OFFICE MEMO

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INTRODUCTION

The U.S. Bureau of Reclamation (Reclamation) and MBK Engineers identified some problematic behaviors in the latest versions of CalSim and CalLite. Reclamation proposed various code changes to resolve the problems. While DWR's Bay-Delta Office was reviewing those issues and proposed code changes, additional problems with the planning models were identified. DWR made refinements to the code changes proposed by Reclamation and made additional code changes to resolve the newly identified issues.

This document describes the: problematic behaviors in the model, implemented code changes, and overall result impact. Examples of these issues and the results are found in Appendix A. The CalLite model was used to diagnose the issues and to perform code change sensitivity. Similar code changes were implemented into the CalSim model and results were compared to those of CalLite (see Appendix B).

PROBLEMATIC MODEL BEHAVIOR

1. Export-Inflow ratio sharing logic
2. Hood "MIF" based on export estimates and other Delta "MIF"
3. Banks pumping plant pumps CVP water for SWP Health and Safety requirement (300cfs)
4. Unnecessary export cuts under BO RPA and the B2 VAMP Export Restriction
5. Feather river flow compliance in November restricts Oroville release for Banks Pumping Plant Health and Safety requirement and SWP COA obligations (300 cfs)

Issue 1: Export-Inflow (EI) Ratio Sharing Logic

Reclamation and DWR have agreed to share available export capacity when Delta exports are controlled by the Export-Inflow (EI) ratio according to D-1641 Water Quality Control Plan (WQCP) Standards. However, the EI sharing implementation in CalSim and CalLite is causing the following issues:

(1) Even when exports are not controlled by the EI ratio per D-1641 standards, model logic encourages the projects (CVP and SWP) to limit export under COA to 50% of the EI ratio limits. Therefore, unused water of one project is picked up by the other project. An example of this model result is shown in the Appendix A (Case 1.1).

(2) Due to the way these penalties for export of water over this 50% threshold and for surplus delta outflow balance with the weights on NOD and SOD storage, there are, at times, unintended releases from upstream storage to increase SOD exports. Two hypothetical situations are described in the Appendix A (Case 1.2).

(3) If CVP reservoirs are releasing for minimum flows or for flood control and Jones has the capacity to export this water but is controlled by the EI sharing constraint even though the EI ratio is not controlling

total exports, the penalty for *not* sharing EI capacity can encourage SWP to release water from Oroville (i.e. increasing delta inflow) to allow Banks to export the same as Jones, even if this would fill SWP San Luis above rule curve. Reclamation reported this issue, but DWR did not find this specific situation in the model. DWR recognizes that this issue can occur.

Issue 2: Hood MIF based on Export Estimates and other Delta MIF

Flow into the Delta is needed to meet Delta water quality criteria and to provide sufficient water for exports. The model estimates both of these needs and imposes a minimum instream flow (MIF) requirement at Hood (Hood MIF) that acts to pull water from upstream reservoirs into the Delta. The Delta has other flow requirement locations (e.g., Sacramento River at Rio Vista) and the model imposes the constraints to meet those MIFs. The following model issues are related to MIF:

(1) In cases where the export estimate (based on allocated water supply) for the SWP is higher than storage conditions in Oroville can support, the MIF requirement pulls water from CVP storage facilities to support the SWP export. This distorts the level of Delta Inflow, affects overall export levels and associated capacity sharing goals, and, at times, prevents the CVP from exporting the water it released to support the Hood MIF. This code issue stems from the use of the Hood flow requirement as a modeling device and to the over-estimating of SWP delivery capacity.
In any of the recent baselines, SWP San Luis hits bottom on a regular basis and SWP deliveries are shorted as a result. This problem is masked somewhat by the model getting water for the Hood "MIF", based on the export target from CVP reservoirs when Oroville can't make releases. Please see example in Appendix A (Case 2.1).

(2) To meet the flow requirements at MIF locations (Hood and Sacramento River at Rio Vista), weights on NOD and SOD storage and the penalties for unused Federal water for export are creating unintended operations (e.g., releasing water from CVP reservoirs and exports through Banks pumping plant as unused CVP water). See Appendix A (Case 2.2).

Issue 3: Banks pumping plant pumps CVP water for SWP Health and Safety (H&S) requirement

In some instances, Banks pumping plant pumps CVP water for SWP minimum health and safety requirement (300 cfs). In these scenarios, Oroville is usually not at the dead pool level or even at the 1.2 MAF storage target. Oroville releases water for IBU, but not enough to meet the H&S requirement. Due to high penalties for releasing Oroville water and weights on other variables, the LP solver finds the maximum objective function by taking CVP water. An example is shown in Appendix A (Case 3.1).

Issue 4: Unnecessary export cuts under BO RPA and the B2 VAMP export restriction

Under the BO RPAs and the B2 VAMP export restriction, model logic for sharing of export capacity unreasonably constrains one project when the other chooses not to use its entire share. If the RPA and OMR controls lead to export reduction in the last cycle of the model, each project is forced to put water back. In these instances, CVP gives up some water and then Banks pumps this water in the form of unused Federal share, because CVP could not put the water back in storage since it was releasing for minimum flows.

Issue 5: Feather River flow threshold prevents SWP from meeting COA obligations and Banks PP health and safety requirements

For the latter half of October and all of compliance in November, if flows in the Feather River exceed a given threshold then those flows must be maintained through the end of March. Since these required flows can be a significant restriction on Oroville storage, operators actively avoid crossing the October/November Feather River flow threshold. In CalLite and CalSim, a highly negative penalty is placed on crossing this threshold in order to replicate this operational bias. However, this negative weight was inhibiting SWP from releasing enough water from Oroville to meet its COA obligations and its health and safety requirements at Banks. Instead, the models have CVP either release water or reduce exports to make up for this SWP release deficit. In real-time operations, this would be a viable solution since the SWP could make the water up to the CVP at a later date. However, in CalLite and CalSim, such balancing of the COA account at a later date is not implemented, so the Feather River threshold was causing an unrealistic water supply gain for the SWP at the expense of the CVP.

IMPLEMENTED CODE CHANGES

Issue 1: Export Inflow (EI) Ratio Sharing Logic cases

An initial cycle ("Upstream") was added to determine Delta operations under D-1641 standards when responding to upstream control on releases and no release to support exports beyond health and safety requirements. Using this cycle output information, if EI controls the Delta exports, model logic constrains appropriate 50% sharing logic in COA. If EI does not control, constraints in latter cycles are implemented to insure that if a project decides to push exports against the EI, then that project pays the associated carriage and the other project does not. While addition of this third cycle is necessary to provide information for the later cycles, it also increases the model run time. See Appendix A for detail on code changes and their effect on results.

If a project exports aggressively against EI constraint, the COA logic has been refined to prevent incurring the carriage cost from the other project.

Issue 2: Hood "MIF" based on Export Estimates and other Delta "MIF"

SWP export estimation procedure was modified to account for Oroville storage. As mentioned above, the SWP export estimate often exceeds what Oroville will release during droughts. The model uses output storage information from the first cycle to estimate SWP export in the second cycle. In the modified SWP export estimation method, DWR proposes a new step function to better reflect how much Oroville can release for exports.

The CVP San Luis rule curve was made conditional on Shasta and Folsom storage. This affects both the balancing decisions between NOD and SOD storage and the calculation of estimated CVP exports that is used to set the upper bound on C_Hood_MIF.

Issue 3: Banks pumping plant pumps CVP water for SWP Health and Safety (H&S) requirement

In the model, releases from Oroville occur through C_Orovl_IBU and C_Orovl_EXP. C_Orovl_IBU is assigned to meet the IBU need and C_Orovl_EXP is assigned to meet the export need. C_Orovl_IBU was relaxed by increasing the highly negative weight of C_Orovl_IBU from -3000 to -1250.

Issue 4: Unnecessary export cuts under BO RPA and the B2 VAMP export restriction

Code was modified so that sharing of available export capacity under the BO RPA and the B2 VAMP export restrictions would not unreasonably constrain one project when the other project is not using its entire share. When exports are restricted due to a BO RPA control or to the B2 VAMP export restriction in the final cycle of the model, the modified logic allows Banks and Jones pumping plants to cut back exports equally when necessary, allowing one project to use more than half of the available export capacity if the other project is trying to keep upstream releases in support of exports to a minimum.

Issue 5: Feather River flow compliance in November restrict on Oroville release

To allow Oroville releases to exceed the October and November Feather River flow thresholds in order to meet SWP COA obligations and Banks health and safety requirements, an integer was introduced into the penalty constraint. If an exceedance of the Feather River threshold is necessary to meet COA obligations and health and safety requirements, the integer is set to zero and the threshold is relaxed. If Oroville releases enough water and D_Banks_exp1 exceeds 300 cfs, the integer switches to 1 and the threshold penalty is applied. In the following months (Dec - Mar), the Feather River minimum instream flow requirement is then conditioned on whether or not the threshold was exceeded to support health and safety. If the threshold is exceeded solely to support COA and health and safety, Oroville is not required to make higher releases from Dec-Mar as a consequence. However, if it is determined that the October or November threshold was exceeded to support exports above health and safety, then the subsequent higher instream flow requirements apply.

DISCUSSION OF OVERALL EFFECTS

Table 1 summarizes the average differences (in TAF) in Delta inflow and outflow, Delta exports, SWP deliveries, and CVP South of Delta deliveries due to the implementation of all code changes discussed above. Figure 1 compares Banks and Jones exports from the base and updated models (referred to as Base and DWR Fix respectively in the text, tables and figures below). The results were obtained from the CalLite model which mimics the operation logic of CalSim II. We expect CalSim II to show similar impacts. Note that the Base model was released in October 2011 for public use and contains all the issues discussed above. The DWR Fix model has potential corrections for these identified issues.

The table indicates that, after the code fixes in the model, the long term (1922-2003) impacts on CVP and SWP exports and deliveries are relatively small, but pronounced impacts are seen on the SWP during the 1929-1934 and 1987-1992 droughts. During these dry periods, the Base model allowed significant CVP NOD releases to meet SWP IBU obligations and to support SWP exports. The DWR Fix model eliminates this artificial support. This has a positive impact on CVP exports and deliveries. In the Base model, the CVP releases made for SWP benefit had negative impacts on CVP deliveries and exports in the long-term and during the droughts. These negative impacts have been eliminated in DWR Fix.

	LongTerm	Dry Periods	
	1922-2003	1929-1934	1987-1992
Delta Inflow	-10	-77	-175
Delta Outflow	-17	16	-7
Delta Exports	8	-101	-166
Banks SWP	-14	-153	-225
Banks CVP	-2	11	4
Tracy	24	52	59
SWP Deliveries	-18	-73	-166
CVP SOD Deliveries	22	37	51

Table 1: Difference between the Base and DWR Fix results for dry periods and for entire simulation period. SWP deliveries include Table A, Article 21 and Article 56 deliveries.

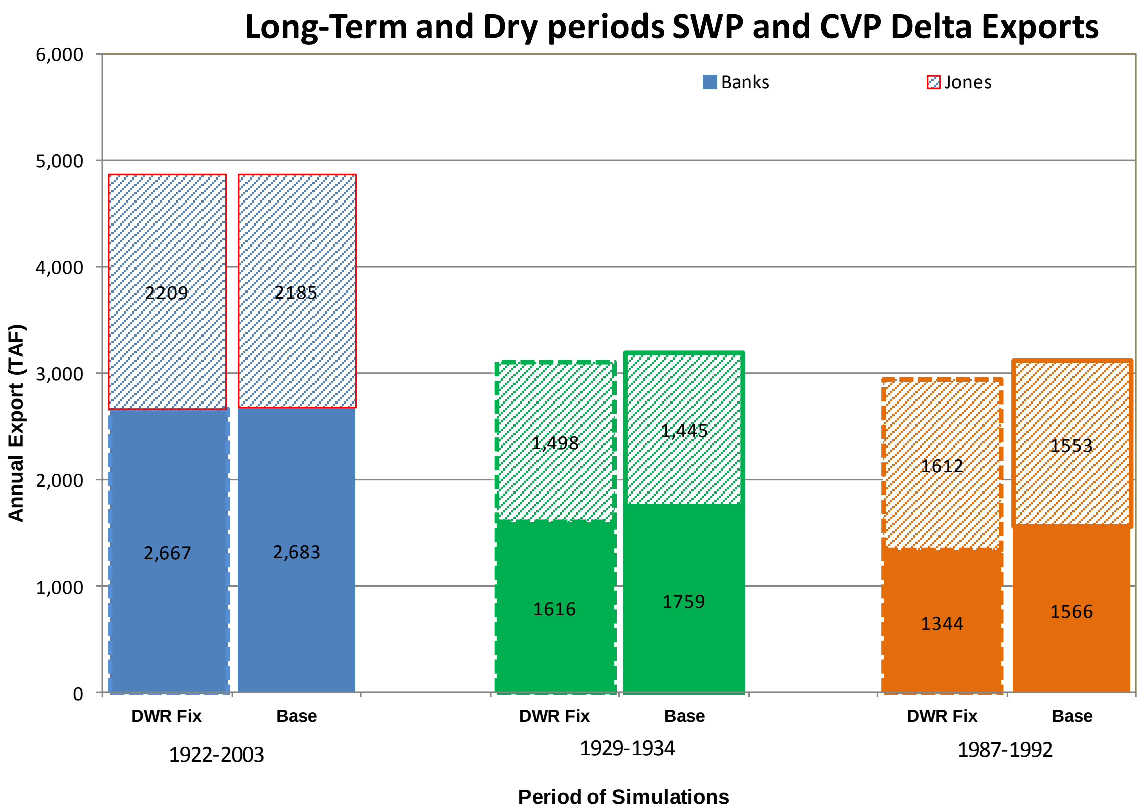

Figure 1: Banks and Jones annual exports for dry periods and entire simulation period. Banks exports include CVP wheeling.

Impacts of the model edits to North of Delta CVP and SWP storage are shown in Figures 2 and 3. The figures show that Shasta storage increased while Orville storage has decreased with DWR Fix. Shasta can hold more water because it releases less water for SWP allocation, while Oroville releases more water to support SWP's own need.

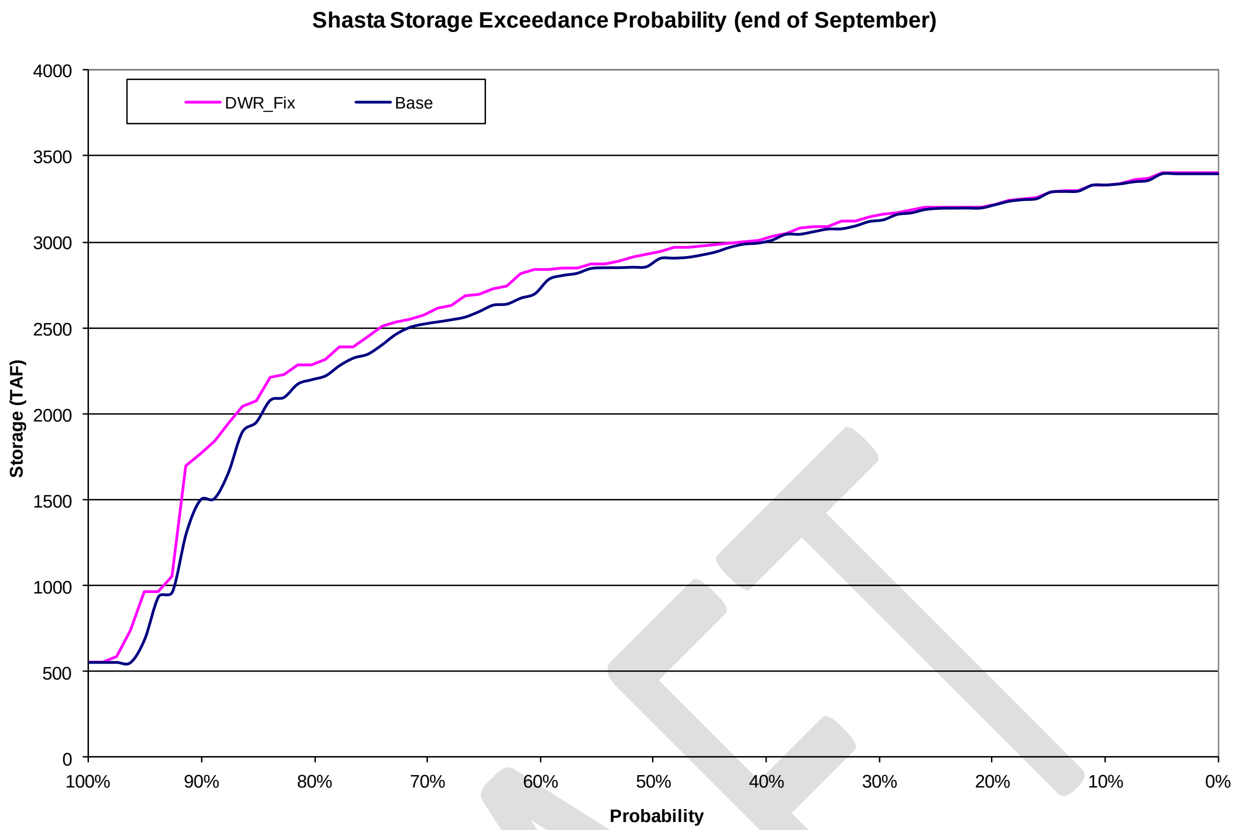

Figure 2: Shasta Exceedance plot for end of September storage.

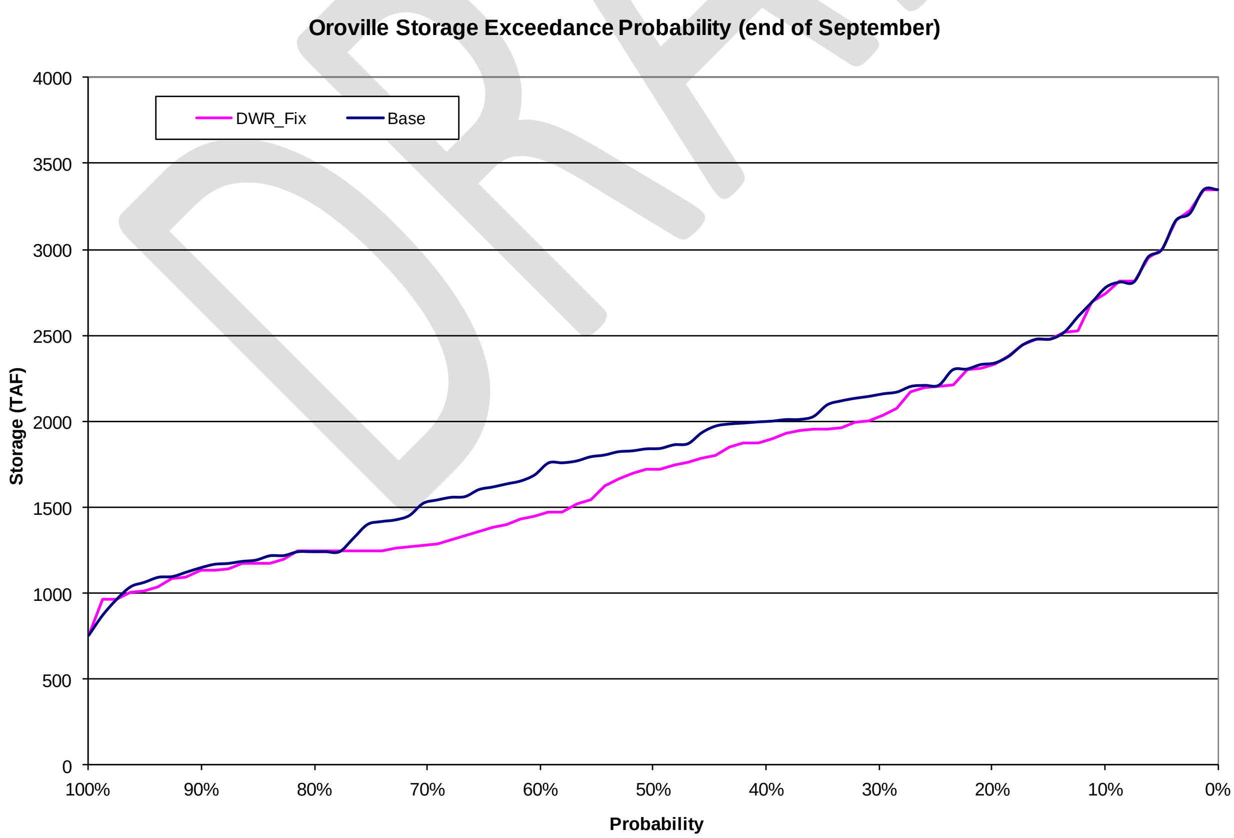

Figure 3: Oroville Exceedance plot for end of September storage.

REMAINING ISSUES

(1) With the implemented changes to the EI ratio sharing logic, the SWP now more frequently pushes the EI ratio to deliver Table A allocations and maintain San Luis carryover. Both CalSim and CalLite have weighted the San Luis rule curve such that Oroville will release against the EI ratio to support exports. The original (pre code changes) implementation of the EI sharing logic often prevented this. Now that it is occurring more frequently, we need to determine whether or not SWP operators would aggressively push the EI constraint even though 35% of the additional release is lost the Delta outflow. If not, the priority structure within CalLite and CalSim will need to be adjusted.

After further investigation, we found that the complicated code fix does not yield in any result (Total exports and Delta outflow difference is not more than 2 TAF) difference in terms of long term. However, some difference is shown in month by month basis.

(2) The solution to Issue 5 (the October-November Feather River flow threshold was preventing the SWP from releasing enough water from Oroville to meet its IBU obligations and maintain H&S exports at Banks Pumping Plant) involved relaxing the flow threshold criteria when necessary. This relaxation happens frequently when Fall X2 is in effect. In real-time operations, the more likely scenario is that the CVP would make NOD releases to support the SWP in October and November as necessary and the SWP would repay the CVP at a later date. This repayment mechanism is not currently represented in CalLite and CalSim. COA accounts are automatically balanced, with no payback, at the end of each month. We need to determine if the Feather River criteria should be removed from the model altogether (acknowledging flow in the model assumptions) or if a mechanism for reconciling COA accounts over many months (rather than one month) should be implemented.

(3) The SWP and CVP allocation logic is now out of date in the DWR Fix model. SWP San Luis is often drawn down to dead pool and SOD shortages are more frequent than in the Base model. The SWP WSI-DI curve and export based allocation logic must be refined to reflect the reduction in water supply to the SWP, particularly during droughts.

(4) Rock Slough constraint files need to be revised as the first segment of slope constraint was not implemented throughout the Rock Slough related code logic. Recently, we found this issue was causing some problems in D1485 implementation.

Rock Slough ANN files are updated to constrain the flow requirement uniformly.

SUMMARY

As discussed above, recent versions of CalSim and CalLite contained operational logic that caused the unintentional transfer of CVP and SWP water supply as defined under COA from one project to the other. The impacts were most pronounced during droughts. Overall, the SWP benefited from the unintended transfers at the expense of the CVP.

Reclamation and DWR have proposed a number of model edits to resolve these issues. These changes result in lower deliveries to SWP contractors during the 1929-1934 drought and 1987-1992 drought and overall lower Oroville storage. Conversely, CVP contractor deliveries and NOD storage are increased. Given the significant attention on drought year operations made in project water supply reliability studies and planning studies focus, it is recommended that the code changes proposed in this document are adopted in future versions of CalSim and CalLite.

APPENDIX A: Demonstration of Problematic Behavior and/or Effects of Code Modifications

Example outputs were obtained from the released CalLite 2.01 model with the following assumptions: Biological Opinion run basis, future land use (LOD), future/ full Table A demand; D-1641 and BO regulations, wheeling, JPOD, and intertie.

Issue 1: Export Inflow (EI) Ratio Sharing Logic cases

Case 1.1: Even though exports are not controlled by the WQCP EI Ratio, the model logic imposes a restriction on project exports.

Date / Time	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_JONES	D_JONES_EXP1	D_JONES_EXP2	D_EXPTD	EIEXPCTRL	0.5*EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
30 Sep 1924, 24:00	1454.1	419.5	1034.6	2934	2934	0	4388	5868	2934
..									
..									
31 Mar 1925, 24:00	3576.4	3576.4	0	2930.4	2429.3	501.12	6507	7153	3576.5

On September 1924, total exports D_EXPTD (4,388 cfs) are lower than EI export control EIEXPCTRL (5,868 cfs). The EI ratio is not controlling the exports, but the model applied a 50% sharing logic to restrict the CVP exports to 2,934 cfs, leaving 1,034.6 cfs of unused Federal share to be picked up by the SWP (D_BANKS_EXP2). Note that D_JONES_EXP1 refers to CVP's share of available water supply as defined under COA and D_BANKS_EXP2 represents CVP's unused share (due to physical and/or regulatory constraints) that SWP picked up.

Similarly, on March 1925, Jones pumping plant (D_Jones_EXP2) picked up unused State water.

Case 1.2: Occurs in a situation where:

- Jones is exporting to full DMC capacity,
- EI ratio is not controlling total exports,
- Banks export of state share under COA is 50% of the allowable export under E/I, and
- SWP San Luis (SWPSL) is below the rulecurve and there is capacity at Banks to pump additional water

The model favors SWP exports with a blend of water from Oroville and CVP storage releases under the sharing constraint, thereby allowing CVP release of unused federal share until some other export constraint applies. The hypothetical examples below show how the constraints and weighting scheme of CalSim and CalLite logic allow this operation.

Hypothetical 1:	Jones PP	4400 cfs	all exp1	full DMC capacity
	Banks PP	5600 cfs	all exp1	
	SWP SL	below rulecurve		
	EIExpCtrl	11,200 cfs		

not controlling total exports, but SWP exports are equal to the 50% sharing bound
Oroville at level 3 storage and above 1 MAF
Delta is in balanced conditions.
<u>In CalLite/CalSim, would Oroville release water for export under these conditions?</u>

Variable	s_orovl_3	banks_exp1	Unused_FS	s_slswp_3	EiExpCtrl	0.5*EiExpCtrl	surpl01709	Total
Weight	88	0	-1285	1235	0	0	-1290	
Flow Change (cfs)	-1	1	0	1	0.65	0.325	0.675	
OBJ Diff	-88	0	0	1235	0		-870.75	**276.25**
								Yes

Hypothetical 2: Take the above circumstance, assume Oroville is releasing an additional 100 cfs for export
Banks PP 5700 cfs all exp1
EIExpCtrl 11265 cfs
not controlling total exports, but SWP exports are now in surplus of 50% sharing bound
Shasta at level 3 storage
Would the model release Shasta storage for SWP export under these conditions instead of Oroville water?

Variable	s_shasta_3	banks_exp1	Unused_FS	s_slswp_3	EiExpCtrl	0.5*EiExpCtrl	surpl01709	Total
Weight	88	0	-1285	1235	0	0	-1290	
Flow Change (cfs)	-1	0	1	1	0.65	0.325	-0.325	
OBJ Diff	-88	0	-1285	1235	0		419.25	**281.25**
								Yes

In the first hypothetical situation, imagine that Jones is at full capacity and Banks is pumping up to half of its share under EI (half of 11,200 is 5,600). EI is not controlling total exports at this point. Oroville is at level 3 and the delta is in balanced conditions. The table shows the effect that a release of 1 cfs from Oroville would have on the objective function – there is a clear benefit to the system taking a penalty for violating the sharing rule to export an additional 1 cfs.

Now extend hypothetical situation #1 to the point where Banks is pumping an additional 100 cfs beyond its EI share. This is hypothetical situation #2. EI is still not controlling total exports, but Banks is now in surplus of the 50/50 split. The table shows that a release of one cfs from Shasta, instead of from Oroville, actually results in a greater benefit to the objective function than the release of one additional cfs from Oroville. The release from Shasta causes a penalty for the creation of a unit of unused federal share (Unused_FS), but that is outweighed by the combined benefit of the additional storage resulting in SWP San Luis (s_slswp_3) and the surplus penalty that does not result from SWP further violating its E/I share (surpl01709).

Given a choice at this juncture between a benefit of 281.25 and 276.25, the solver will elect to pull water from Shasta instead of Oroville. In this way, the model favors SWP exports with a blend of CVP and SWP storage releases (under the EI sharing constraint), up until some other constraint applies or San Luis hits its rule curve.

Code Changes

All Cycles:

(1) Main_BO.WRESL: Added a new initial cycle just to run with D-1641 regulations (no wheeling) with minimum Delta exports.

(2) Weight-table.wresl: Changed the weight of C_Delta_ANN from -2010 to -2050. This is part of the solution to prevent carriage cost paid by the other project, while one project is pushing against EI share.

Cycle 1 (Upstream):

(3) COA_up.wresl: Added new COA_up.wresl file (a modification of COA.wresl). In COA_up.wresl, EI and Apr-May sharing constraints are commented out and replaced with soft constraints that discourage releases for exports above H&S.
The C209_np_exc and C209_prj_exc variables were introduced to overcome a mismatch between the DSA diversion requirement and point of diversion demand constraints. The high negative weights on each was intended to limit their use to timesteps where there was a disconnect. In the upstream cycle, when negative weights are added to exports and DO, it upsets the weighted balance and EXC arcs end up diverting much more water than intended. This was noticed in a D1485 study because DCC operations in the BASE cycle are dependent on flow at Hood in the UPSTREAM cycle (25,000 cfs flood trigger). There was one timestep where the EXC diversions lowered C_hood below 25,000 cfs in the Upstream cycle, but when they stopped diverting in the BASE cycle, C_Hood went well above 25,000 cfs. This led to the wrong decision to leave the gate open. The EXC diversions were also occurring in D1641 and BO studies, but there was no observed impact on the BASE and BO cycle results. However, that doesn't mean it can't cause problems. The key point is that diversions on the Feather river should

remain constant from cycle to cycle (except for diversion to storage in Oroville). The negative weights on Exports and DO in the UPSTREAM cycle were causing them to fluctuate significantly from cycle to cycle.

(4) ExportEstimate1_up.wresl: Added new ExportEstimate1_up.wresl file (a modification of ExportEstimate1_up.wresl). The export estimate for the Upstream cycle is limited to exports necessary for Health & Safety, so that C_Hood_mif does not encourage additional releases for export.

Cycle 2 (Base):

(5) COA.wresl: Edited so that the EI and Apr-May export capacity sharing constraints are conditioned on EI or Apr-May export constraints controlling in the Upstream cycle (otherwise the sharing constraints are not applied). New code contains the solution to prevent carriage cost paid by the other project while one project is pushing against EI share. When NOT controlling in the Upstream cycle, EI sharing logic is turned off and protections are implemented to prevent one project from incurring the carriage costs if the other project is aggressively pressing against the EI constraint in the remaining cycles.

(6) Apr_may_maxexport.wresl: Extended the conditional on the goal constraining AprMayExpCtrl to all months, so the variable could be used in the COA.wresl conditional statement for sharing export capacity.

Cycle 3 (B2_BO_DailyWeir):

(7) COA_BO.wresl: Replaced COA.wresl with COA_BO.wresl. The EI sharing constraint is conditioned on OMR not controlling. New code contains the solution to prevent carriage cost paid by the other project while one project is pushing against EI share.

Effects of Code Modifications

After the above code implementations, the modified model results indicate that 50% sharing is not imposed on the project pumps when Delta exports are not controlled by EI. On September 1924, Banks and Jones pumping plants are pumping their own water through EXP1 arcs. On March 1925, CVP San Luis reached capacity, so Jones could not pick up all CVP water released from its reservoir to meet Delta requirements and exports. Banks (through the Banks_Exp2 arc) picked up the unused Federal water.

Date / Time	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_JONES	D_JONES_EXP1	D_JONES_EXP2	D_EXPTD	EIEXPCTRL	0.5*EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
30 Sep 1924, 24:00	422.8	422.8	0.0	3966.2	3966.2	0.0	4389.0	5869.9	2935.0
..									
..									
31 Mar 1925, 24:00	4364.1	4164.6	199.4	2105.4	2105.4	0.0	6469.5	7139.4	3569.7

Issue 2: Hood "MIF" based on Export Estimates and other Delta "MIF"

Case 2.1: Hood "MIF" based on Export Estimates

On July 1924, Hood MIF controls releases from the NOD reservoirs. Jones is pumping only 800 cfs (Health and Safety level) while Banks is pumping at full capacity that includes 1,618.7 cfs from CVP unused water (Table a). Given the storage condition at Oroville (Table c), SWP restricts Oroville releases to support in basin use (IBU) obligations under the COA as well as exports for Health and Safety. This estimation for SWP exports (EXP_EST_SWP) of 6,680 cfs (Table b) was too high and resulted in inflated Hood MIF requirements. Since Oroville releases were penalized, the inflated MIF forced CVP to release additional water from Shasta, despite CVP San Luis being above the rule curve (Table c).

Table a: Banks and Jones pumping

	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_BANKS_SWP	D_BANKS_CVC	D_BANKS_CVP	D_JONES	D_JONES_EXP1	D_JONES_EXP2	EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
31-Jul-24	6680.0	5061.3	1618.7	6680.0	0.0	0.0	800.0	800.0	0.0	10122.6

Table b: SWP and CVP export estimation along with Hood flow

	EXP_EST_SWP	EXP_EST_CVP	ANNSACREQDV	C_HOOD_Exc	C_HOOD_MIF	C_YoloBP_Mif
	CFS	CFS	CFS	CFS	CFS	
31-Jul-24	6680.0	800.0	14549.5	0.0	14501.3	48.2

Table c: Reservoir condition and Rule Curve value on July 1924.

	BASE	BO_B2	BASE	BO_B2
	Storage(TAF)	Storage(TAF)	Condition	
Shasta	1413	1413	Not spilling	Not spilling
Folsom	353	353	Not spilling	Not spilling
Trinity	815	815	Not spilling	Not spilling
Oroville	1349	1349	Not spilling	Not spilling
SLCVP	398	398	Above rule curve	Above rule curve
SLSWP	526	526	Below rule curve	Below rule curve
SLCVP_RC	90	90		
SLSWP_RC	819	819		

Case 2.2: Other "MIF" issue with combination of complex weights and penalties

On September 1929, Rio Vista is controlling the releases from NOD reservoir. In this case, Jones has no restriction to pump its water. The complex weights and/or penalties allowed Banks to pull CVP water as unused Federal water instead of pumping its own water. We performed several sensitivity runs for this time step to check what happens if Banks_EXP2 does not export unused Federal water. In all cases, the objective value decreased from the base solution. Because Jones pumping plant has a high penalty (Jones_pump_allow.wresl) for pumping if Folsom and/or Shasta storage are below 400 TAF and 1,500 TAF, respectively. The LP solver finds optimal solution by giving up CVP water to Bank_Exp2 as unused Federal water rather than pumping its own. In this time step, Folsom and Shasta storage are 301 TAF and 1,655 TAF, respectively.

Sep-29	Jones PP	2123	cfs all exp1
	Banks PP	2663	cfs
	Banks_Exp1	598	cfs
	Banks_Exp2	2065	cfs
	C_Delta_Ann	0	cfs
	C_hood	7724	cfs
	C_hood_mif	3625	cfs
	S_Shsta	1655	taf level 3
	S_Orovl	1099	taf level 5
	S_SLSWP	200	taf level 4
	SWPRuleCV	200	taf level 4
	EIExpCtrl	6216	cfs
	0.5*EIExpCtrl	3108	cfs
	C_Sac_RV	3000	cfs
	Rio Vista is controlling		

Code Changes

All Cycles:

(1) Tracy_pump_allow.wresl: Removed penalties on pumping above H&S level when Shasta/Folsom are low – this was interfering with operations under the new EI and export estimate code corrections.

(2) CVP_delivery_rule_curve.wresl: Conditioned CVP rule curve for San Luis storage on Shasta and Folsom storage. This affects both the balancing decisions between NOD and SOD storage and the calculation of estimated CVP exports that is used to set the upper bound on C_Hood_MIF.

Cycle 2 (Base):

(3) ExportEstimate1.wresl: Modified so that the estimate of SWP exports accounts for whether or not Oroville storage is going to take precedence over exports. Previously, the SWP export estimate would often exceed what Oroville will release during droughts.

Cycle 3 (B2_BO_DailyWeir):

(4) ExportEstimate1_b2.wresl: Accounted for availability of Oroville water for export.

Effects of Code Modifications

The code fixes for the EI sharing issues and the MIF issues produce results making reasonable estimations of SWP exports, especially during the drought years. New model results show that the MIF issues have been resolved. As a result of lower SWP export estimation, operational control by HOOD_MIF was reduced from 66 to 43 months out of 982 simulation time steps.

Due to the code changes, the SWP export estimation on July 1924 from the fixed model is lower than that of the base model. HOOD_MIF is not controlling the release from upstream reservoirs, but minimum required Delta Outflow is controlling the Delta. Since Banks_Exp2 did not get any CVP water, Banks pumping plant has capacity to wheel CVP water for Cross Valley Canal.

	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_BANKS_SWP	D_BANKS_CVC	D_BANKS_CVP	D_JONES	D_JONES_EXP1	D_JONES_EXP2	EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
31-Jul-24	5689.3	5689.3	0.0	5689.3	0.0	0.0	800.0	800.0	0.0	9231.3

	EXP_EST_SWP	EXP_EST_CVP	ANNSACREQDV	C_HOOD_Exc	C_HOOD_MIF	C_YoloBP_Mif
	CFS	CFS	CFS	CFS	CFS	
31-Jul-24	2001.9	800.0	9022.1	4156.1	8973.9	48.2

An example of September 1929 (post code fixes), showing that the model produces expected results:

	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_BANKS_SWP	D_BANKS_CVC	D_BANKS_CVP	D_JONES	D_JONES_EXP1	D_JONES_EXP2	EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
30-Sep-29	598.0	598.0	0.0	598.0	0.0	0.0	4188.2	4188.2	0.0	6216.9

Issue 3: Banks pumping plant pumps CVP water for SWP Health and Safety (H&S) requirement

Case 3.1:

On July 1929, Hood MIF is controlling the releases from NOD reservoirs. Jones has no restriction on pumping CVP water and Banks is pumping at the Health and Safety level (300 cfs). Even though Oroville is releasing above the minimum in-stream flow and IBU requirements, the model finds a higher objective value by not releasing Oroville water.

Table a: Banks and Jones pumping.

	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_BANKS_SWP	D_BANKS_CVC	D_BANKS_CVP	D_JONES	D_JONES_EXP1	D_JONES_EXP2	EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
31-Jul-29	300	0	300	300	0	0	2064	2064	0	6741

Table b: Reservoir condition on July 1929.

	BASE	BO_B2	BASE	BO_B2
	Storage(TAF)	Storage(TAF)	Condition	
Shasta	2255	2255	Not spilling	Not spilling
Folsom	400	400	Not spilling	Not spilling
Trinity	1142	1142	Not spilling	Not spilling
Oroville	1230	1230	Not spilling	Not spilling
SLCVP	320	320	Above rule curve	Above rule curve
SLSWP	240	240	Below rule curve	Below rule curve
SLCVP_RC	310	310		
SLSWP_RC	430	430		

Code Change

All Cycles:

(1) Weight-table.wresl: Changed the weight of C_Orovl_IBU from -3000 to -1250.

Effects of Code Modifications

The updated code allows Oroville to release enough water to meet its health and safety requirements and resolves this issue.

	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_BANKS_SWP	D_BANKS_CVC	D_BANKS_CVP	D_JONES	D_JONES_EXP1	D_JONES_EXP2	EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
31-Jul-29	300	300	0	300	0	0	2002	2002	0	6702

Issue 4: Unnecessary export cuts under BO RPA and the B2 VAMP export restriction

Case 4.1:

On April 1924, OMR flow is restricting the exports from Delta. Before code changes, CVP reservoirs released water to meet the in stream requirements and Oroville released above the instream requirement for the IBU condition. Even though CVP is releasing for the instream flow requirement, the OMR restriction did not allow Jones to pick up its water. CVP gave up Banks_EXP2 as unused CVP water used by Banks to meet its health and safety requirements. Example output is shown below for the base model (pre code changes).

Date / Time	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_JONES	D_JONES_EXP1	D_JONES_EXP2	D_EXPTD	EIEXPCTRL	0.5*EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
30-Apr-24	903.9	0.0	903.9	903.9	1174.1	0.0	1807.9	3525.3	1762.7

Code Changes

Cycle 3 (B2_BO_DailyWeir):

(1) OMR_constraint.wresl: Modified so that sharing of export capacity under the OMR flow requirements does not unreasonably constrain one project when the other chooses not to use its entire share. The modified logic first determines how much exports need to be reduced and then implements an equivalent reduction to both projects.

(2) EXP_constraint.wresl: Modified in the same way as OMR_constraint.wresl

(3) B2Action3.wresl: Added VAMP export restriction logic to share available export capacity equally between the SWP and CVP (if both projects wish to use it). If one project decides to limit upstream releases and does not need its full share of export capacity under the VAMP restriction, the other project is allowed to use the unused capacity. The variables swp_unused_VAMP_exp and cvp_unused_VAMP_exp quantify the unused capacity for each project and are added on to the other project's available capacity under the VAMP export restriction.

Effect of Code Modifications

After adding code changes 1 and 2 above for Issue #4, we found that Jones was not pumping up to its allowable capacity in this time step. Surplus water was seen as Delta outflow and exports were restricted by B2 Action 3.

Date / Time	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_JONES	D_JONES_EXP1	D_JONES_EXP2	D_EXPTD	EIEXPCTRL	0.5*EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
30-Apr-24	300.0	276.5	23.5	1245.0	1245.0	0.0	1545.0	3621.332	1810.7

Code change 3 under this issue solved this problem. The final output of this time step is shown below. Now the exports are controlled by OMR flow restriction, but Jones is pumping up to its capacity and there is less Delta surplus.

Date / Time	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_JONES	D_JONES_EXP1	D_JONES_EXP2	D_EXPTD	EIEXPCTRL	0.5*EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
30-Apr-24	300.0	276.5	23.5	1778.0	1778.0	0.0	2078.0	3621.332	1810.7

Issue 5: Feather River flow compliance in November restrict on Oroville release

Case 5.1:
As an example for Issue 5, on November 1938, the LP solver finds the optimal solution by not releasing water from Oroville rather than allocating unused CVP water for Banks Exp2. In this month, Banks is also pumping for Cross Valley Canal wheeling.

	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_BANKS_SWP	D_BANKS_CVC	D_BANKS_CVP	D_JONES	D_JONES_EXP1	D_JONES_EXP2	EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
30-Nov-38	1697.0	0.0	300.0	300.0	1397.0	1397.0	800.0	800.0	0.0	11269.0

Code Change
feather_special.wresl: Introduced new integer to find if threshold needs to be relaxed or not. If Oroville releases enough water and D_Banks_exp1 exceeds 300 cfs, the integer switches to 1 and the threshold penalty is applied. In the following months (Dec - Mar), the Feather River minimum instream flow requirement is then conditioned on whether or not the threshold was exceeded to support health and safety.

Effect of Code Modifications
After implementing the code change, Oroville is releasing water to meet its requirement.

	D_BANKS	D_BANKS_EXP1	D_BANKS_EXP2	D_BANKS_SWP	D_BANKS_CVC	D_BANKS_CVP	D_JONES	D_JONES_EXP1	D_JONES_EXP2	EIEXPCTRL
	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
30-Nov-38	2451.1	300.0	0.0	300.0	2151.1	2151.1	800.0	800.0	0.0	11759.3

Other minor changes in the CalLite model and CalSim models

Missing continuity equation for wheeling code (CalLite only)
While reviewing the latest version of CalLite, DWR noticed that there was frequent wheeling through sub arc D_Banks_CVCsurp in October. The intent of D_Banks_CVCsurp is to allow the CVP to wheel what would otherwise be surplus Delta outflow through Banks Pumping Plant to the Cross Valley Canal (there is a parallel surplus wheeling arc for JPOD – D_Banks_WHLsurp). This would only occur if the SWP did not have the ability to export the surplus water (i.e., SWP San Luis full, all SOD demand met). This was not the condition found in many of the months that D_Banks_ CVCsurp was in use. It was found that D_Banks_ CVCsurp was in fact diverting additional upstream releases. The reason that this was occurring in CalLite, and not in CalSim, was that a constraint tying D_Banks_ CVCsurp to Delta surplus was NOT included in CalLite.

Code Change

Cycle 3 (B2_BO_DailyWeir):

(1) Wheelfixes.WRESL: Added continuity equation with conditional statement. Related file: Wheelcap.wresl. Similar code in Wheelcap.wresl was commented out.

Effect of Code Modifications
Results are not affected by these code modifications.

Other changes in the model:
We added some intermediate output for debugging the model, and therefore added a large number of aliases in the model. We also added some minor code change in the model to avoid non-unique solution.
Modified Rock Slough ANN files to constrain the Sacramento river flow requirement uniformly.

APPENDIX B: Comparison of CalLite and CalSim results (pre and post code fixes)

(1) **Comparisons of CalLite Base and DWR fix model results**
(2) **Comparison of CalLite Base, BOR fix, and DWR fix model**
(3) **Comparison of CalSim Base and DWR fix model (This CalSim is only for CalLite corroboration, CalSim II Arpil 2010 version)**
(4) **Water Balance of NOD and SOD for Dry period 1987-1992.**

Comparisons of CalLite Base and DWR fix model results

System Flow Comparison: CalLite Alt vs CalLite Base

CalLite Alt: DWR code fix and BOR code fix refinement, Base: Released Version on 10/2011. Assumptions: Future LOD and Demand, D1641+BO

	1922-2003				1929-1934				1987-1992			
River Flows	**DWR_Fix**	**Base**	**Diff**	**% Diff**	**DWR_Fix**	**Base**	**Diff**	**% Diff**	**DWR_Fix**	**Base**	**Diff**	**% Diff**
Trinity R blw Lewiston	700.0	698.2	1.8	0.3%	411.5	411.5	0.0	0.0%	472.0	472.0	0.0	0.0%
Trinity Export	529.9	533.2	-3.3	-0.6%	400.6	432.4	-31.8	-7.3%	447.4	489.9	-42.5	-8.7%
Clear Cr blw Whiskeytown	129.3	129.3	0.0	0.0%	100.6	100.6	0.0	0.0%	116.2	116.2	0.0	0.0%
Sacramento R @ Keswick	6246.0	6249.9	-3.9	-0.1%	4073.0	4101.0	-28.0	-0.7%	4508.1	4636.3	-128.2	-2.8%
Sacramento R @ Red Bluff	8240.0	8249.5	-9.5	-0.1%	5142.8	5175.9	-33.1	-0.6%	5652.0	5790.2	-138.2	-2.4%
Sacramento R @ Wilkins Slough	6622.1	6633.3	-11.2	-0.2%	4073.5	4106.7	-33.2	-0.8%	4781.5	4919.8	-138.2	-2.8%
Oroville Dam Release	3928.6	3926.6	2.0	0.1%	2229.9	2274.1	-44.2	-1.9%	2103.6	2131.7	-28.0	-1.3%
Feather R blw Thermalito	3183.1	3179.8	3.3	0.1%	1563.2	1605.0	-41.8	-2.6%	1466.0	1490.3	-24.2	-1.6%
YubaFeather Confluence	1453.8	1453.8	0.0	0.0%	589.9	589.9	0.0	0.0%	578.0	578.0	0.0	0.0%
Feather R @ Confluence	5611.8	5608.7	3.1	0.1%	2220.0	2263.3	-43.3	-1.9%	2538.6	2562.9	-24.3	-0.9%
Sacramento R @ Verona	13235.9	13231.2	4.7	0.0%	6866.7	6943.2	-76.5	-1.1%	7970.9	8133.4	-162.5	-2.0%
American R blw Nimbus	2386.7	2388.5	-1.7	-0.1%	1266.7	1267.4	-0.6	0.0%	1109.5	1121.6	-12.0	-1.1%
Delta Inflow	**21595**	**21605**	**-10.0**	**0.0%**	**9910**	**9987**	**-77.3**	**-0.8%**	**10360**	**10535**	**-174.7**	**-1.7%**
Sacramento R @ Hood	15669.0	15665.3	3.6	0.0%	8258.0	8335.3	-77.3	-0.9%	8993.1	9167.8	-174.7	-1.9%
Yolo Bypass	2235.8	2249.4	-13.6	-0.6%	99.9	99.9	0.0	0.0%	141.3	141.3	0.0	0.0%
Mokelumne R	666.1	666.1	0.0	0.0%	205.6	205.6	0.0	0.0%	155.0	155.0	0.0	0.0%
San Joaquin R d/s Calaveras	3024.3	3024.3	0.0	0.0%	1346.4	1346.4	0.0	0.0%	1070.7	1070.7	0.0	0.0%
Delta Outflow	**15754**	**15771**	**-16.6**	**-0.1%**	**5626**	**5610**	**16.0**	**0.3%**	**6174**	**6181**	**-7.2**	**-0.1%**
Required	5013	5011	1.5	**0.0%**	4110	4106	4.0	**0.1%**	4024	4035	-10.5	**-0.3%**
Delta Exports	**4876**	**4868**	**8.2**	**0.2%**	**3095**	**3196**	**-100.9**	**-3.2%**	**2925**	**3091**	**-165.8**	**-5.4%**
Banks SWP	2605.7	2620.0	-14.3	**-0.5%**	1597.2	1750.4	-153.2	**-8.7%**	1312.4	1537.5	-225.1	**-14.6%**
Banks CVP	61.2	63.2	-2.0	**-3.2%**	19.1	8.3	10.7	**128.8%**	31.7	28.1	3.5	**12.5%**
Tracy	2209.2	2184.7	24.5	**1.1%**	1497.7	1445.4	52.3	**3.6%**	1612.5	1553.2	59.2	**3.8%**
SWP Deliveries	**2581**	**2599**	**-18.0**	**-0.7%**	**1572**	**1645**	**-73.3**	**-4.5%**	**1290**	**1456**	**-166.6**	**-11.4%**
Table A	2441.0	2466.0	-25.0	**-1.0%**	1485.7	1547.9	-62.2	**-4.0%**	1238.2	1421.8	-183.5	**-12.9%**
Article 21	53.0	50.0	3.0	**6.0%**	58.2	82.3	-24.1	**-29.2%**	12.4	12.3	0.1	**0.5%**
Article 56	87.0	83.0	4.0	**4.8%**	27.7	14.8	12.9	**87.5%**	39.0	22.2	16.8	**75.8%**
CVP SOD Deliveries	**2382**	**2360**	**22.0**	**0.9%**	**1439**	**1402**	**37.3**	**2.7%**	**1671**	**1620**	**51.0**	**3.1%**

Comparison of CalLite Base, BOR fix, and DWR fix model

System Flow Comparison: CalLite Base with two alternative studies

Base: Released version; BORFix: Problems identified and code fixed by BOR and MBK ; DWRFix: Addn'l problems, code fix, and refinements by DWR

Assumptions: Future LOD, Demands, D1641+BO

	1922-2003					1929-1934					1987-1992				
	DWRFix	BORFix	Base	Diff from Base		DWRFix	BORFix	Base	Diff from Base		DWRFix	BORFix	Base	Diff from Base	
River Flows				DWRFix	BORFix				DWRFix	BORFix				DWRFix	BORFix
Trinity R blw Lewiston	700.0	700.5	698.2	1.8	2.3	411.5	411.5	411.5	0.0	0.0	472.0	472.0	472.0	0.0	0.0
Trinity Export	529.9	530.4	533.2	-3.3	-2.7	400.6	431.6	432.4	-31.8	-0.8	447.4	460.0	489.9	-42.5	-30.0
Clear Cr blw Whiskeytown	129.3	129.2	129.3	0.0	-0.1	100.6	100.6	100.6	0.0	0.0	116.2	116.2	116.2	0.0	0.0
Sacramento R @ Keswick	6246.0	6246.8	6249.9	-3.9	-3.1	4073.0	4106.7	4101.0	-28.0	5.7	4508.1	4552.5	4636.3	-128.2	-83.8
Sacramento R @ Red Bluff	8240.0	8243.1	8249.5	-9.5	-6.4	5142.8	5184.1	5175.9	-33.1	8.3	5652.0	5700.9	5790.2	-138.2	-89.3
Sacramento R @ Wilkins Sl	6622.1	6626.1	6633.3	-11.2	-7.2	4073.5	4119.6	4106.7	-33.2	12.9	4781.5	4830.5	4919.8	-138.2	-89.3
Oroville Dam Release	3928.6	3928.4	3926.6	2.0	1.8	2229.9	2235.7	2274.1	-44.2	-38.3	2103.6	2086.2	2131.7	-28.0	-45.4
Feather R blw Thermalito	3183.0	3182.6	3179.8	3.2	2.8	1563.5	1567.2	1605.0	-41.5	-37.9	1466.0	1446.8	1490.3	-24.3	-43.4
YubaFeather Confluence	1453.8	1453.8	1453.8	0.0	0.0	589.9	589.9	589.9	0.0	0.0	578.0	578.0	578.0	0.0	0.0
Feather R @ Confluence	5611.8	5610.9	5608.7	3.1	2.2	2220.0	2225.3	2263.3	-43.3	-38.1	2538.6	2520.1	2562.9	-24.3	-42.8
Sacramento R @ Verona	13235.9	13233.6	13231.2	4.7	2.4	6866.7	6918.0	6943.2	-76.5	-25.2	7970.9	8001.3	8133.4	-162.5	-132.1
American R blw Nimbus	2386.7	2387.4	2388.5	-1.7	-1.1	1266.7	1268.7	1267.4	-0.6	1.3	1109.5	1113.0	1121.6	-12.0	-8.6
Delta Inflow	**21595**	**21599**	**21605.2**	**-9.9**	**-6.1**	**9910**	**9963**	**9987**	**-77.3**	**-23.9**	**10360**	**10394**	**10535**	**-174.7**	**-140.8**
Sacramento R @ Hood	15669.0	15666.6	15665.3	3.6	1.2	8258.0	8311.4	8335.3	-77.3	-23.9	8993.1	9026.9	9167.8	-174.7	-140.8
Yolo Bypass	2235.8	2242.1	2249.4	-13.6	-7.3	99.9	99.9	99.9	0.0	0.0	141.3	141.3	141.3	0.0	0.0
Mokelumne R	666.1	666.1	666.1	0.0	0.0	205.6	205.6	205.6	0.0	0.0	155.0	155.0	155.0	0.0	0.0
San Joaquin R d/s Calaveras	3024.3	3024.3	3024.3	0.0	0.0	1346.4	1346.4	1346.4	0.0	0.0	1070.7	1070.7	1070.7	0.0	0.0
Delta Outflow	**15754**	**15762**	**15771.0**	**-16.5**	**-8.9**	**5626**	**5625**	**5610**	**16.0**	**15.1**	**6174**	**6166**	**6181**	**-7.2**	**-14.9**
Required	5013	5015	5011.2	1.5	3.8	4110	4108	4106	4.0	1.9	4024	4028	4035	-10.5	-6.3
Delta Exports	**4876**	**4872**	**4867.9**	**8.1**	**4.0**	**3095**	**3148**	**3196**	**-100.9**	**-48.1**	**2925**	**2966**	**3091**	**-165.8**	**-124.6**
Banks SWP	2605.8	2616.3	2620.0	-14.2	-3.7	1597.2	1666.0	1750.4	-153.2	-84.4	1312.4	1356.7	1537.5	-225.1	-180.8
Banks CVP	61.2	60.3	63.2	-2.0	-2.9	19.1	17.6	8.3	10.7	9.3	31.7	30.1	28.1	3.5	2.0
Tracy	2209.0	2195.2	2184.7	24.3	10.5	1497.7	1481.7	1445.4	52.3	36.3	1612.4	1609.4	1553.2	59.2	56.2
SWP Deliveries	**2581**	**2592**	2599.0	**-18.0**	**-7.0**	**1572**	**1639**	**1645**	**-73.3**	**-5.9**	**1290**	**1337**	**1456**	**-166.4**	**-118.9**
Table A	2441.0	2451.0	2466.0	-25.0	-15.0	1485.7	1542.8	1547.9	-62.2	-5.1	1238.2	1286.3	1421.8	-183.5	-135.4
Article 21	53.0	52.0	50.0	3.0	2.0	58.2	69.4	82.3	-24.1	-12.8	12.6	11.4	12.3	0.3	-1.0
Article 56	87.0	89.0	83.0	4.0	6.0	27.7	26.8	14.8	12.9	12.0	39.0	39.7	22.2	16.8	17.5
CVP SOD Deliveries	**2382**	**2367**	**2360.2**	**21.9**	**7.2**	**1439**	**1417**	**1402**	**37.3**	**15.3**	**1671**	**1648**	**1620**	**51.0**	**27.9**

Comparison of CalSim Base and DWR fix model (This CalSim is only for CalLite corroboration, CalSim II [April 2010 version])

System Water Balance Comparison: Alt(corrected) vs Base(old)

CalSim Corroboration Study

	1922-2003				1929-1934				1987-1992			
	All Fixes	Base	Diff	% Diff	All Fixes	Base	Diff	% Diff	All Fixes	Base	Diff	% Diff
Trinity R blw Lewiston	697	694	2	0.3%	411	408	3	1%	472	472	0	0%
Trinity Export	534	537	-3	-0.6%	417	435	-18	-4%	460	499	-39	-8%
Clear Cr blw Whiskeytown	127	127	0	0.1%	101	100	1	1%	116	116	0	0%
Sacramento R @ Keswick	6252	6256	-4	-0.1%	4088	4107	-19	0%	4527	4646	-119	-3%
Sacramento R @ Wilkins Slough	6615	6638	-23	-0.3%	4095	4117	-22	-1%	4808	4930	-122	-2%
Feather R blw Thermalito	3184	3180	4	0.1%	1567	1625	-58	-4%	1480	1489	-9	-1%
American R blw Nimbus	2387	2389	-2	-0.1%	1267	1271	-4	0%	1111	1123	-11	-1%
Delta Inflow	**21659**	**21666**	**-7**	**0.0%**	**9981**	**10090**	**-109**	**-1%**	**10465**	**10620**	**-155**	**-1%**
Sacramento R @ Hood	15747	15737	10	0.1%	8328	8438	-110	-1%	9098	9253	-156	-2%
Yolo Bypass	2221	2239	-18	-0.8%	101	100	1	1%	141	141	0	0%
Mokelumne R	666	666	0	0.0%	206	206	0	0%	155	155	0	0%
San Joaquin R d/s Calaveras	3024	3024	0	0.0%	1347	1346	0	0%	1071	1071	0	0%
Delta Outflow	**15767**	**15777**	**-10**	**-0.1%**	**5645**	**5644**	**0**	0%	**6216**	**6184**	**32**	1%
Required	5010	5013	-2	0.0%	4110	4112	-3	0%	4033	4036	-3	0%
Surplus												
Delta Diversions	**4865**	**4869**	**-3**	**-0.1%**	**3071**	**3197**	**-126**	**-4%**	**2905**	**3101**	**-197**	**-6%**
Banks SWP	2598	2624	-26	-1.0%	1579	1756	-177	-10%	1314	1546	-232	-15%
Banks CVP	59	63	-5	-7.3%	18	8	10	126%	31	28	3	11%
Tracy	2208	2182	27	1.2%	1492	1441	50	4%	1591	1555	35	2%
SWP SOD Deliveries	**2584**	**2603**	**-19**	**-0.7%**	**1562**	**1650**	**-87**	**-5%**	**1301**	**1466**	**-165**	**-11%**
Table A	2446	2471	-26	-1.0%	1479	1559	-80	-5%	1243	1425	-182	-13%
Article 21	51	48	3	7.3%	58	72	-14	-19%	13	11	1	10%
Article 56	87	84	3	3%	25	19	7	36%	46	30	16	54%
CVP SOD Deliveries	**2379**	**2357**	**22**	**0.9%**	**1436**	**1397**	**39**	**3%**	**1659**	**1616**	**43**	**3%**

Water Balance of NOD and SOD for Dry period 1987-1992.
System Balance on the table:

Water Balance for Dry Periods June 1986 - September 1992			
Base Study: Released CalLite 2.01 and Alt Study: DWR fixes on the Released Version			
Difference			
Storage	Initial Condition (June 86)	Final Condition (Sep 92)	Storage Difference
Shasta	3	413	410
Folsom	0	40	40
Oroville	0	1	1
Trinity import	-311		311
Evap - Shasta	48		48
Evap - Folsom	9		9
Evap - Orovile	-6		-6
Delivery - Sac	62		62
Delivery - Ame	23		23
Delivery - Fea	-23		-23
	Total		**874**
Detla Inflow			
Sac R. @ Hood	-874		-874
Yolo BP	0		0
	Total		**-874**
Delta Exports and Outflow			
Delta Exports	-800		-800
Banks	-1156		
Jones	355		
Delta Outflow	-43		-43
NBA	-31		-31
	Total		**-874**

System Balance on the chart: