. For the SWP, export estimates are provided for January through August, but the key component of the export estimate for setting Table A allocations is the aggregation or sum of the April through August export estimates and the May through August estimates, which are also listed in **Table 1**, **Table 2,** through **Table 3**. The April through August sum is used in the determination of the April 1st allocation each year. As assumed in CalSim II, the final allocation cannot drop below the April 1st allocation, and the May through August sum is used to determine the final allocation on May 1st.

Table 1. User Input Export Estimates for Bounding SWP Table A Allocations in non-Wet SJR Years

User Input Export Estimates for Bounding SWP Table A Allocations in non-Wet SJR Years
(used in same 58 years of all DWR/USBR alternatives)

Alternative	USER INPUT EXPORT ESTIMATES								SUM		Difference with NAA	
	JAN (CFS)	FEB (CFS)	MAR (CFS)	APR (CFS)	MAY (CFS)	JUN (CFS)	JUL (CFS)	AUG* (CFS)	APR-AUG (TAF)	MAY-AUG (TAF)	APR-AUG (TAF)	MAY-AUG (TAF)
BA NAA	3750	4250	4250	1000	1000	2500	7000	7000	1131	1071	--	--
Boundary 1	3750	4250	4250	1000	1000	2500	7000	7000	1131	1071	0	0
H3	3750	4250	4250	1000	1000	2500	7000	7000	1131	1071	0	0
H4	2250	3500	1000	750	750	750	5000	5000	750	706	-380	-365
Boundary 2	600	700	700	400	100	800	2500	2500	385	361	-746	-710

*August export estimate set equal to July export estimate in each alternative for purposes of bounding SWP Table A allocations

Table 2. User Input Export Estimates for Bounding SWP Table A Allocations in non- Flood Wet SJR Years

User Input Export Estimates for Bounding SWP Table A Allocations in non-Flood Wet SJR Years
(used in same 12 years of all DWR/USBR alternatives)

Alternative	USER INPUT EXPORT ESTIMATES								SUM		Difference with NAA	
	JAN (CFS)	FEB (CFS)	MAR (CFS)	APR (CFS)	MAY (CFS)	JUN (CFS)	JUL (CFS)	AUG* (CFS)	APR-AUG (TAF)	MAY-AUG (TAF)	APR-AUG (TAF)	MAY-AUG (TAF)
BA NAA	3750	4250	4250	2000	2000	6000	7000	7000	1460	1341	--	--
Boundary 1	3750	4250	4250	2000	2000	6000	7000	7000	1460	1341	0	0
H3	3750	4250	4250	2000	2000	6000	7000	7000	1460	1341	0	0
H4	2250	3500	1000	3500	2000	3000	5000	5000	1125	916	-335	-424
Boundary 2	600	700	700	700	700	3100	2500	2500	577	535	-883	-806

*August export estimate set equal to July export estimate in each alternative for purposes of bounding SWP Table A allocations

Table 3. User Input Export Estimates for Bounding SWP Table A Allocations in Flood SJR Years

User Input Export Estimates for Bounding SWP Table A Allocations in Flood SJR Years
(used in same 12 years of all DWR/USBR alternatives)

Alternative	USER INPUT EXPORT ESTIMATES								SUM		Difference with NAA	
	JAN (CFS)	FEB (CFS)	MAR (CFS)	APR (CFS)	MAY (CFS)	JUN (CFS)	JUL (CFS)	AUG* (CFS)	APR-AUG (TAF)	MAY-AUG (TAF)	APR-AUG (TAF)	MAY-AUG (TAF)
BA NAA	3750	4250	4250	6000	6000	6000	7000	7000	1944	1587	--	--
Boundary 1	3750	4250	4250	6000	6000	6000	7000	7000	1944	1587	0	0
H3	3750	4250	4250	6000	6000	6000	7000	7000	1944	1587	0	0
H4	2250	3500	1000	4500	4000	3000	5000	5000	1307	1039	-637	-547
Boundary 2	600	700	700	1100	700	3100	2500	2500	600	535	-1343	-1052

*August export estimate set equal to July export estimate in each alternative for purposes of bounding SWP Table A allocations

Table 4 and **Table 5** show CVP export estimates for Non-Wet SJR and Wet SJR conditions respectively. The CVP allocation logic does not distinguish between Wet SJR and Flood SJR conditions. All such years are considered Wet SJR for determining CVP export estimates. For the CVP, export estimates are provided for March through August, but the key component of the export estimate for setting CVP SOD service contractor allocations in CalSim is the aggregation, or sum, of the April through August export estimates in addition to the May through August estimates, which are also listed in **Table 4** and **Table 5**. As with the SWP, the April through August sum is used in the determination of the April 1st allocation each year. As assumed in CalSim II, the final allocation cannot drop below the April 1st allocation, and the May through August sum is used to determine the final allocation on May 1st.

Table 4. User Input Export Estimates for Bounding CVP SOD Service Allocations in non-Wet SJR Years

User Input Export Estimates for Bounding CVP SOD Service Allocations in non-Wet SJR Years
(used in same 58 years of all DWR/USBR alternatives)

Alternative	USER INPUT EXPORT ESTIMATES						SUM		Difference with NAA	
	MAR (CFS)	APR (CFS)	MAY (CFS)	JUN (CFS)	JUL (CFS)	AUG* (CFS)	APR-AUG (TAF)	MAY-AUG (TAF)	APR-AUG (TAF)	MAY-AUG (TAF)
BA NAA	2500	1000	1000	2000	4600	4600	806	746	--	--
Boundary 1	2500	1000	1000	2000	4600	4600	806	746	0	0
H3	2500	1000	1000	2000	4600	4600	806	746	0	0
H4	1250	750	750	2500	4000	4000	731	687	-74	-59
Boundary 2	800	800	800	800	800	800	243	195	-563	-551

*August export estimate set equal to July export estimate in each alternative for bounding CVP SOD service contractor allocations

Table 5. User Input Export Estimates for Bounding CVP SOD Service Allocations in Wet SJR Years

User Input Export Estimates for Bounding CVP SOD Service Allocations in Wet SJR Years
(used in same 24 years of all DWR/USBR alternatives)

Alternative	USER INPUT EXPORT ESTIMATES						SUM		Difference with NAA	
	MAR (CFS)	APR (CFS)	MAY (CFS)	JUN (CFS)	JUL (CFS)	AUG* (CFS)	APR-AUG (TAF)	MAY-AUG (TAF)	APR-AUG (TAF)	MAY-AUG (TAF)
BA NAA	2500	2000	2000	4600	4600	4600	1081	962	--	--
Boundary 1	2500	2000	2000	4600	4600	4600	1081	962	0	0
H3	2500	2000	2000	4600	4600	4600	1081	962	0	0
H4	1250	2750	3000	3000	4000	4000	1019	855	-63	-108
Boundary 2	800	3000	3000	3000	800	800	640	461	-442	-501

*August export estimate set equal to July export estimate in each alternative for bounding CVP SOD service contractor allocations

Also included in **Table 1** through **Table 5,** is the April through August, and May through August export estimate difference between each Boundary Analysis Alternative and the BA NAA. As shown in **Table 1, Table 2, and Table 3**, the aggregate export estimates for the SWP in the Boundary 1 and H3 are identical to the BA NAA (the difference equals zero) for all three SJR hydrologic conditions. Also shown in **Table 1** through **Table 3**, H4 and Boundary 2 alternatives have *lower* export estimates (the difference is negative) than those in the BA NAA for all three SJR hydrologic conditions. Likewise, **Table 4** and **Table 5** show equal export estimates when comparing Boundary 1 and H3 to the BA NAA for the two SJR hydrologic conditions, and *lower* export estimates when comparing H4 and Boundary 2 to the BA NAA.

The primary purpose of the CWF would be to provide additional capacity to convey water across the Delta through the NDD facility. There is no indication that Delta exports through the NDD facility would be subject to existing SDD export constraints like OMR flow criteria, SJR IE and Banks permitted capacity. Therefore, it is counterintuitive that none of the alternative scenarios of the Boundary Analysis considered the possibility that the CVP and SWP could increase SOD and Table A allocations by using the NDD to export more water from May through August. Such an analysis is necessary to determine the range of impacts, especially to upstream storage, that actually could be caused by the CWF. Because the Boundary Analysis does not analyze this additional capacity and the flexibility it would provide to the operations of the CVP and SWP, the Boundary Analysis fails to meet its purported purpose.

Comparisons of modeled final (May) SWP allocations and subsequent SWP operations in 1975, under the BA NAA and H4, provide an instructive example of the significance of the user-input export estimates. In both the BA NAA and H4 scenarios, the modeled 1975 SWP Table A allocations are bounded by the export estimate based allocations. The export estimate based allocations are calculated with Equation 1:

(1) EEBDT = (EE + SL_init – SL_lpb)/DF

Where,

- EEBDT = the Export Estimate Based Delivery Target in thousand acre-feet;
- EE = the Export Estimate as selected from ExportEstimate_SWP and summed from the allocation decision month to August in thousand acre-feet;
- SL_init = San Luis storage at the beginning of the allocation decision month in thousand acre-feet;
- SL_lpb = the desired storage at the end of August to prevent low point issues;
- DF = the fraction of annual project demand that is expected to occur between the allocation decision month and the end of August.

For both alternatives, DF in May equals 0.566, and the SL_lpb equals 110 TAF. At the beginning of May 1975, the San Luis storage (SL_init) is 728 TAF in the BA NAA and H4 San Luis storage is 591 TAF, a difference of 137 TAF. The May through August aggregate Export Estimate (EE) in **Table 1** (1975 is a Non-Wet SJR year) is 1,071 TAF in the BA NAA and 706 TAF in H4, a difference of 365 TAF. The export Estimate Based Delivery Target for both the BA NAA and H4 can be calculated by inserting these numbers into Equation 1:

NAA : EEBDT = (1071 + 728 – 110) / 0.566 = 2984 TAF
H4 : EEBDT = (706 + 591 – 110) / 0.566 = 2097 TAF
Difference : EEBDT = 887 TAF (2984 – 2097)

The export estimate based delivery targets in May 1975 are 2,984 TAF for the BA NAA and 2,097 TAF for H4. These export estimate based delivery targets correspond to approximately a 70 percent Table A allocation in the BA NAA and approximately a 50 percent Table A allocation in H4. While the significantly lower allocation in H4 was partly a result of the lower San Luis storage at the beginning of May of 137 TAF (728 – 591), 645 TAF of the 887 TAF difference in delivery target was due to the lower export estimate.

The difference in 1975 Table A allocations between H4 and BA NAA causes changes in modeled Oroville operations. **Figure 12** compares Oroville storage in the two studies from February 1975 through December 1976. Oroville storage in both scenarios is at flood control levels from March through June, with no changes between the alternatives. Starting in July and continuing through December 1975, Oroville storage in H4 is higher than in the BA NAA and is more than 1.0 MAF higher by December 1975. Higher storage in Oroville under alternative H4 is the result of lower Table A allocations and less water being released to support Table A allocations SOD. Higher storage in Oroville continues into the 1976-1977 critical drought period.

Figure 13 compares SWP exports from February 1975 through December 1976. The NDD facility would provide higher SWP exports from March to May when Delta surplus is available. While there are additional spring outflow requirements in H4, the 1975 March through May average Delta outflow requirement of approximately 20,000 cfs is met entirely in the month of March when simulated Delta outflow was approximately 87,000 cfs.

From July through October and in December 1975, modeled SWP exports in H4 are lower than the BA NAA exports by a cumulative total of 975 TAF or approximately the same difference in Oroville Reservoir storage in December 1975 illustrated in **Figure 12**. Reductions in modeled releases from Oroville in H4 occurred because of the lower Table A allocation. The lower Table A allocation was a direct result of the lower export estimate based delivery target. The lower export estimate based delivery target was primarily caused by user-input export estimate tables that fail to include the additional Delta export capacity provided by the NDD and in fact, for the H4 and Boundary 2 alternatives assumes there will be less Delta export capacity with the NDD than without it. There is no defensible reason for 1975 BA NAA Table A allocations to be higher than 1975 H4 Table A allocations. In fact, it is reasonable to expect that H4 allocations could be higher in a year like 1975. The issue with SWP allocation described in this example occurs in many years in the H4 and Boundary 2 analysis.

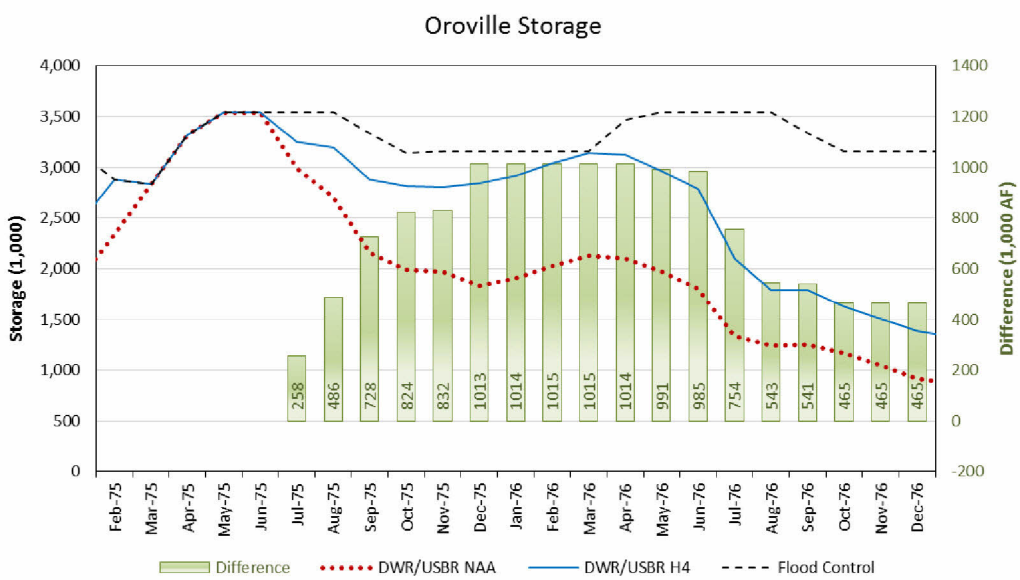

Figure 12. Oroville storage from February 1975 to December 1976 in DWR/USBR DA NAA and H4

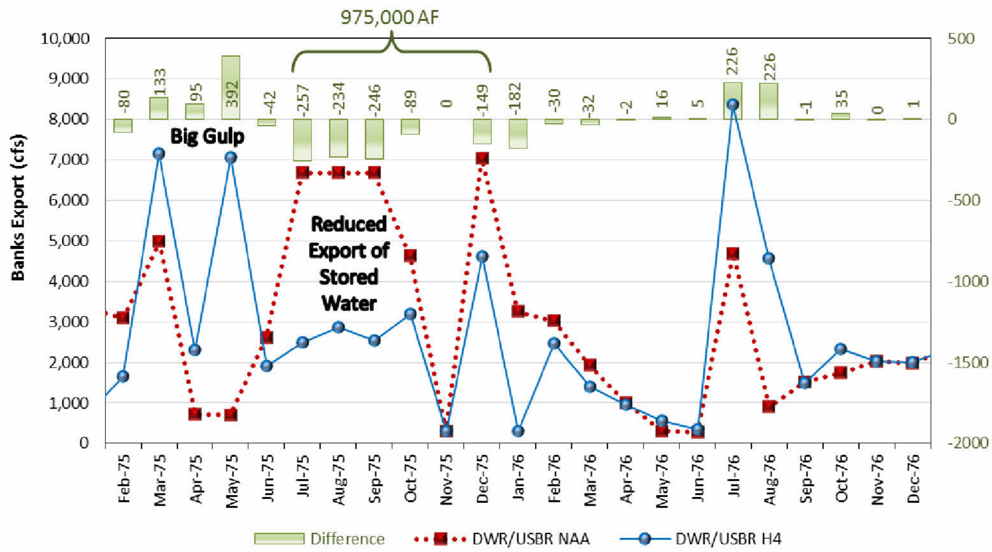

Figure 13. SWP Exports from March 1975 to December1976 in DWR/USBR BA NAA and H4

Boundary 1 Scenario

Summary of Scenario

Of all the Boundary Analysis scenarios, Boundary 1 assumes the least restrictive regulations on exports and the lowest Delta outflow requirements. For Boundary 1, OMR flow criteria are the same as for the BA NAA, but there are two actions - one from the U.S. Fish and Wildlife Service's 2008 Delta Smelt Biological Opinion (FWS BO) and one from the National Marine Fisheries Service's 2009 Steelhead and Salmon Biological Opinion (NMFS BO) – that are not included in Boundary 1 and therefore do not constrain project operations. Those actions are the Fall X2 requirement and the San Joaquin River inflow-export ratio (SJR IE).

Boundary 1 Scenario Deficiencies

Boundary 1 modeling limits Joint Point of Diversion (JPOD) wheeling to remaining Banks Pumping Plant South Delta Diversion (SDD) permitted capacity (see page 4, footnote 2, above) regardless of whether the water is conveyed through SDD or NDD. Banks pumping of SWP water, Cross Valley Canal (CVC) wheeling water, and Lower Yuba River Accord (LYRA) transfer water is not subject to the remaining Banks permitted capacity constraint when conveyed through the NDD in the Boundary 1 model, so it is inconsistent that JPOD wheeling alone would be subject to this constraint. This assumption limits the CVP's ability to use JPOD to convey both Delta excess and water stored in upstream CVP reservoirs. This tends to artificially and incorrectly keep storage in NOD CVP reservoirs higher under Boundary 1, as compared to the No Action Alternative.

In Boundary 1, exports are not subject to the SJR IE in April and May, and exports through the NDD facility are not subject to the OMR flow criteria or Banks Corps of Engineers permitted capacity limits for purposes of exporting water South of Delta. However, as shown in **Table 1** through **Table 5,** and discussed previously, the model assumes Boundary 1 has the same Delta conveyance capacity as that available in the BA NAA for purposes of calculating the export-based SWP Table A allocations and export-based CVP SOD service contractor allocations. This causes under-allocations for both the CVP and SWP and, therefore, underestimates potential negative impacts to upstream storage.

Evidence that the Boundary 1 scenario underestimates CVP SOD service contractor allocations is shown in **Figure 14**. The blue bars in this figure quantify the total availability of water in Shasta and Folsom Reservoirs and availability of export capacity – whichever is less - as calculated from the Boundary 1 results. Total water available in Shasta and Folsom was calculated as the difference between end of September combined storage and 3 MAF. The threshold of 3 MAF includes the 2.4 MAF BO action threshold for Shasta, 0.4 MAF carryover for Folsom, and a 0.2 MAF operational buffer. Available export capacity was calculated as the sum of unused export capacity from June to September. The determination of unused capacity available to the CVP assumed that JPOD would not be constrained by Banks Corps of Engineers permitted capacity for water that would be conveyed through NDD (the opposite was assumed in the Boundary 1 model). The determination of unused export capacity also takes into account use of the NDD facility and all relevant regulations. Each bar in **Figure 14** is labeled with that year's simulated CVP SOD agricultural service contractor allocation. If the allocation is 100%, then no increase in allocation is possible, but if the allocation is less than 100% and there is both available stored water and available conveyance capacity to meet that allocation, then the modeled CVP SOD agricultural service contractor allocation could have been increased. A true Boundary Analysis would have attempted to do this. As shown in **Figure 14**, there are 30 years of the 82-year modeled period of record for which more than 200 TAF was modeled as available in total Shasta and Folsom storage, there was export capacity available to convey the stored water, and CVP SOD Ag service allocations were less than 100%. For such years, modeled CVP allocations could be increased, and such modeled increases would indicate potential for impacts to upstream CVP storage that are not shown in the Boundary 1 analysis.

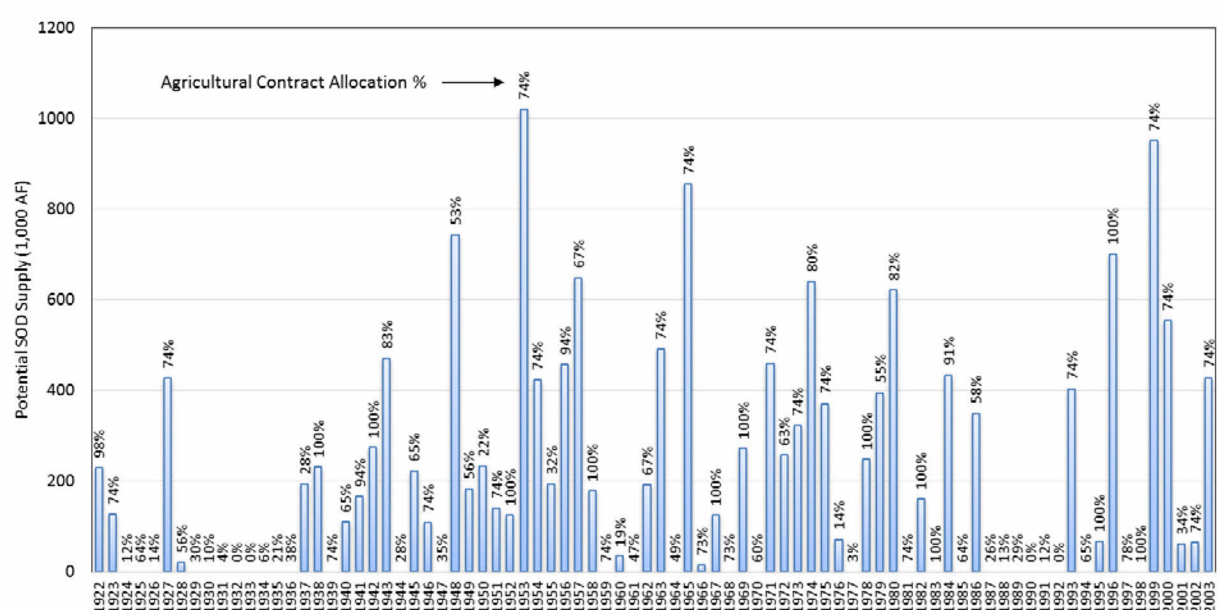

Figure 14. Ability to Increase CVP SOD Water Supply in Boundary 1 (minimum of available export capacity and available upstream storage)

Evidence that the Boundary 1 scenario underestimates SWP Table A allocations is shown in **Figure 15**. The green bars in this figure quantify the availability of water in Oroville and the availability of export capacity at Banks Pumping Plant, whichever is less, as calculated from the Boundary 1 results. Water available in Oroville was calculated as the difference between end of September Oroville storage and 1.5 MAF. Available export capacity was calculated as the sum of unused export capacity from June to September and takes into account use of the NDD facility and all relevant regulations. Each bar in **Figure 15** is labeled with that year's simulated SWP Table A allocation. If the Table A allocation is 100%, then no increase in allocation is possible, but if the Table A allocation is less than 100% and there is both stored water supply and conveyance capacity to increase that allocation, then the Table A allocation could have been increased. A true Boundary Analysis would have attempted to do this. In analyzing **Figure 15**, there are 34 years of the 82-year modeled period of record for which more than 200 TAF was available in Oroville, there was export capacity to convey the stored water, and Table A allocations were less than 100%. For such years, modeled SWP allocations could be increased, and such modeled increases would indicate potential for impacts to Oroville storage that are not shown in the Boundary 1 analysis.

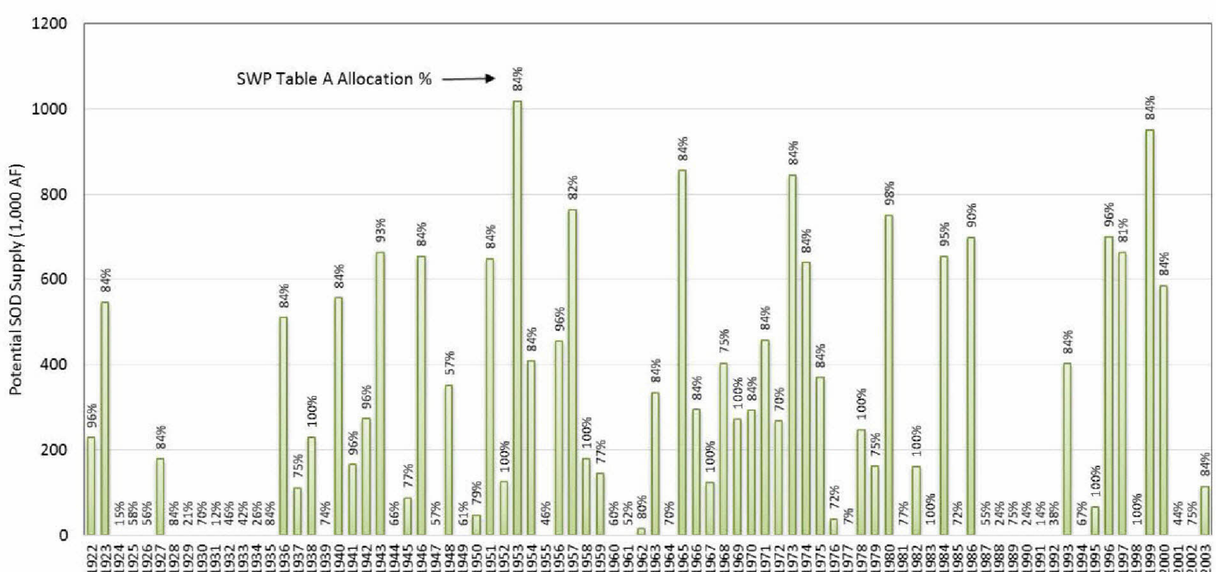

Figure 15. Ability to Increase SWP SOD Water Supply in Boundary 1 (minimum of available export capacity and available upstream storage)

H3 Scenario

Summary of Scenario

The H3 scenario is more restrictive than Boundary 1 in terms of constraints on SDD exports and Delta outflow criteria, but it still would provide significant opportunities to use the NDD facility to increase exports. OMR flow criteria in H3 are more restrictive than in the BA NAA and Boundary 1, and are the same as those contained in Alternative 4A H3+, the CWF BA preferred alternative. SJR IE for the H3 scenario, as for Boundary 1, does not constrain exports. Fall X2 Delta outflow criteria is modeled as being implemented in H3.

H3 Scenario Deficiencies

H3 modeling limits JPOD wheeling to remaining Banks Pumping Plant South Delta Diversion (SDD) permitted capacity (see page 4, footnote 2 above), regardless of whether the water is conveyed through SDD or NDD. Further description of this modeling deficiency is provided in the discussion above of Boundary 1.

In the H3 scenario, exports are not subject to the SJR IE in April and May, and exports through the NDD facility can bypass OMR flow criteria and Banks permitted capacity for purposes of exporting water South of Delta. However, as shown in **Table 1** through **Table 5,** and discussed previously, the model assumes there is only the same capacity as that available in the BA NAA for purposes of calculating the export based SWP Table A allocations and export based CVP SOD service contractor allocations. This causes under-allocations for both the CVP and SWP and, therefore, underestimates potential negative impacts to upstream storage.

Evidence that the H3 scenario underestimates CVP SOD service contractor allocations is shown in **Figure 16**. The same metrics used to calculate potential SOD supply in the Boundary 1 analysis are also used in the H3 analysis. Each bar in **Figure 16** is labeled with that year's simulated CVP SOD Ag service contractor allocation. If the allocation is 100%, then no increase in allocation is possible, but if the allocation is less than 100% and there is both stored supply and conveyance capacity to meet that allocation, then the CVP SOD Ag service contractor allocation could have been increased, and a true boundary analysis would have attempted to do this. As shown in **Figure 16**, there are 26 years of the 82-year modeled period of record for which more than 200 TAF was modeled as being available in total Shasta and Folsom storage , there was export capacity to convey the stored water, and CVP SOD Ag service allocations were less than 100%. For such years, modeled CVP allocations could be increased, and such modeled increases would indicate the potential for impacts to upstream CVP storage that are not shown in H3 scenario.

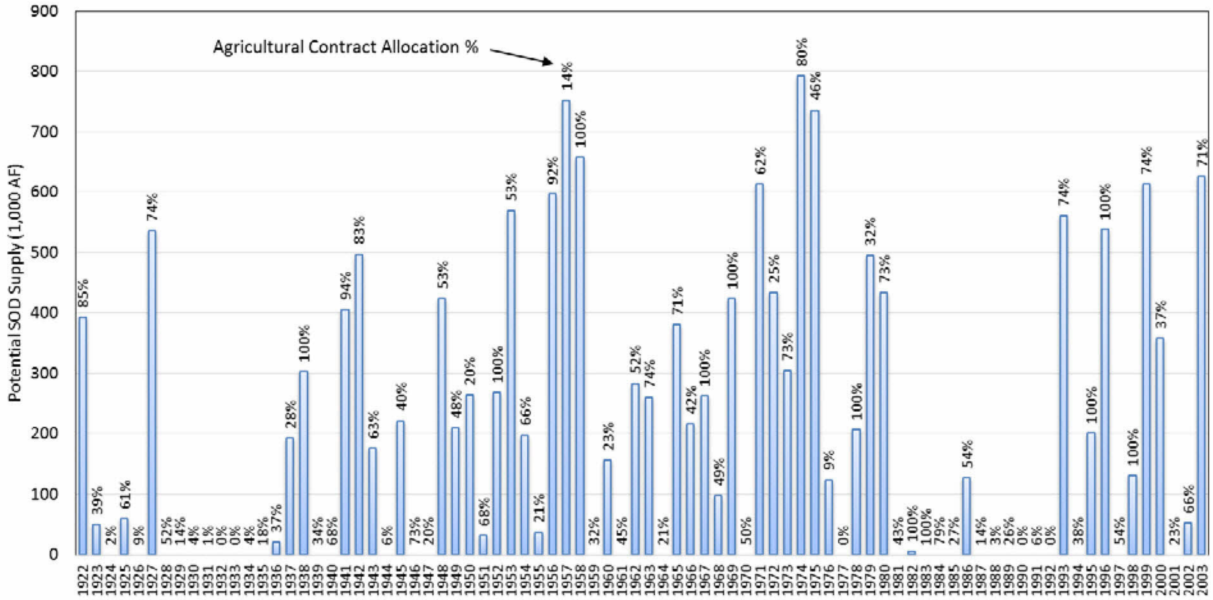

Figure 16. Ability to Increase CVP SOD Water Supply in H3 (minimum of available export capacity and available upstream storage)

Evidence that the H3 scenario underestimates SWP Table A allocations is shown in **Figure 17**. The same metrics used to calculate potential SOD supply in the Boundary 1 analysis are also used in the H3 analysis. Each bar in **Figure 17** is labeled with that year's simulated SWP Table A allocation. If the Table A allocation is 100%, then no increase in allocation is possible, but if the Table A allocation is less than 100% and there is both stored supply and conveyance capacity to meet that allocation, then the Table A allocation could have been increased. A true Boundary Analysis would have attempted to do this. As shown in **Figure 17**, there are 27 years where more than 200 TAF was available in Oroville, there was export capacity to convey the stored water, and Table A allocations were less than 100%. For such years, modeled SWP allocations could be increased, and such modeled increases would indicate the potential for impacts to Oroville storage that are not shown in the H3 scenario.

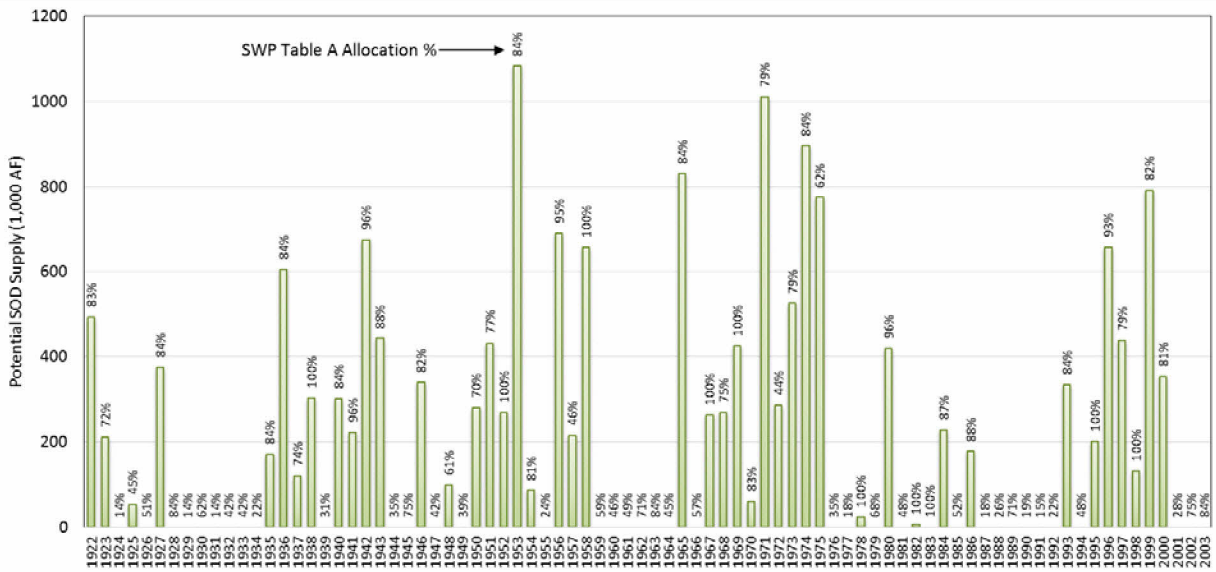

Figure 17. Ability to Increase SWP SOD Water Supply in H3 (minimum of available export capacity and available upstream storage)

H4 Scenario

Summary of Scenario

The H4 scenario has high spring outflow criteria in addition to the OMR criteria and Fall X2 found in H3. SJR IE does not bound exports in H4. The D1641 Export to Inflow ratio (EI Ratio) considers total exports and inflow upstream of the NDD in the H4 scenario, whereas the H3 scenario considered SDD exports and inflow downstream of the NDD.

The metric for the high spring outflow criteria is average March through May Delta outflow. In a given year, the spring outflow requirement is dependent on the March to May Eight River Index. The spring outflow targets are as high as 44,500 CFS. If the March to May Eight River Index is below 6.547 MAF, then the only action taken to achieve the outflow target is to curtail exports. If the March to May Eight River Index is above 6.547 MAF, then Oroville releases can be made in April and May to achieve the average outflow target as long as Oroville is not projected to fall below 2 MAF storage by the end of May.

H4 Scenario Deficiencies

H4 modeling limits JPOD wheeling to remaining Banks Pumping Plant South Delta Diversion (SDD) permitted capacity (see page 4, footnote 2 above) regardless of whether the water is conveyed through SDD or NDD. Further description of this modeling deficiency is provided in the discussion of Boundary 1.

In the H4 scenario, exports are not subject to the SJR IE in April and May, and exports through the NDD facility can bypass OMR flow criteria and Banks permitted capacity, for purposes of exporting water South of Delta. There are years where exports in April and May would be curtailed to meet the high spring outflow criteria, but this would not occur in all years. While the EI Ratio is applied to total exports, it is not overly restrictive of export capacity for conveyance of stored water in the summer, and the high spring outflow criteria do not prevent exports in June, July, or August. However, as shown in **Table 1** through **Table 5** and discussed previously, H4 assumes there is *less* capacity than is available in the BA NAA for purposes of calculating the export-based SWP Table A allocations and export-based CVP SOD service contractor allocations. These model assumptions cause under-allocations for both the CVP and SWP, and as a result, potential negative impacts to upstream storage are underestimated.

Evidence that the H4 scenario underestimates CVP SOD service contractor allocations is shown in **Figure 18**. The same metrics used to calculate potential SOD supply in the Boundary 1 analysis are also used in the H4 analysis. Application of the EI Ratio to total exports was also considered. Each bar in **Figure 18** is labeled with that year's simulated CVP SOD Ag service contractor allocation. If the allocation is 100%, then no increase in allocation is possible, but if the allocation is less than 100% and there is both stored supply and conveyance capacity to meet that allocation, then the CVP SOD Ag service contractor allocation could have been increased. A true boundary analysis would have attempted to do this. In analyzing **Figure 18**, there are 32 years of the 82-year modeled period of record for which more than 200 TAF was available in total Shasta and Folsom storage, there was export capacity to convey the stored water, and CVP SOD Ag service allocations were less than 100%. For such years, modeled CVP allocations could be increased, and such modeled increases would indicate the potential for impacts to upstream CVP storage that are not shown in H4 scenario.

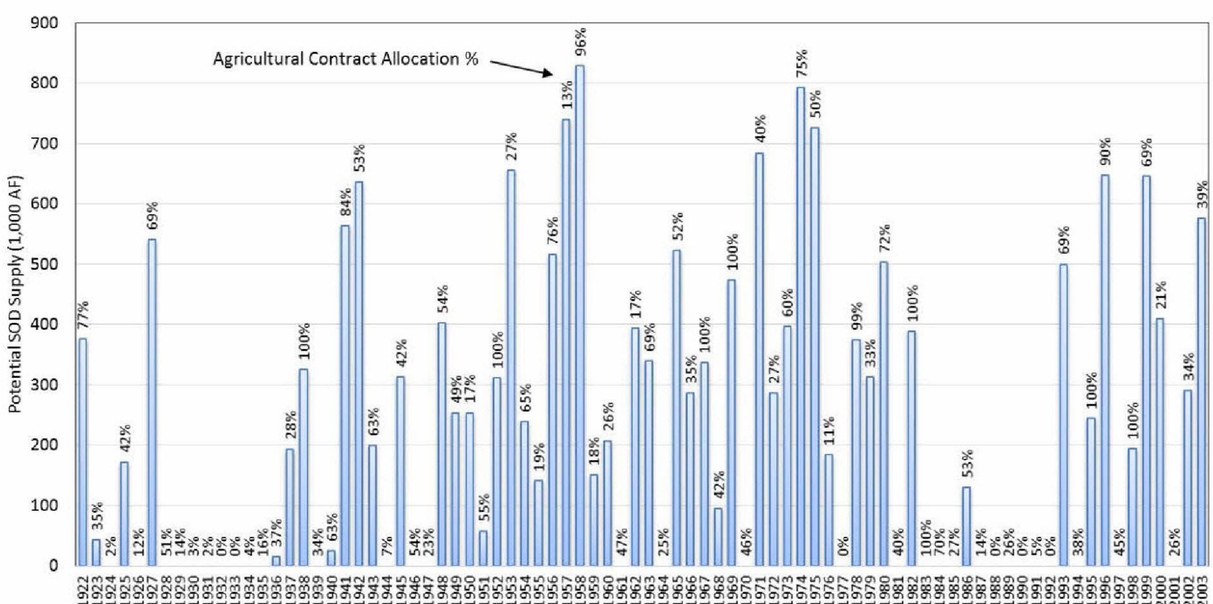

Figure 18. Ability to Increase CVP SOD Water Supply in H4 (minimum of available export capacity and available upstream storage)

Evidence that the H4 scenario underestimates SWP Table A allocations is shown in **Figure 19**. The same metrics used to calculate potential SOD supply in the Boundary 1 analysis are also used in the H3 analysis. Application of the EI Ratio to total exports was also considered. Each bar in **Figure 19** is labeled with that year's simulated SWP Table A allocation. If the Table A allocation is 100%, then no increase in allocation is possible, but if the Table A allocation is less than 100% and there is both stored supply and conveyance capacity to meet that allocation, then the modeled Table A allocation could have been increased. A true boundary analysis would have attempted to do that. As shown in **Figure 19**, there are 27 years of the 82-year modeled period of record for which more than 200 TAF was available in Oroville, there was export capacity to convey the stored water, and Table A allocations were less than 100%. For such years, modeled SWP allocations could be increased, and such modeled increases would indicate the potential for impacts to Oroville storage that are not shown in the H4 scenario.

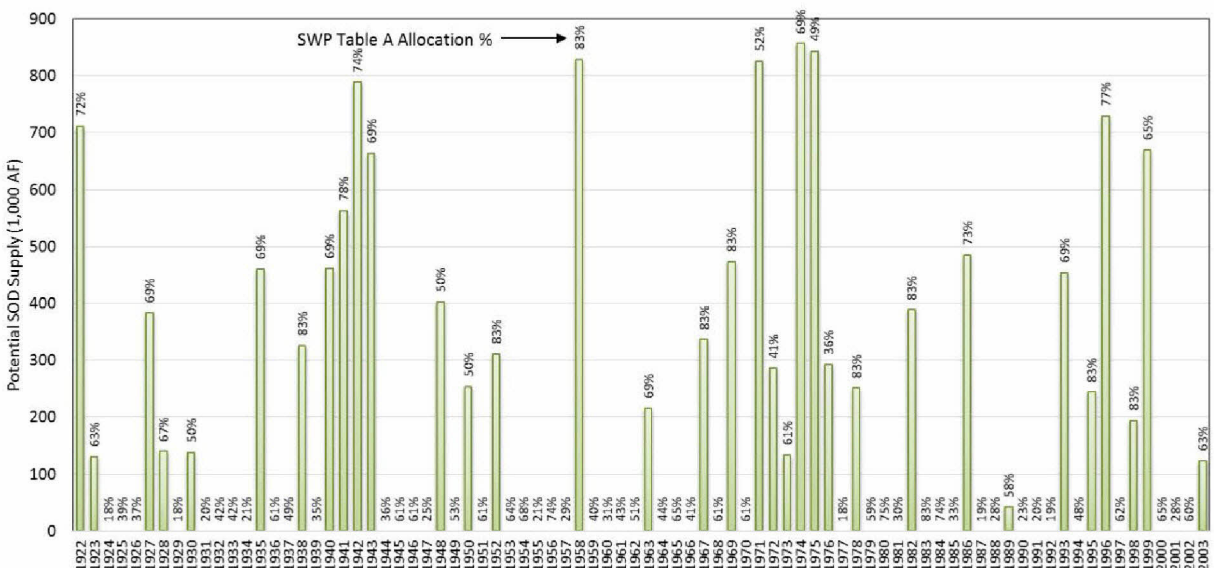

Figure 19. Ability to Increase SWP SOD Water Supply in H4 (minimum of available export capacity and available upstream storage)

Boundary 2 Scenario

Summary of Scenario

The Boundary 2 scenario has the same assumptions as the H3 scenario except the OMR flow criteria are more stringent, the Head of Old River (HOR) gate is closed more frequently, and there are additional Delta outflow targets throughout the year that are to be primarily met through export curtailments. The summer Delta outflow targets can be met through a combination of export curtailments and upstream reservoir releases as long as it is not a critically dry year.

Boundary 2 Scenario Deficiencies

Boundary 2 modeling limits JPOD wheeling to remaining Banks Pumping Plant South Delta Diversion (SDD) permitted capacity (see page 4, footnote 2 above), regardless of whether the water is conveyed through SDD or NDD. Further description of this modeling deficiency is provided in the discussion of Boundary 1.

In the Boundary 2 scenario, exports are not subject to the SJR IE in April and May, and exports through the NDD facility can bypass OMR flow criteria and Banks permitted capacity for purposes of exporting water South of Delta. While exports are supposed to be curtailed to meet the new Delta outflow targets, the scenario description does not say that the export facilities may not be used to re-divert stored water. This re-diversion of stored water in a given month would have no direct impact on Delta outflow in the same month because during balanced conditions the CVP and SWP will not release the stored water unless the export pumps can divert it. So, while the NDD facility would add significant export capacity to the CVP and SWP, as shown in **Table 1** through **Table 5,** and discussed previously, Boundary 2 assumes there is *less* capacity than is available in the BA NAA for purposes of calculating the export-based SWP Table A allocations and export-based CVP SOD service contractor allocations. This causes under-allocations for both the CVP and SWP and, therefore, underestimates potential negative impacts to upstream storage.

Evidence that the Boundary 2 scenario underestimates CVP SOD service contractor allocations is shown in **Figure 20**. The same metrics used to calculate potential SOD supply in the Boundary 1 analysis are also used in the Boundary 2 analysis. Each bar in **Figure 20** is labeled with that year's simulated CVP SOD Ag service contractor allocation. If the allocation is 100%, then no increase in allocation is possible, but if the allocation is less than 100% and there is both stored supply and conveyance capacity to meet that allocation, then the CVP SOD Ag service contractor allocation could have been increased. A true boundary analysis would have attempted to do that. Analyzing **Figure 20**, there are 48 years of the 82-year modeled period of record for which more than 200 TAF was available in total Shasta and Folsom storage, there was export capacity to convey the stored water, and CVP SOD Ag service allocations were less than 100%. This stored water would not meet any immediate Delta outflow targets and would remain in upstream reservoirs until spilled. Releasing this water for export and delivery has potential for impacts to upstream CVP storage that are not shown in Boundary 2 scenario.

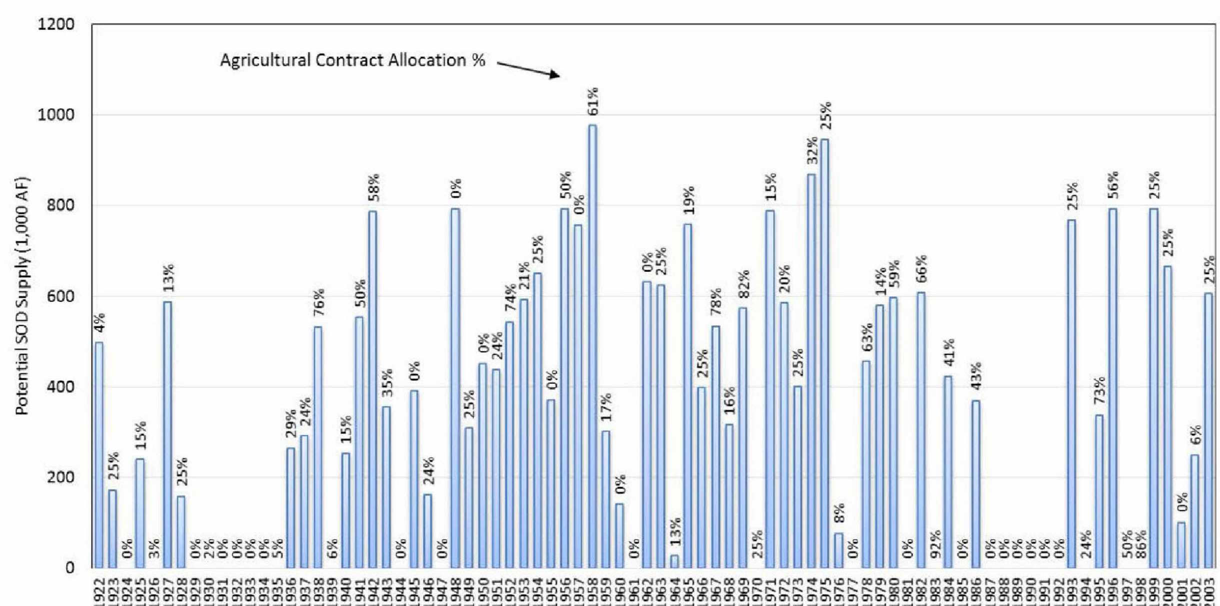

Figure 20. Ability to Increase CVP SOD Water Supply in Boundary 2 (minimum of available export capacity and available upstream storage)

Evidence that the Boundary 2 scenario underestimates SWP Table A allocations is shown in **Figure 21**. The same metrics used to calculate potential SOD supply in the Boundary 1 analysis are also used in the Boundary 2 analysis.   Each bar in **Figure 21** is labeled with that year's simulated SWP Table A allocation. If the Table A allocation is 100%, then no increase in allocation is possible, but if the Table A allocation is less than 100% and there is both stored supply and conveyance capacity to meet that allocation, then the Table A allocation could have been increased. A true boundary analysis would have attempted to do this. As shown in **Figure 21**, there are 60 years of the 82-year modeled period of record for which more than 200 TAF was available in Oroville, there was export capacity to convey the stored water, and Table A allocations were less than 100%. This stored water would not meet any immediate Delta outflow targets and would remain in Oroville until it spills. Releasing this water for export and delivery has potential for impacts to Oroville storage that are not shown in Boundary 2 scenario.

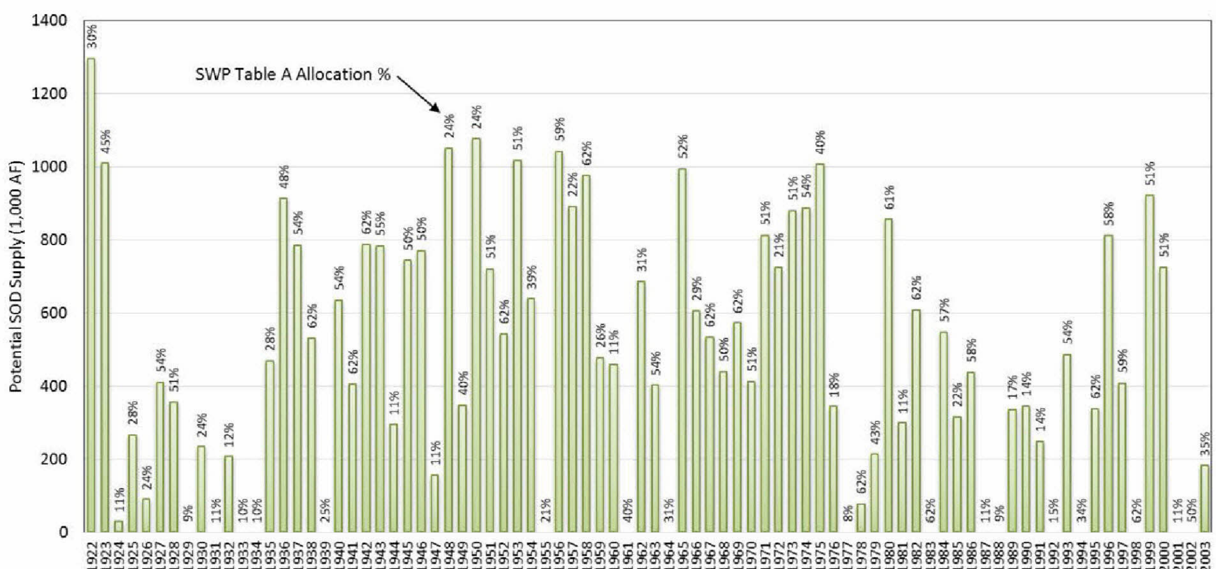

Figure 21. Ability to Increase SWP SOD Water Supply in Boundary 2 (minimum of available export capacity and available upstream storage)

Beyond the export estimate based allocation issue, the implementation of the Boundary 2 Delta outflow targets is problematic for other reasons. These Delta outflow targets that are intended to be met only with Delta export curtailments have no comparable requirements in current SWP and CVP operations and, therefore, do not have a basic framework for implementation. For each month of the Boundary 2 model simulation, the model first determines what the Delta outflow and exports would be if there were no additional Delta outflow target. If Delta outflow is short of the proposed Delta outflow target in that month, then Delta exports are cut by the amount that Delta outflow was short of the target, but exports are not cut by more than this amount. The following limits on export curtailments also apply:

- Banks Pumping Plant may not be cut below Health and Safety (H&S) pumping of 300 CFS.
- Jones Pumping Plant may not be cut below H&S pumping that varies between 600 CFS and 800 CFS.
- Jones Pumping Plant may not be cut below the sum of that month's exchange contractor deliveries, SOD refuge deliveries, DMC losses, and CVP San Luis evaporation.

The problem is that, even though exports are modeled as being cut, the water made available by the export cut does not always go directly to Delta outflow. **Figure 22** plots each of Boundary 2 simulated month's increase in Delta outflow with the same month's export curtailment (green dots). Much of the data follows a distinct line of equality – the dashed line where the increase in outflow equals the export curtailment. This represents the expected operation described in Boundary 2 scenario documentation. However, there are many points both above the line of equality and below the line. If export curtailments were intended to boost Delta outflow, then these data points that are not on the dashed equality line are unexpected. The points below the line represent months where exports were cut to meet an outflow target but the water was held in upstream reservoirs instead of going directly to outflow. This happens in months that the Delta is in balanced conditions. For such months, the model intentionally releases upstream stored water for exports before implementation of the Delta outflow target, and the model holds the water in storage instead of releasing it to outflow. The end result is higher carryover storage compared to the NAA as shown for Oroville in **Figure 23**. This additional carryover does eventually supplement Delta outflows, but only when Oroville spills.

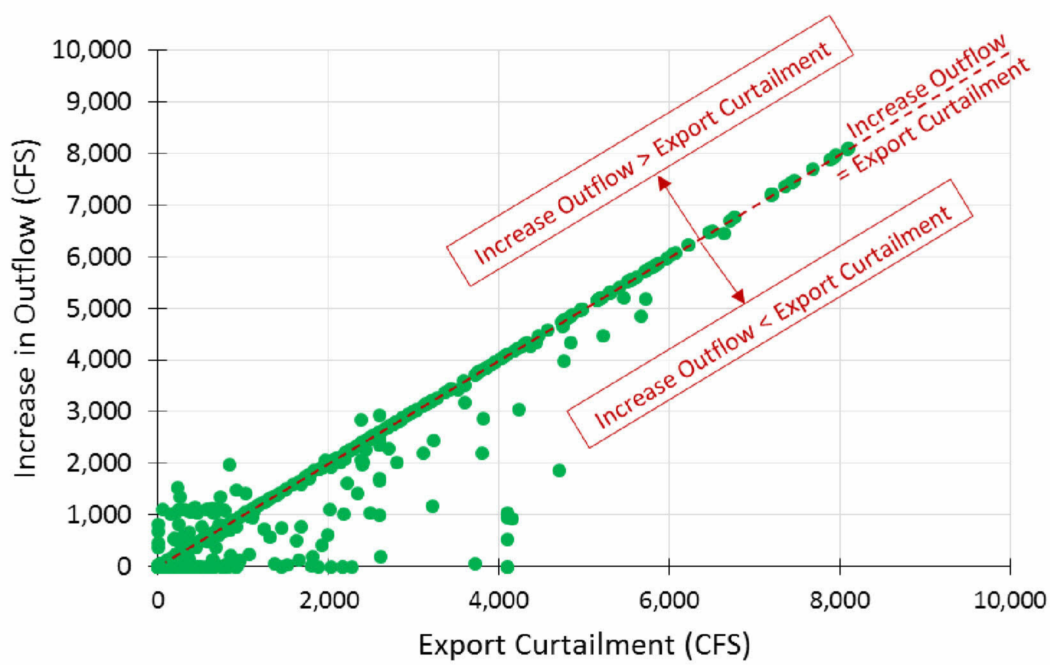

Figure 22. Increase in Outflow vs. Export Curtailment in Boundary 2

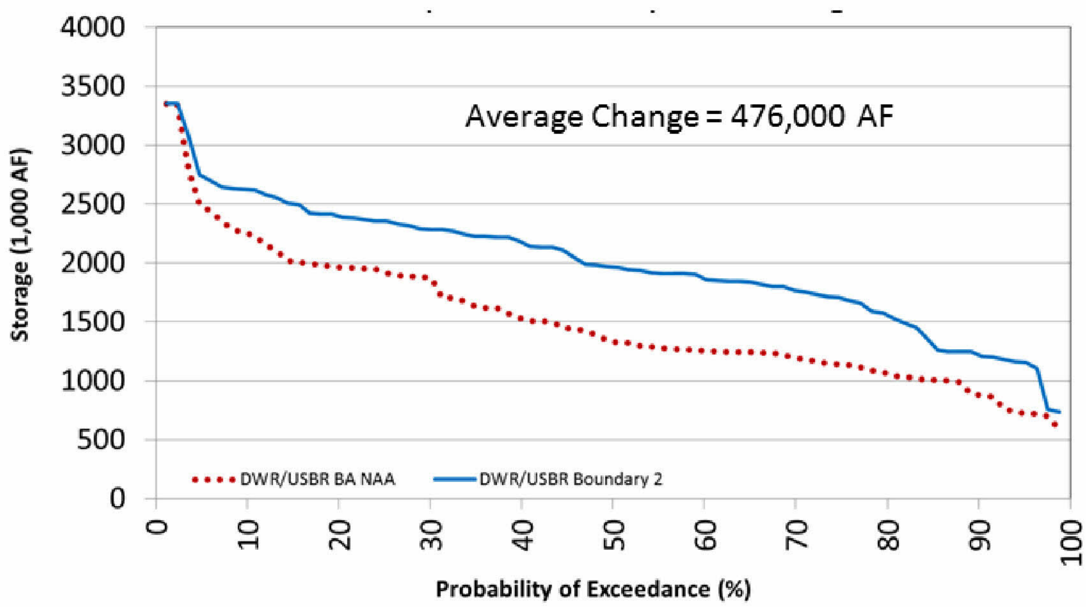

Figure 23. Oroville Reservoir carryover storage in Boundary 2 and DWR/USBR BA NAA

The export curtailments that are on the x-axis in **Figure 22** do not represent all export curtailments. These are the export curtailments intended to directly supplement outflow even though **Figure 22** shows that they do not contribute to Delta outflow for a significant number of months. There are other export curtailments that are not measured in the model and are not displayed in **Figure 22**. These are for Banks wheeling of CVP Cross Valley Canal contractor water and transfers of Lower Yuba River Accord (LYRA) water.

In Boundary 2, the average allocation to CVP Cross Valley Canal contractors is 29 TAF per year. However, none of this water is modeled as being delivered. The export curtailment constraints applied to generate outflow also prevent wheeling of CVC water. The water that would otherwise go to CVC contractors is held in Shasta or Folsom and contributes to increased carryover storage. Most of this is held in storage until the reservoirs spill. **Figure 24** and **Figure 25** compare Shasta and Folsom carryover, respectively, for the DWR/USBR BA NAA and Boundary 2.

In Boundary 2, the LYRA provides an average of 53 TAF per year of transfer water over the 82-year modeled period of record. This is the same as under the DWR/USBR BA NAA. However, Boundary 2 never delivers this water to SOD, but the NAA does. Instead, under Boundary 2 a significant portion of this water is held in Oroville and Shasta until those reservoirs spill. The export curtailment constraints prevent the export of LYRA transfers even though these curtailments make no direct contribution to Delta outflows when the Delta is in balanced conditions. The additional carryover storage does eventually end up as Delta outflow when the reservoirs spill.

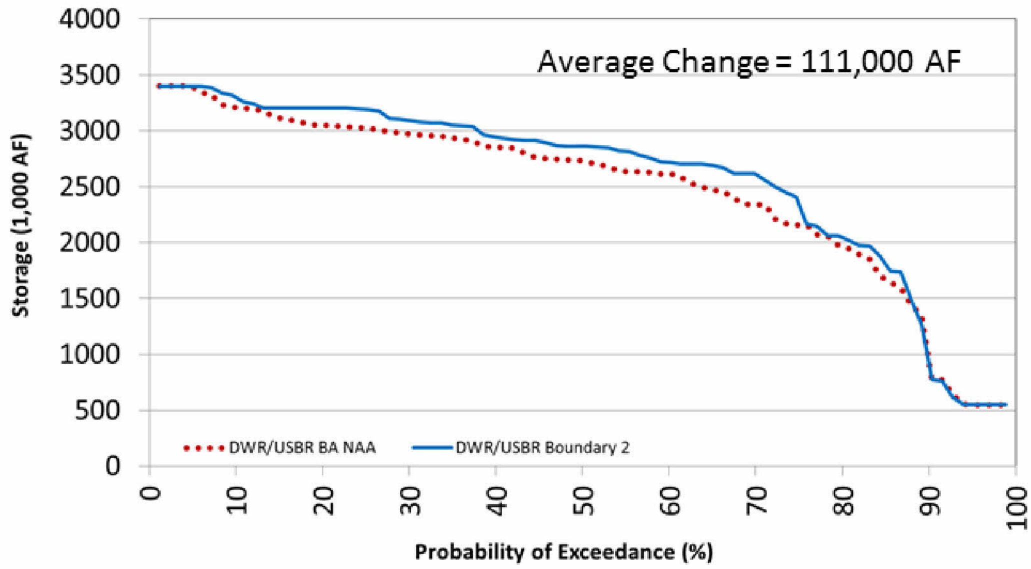

Figure 24. Shasta Reservoir Carryover Storage in Boundary 2 and DWR/USBR BA NAA

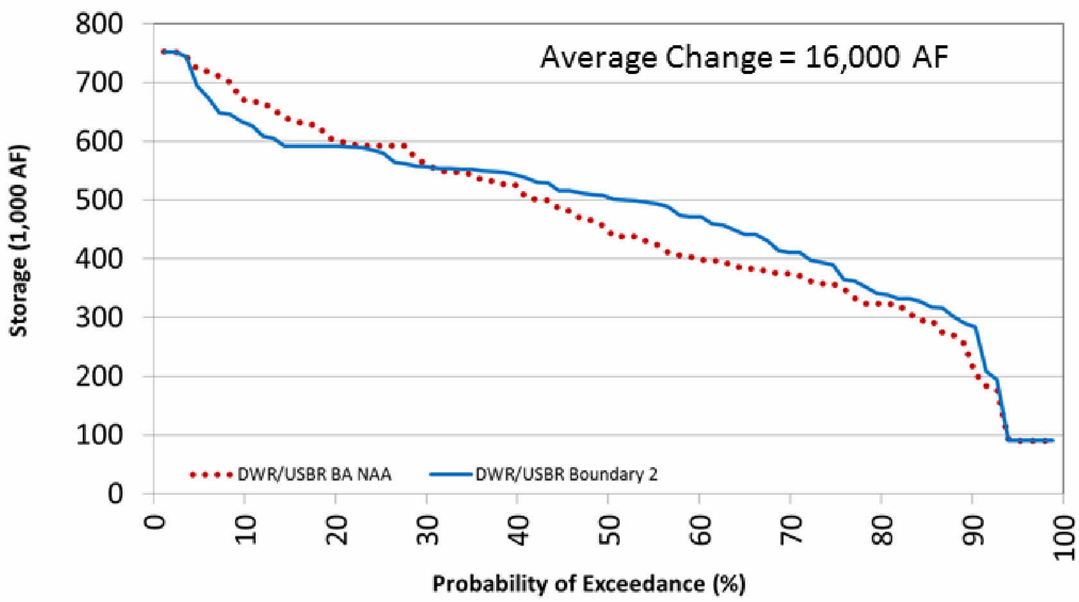

Figure 25. Folsom Reservoir Carryover Storage in Boundary 2 and DWR/USBR BA NAA

Figure 26 relates Boundary 2 Jones pumping after Delta outflow export curtailments are applied to Boundary 2 Jones pumping before export curtailments are applied for every month in the simulation. Points on the equality line indicate months where no curtailment of exports through Jones Pumping Plant was needed. Points below the line of equality indicate months where curtailments to Jones exports were made. Both these operations, represented by points on or below the equality line, are expected based on the description of Boundary 2. The data points that are not expected are those above the line of equality. This is largely caused by the model's intended protection of exports needed for San Joaquin River Exchange Contractor and refuge deliveries. The problem is that rather than just protecting these exports when desired, the applied constraint also is forcing these exports when the model would otherwise keep the water in upstream storage. The additional exports are not meeting any more San Joaquin River Exchange Contractor or refuge deliveries than were met in the BA NAA. The additional exports are only serving to keep CVP San Luis carryover unreasonably high. As shown in **Figure 27**, CVP San Luis carryover is 236 TAF greater in Boundary 2 than it was in the DWR/USBR BA NAA on average.

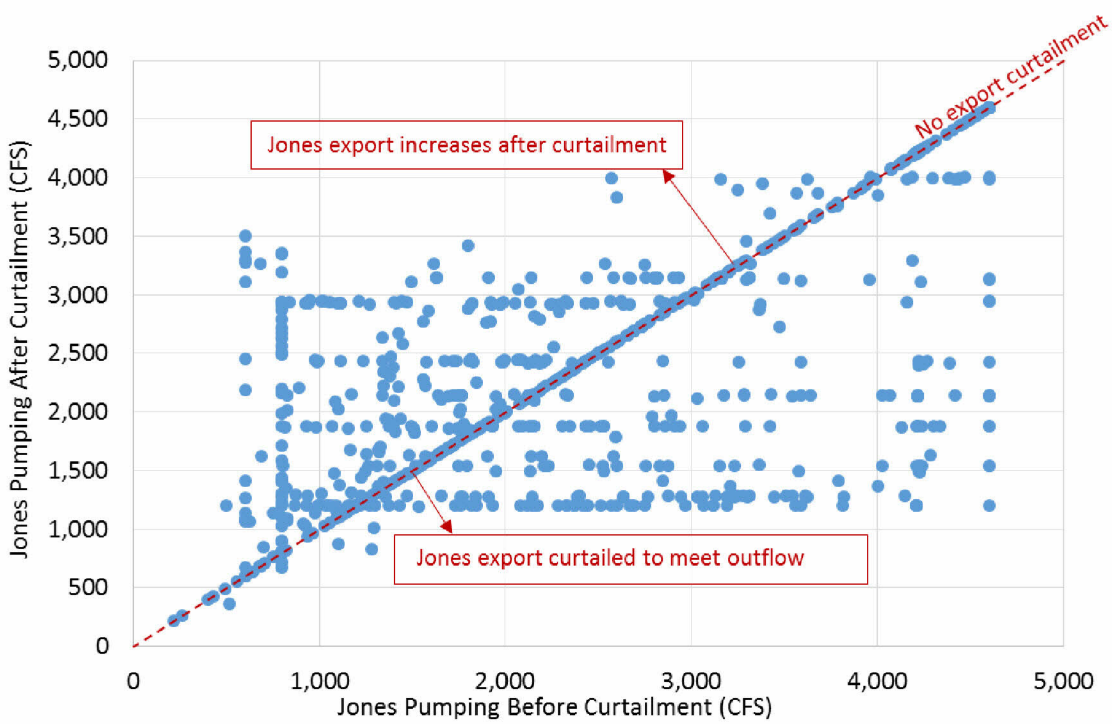

Figure 26. Jones Pumping after Delta Outflow Target Export Curtailment vs. Jones Pumping before Delta Outflow Target Export Curtailment in Boundary 2

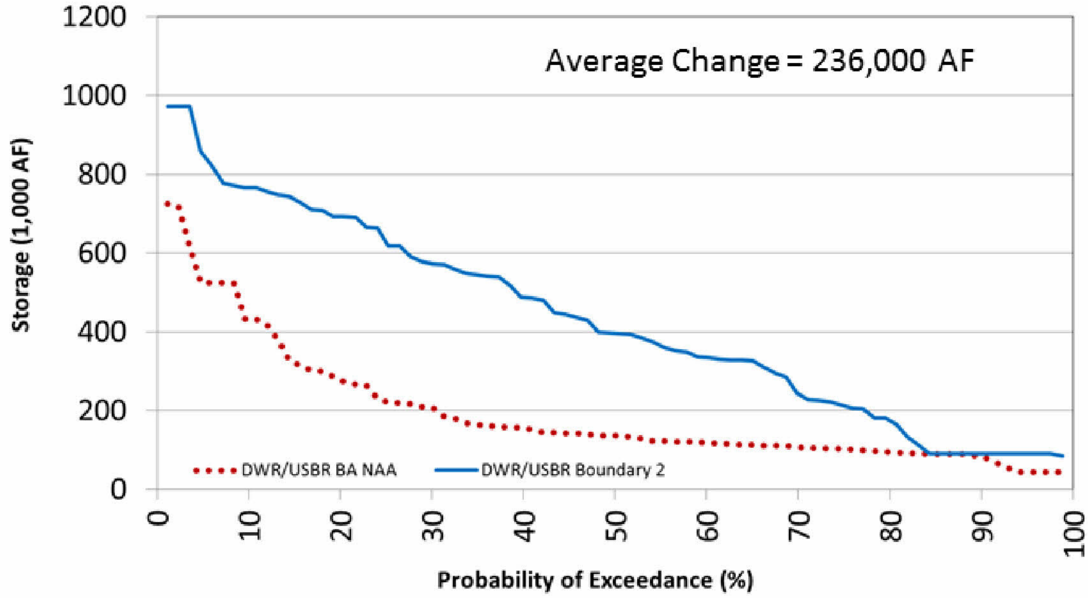

Figure 27. CVP San Luis Carryover Storage in Boundary 2 and DWR/USBR BA NA

Figure 28 relates Banks pumping after curtailments to Banks pumping before curtailments in each month of the Boundary 2 simulation. As shown in this figure, many data points are on the equality line (dashed), representing months for which there are no curtailments of Banks exports. Many data points are on the horizontal line where Banks pumping after curtailments equals 300 CFS. This represents months for which Banks exports were curtailed to Health and Safety levels. All data points below the equality line represent Banks Pumping Plant curtailments to meet a outflow target. While the intention is to augment outflow, as shown in **Figure 22** and **Figure 23**, that is not the result. Instead, for many months, some of the water for export cuts is stored in Oroville.

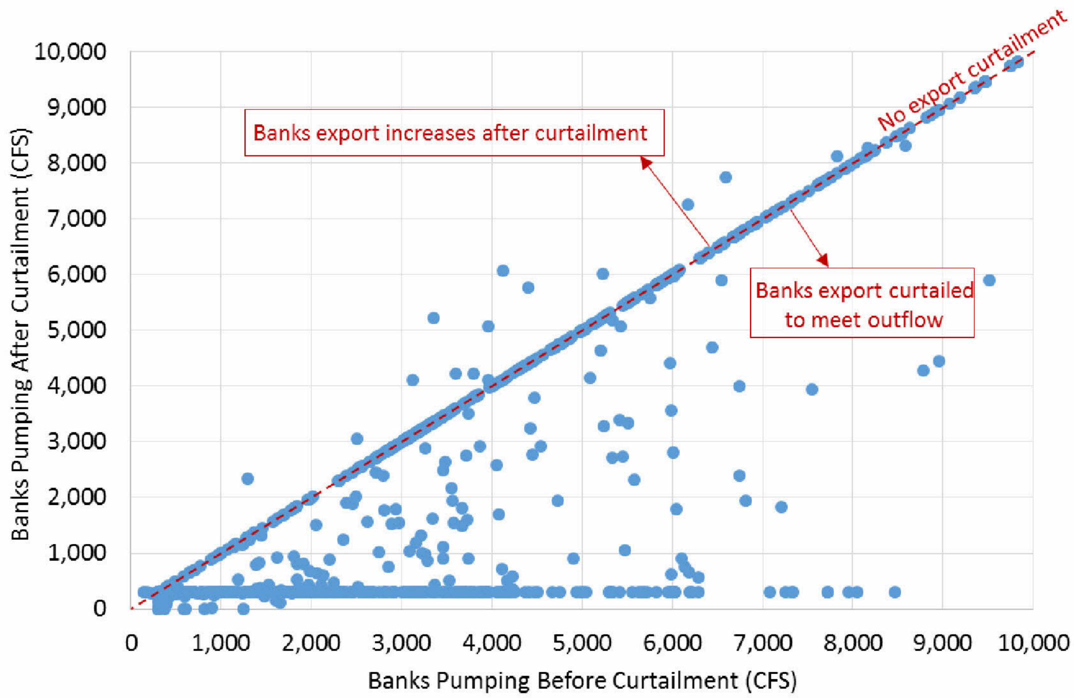

Figure 28. Banks pumping after curtailment vs. Banks pumping before curtailment in Boundary 2