California WaterFix Hearing
Exhibit No. DOI – 37

California Water Fix Sur-Rebuttal Phase
Testimony of Nancy Parker, U.S. Bureau of Reclamation

Introduction

Reclamation's and DWR's rebuttal testimony on CalSim modeling raised three main concerns:

- MBK's modeling used pre-determined allocations. This is an approach that would have correctly been found unacceptable if it had been used in Petitioner' modeling
- MBK's modeling depicted inappropriate operations that conflict with Reclamation's long-standing operational philosophy
- Storage results in Petitioners' modeling, which used climate change inflows and sea level rise, were wrongly compared to MBK modeling done using historical hydrology inputs. Such a comparison largely reveals only the difference in the hydrology between Petitioners' modeling and MBK modeling. Petitioners' modeling does not demonstrate significant California Water Fix impacts to storage or to deliveries to legal users of water.

Other Parties' Rebuttal testimony and cross examination obfuscated many of these points by:

- Introducing the claim that Water Supply Index – Delivery Index (WSI-DI) is also perfect foresight. This is a misleading argument and mischaracterization of the WSI-DI and the manner in which Reclamation is using the term "perfect foresight."
- Declaring that it's actually *better* to manually input allocations in CalSim, since it enables a more accurate depiction of CVP operations than can be achieved using WSI-DI. This is an unrealistic approach to planning analysis, and the resulting CVP operations are not realistic.
- Claiming that because Petitioners' modeling shows North of Delta (NOD) storage at dead pool conditions in several years of extreme drought, the model is incapable of demonstrating the effect of the Water Fix.

This testimony will attempt to clarify these issues, covering the following topics on CalSim modeling:

- Water Supply Index – Delivery Index (WSI-DI) curve generation process is not perfect foresight
- CalSim allocation logic (governed by WSI-DI) is appropriate for a long term water supply reliability planning model
- Reclamation's long-standing operational philosophy to meet all project obligations, and provide a steadier, reliable water supply through most years, is reflected in and consistent with Petitioners' modeling for the Water Fix.
- Drought year CalSim results are reasonable for the long-term planning purpose that the Water Fix CPOD Petition analysis requires.

We will also address testimony of ARWA witnesses on analysis of their proposed Modified American River Flow Management Standard (FMS).

California Water Fix does not warrant the need for the Modified American River Flow Management Standard

Mr. Gohring's testimony in Exhibit ARWA-300 paragraph 3 incorrectly claims that the proposed modified FMS (Exhibit ARWA-308) was developed to protect Folsom Reservoir storage against severe dry conditions, such as the recent drought, and that CWF could increase risk of low Folsom storage in severe dry years. Also, his claims (in Exhibit ARWA-309 slides 1, 3, 4, and 14) that the CWF would exacerbate the risk of very low storage conditions at Folsom are unfounded. Based on the modeling results provided by the Petitioners as well as SVWU (Exhibit SVWU-107), CWF scenarios do not increase risk of very low storage conditions at Folsom.

To substantiate his incorrect claim that CWF increases risk to Folsom very low storage conditions, Mr. Gohring cited results for Alternative 4 from the BDCP DEIRS (Exhibit SWRCB-4), in Exhibit ARWA-309 slides 3 and 4. In addition, he also cited Alternative 4 results from the BDCP/CWF FEIRS in Exhibit ARWA-306. However, Alternative 4 was a BDCP alternative, and it included the conservation measures contemplated as part of the BDCP, including 65,000 acres of habitat restoration in the Delta. More importantly, Mr. Gohring did not present the results for Alternative 4A from the FEIRS, which is the preferred alternative for the CWF, and currently being discussed at this hearing, to substantiate his claim.

Figure 1 compares the simulated end of September Folsom storage for the NAA, Boundary 1, H3, H4 and Boundary 2 scenarios. This figure shows that the probability of exceedance of Folsom storage conditions under the CWF scenarios is similar to the NAA below approximately 500 TAF.

Figure 1: Probability of exceedance of simulated end of September storage for the NAA, Boundary 1, H3, H4, and Boundary 2 scenarios (same as Exhibit DWR-514 Figure 14).

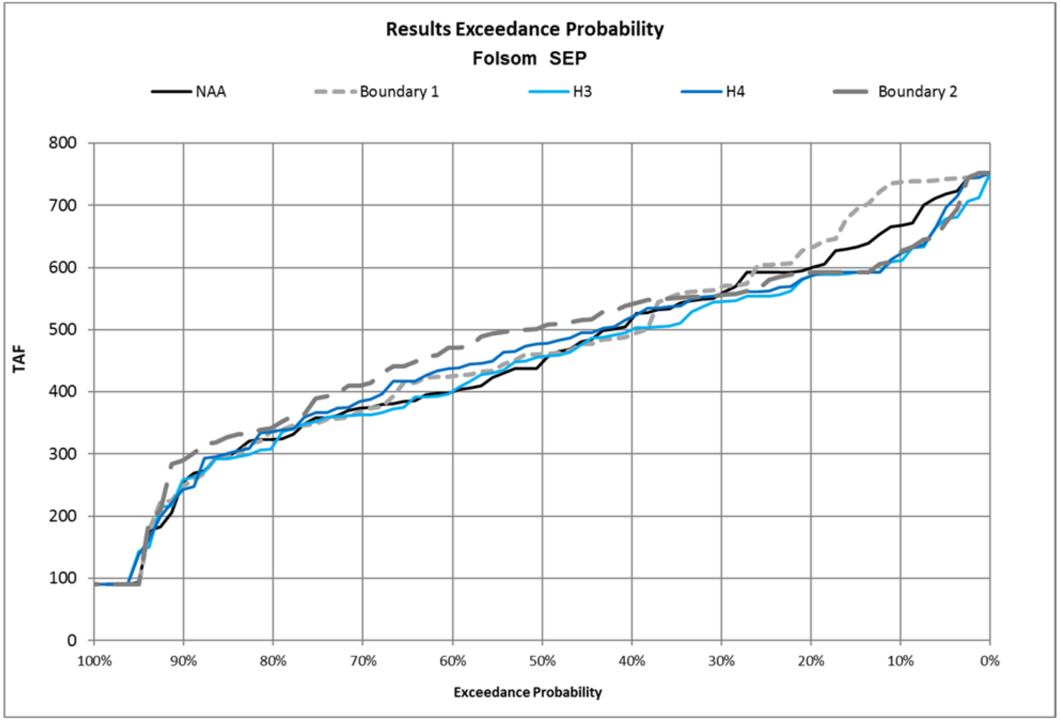


Table 1 compares the simulated end of September Folsom carryover storage for all the critical years (under ELT Q5 climate change projection) in the 82-year simulation period. In most of the critical years the carryover storage conditions under the CWF scenarios are similar to or better than the NAA. Only in 1932 and 1994 do the CWF scenarios show reductions compared NAA, and in both of those years Folsom carryover storage is above the very low storage conditions in Folsom.

Table 1: Simulated End of September Folsom Carryover Storage in the Critical Water Years (based on ELT Q5 climate change scenario) in the 82-year CalSim II Simulation Period.

	End of September Folsom Storage in TAF					
Year	**NAA**	**B1**	**H3**	**H3+**	**H4**	**B2**
1924	273	299	292	264	300	301
1929	294	295	295	296	296	318
1931	94	90	90	90	90	90
1932	666	544	545	545	538	489
1933	90	90	90	90	90	90
1934	90	90	90	90	90	90
1976	332	356	360	362	359	362
1977	90	90	90	90	90	90
1988	294	294	292	293	294	290
1990	362	368	363	367	366	209
1991	176	269	271	242	243	194
1992	90	90	150	168	139	90
1994	255	249	216	205	221	332

Figure 2 compliments Table 1 to compare the exceedance of all monthly Folsom storage results for the NAA and H3+ studies. This plot shows that even for extremely low storage levels, the Water Fix does not cause lower storage levels in Folsom relative to the No Action Alternative.

Figure 2

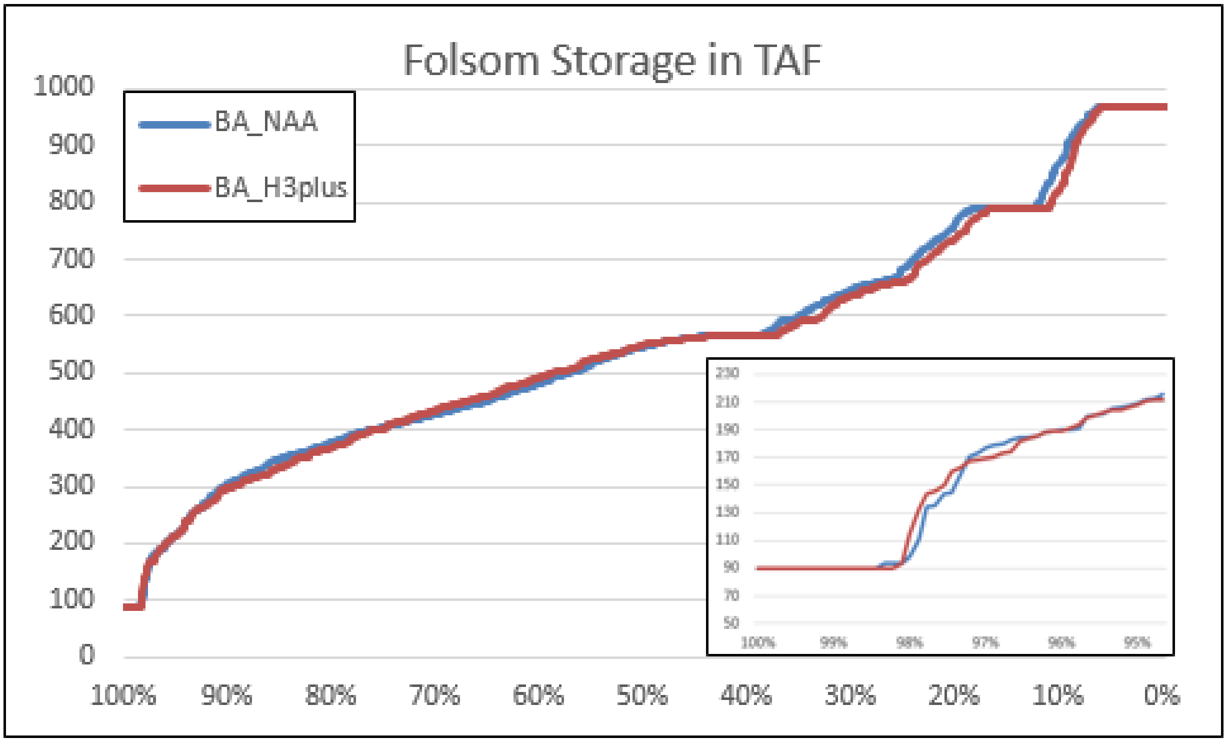


Figure 3 is the Table C-43-6 excerpted from Appendix 5A of the FEIRS compares end of month storage for Alternative 4A from the FEIRS. It compares the simulated end of month Folsom storage for Alternative 4A with the No Action Alternative. As shown in the figure, Alternative 4A results in storage conditions similar to the No Action Alternative in majority of the months, and especially in December and May.

Mr. Gohring states that the Modified FMS would require that Folsom be operated to carryover storage targets in December and May (ARWA-308) given the risk of very low storage conditions due to CWF (ARWA-309 slide 14). However, all of the results shown here make it clear that CWF does not increase the risk of very low Folsom storage conditions in severely dry years compared to the No Action Alternative. Notwithstanding the consequences of the Modified FMS on the rest of the CVP-SWP system, as well as its operability, the proposed Modified FMS is not required as the CWF does not exacerbate the risk to Folsom of very low storage conditions.

The general issue of extremely low storage results is further discussed in the subsequent section on drought operations.

California WaterFix Hearing
Exhibit No. DOI – 37

Figure 3: Comparison of simulated end of month storage for the Alternative 4A with the NAA from the BDCP/CWF FEIRS

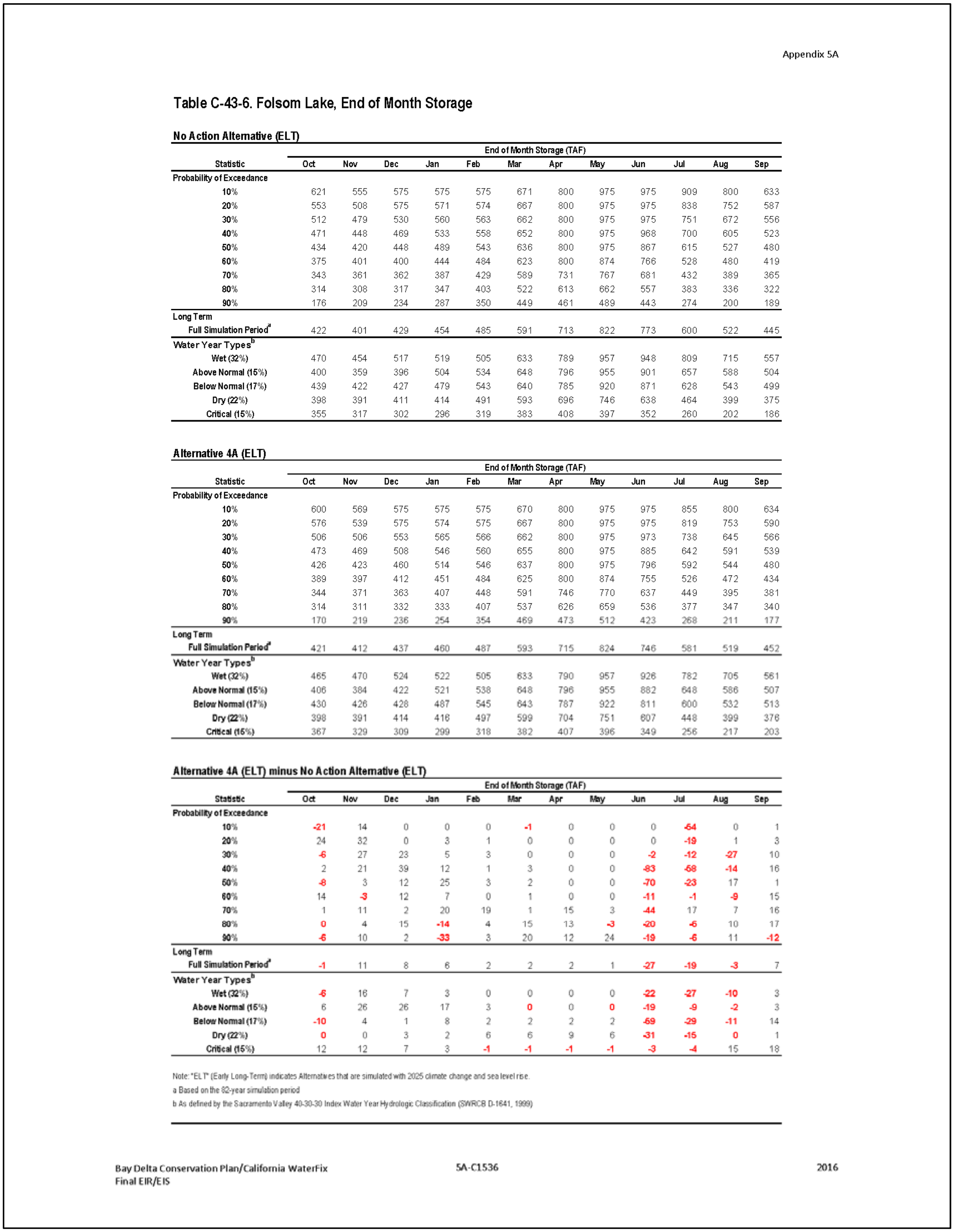


Table C-43-6. Folsom Lake, End of Month Storage

No Action Alternative (ELT)

	End of Month Storage (TAF)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	621	555	575	575	575	671	800	975	975	909	800	633
20%	553	508	575	571	574	667	800	975	975	838	752	587
30%	512	479	530	560	563	662	800	975	975	751	672	556
40%	471	448	469	533	558	652	800	975	968	700	605	523
50%	434	420	448	489	543	636	800	975	867	615	527	480
60%	375	401	400	444	484	623	800	874	766	528	480	419
70%	343	361	362	387	429	589	731	767	681	432	389	365
80%	314	308	317	347	403	522	613	662	557	383	336	322
90%	176	209	234	287	350	449	461	489	443	274	200	189
Long Term												
Full Simulation Period[a]	422	401	429	454	485	591	713	822	773	600	522	445
Water Year Types[b]												
Wet (32%)	470	454	517	519	505	633	789	957	948	809	715	557
Above Normal (15%)	400	359	396	504	534	648	796	955	901	657	588	504
Below Normal (17%)	439	422	427	479	543	640	785	920	871	628	543	499
Dry (22%)	398	391	411	414	491	593	696	746	638	464	399	375
Critical (15%)	355	317	302	296	319	383	408	397	352	260	202	186

Alternative 4A (ELT)

	End of Month Storage (TAF)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	600	569	575	575	575	670	800	975	975	855	800	634
20%	576	539	575	574	575	667	800	975	975	819	753	590
30%	506	506	553	565	566	662	800	975	973	738	645	566
40%	473	469	508	546	560	655	800	975	885	642	591	539
50%	426	423	460	514	546	637	800	975	796	592	544	480
60%	389	397	412	451	484	625	800	874	755	526	472	434
70%	344	371	363	407	448	591	746	770	637	449	395	381
80%	314	311	332	333	407	537	626	659	536	377	347	340
90%	170	219	236	254	354	469	473	512	423	268	211	177
Long Term												
Full Simulation Period[a]	421	412	437	460	487	593	715	824	746	581	519	452
Water Year Types[b]												
Wet (32%)	465	470	524	522	505	633	790	957	926	782	705	561
Above Normal (15%)	406	384	422	521	538	648	796	955	882	648	586	507
Below Normal (17%)	430	426	428	487	545	643	787	922	811	600	532	513
Dry (22%)	398	391	414	416	497	599	704	751	607	448	399	376
Critical (15%)	367	329	309	299	318	382	407	396	349	256	217	203

Alternative 4A (ELT) minus No Action Alternative (ELT)

	End of Month Storage (TAF)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	-21	14	0	0	0	-1	0	0	0	-54	0	1
20%	24	32	0	3	1	0	0	0	0	-19	1	3
30%	-6	27	23	5	3	0	0	0	-2	-12	-27	10
40%	2	21	39	12	1	3	0	0	-83	-58	-14	16
50%	-8	3	12	25	3	2	0	0	-70	-23	17	1
60%	14	-3	12	7	0	1	0	0	-11	-1	-9	15
70%	1	11	2	20	19	1	15	3	-44	17	7	16
80%	0	4	15	-14	4	15	13	-3	-20	-6	10	17
90%	-6	10	2	-33	3	20	12	24	-19	-6	11	-12
Long Term												
Full Simulation Period[a]	-1	11	8	6	2	2	2	1	-27	-19	-3	7
Water Year Types[b]												
Wet (32%)	-6	16	7	3	0	0	0	0	-22	-27	-10	3
Above Normal (15%)	6	26	26	17	3	0	0	0	-19	-9	-2	3
Below Normal (17%)	-10	4	1	8	2	2	2	2	-69	-29	-11	14
Dry (22%)	0	0	3	2	6	6	9	6	-31	-15	0	1
Critical (15%)	12	12	7	3	-1	-1	-1	-1	-3	-4	15	18

Note: "ELT" (Early Long-Term) indicates Alternatives that are simulated with 2025 climate change and sea level rise.

a Based on the 82-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

California WaterFix Hearing
Exhibit No. DOI – 37

Water Supply Index - Delivery Index Curve Generation is Not Perfect Foresight

During presentation of his rebuttal testimony on May 12, 2017, Walter Bourez testified that "the WSIDI procedure is a form of perfect foresight itself." (Transcript Volume 44, at 107:9-10.)

The WSI-DI curve is a relationship depicting the ability to deliver water relative to a given water supply. It must be "trained" when the water supply and/or demand/delivery capability situation changes (climate change, transfer, regulation, etc…) Neither the curve generation process nor the application of WSI-DI logic to determine project allocations is perfect foresight. The WSI-DI approach is appropriate because it uses a consistent and reproducible methodology. It is intended to include components of the allocation process that humans undertake in the Spring, when the year's hydrology is forecasted but not yet known with certainty.

A baseball analogy may be apt. A veteran hitter may have faced a well-known pitcher many times, watched film, and researched statistics to acquire information, but he does not know exactly what pitches he will see in this particular at-bat. So he estimates, based upon the range of what he knows. The actual throw may be down and inside, could be a ball, or possibly even a rare wild pitch. The pitches that the hitter has experienced in person or seen on video inform his idea about what he will face. But he doesn't really know until he gets that pitch. It's not perfect foresight unless someone in the bleachers is stealing signs and conveying them to the hitter. The Petitioners modeling is based on research and the MBK modeling is stealing signs, as I will explain below.

The WRIMS software in which CalSim is developed uses a three-step process to train the WSI-DI curve, illustrated in Figure 4:

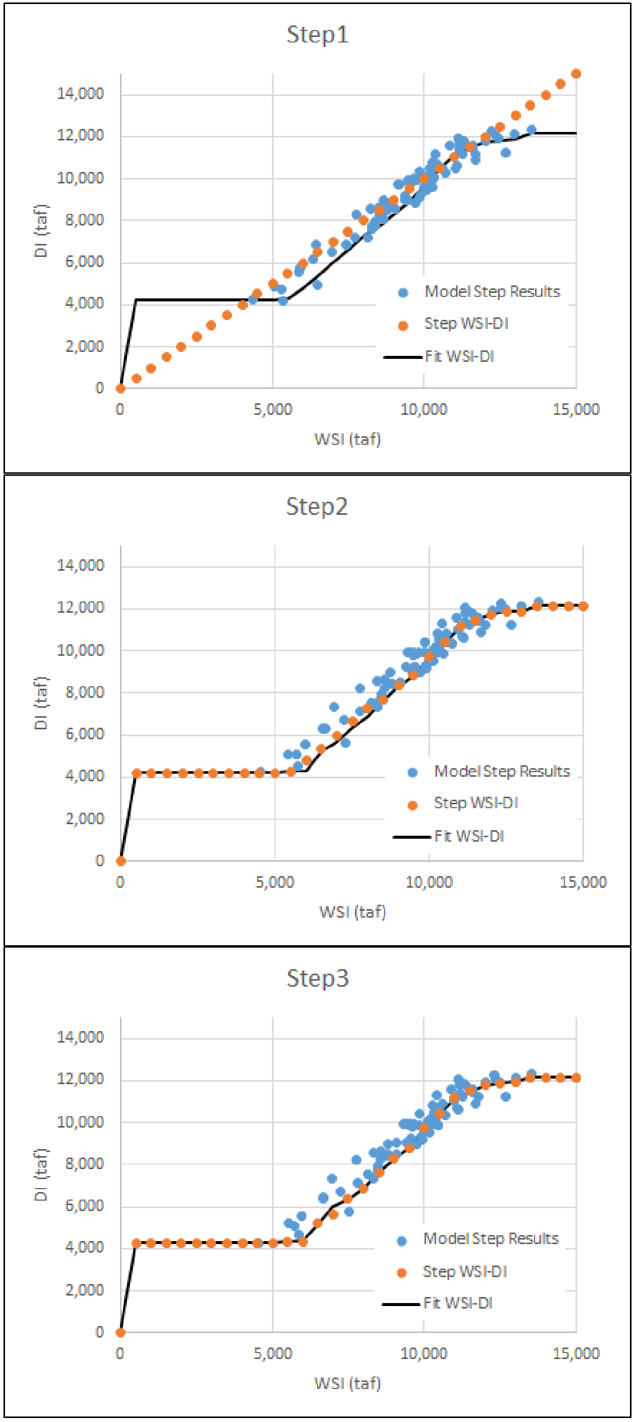
1) CalSim is run using a 45 degree line for wsi-di – i.e. WSI = DI. This is the set of orange points in the Step1 plot of Figure 4. After the model is run for the full 82 years, a set of data can be computed for:
   a) WSI values – Spring storage plus forecasted inflows
   b) DI values – Actual results for total annual delivery and end-of-September carryover storage
   c) The set of points created from these WSI and DI values are shown in blue on the Step1 plot
   d) A curve is fitted to the blue points, shown as the black line in the Step1 plot. This curve becomes the wsi-di curve used for Step 2. Points for the curve are computed for each 500 taf increment of WSI value.

2) The orange dots in the Step2 plot are the same as the points in the black line in the Step1 plot. CalSim is run for the second time using this WSI-DI curve for the full 82 years, and based on this second run's results, just as in Step 1, data is computed for:
   a) WSI values – Spring storage plus forecasted inflows
   b) DI values – Actual results for total annual delivery and end-of-September carryover storage
   c) The set of points created from these WSI and DI values are shown in blue on the Step2 plot
   d) A curve is fitted to the blue points, shown as the black line in the Step2 plot. This curve becomes the wsi-di curve used for Step 3.

3) The orange dots in the Step3 plot are the same as the points in the black line in the Step2 plot. This curve is the wsi-di curve used for Step3. CalSim is now run for the third time for the full 82 years, and based on this third run's results, data is computed for:

a) WSI values – Spring storage plus forecasted inflows
b) DI values – Actual results for total annual delivery and end-of-September carryover storage
c) The set of points created from these WSI and DI values are shown in blue on the Step3 plot
d) A curve is fitted to the blue points, shown as the black line in the Step3 plot. This curve becomes the final WSI-DI curve to be used by CalSim for production studies.

Figure 4 – WSI-DI Curve Training Process



(Example for demonstration purposes only – not from BA or EIS studies for California Water Fix)

While the blue point clouds in Step2 and Step3 of Figure 4 may seem similar, there are refinements to these values. The curve training process has three steps because empirical testing has identified that additional steps beyond three resulted in little or no refinement. In each of the three steps, the black line which is fit to the blue points actually sits a bit low within the point cloud. This is done deliberately in order to achieve a level of conservativism in the allocation process.

The final generated curve is what is used by CalSim in actual model runs. *It would be perfect foresight if the actual 82 blue points calculated in the third step were used as a time series of inputs, specifying the delivery index for each year's water supply index. But that is not the case.* These points are simply used as the basis for a curve that has one DI value for each 500 TAF increment of WSI value. Using a generalized rule, developed by a standardized analytical process, enables CalSim to model a consistent approach to water supply allocation. The WSI-DI curve development process is not perfect foresight.

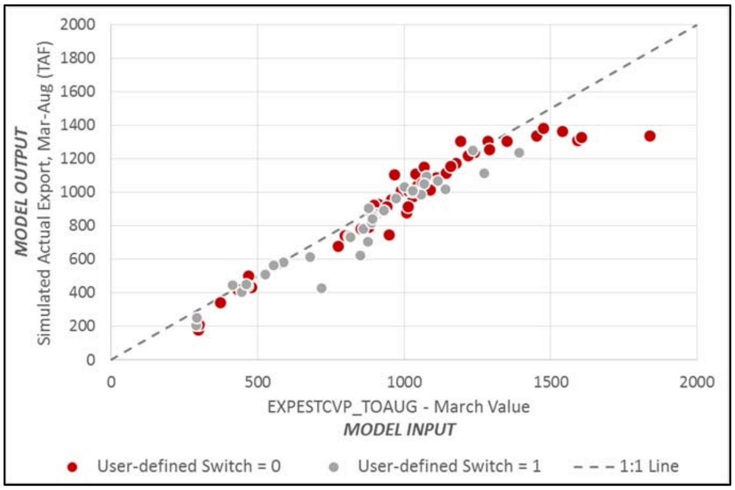
Going back to the baseball analogy, the blue dots in our plot are like pitches. And the black line (WSI-DI curve) is like the hitters hunch about what pitch he will get. Drawing that line through the field of blue dots is drawing a relationship between WSI and DI, given the 82 results that the research produces.

As a contrast to the WSI-DI curve training process, Petitioners affirm their characterization of MBK's iterative runs to determine export estimates as being a clear case of perfect foresight. MBK's effort did not fit a curve relating export capability to some hydrology index. Instead, the actual export capability was successively refined and the exact value was used as input to their South of Delta (SOD) allocation calculation. The plot in Figure 5 shows an XY plot of MBK's March-August export estimate time series values compared to the actual March-August exports achieved in their NAA study. These points lie very close to the 1:1 line, indicating the perfectly predictive nature of the data.

Further notes on Figure 5:

- The spread of points around the 1:1 line should not be visually compared to the point clouds around the WSI-DI curve in Figure 4 – the scales in the two figures are almost an order of magnitude different.
- The grey dots in Figure 5 are data points that were not even used, since allocations were not calculated but instead were hand-entered for those years.
- The red dots to the right simply indicate where export capacity is maxed out.

Figure 5 – MBK Export Estimates

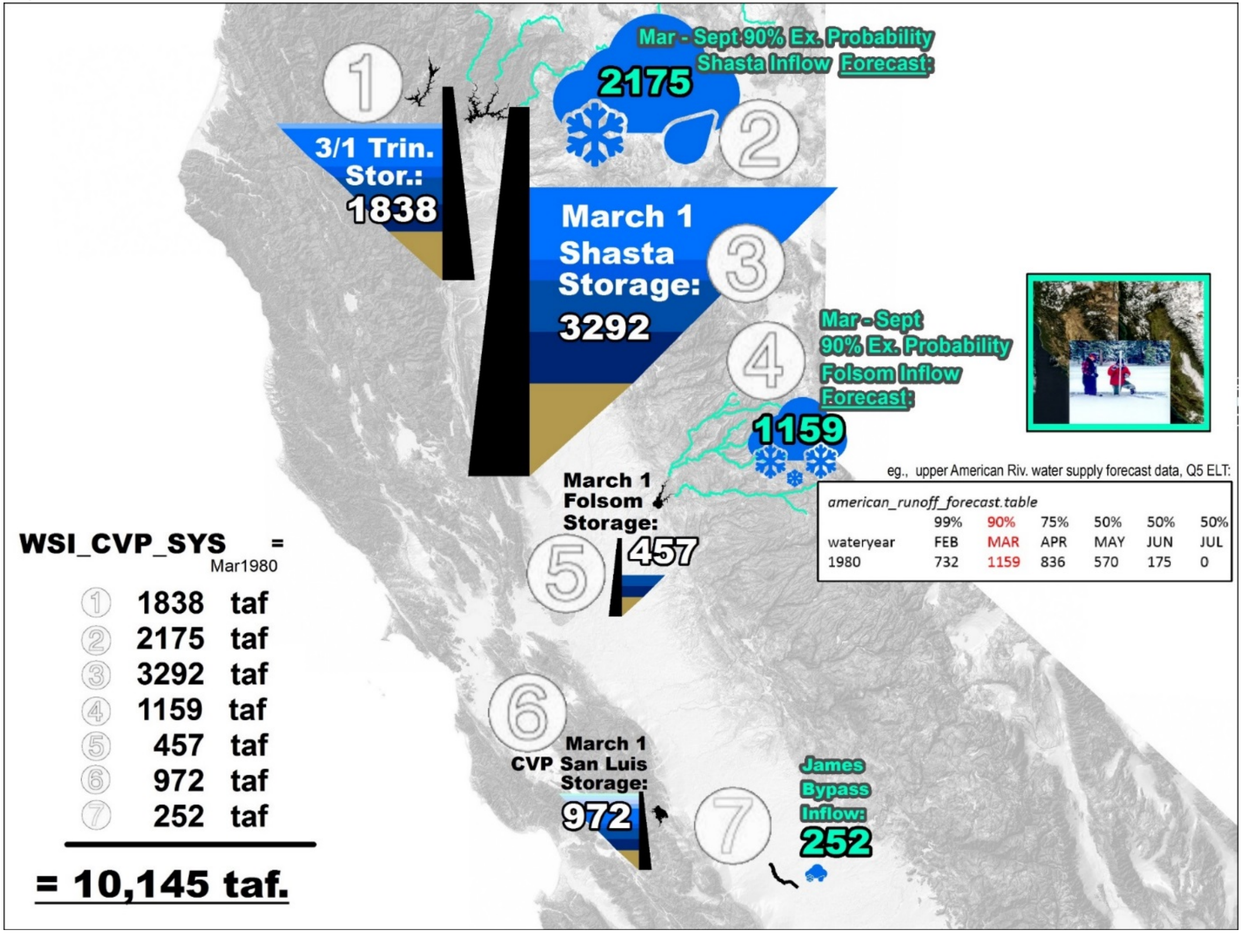


CalSim Allocation Logic Is Appropriate for a Long Term Water Supply Reliability Planning Model

Applying the CalSim allocation logic is appropriate for long term water supply reliability planning because it uses a consistent and reproducible methodology. A detailed example of how the WSI-DI curve is used to calculate an allocation may help to clear up confusion.

In March-May, a value for WSI is calculated from current storage condition and forecasted inflow from the current month through the end of the water year. A diagram of the components of this calculation is shown in Figure 6. The example is from March 1980 of the BA NAA. End of February (March 1) storage is shown for Trinity, Shasta, Folsom, and the CVP portion of San Luis. The 90% March-September inflow forecasts for the Sacramento and American River watersheds are added, along with an assessment of the James Bypass flood flows that can be delivered to San Joaquin River Exchange contractors.[1] The WSI value is 10,145 TAF.

Figure 6 – WSI Calculation



eg., upper American Riv. water supply forecast data, Q5 ELT:

american_runoff_forecast.table

	99%	90%	75%	50%	50%	50%
wateryear	FEB	MAR	APR	MAY	JUN	JUL
1980	732	1159	836	570	175	0

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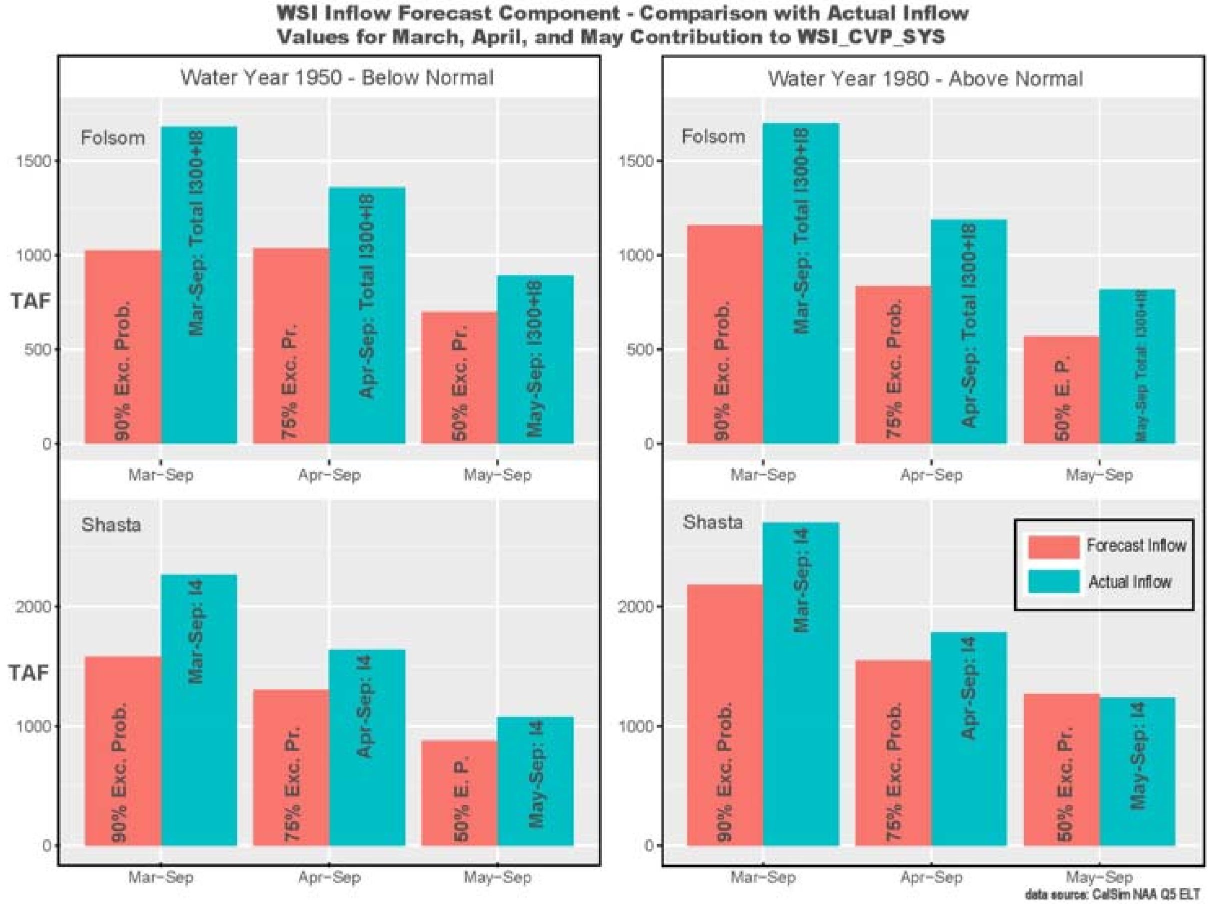
[1] Note that the James Bypass component is the one element of the WSI that is indeed perfect foresight. It is computed by looking ahead at Spring inflows to determine how much of the Exchange Contractor demand can be met. Typically, this contribution to the WSI value is extremely small – in this example it is 2.5%.

The inflow forecast component of the WSI is not perfect foresight. If it were perfect foresight, it would simply add up the actual known inflow input values for Shasta and Folsom from March through the coming months until September. That would give the model precise knowledge of conditions that will happen as the water year progresses. Instead, to represent the type of information actually available to operators, CalSim uses a table of historical or derived *forecasts* for inflow through September. As in real life, a very conservative estimate of the forecast is used in March, and successively less conservative forecasts are used as the initial allocation is updated in April and then in May: 90% exceedance forecasts are used in March, 75% exceedance forecasts are used in April, and 50% exceedance forecasts are used in May.

Figure 7 shows two examples of the inflow forecasts that are used to compute WSI compared to the actual inflows – one for our example of 1980 (an above-normal year), and another for 1950 (a below-normal year). Data is shown for Folsom and Shasta as it evolves from March to April to May. The forecast value is compared to the actual inflow through September. The conservative nature of the forecast can be seen in that the actual inflows in these two examples are higher than the forecasts. As the forecast gets more certain and less conservative, the gap between the forecast and the actual inflow is reduced. The 1980 data shows an example of the actual inflow exceeding the May 50% forecast. This is an example of the uncertainty introduced into the allocation process by using forecast data in the calculation of the WSI.

Figure 7 – Inflow Forecast compared to Actual Inflow

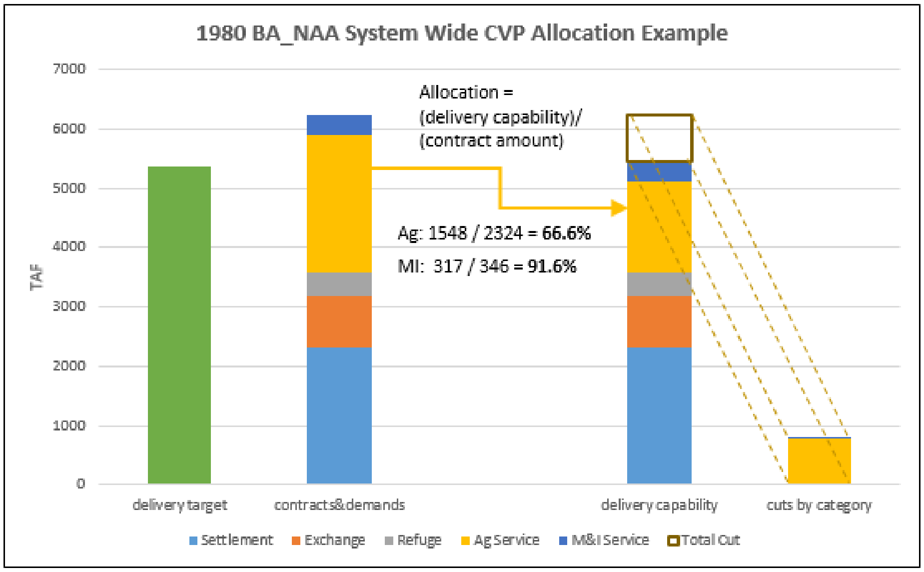


The WSI value of 10,145 TAF is used to derive a Delivery Index value of 9874 TAF from the WSI-DI curve. This is shown graphically in Figure 8. The DI value is a total of delivery capability and end-of-year total carryover storage. A Delivery Target is derived from the DI value through the Delivery/Carryover curve, also shown in Figure 8. The Delivery Target value for 1980 is 5356 TAF. This is the system-wide capability for CVP delivery, based upon the water supply, and this is what is used to calculate the CVP North of Delta (NOD) Ag Service allocation.

Figure 9 reflects actual data from the BA_NAA in March 1980. The 5356 taf delivery target is shown as the green bar. This is compared to a total system demand of 6160 taf. Total demand is assessed as the lesser of total contract obligation and total applied water demand. A cut of 806 taf is needed (6160 – 5356 = 806). Most of this comes from the Ag Service category, with a small reduction to M&I Service as well. Final allocations are 66.6% to Ag and 91.6% to M&I.

Figure 8 – March 1980 WSI … DI … DelTar for BA_NAA

Figure 9 – March 1980 BA_NAA Example – Delivery Target … Allocation Calculation



Walter Bourez's criticism is that the WSI-DI methodology allows CalSim to depict unrealistic allocations. In his rebuttal testimony, he states:

> "Although the method of running the model and using output to develop model inputs employs a form of perfect foresight, this method creates an unreasonable balancing of available supply to water supply allocation and is very different from what is done in actual operations. Revising or replacing the WSI-DI with a procedure that has more reasonable water supply allocations would improve model simulations of drought periods." (Exhibit SVWU-202 Errata, at p.6.)

First, Mr. Bourez's characterization of the WSI-DI training process as perfect foresight is incorrect. There is an important distinction between perfect foresight and developing a rule curve to guide model operations.

Second, we can only re-iterate that CalSim is not an operations model and does not have the depth of information available to it that operators have in real time. CalSim is a long term water supply reliability planning model, and must use consistent, generalized logic that can apply to a broad range of hydrologic conditions.

Third, changing how the model calculates discretionary allocations will not improve drought period simulations. Petitioners maintain that allocations derived using the WSI-DI approach are largely appropriate, with higher allocations in wetter years and lower allocations in drier years. Mr. Bourez objects to CalSim's calculation of very small Ag allocations in extremely dry years. Subsequent testimony will discuss how CalSim handles droughts, but in short, in years when the model's input hydrology struggles to meet all Project obligations, whether the Ag allocation is 0% or 4% has a negligible effect on the overall outcome of the planning model analysis.

In an attempt to justify MBK's own modeling done for SVWU, Mr. Bourez has chosen to criticize CalSim allocation logic. However, MBK's approach to adjusting CVP allocation profiles to their point of view was not to adjust the guide curves discussed above, but to manually manipulate individual year allocations. The 1980 BA_NAA example discussed above is contrasted in Table 2 with the same process in MBK's NAA study. Although their model run (affected as it was by prior year manual manipulation) would have calculated 73.4% and 95.8% Ag Allocations for NOD and SOD respectively, MBK manually entered 100% allocations for both. This is the core difference between Petitioners' and SVWU perspectives in modeling analysis. Petitioners used the modeling to ***calculate*** system response to a proposed action by applying a consistent and reproducible set of rules. MBK ***pre-determined*** an unrealistic, overly aggressive outcome and manually manipulated the model to achieve that result.

Table 2

	BA_NAA	MBK_NAA	
WSI_CVP	10145	10318	
DI_CVP	9872	10162	
Delivery Target	5354	5535	
Total CVP Demand	6160	6160	
Total CVP Cuts	806	625	
Ag Cut	766	618	
NOD Ag Alloc	66.6%	~~73.4%~~ →	**100%**
SOD Ag Alloc	66.6%	~~95.8%*~~ →	**100%**

I do not agree with MBK's modeling because it doesn't use an algorithm to calculate allocations. Mr. Bourez's response appears to be that allocation decisions are so complicated and difficult that you can't do it with an algorithm, so you should just manually input data until you get an outcome you like. He may as well have not used a model at all. MBK's modeling does not approximate an operational philosophy that can be reproduced and operationalized. Furthermore, the overly aggressive operational philosophy presented by the MBK modeling doesn't reflect Reclamation's current and past practices, as testified to by Reclamation's Operations Manager, Ron Milligan.

Reclamation's operational philosophy to meet all project obligations is reflected in and consistent with Petitioners' modeling for the Water Fix

As described above, MBK asserts that the Petitioners' modeling is `“different from what is done in actual operations.” (Exhibit SVWU-202 Errata, at p.6.)` I do not agree with MBK. Petitioners' modeling is consistent with the operational philosophy applied in planning studies over the past 15 years.

SVWU's and multiple other Parties' testimony and cross examination questioned how they can "trust" the projects to operate with the general philosophy depicted in Petitioners' modeling. A review of the entire history of CalSim analysis indicates the consistency with which the CVP has depicted its operational strategy and perspective.

The plots in Figure 10 show CalSim Ag Service allocation exceedance results for 12 studies. It is noted that MBK performed the three studies identified in *italics*.

- 2002 Benchmark Study 2020 Run – the first joint model release by DWR/USBR
- 2004 Operations Control and Plan (OCAP) Study 5 – produced by the Central Valley Operations Office
- 2008 OCAP Study 8.0 – produced by the Central Valley Operations Office
- *SJRR FNA – San Joaquin River Restoration PEIS – Future No Action*
- *USJRSI NAA – Upper San Joaquin River Storage Investigation No Action Alternative*
- *SLLP FNA – San Luis Low Point Future No Action*
- Q0_NAA – Water Fix BA study re-run with historical 2020 hydrology
- 2015 LTO – the No Action Alternative for USBR Long Term Operations Study (Q5 inputs)
- BA_NAA – No Action Alternative for the Water Fix Hearing Process
- BA_H3plus – Proposed Alternative for the Water Fix Hearing Process
- MBK_NAA
- MBK_Alt4A

Reclamation Studies – CalSim Ag Service allocations NOD and SOD are shown in Figure 10A and 10B respectively. The studies using 2020 LOD historical hydrology are all shown with light blue lines. Studies using 2025 Central Climate Change Tendency (Q5) hydrology are shown with olive lines. These models span a range of study purposes, regulatory environments, and hydrology inputs, and they depict an evolution over time of the water supply reliability that Reclamation has indicated it can achieve. All of these allocation exceedance results demonstrate the convention described by Ron Milligan, which is to be somewhat conservative with allocations in wet years to enable meeting CVP obligations through drier years. The slopes on all of the blue and olive lines in the Figure 10 plots enable some level of delivery in all but the very driest years.

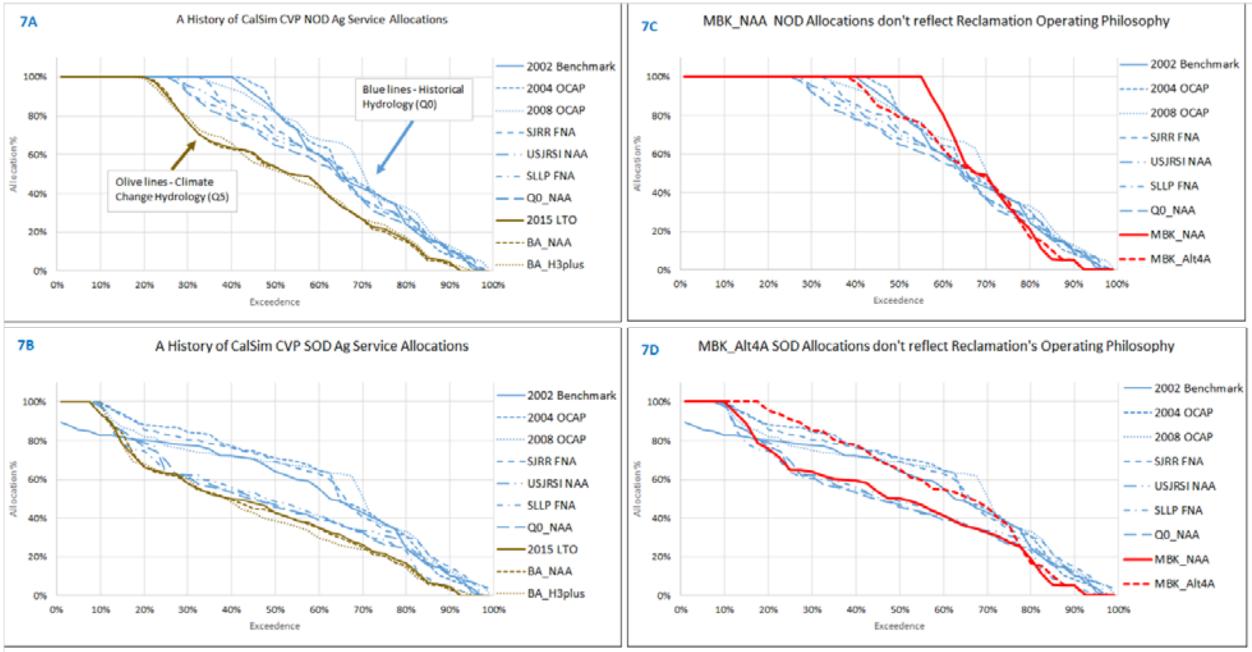
MBK studies for SVWU are shown in red in Figures 10C and 10D, and compared to the Reclamation studies that were run with historical hydrology.

MBK North of Delta – the range of NOD allocations used by MBK for their No Action Alternative, shown in Figure 10C is far more aggressive than any other CalSim study, ever, in the wettest 65% of the model run. Conversely, 25% of the time MBK's allocations fall below any dry year delivery reliability for Reclamation studies done with historical hydrology.

MBK South of Delta – Figure 10D shows a Water Fix allocation that is more aggressive in the wettest 30% of years than any Reclamation models depicted even before the RPA's. The primary focus of the

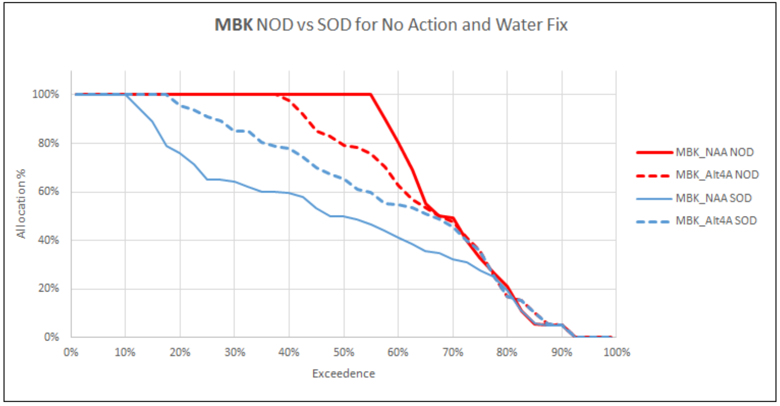
Water Fix will be to enable capture of excess flows that could otherwise not be exported due to through-Delta limitations. MBK's allocation strategy achieves every bit of that, and more. This is unlikely.

Figure 10



Finally, Figure 11 illustrates the NOD/SOD allocation disparity in MBK's studies. It is standard practice that, as export capacity allows, CVP SOD Ag allocation should be as close as possible to that which is achievable NOD. Figure 11 demonstrates that the disparity between NOD and SOD allocations in MBK's No Action Alternative is irrationally large. This is also not a reflection of Reclamation operating philosophy.

Figure 11



MBK has criticized Petitioners' modeling as not representative of actual operations. Reclamation rejects this claim and maintains that a long history of planning analysis depicts a consistent and reasonable operational philosophy. It is MBK's analysis that does not appropriately represent CVP operations or the potential operation of the Water Fix.

Drought Operations in CalSim

Other Parties' rebuttal and cross examination had a notable focus on drought conditions and how CalSim handles these, raising the specter that if operations under severe drought conditions are not carefully represented this makes the analysis of potential Water Fix effects unreliable. Some examples of this testimony are provided below:

`Dierdre DesJardins, 5/12/2017 Transcript, Vol. 44 at 59:12-16: "My question is how can you have a planning model that doesn't address droughts? I mean, how can you do water supply planning in California without addressing droughts in the Sacramento River Basin?"`

`Walter Bourez, Exhibit SVWU-202 Errata at p. 4: "Prioritize meeting BiOp CVP and SWP reservoir storage level specifications, avoid dead pool storage conditions, and meet public health and safety requirements, rather than unnecessarily making reservoir releases for exports or over-allocating water supplies to discretionary water contractor deliveries."`

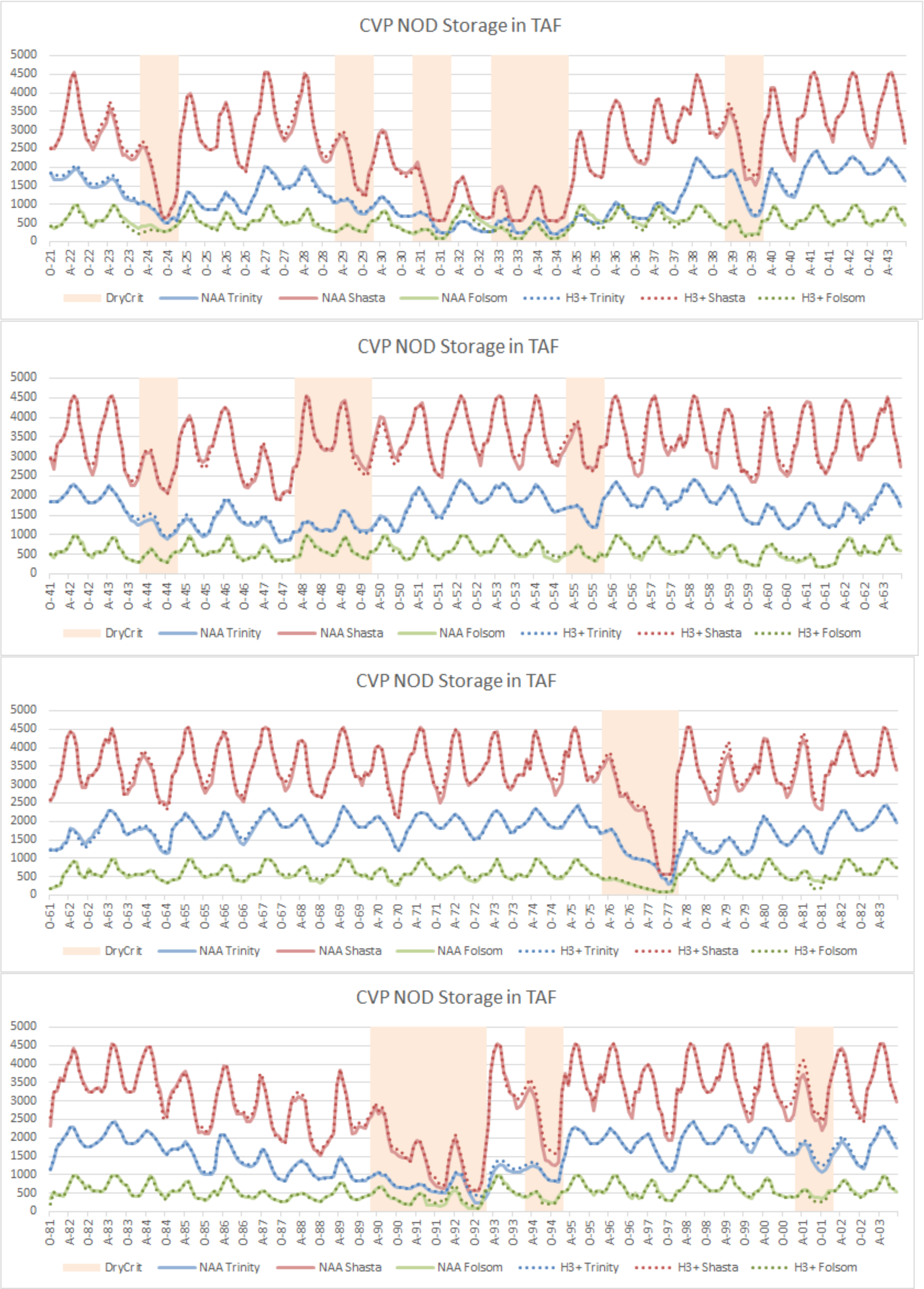
`Tom Gohring, 5/18/2017, Transcript, Vol. 45, at 37:17-19: "Reclamation and DWR witnesses had repeatedly said that their modeling cannot be trusted in the driest 10 or 20 percent of the years."`

Mr. Gohring has not heard Petitioners' witnesses correctly. CalSim modelers have repeatedly and consistently said that model results showing extremely low storage conditions, including dead pool, are indicative of severe drought when CalSim does not have sufficient knowledge about specific local and unique situations that typically inform collaborative decisions about how to best manage resources. This is not synonymous with a lack of trust in the model, and these results do not reflect a proposal to operate at these low storage conditions. If 600 taf at Trinity, 1200 taf at Shasta, and 250 taf at Folsom are considered low storage thresholds, extreme conditions exist in no more than 8% of all monthly results.

There are many dry and critical years when CalSim does model drought operations without draining NOD storage. Plots in Figure 12 show the entire 82 year period of record for a CalSim run, with the driest 20% (17 years with the lowest Sacramento Valley Index values) designated with a shaded background. Storage results are shown for Shasta, Trinity, and Folsom Reservoirs for the BA_NAA and BA_H3plus scenarios. Many of these driest years, including some designated as critical, depict storage operations well within normal ranges. In these years that depict system operations under dry but not severe conditions, CalSim is able to meet regulatory criteria and CVP contract obligations and discretionary operations. Impacts of the Water Fix in these years on storage conditions and water supply are minimal. CalSim can and does demonstrate the effect of the Water Fix in dry years and in drought conditions.

The Technical Appendix to this document provides detailed descriptions of CalSim operations in the 1930's drought to clarify results and rebut testimony of Walter Bourez (Exhibit SVWU-202 Errata) that these are unreasonable. It is important to understand that the reason that Petitioners' modeling results in extremely low NOD storage in many drought years, where MBK modeling does not, is that there is more water in MBK's analysis. The ELT Q5 inputs and sea level rise assumptions used by petitioners are more challenging in drought years.

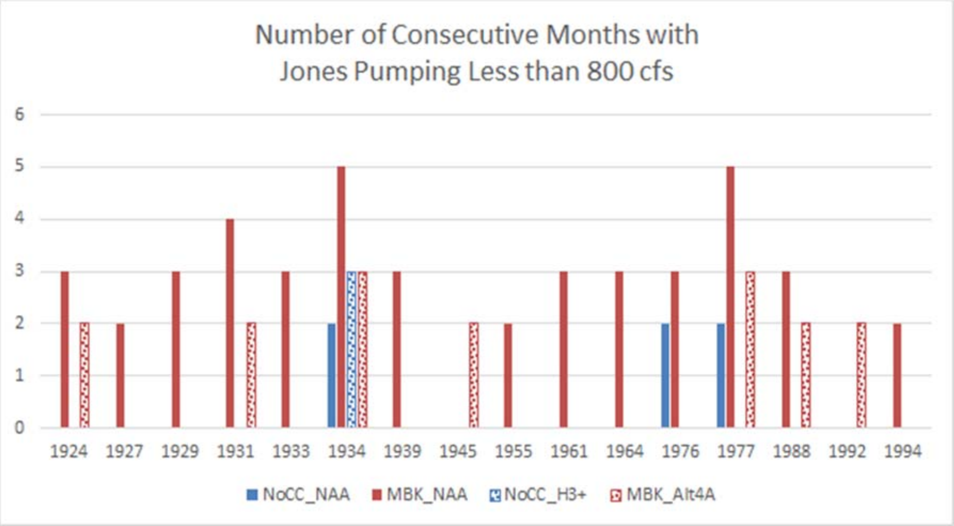
Figure 12 – CalSim Operations in the Driest 20% of Years



Minimum Export Level at Jones Pumping Plant

Walter Bourez has re-iterated upon rebuttal that extremely low exports at Jones Pumping Plant are normal operations during drought conditions. Ron Milligan's rebuttal testimony indicated that although occasional low pumping levels can be a result of extreme operations during droughts, it is not a reasonable long term operational norm. MBK's modeling shows numerous years with consecutive months of Jones pumping less than 800 cfs as shown in Figure 13.

Figure 13 - years with multiple sequential months of Jones exports below 800 cfs.



Summary

A discussion on May 12, 2017 (Transcript, Vol. 44 at 105-111) between Mr. Herrick and Mr. Bourez commingled all of the topics addressed here, exhibiting confusion and sowing significant mischaracterizations about CalSim and Petitioners' modeling. We have provided background and explanations in this document that clarify issues of perfect foresight, CVP allocation logic, drought operations, effects of climate change hydrology, and Reclamation operational philosophy.

California WaterFix Hearing
Exhibit No. DOI – 37

Technical Appendix – CalSim Decisions in a Drought Sequence

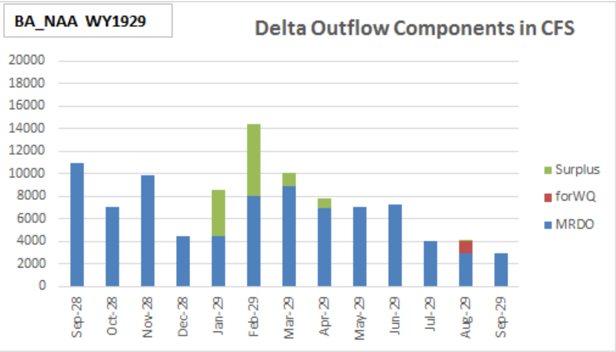
The decisions taken by the model can be clarified by presenting details of operations through a drought sequence. First, we will present the evolution of decisions through the initial years of the 1930's drought. Details will also be presented on 1933 model decisions criticized by Walter Bourez in SVWU-202.

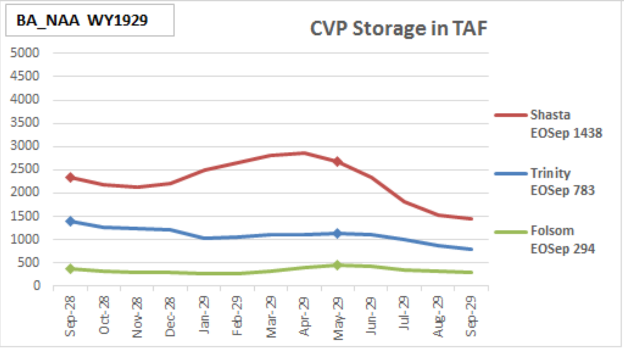
1930's Drought Sequence

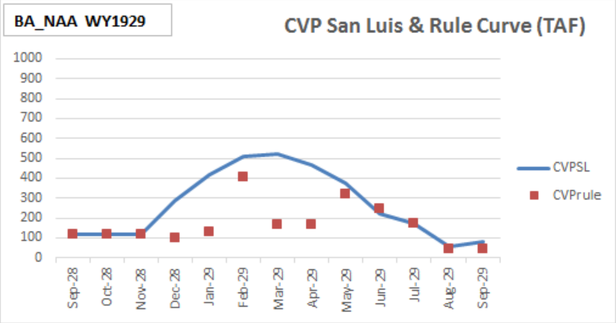
For each year of this sequence, plots show:

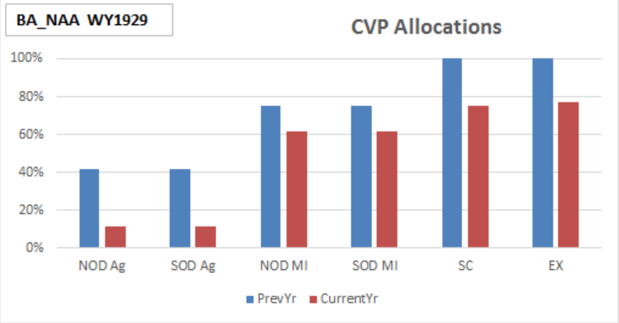
- Components of total Delta outflow that meet D1641 Table 3 flows and both Fall and D1641 X2 requirements, additional increments that are needed to satisfy D1641 water quality standards, and flows above those levels.
- CVP NOD storage at Shasta, Trinity, and Folsom Reservoirs
- CVP storage in San Luis Reservoir and the rule curve
- CVP allocations for the previous and current year
- Jones and Banks Exports
- CVP Delivery totals – combined NOD and SOD delivery, split into Oct-Feb and Mar-Sep segments

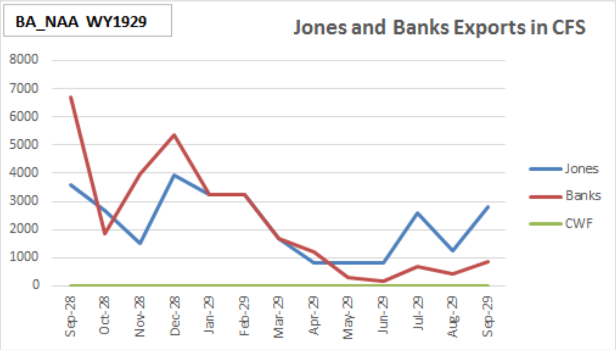
<u>1929</u> <u>is the first full year of drought</u>. A 40-30-30 Critical year and a Shasta Critical year, it is preceded by an above-normal year. Allocations to CVP Ag are 11%. Releases are made in May and June to meet Delta Outflow of 7100 cfs for X2, and July-September to meet Table 3 D1641 flows. Shasta, Trinity, and Folsom balance responsibilities to meet CVP obligations and finish September at 1438 taf, 783 taf, and 294 taf respectively.

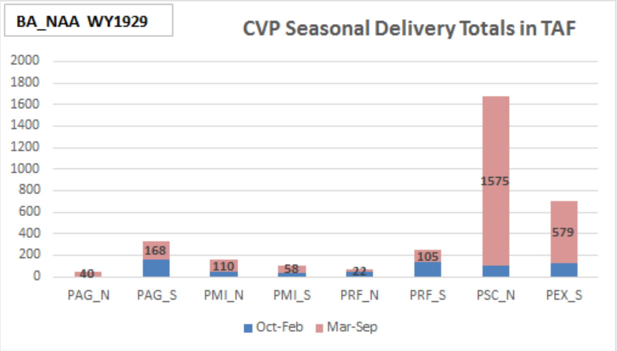




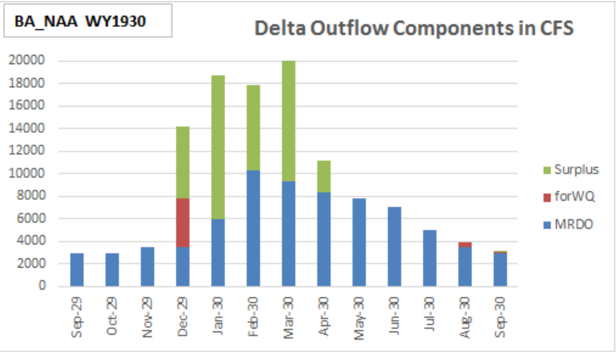


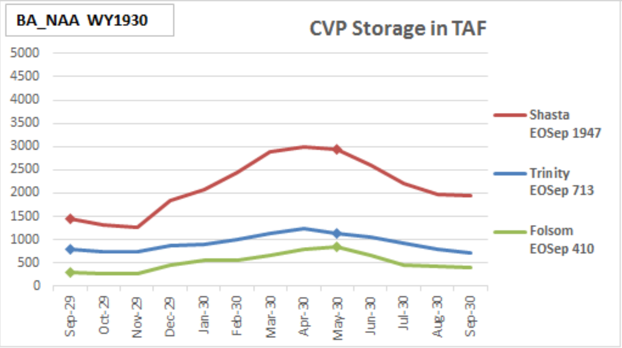


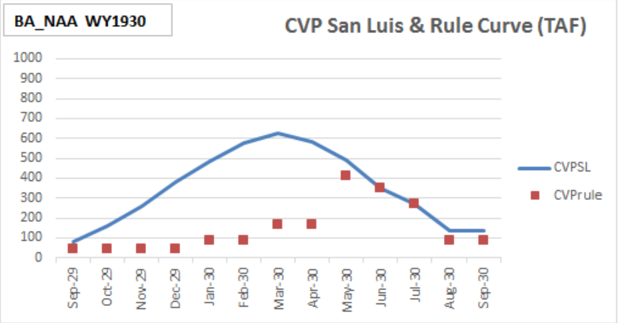


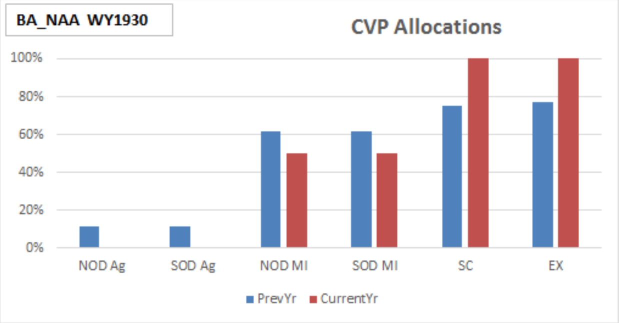


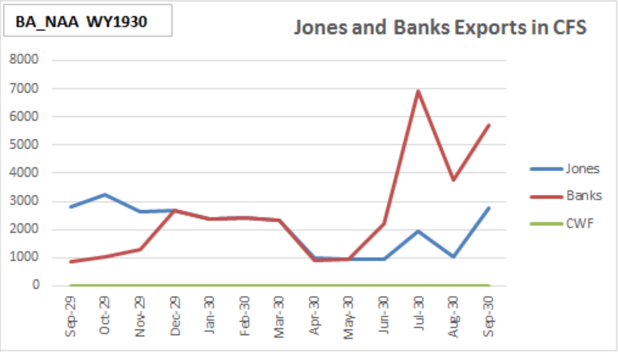
<u>**1930** is the second year of drought</u>. It is a 40-30-30 Dry year and not Shasta Critical, and even though the water supply forecast is better than the previous year, the higher obligation to Settlement and Exchange contractors leads to a need to cut Ag Service allocations to 0%. Late summer hydrology enables NOD reservoirs to limit releases for delivery, and September carryover is 1947 taf, 713 taf, and 410 taf at Shasta, Trinity, and Folsom.

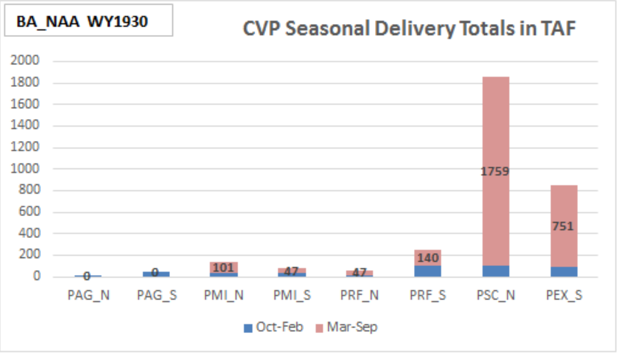








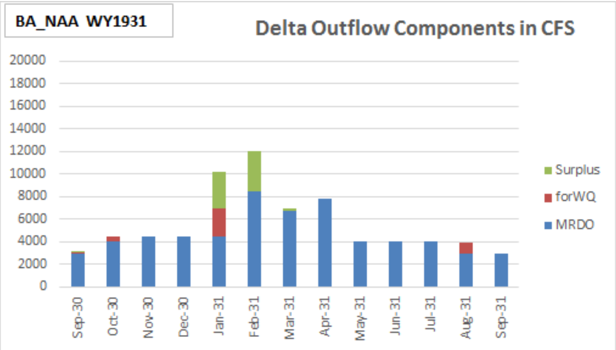


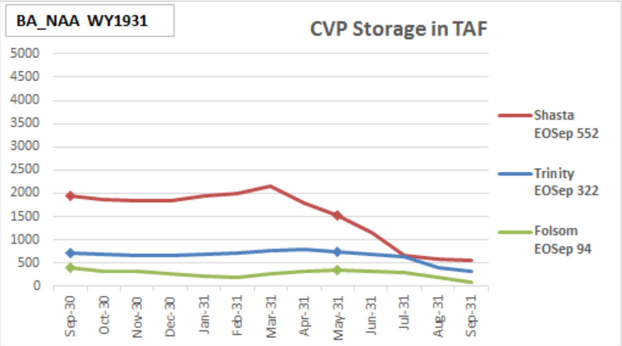


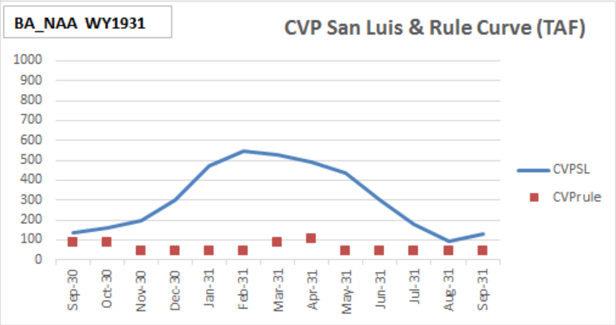
<u>**1931** is 40-30-30 Critical and Shasta Critical</u>. Reservoirs do not fill much beyond their Fall carryover levels. Ag Service allocations are 0%. Reservoirs operate through the Spring and Summer to meet Delta outflow and water quality standards and to deliver contract obligations. Shasta and Folsom finish barely above dead pool, as storage is withdrawn to meet flow and delivery requirements.

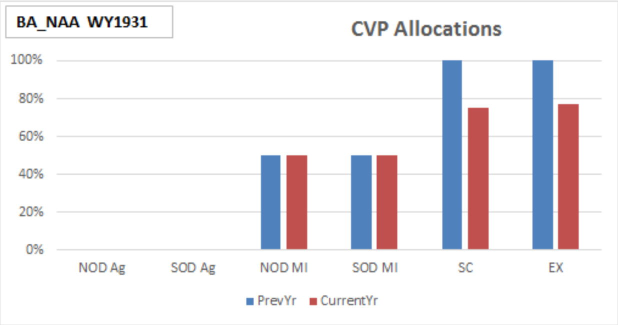
This is a good example of what Mr. Bourez objects to. He has testified that the model should make decisions to prioritize carryover storage (Exhibit SVWU-202 Errata, at p.4.), but logic would be needed to balance that with other priorities. When water supplies fall below those amounts needed to meet even critical year objectives in water rights and biological opinions, as may happen in multiple sequential severe drought years, use of project water must be approved by the Board and the fishery agencies to meet the unique needs and circumstances of those years.

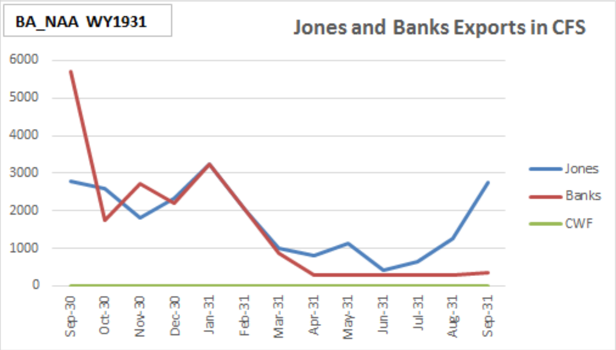
The results of CalSim in 1931 indicate simply that the system is not able to meet all obligations with the water supply that is available. The same low storage conditions are indicated in both the NAA and WaterFix scenarios. The system is equally stressed in both scenarios.

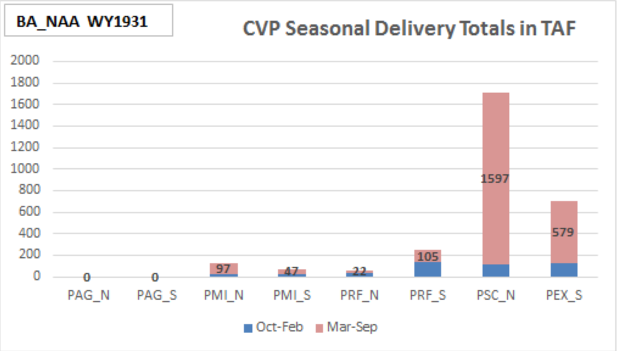






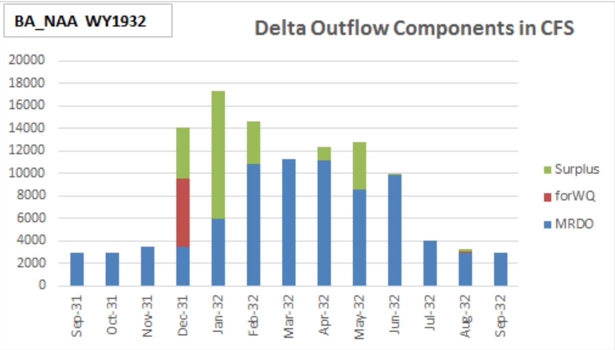


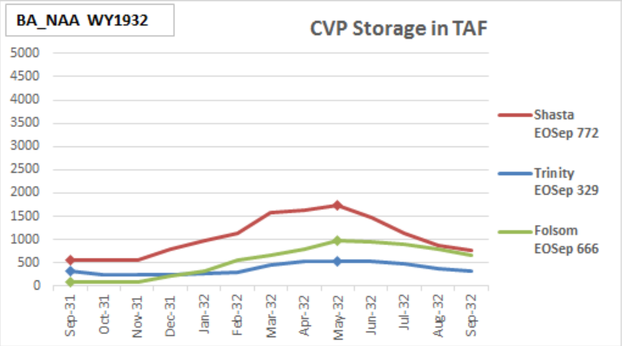


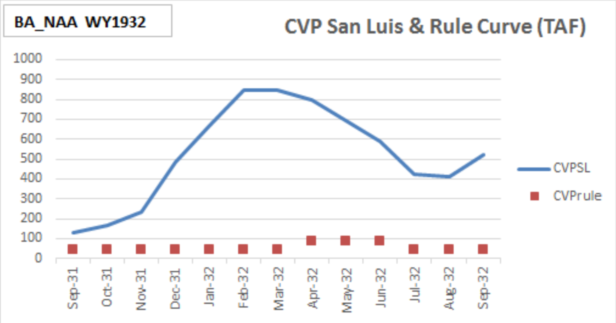


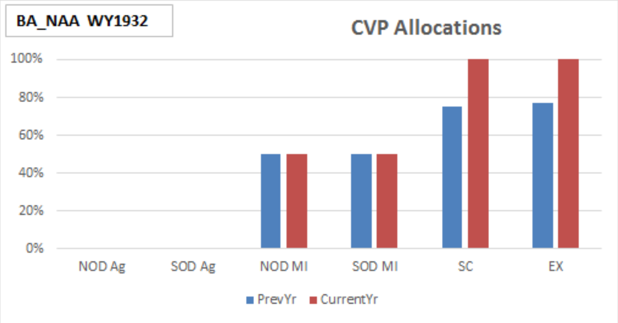
<u>1932</u> <u>is 40-30-30 Critical but not Shasta Critical</u>. Excess water in December-February enables export to San Luis storage, but due to low NOD storage and forecasted inflow, Ag Service allocation is again 0%. The CVP again operates only to meet system standards and contract obligations. Folsom carryover in September is fairly high, while Shasta and Trinity are both low.

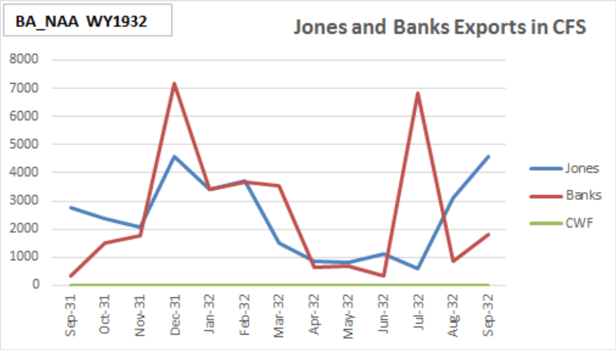
Why draw Shasta down so much and leave water in Folsom? This is largely due to releases from Shasta being necessary for deliveries to Settlement Contractors and minimum flows at Wilkins Slough through April, May, and June. Jones exports in August and September are interesting – Folsom is actually releasing for flood control in August! In September, Shasta is only releasing to meet Wilkins Slough minimum flows, and storage withdrawal from Folsom contributes to the CVP share under the Coordinated Operation Agreement (COA) for a small excess condition.

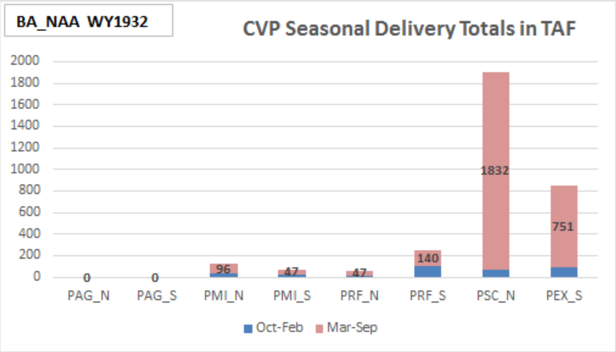




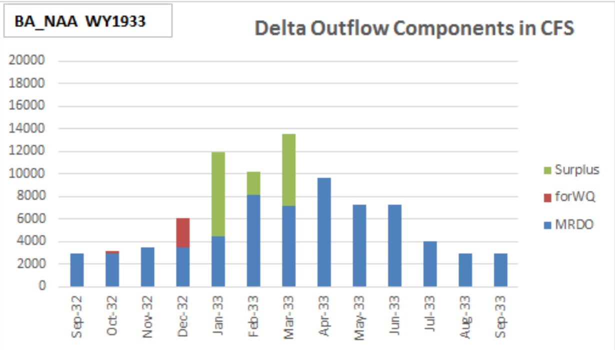


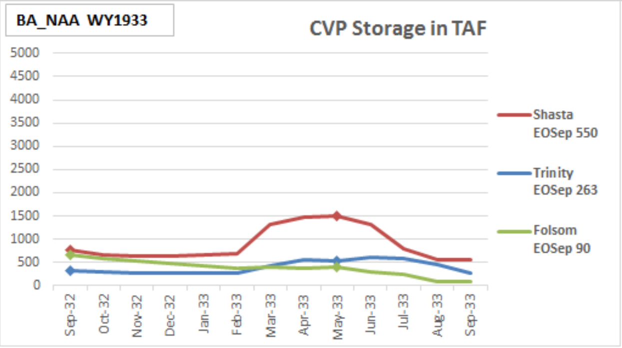


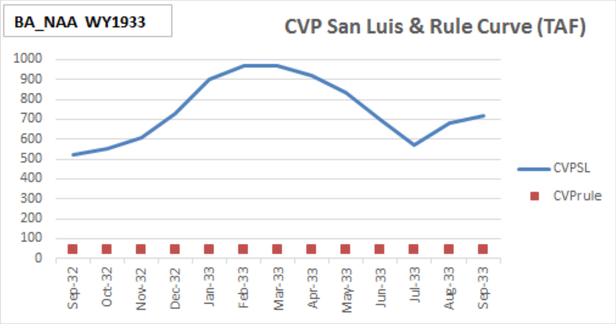


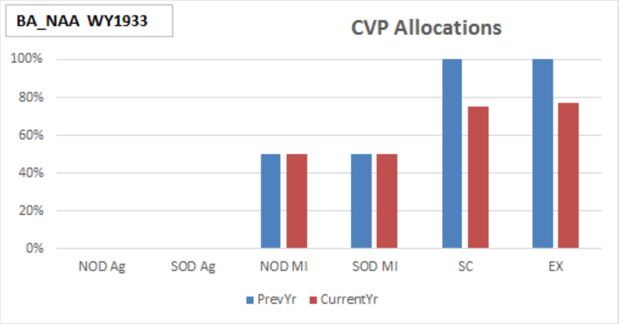


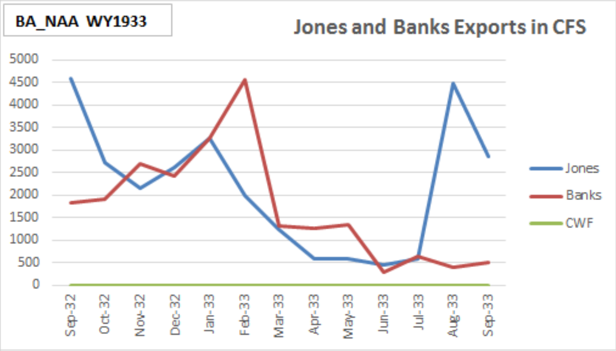
1933 is the year specifically criticized in Exhibit SVWU-202 Errata for unreasonable operations.

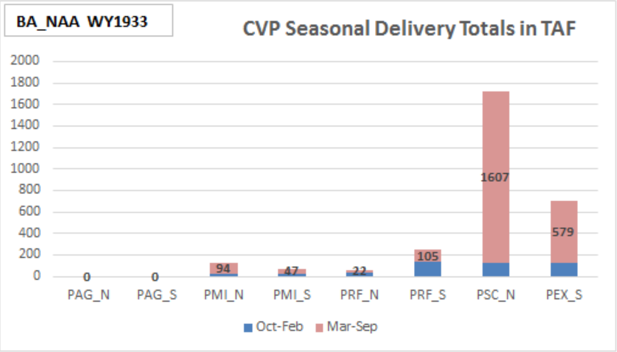












The plots show that Winter gains in San Luis storage are achieved through export of available water in the Delta, not specific releases from NOD storage. Ag Service allocations are 0% for the 4th year in a row. Exports are at minimal levels April through July. Some NOD storage gains are made after February, but meeting system standards and contract obligations has drawn storage to extremely low levels by July. In addition to meeting delta outflow for X2 in April, May, and June, releases from Shasta and Folsom are further influenced by flow standards that they are uniquely responsible for, listed in the table below.

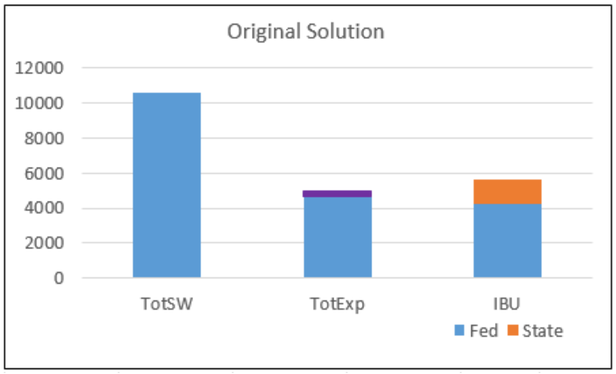
	March	**April**	**May**	**June**	**July**	**August**	**Sept.**
Shasta	Keswick	Wilkins Sl.	Wilkins Sl.	Wilkins Sl.		COA/WQ	Rio Vista
Folsom	Nimbus				H Street	COA/WQ	Rio Vista

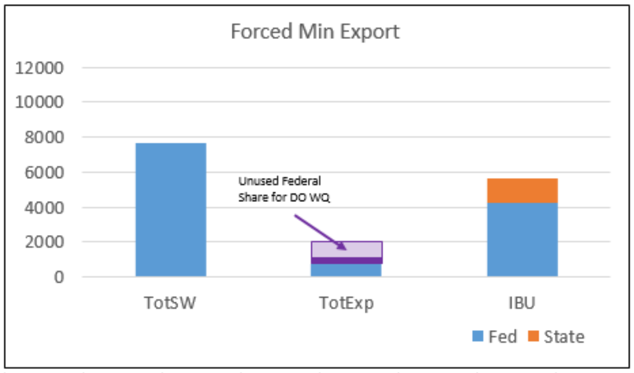
SVWU-202 Errata particularly takes CalSim to task for releasing water in August to export 4476 cfs at Jones only to be stored in San Luis. Taken out of context, this certainly does look like an unreasonable operation. In layman’s terms, CalSim adheres strictly to COA sharing formulas, and uses linear programming priorities to encourage operations that appropriately balance inflow, export, and delta outflow to meet delta water quality. The combination of strained system conditions created by severe drought (low storage, water quality conditions) with a devout adherence to COA forces the model to devise a solution that is not a reasonable reflection of actual operations.

Details of the August 1933 CalSim Results

Oroville is releasing to meet Feather River minimum flow. CVP reservoirs are releasing to export 4476 cfs. If Jones exports were to be curtailed to a minimum export of 600 cfs, not all of the reduction could be backed up into CVP reservoirs. The lower flow into the Delta would create conditions such that an additional 980 cfs of Delta outflow would be required to meet D-1641 water quality standards. That would still leave 2896 cfs, or ~ 178 taf, which could remain in CVP storage.

Relative to the original solution, the suggested solution would mean a lower reduction in CVP storage withdrawal than reduction in total export, and for the same CVP share of an equivalent In Basin Use, that effectively converts the balance to unused federal share, even though most of it goes to the new water quality outflow. This element of the “Total Export” side of the COA balance is shown in the figure below. CalSim’s linear programming solution approach penalizes incremental Delta outflow for water quality (C407_ANN) with a weight of -2050 to encourage the model to make reasonable choices about the Inflow:Outflow:Export relationship that meets WQ standards. CalSim also penalizes unused share of storage withdrawal with a weight of -1285.





Under normal operating conditions, the system has flexibility to avoid these solutions, and it is rare to have unused federal share that is not exported at Banks (it happens only 13 times in the 984 months of simulation in the NAA). Under the stressed conditions experienced in August 1933, however, these generalized rules do not enable the model to make the more realistic choice to preserve upstream storage over an unreasonable export. This extremely rare behavior in CalSim results under stressed conditions does not reduce the level of confidence in the overall capability of the model to depict the water supply reliability impacts of a proposed alternative relative to a no action alternative.