Description of studies referred to in this technical report.

DWR/USBR Alternative 4a: Petitioners' Alternative 4a with Early Long-Term climate change
DWR/USBR NAA: Petitioners' No-Action Alternative with Early Long-Term climate change
MBK Alternative 4a: Alternative 4a prepared by MBK (historical hydrology)
MBK NAA: No-Action Alternative prepared by MBK (historical hydrology)

1. Introduction

Through testimony on behalf of Sacramento Valley Water Users, MBK claims that they use a more accurate export estimate methodology in their modeling to produce more accurate results. Dan Easton testified that, in the Petitioner's modeling, "*the export estimates are often very inaccurate and it can, at times, lead to unrealistic allocations*", and that MBK used "*an iterative process to come up with more accurate export estimates for purposes of making an allocation.*" (Vol. 20, 207:12-14). Later in the testimony, Walter Bourez clarified that MBK used the iterative process to "*get the model to be commensurate with the amount of information and knowledge that the operators have"* when making allocations (Vol. 20, 221:10.) This is further documented in MBK's written testimony SVWU-107, which states: *"For the export forecast based allocations, a more accurate set of export forecasts was used that recognizes the unique hydrologic circumstances of each year just as operators do in their operations forecasts."* (SVWU 107, p. 39).

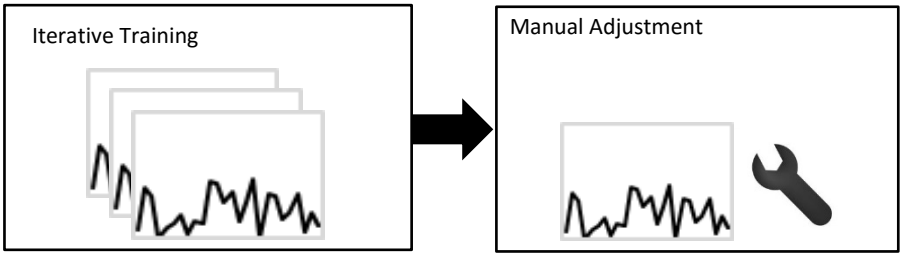
MBK's approach for developing export estimates is inappropriate for use in planning models because it provides the model with foresight that operators would not have when making allocation decisions. In my opinion, Petitioners' modeling more accurately mimics operator decisions and, more importantly, it applies a set of principled guidelines that does not rely on foresight and does not change from year to year. Finally, Petitioners' modeling does not manually modify export estimates from year to year. All of this is important for a planning model to enable accurate comparisons and isolation of the changes that are associated with a particular project.

Below I will describe two issues that undermine MBK's discretionary choice to modify the export estimates in their modeling. These issues are:

1. MBK's iterative training process introduces foresight in the model, which is inappropriate for a planning model; and
2. MBK frequently modifies its own export allocation methodology by manually increasing export estimates (17/82 years) or by bypassing their methodology all together (35/82 years). This is done using trial-and-error (Vol. 20, 224:19-24), which they admit cannot be replicated by anyone other than MBK. (Vol. 20, 233:14-25 - 234:1-6).

2. MBK's Export Estimate Approach

MBK Alternative 4a export estimate uses a pre-processed timeseries whose development involves two main components: iterative training and manual manipulation, the details of which are discussed in the following subsections. The illustration below shows that first, MBK used an iterative training process then second, MBK made manual adjustments.

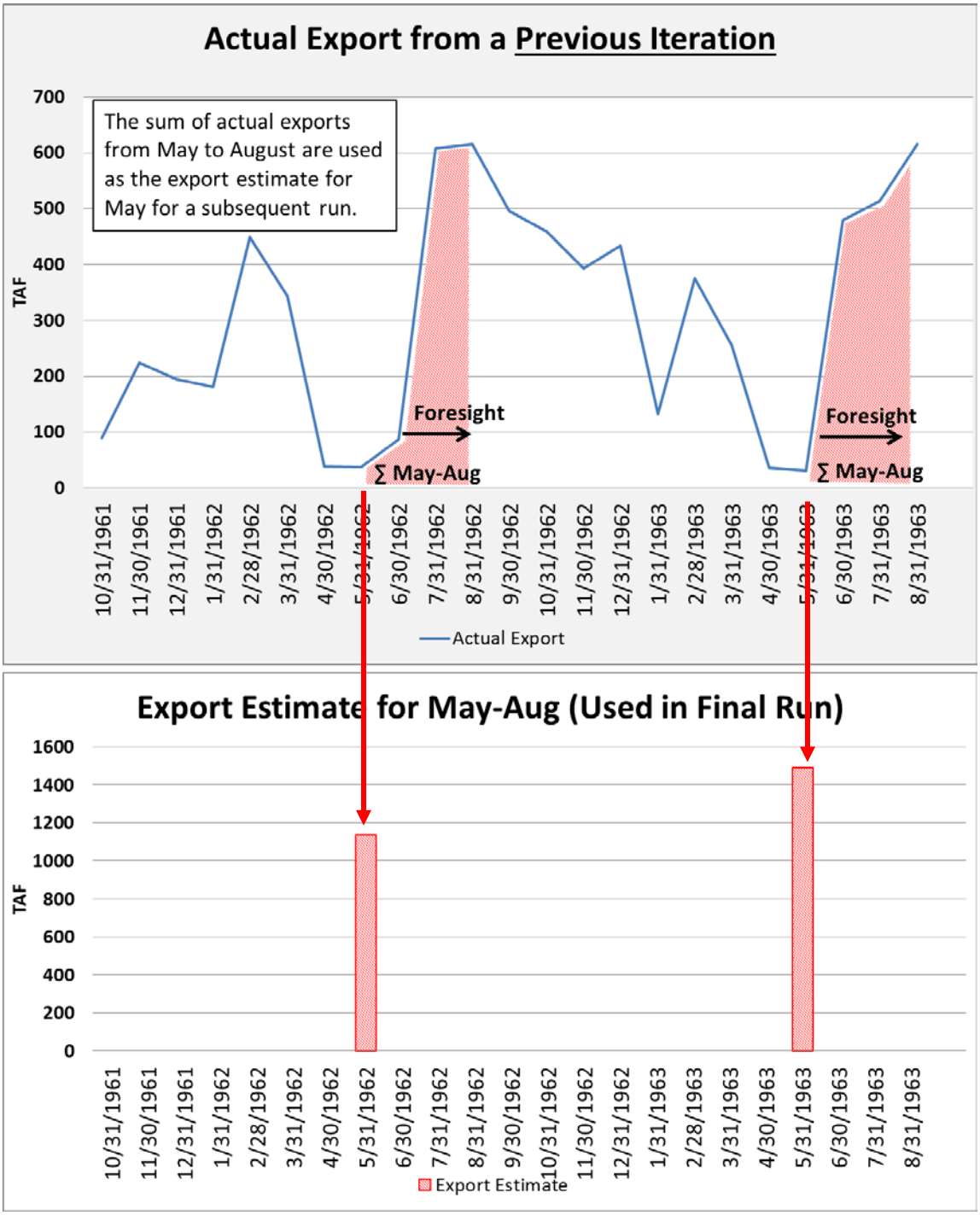


2.1 MBK's iterative training process

The export estimate timeseries used in MBK Alternative 4a is developed through an iterative training process where the previous iteration's *actual* exports are set as the export *estimates* for a subsequent iteration. The previous iterations use the same hydrologic inputs as the final run. By setting an actual export (which is established as viable, or "safe", based on the outcomes of previous runs) as an export *estimate* for a subsequent run, foresight is inherited from the previous iterations to influence the final allocation decision. Introducing such foresight reduces uncertainty in the modeling to a greater degree than real-time information would reduce uncertainty for an operator. Figure 1 shows the conceptual overview of the iterative training process where the actual exports from a previous iteration are set as an export estimate for a subsequent run.

The export estimate timeseries was qualified as "iterative" and "more accurate" in MBK's testimony, but they did not specify technical details regarding its development. To determine the technical basis of the timeseries development, the Petitioners reviewed a technical memorandum entitled "Improvements to CalSim San Luis Operations" dated July 16, 2015, prepared for Reclamation by MBK Engineers. (DWR-___.) The work presented in that technical memo was used as part of the San Luis low Point Improvement Project. MBK acknowledges that they had done modeling work for the San Luis Low Point Improvement Project. (Vol. 20, 114:3-22).

Figure 1: Conceptual depiction of transferring foresight from previous iterations to the final run. The values used in the chart are for conceptual purposes only – they do not reflect the results from actual iterations.



The export estimate provided by MBK in May of 1962 incorporates the actual exports the system is capable of making in consideration of the actual hydrology of June, July and August. This information would not be available to an operator making that same decision and therefore is inappropriate to use in a planning model.

2.2 MBK's manual manipulation of their iteratively trained export estimate timeseries

In addition to the iterative training process, there are indications that the export estimate timeseries produced by MBK has been modified through trial-and-error and institutional knowledge. The manual manipulations are manifested in two ways: manually increasing export estimates in 17 out of 82 years and by bypassing their methodology altogether in 35 out of 82 years.

2.2.1 Bypassing their export estimate timeseries

In select years, MBK bypasses export estimate methodology and specifically directs the model to allocate based only on the WSI-DI (water supply based) methodology. In bypassed years, MBK assumes that export capacity limitations would not be a factor in determining allocations. MBK's determination to bypass export estimates is not consistently reproducible, nor does it follow a discernible guideline (i.e. sometimes wet years are bypassed and sometimes critical years are bypassed). This model behavior is indicated by Dan Easton's testimony on October 20, 2016: *"And, I mean, we looked at the allocations, and there were years where the standard practice, WSI-DI -- and we had more detailed export estimates -- where the allocation, we look at that and we think that looks reasonable*." (Vol. 20, 213:18-22.)

Selectively bypassing export estimates in certain years is not appropriate, especially in years where the San Joaquin River is dry and export limitations due to OMR and SJR I/E could be a factor in determining allocations. For example, Tables 1-3 show allocation decisions made by MBK Alternative 4a in various critical, dry and below normal years where export estimate was deliberately bypassed. It is unrealistic that export limitations would be ignored in a below normal water year; an operator would likely factor in export limitations due to OMR or SJR I/E when developing an allocation.

Figure 2 shows that export estimate is bypassed in 35 out of 82 years in MBK Alternative 4a. The export estimates were not bypassed in MBK NAA (Figure 3). This shows an inconsistent implementation of their own methodology between studies, and places the two studies on differing bases for comparison. In other words, these modeling runs are not comparing only the impacts of the CWF, but impacts that are unrelated to the CWF and attributing them to MBK Alternative 4a.

This differs from the Petitioner's studies, where both the WSI-DI and export estimate methodologies are considered in every year, with the minimum of the two selected to inform the final allocation. The model (not the manual decision of a modeler) considers both storage conditions and export limitations while making a decision. Furthermore, the allocation method is consistent, unlike MBK, between the DWR/USBR NAA and DWR/USBR Alternative 4a, allowing the same basis for comparative analysis.

Tables 1-3: Allocation decisions made in various critical, dry and below Normal years (according to the SJR 60-20-20 WYT index). In these years where SJR is dry, one would expect export limitations to be considered when making an allocation decision.

Table 1

MBK Alternative 4a	May-25	May-26	May-30	May-33	May-44
1. Sac WYT Index	D	D	D	C	D
2. SJR WYT Index	BN	D	C	D	BN
3. Export Estimate (ToAug)	9,999	9,999	9,999	9,999	9,999
4. Allocation based on Export Estimate (ToAug)	19,259	18,778	19,044	18,683	18,035
5. Allocation based on WSIDI (ToAug)	**2,022**	**2,188**	**2,108**	**755**	**1,416**
6. Oroville storage	2,324	2,531	2,547	1,332	2,196
7. SWP San Luis storage	898	608	765	627	207
8. Final allocation	2,022	2,188	2,108	755	1,416
9. Final allocation (%)	48%	52%	50%	18%	33%
10. Method used for allocation decision	WSIDI	WSIDI	WSIDI	WSIDI	WSIDI

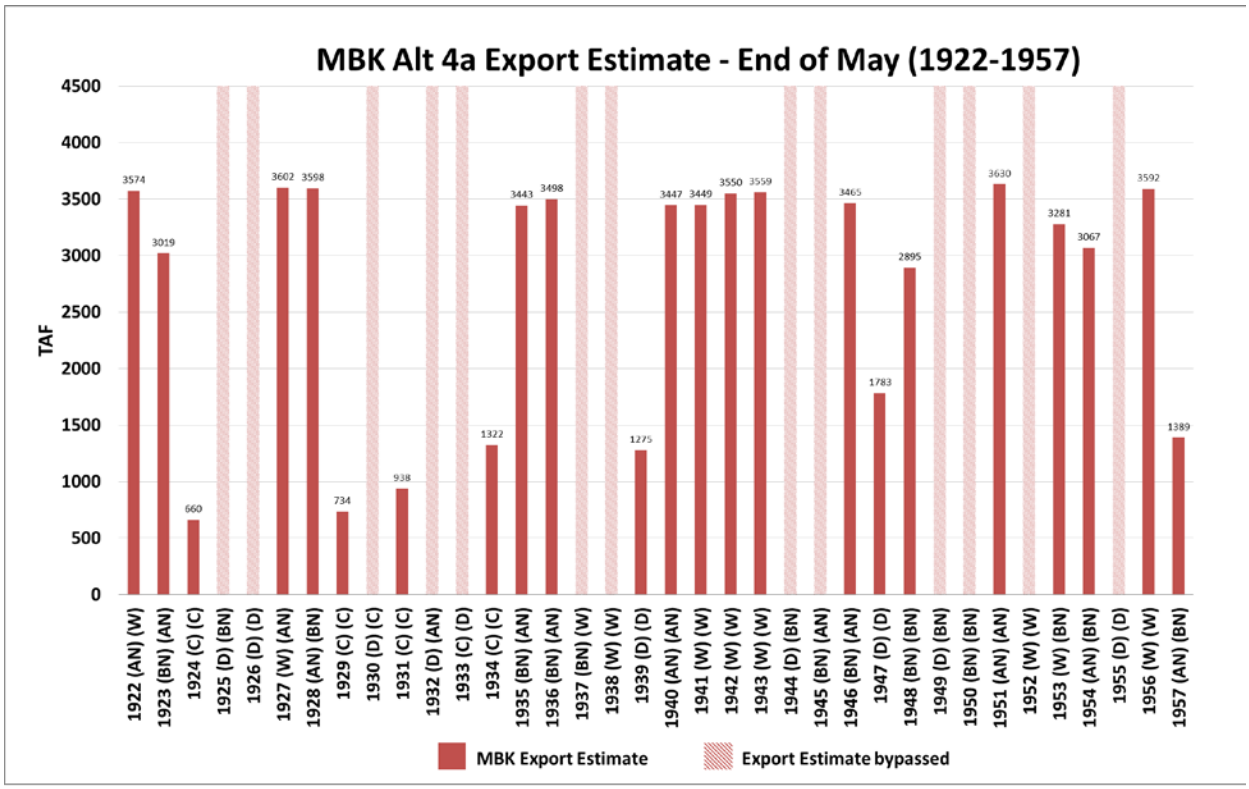
Table 2

	May-49	May-50	May-55	May-60	May-64
1. Sac WYT Index	D	BN	D	D	D
2. SJR WYT Index	BN	BN	D	C	D
3. Export Estimate (ToAug)	9,999	9,999	9,999	9,999	9,999
4. Allocation based on Export Estimate (ToAug)	18,836	18,440	18,862	18,507	18,426
5. Allocation based on WSIDI (ToAug)	**938**	**2,371**	**1,355**	**1,811**	**1,028**
6. Oroville storage	1,861	2,842	1,715	2,567	1,914
7. SWP San Luis storage	652	359	688	474	431
8. Final allocation	938	2,371	1,355	1,811	1,028
9. Final allocation (%)	22%	56%	32%	43%	24%
10. Method used for allocation decision	WSIDI	WSIDI	WSIDI	WSIDI	WSIDI

Table 3

	May-68	May-72	May-76	May-77	May-88
1. Sac WYT Index	BN	BN	C	C	C
2. SJR WYT Index	D	D	C	C	C
3. Export Estimate (ToAug)	9,999	9,999	9,999	9,999	9,999
4. Allocation based on Export Estimate (ToAug)	18,678	18,005	18,040	18,188	18,605
5. Allocation based on WSIDI (ToAug)	**2,628**	**1,643**	**1,085**	**617**	**949**
6. Oroville storage	3,264	3,000	2,323	723	1,780
7. SWP San Luis storage	375	201	215	357	568
8. Final allocation	2,628	1,643	1,085	617	949
9. Final allocation (%)	62%	39%	26%	15%	22%
10. Method used for allocation decision	WSIDI	WSIDI	WSIDI	WSIDI	WSIDI

Figure 2: Export estimate timeseries use in MBK Alternative 4a. In 35/82 years, the export estimate was bypassed.



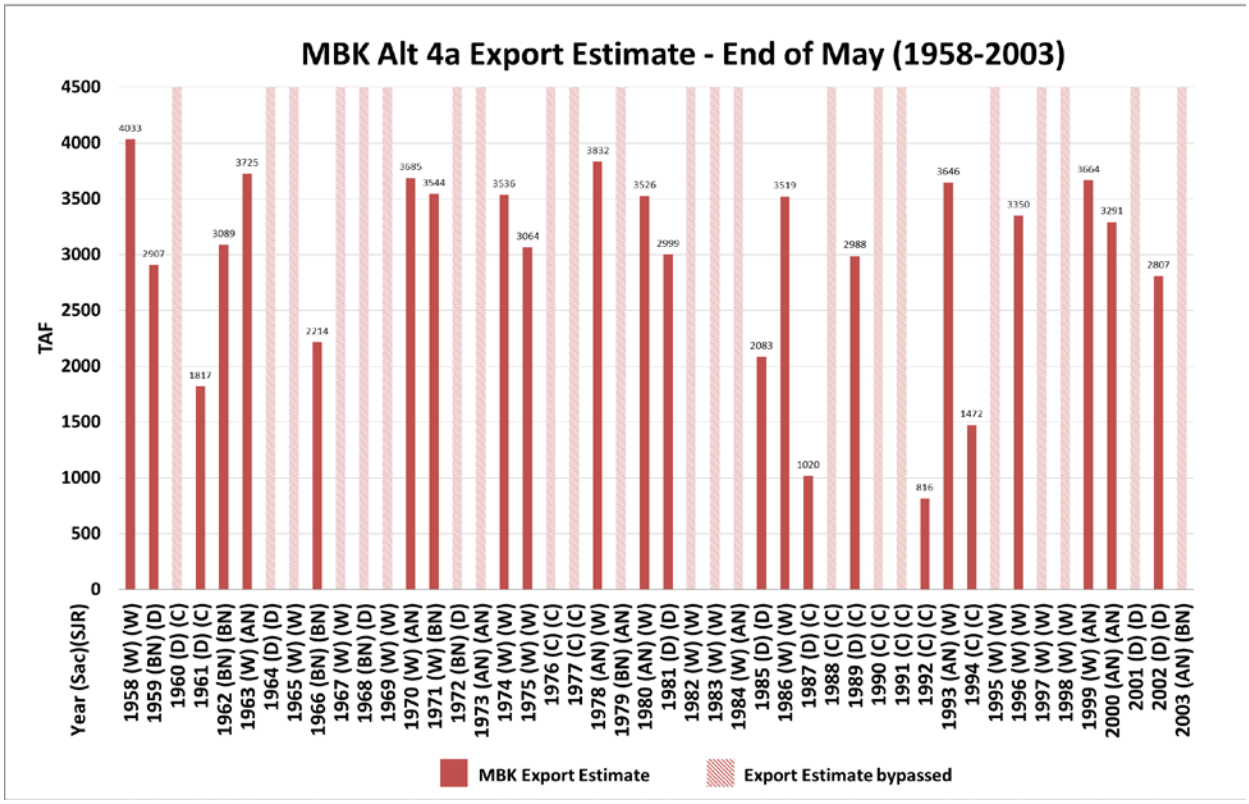
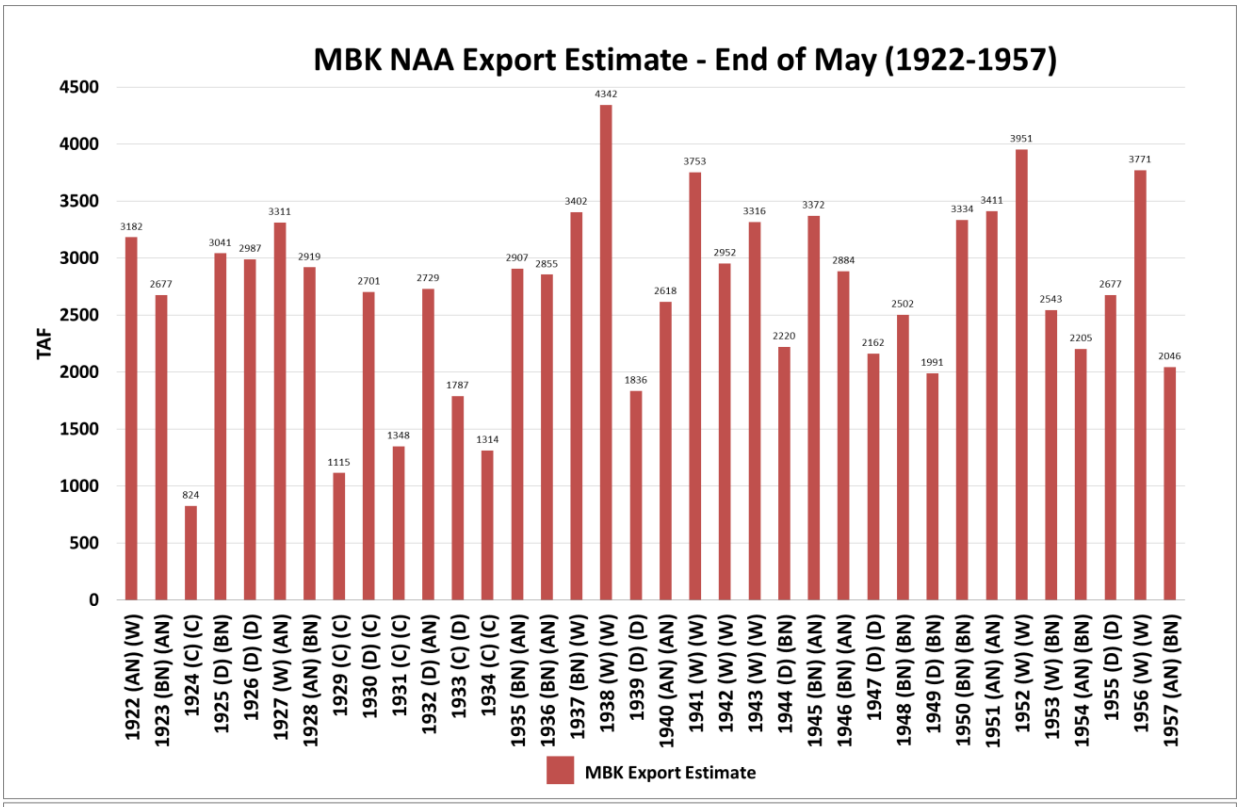
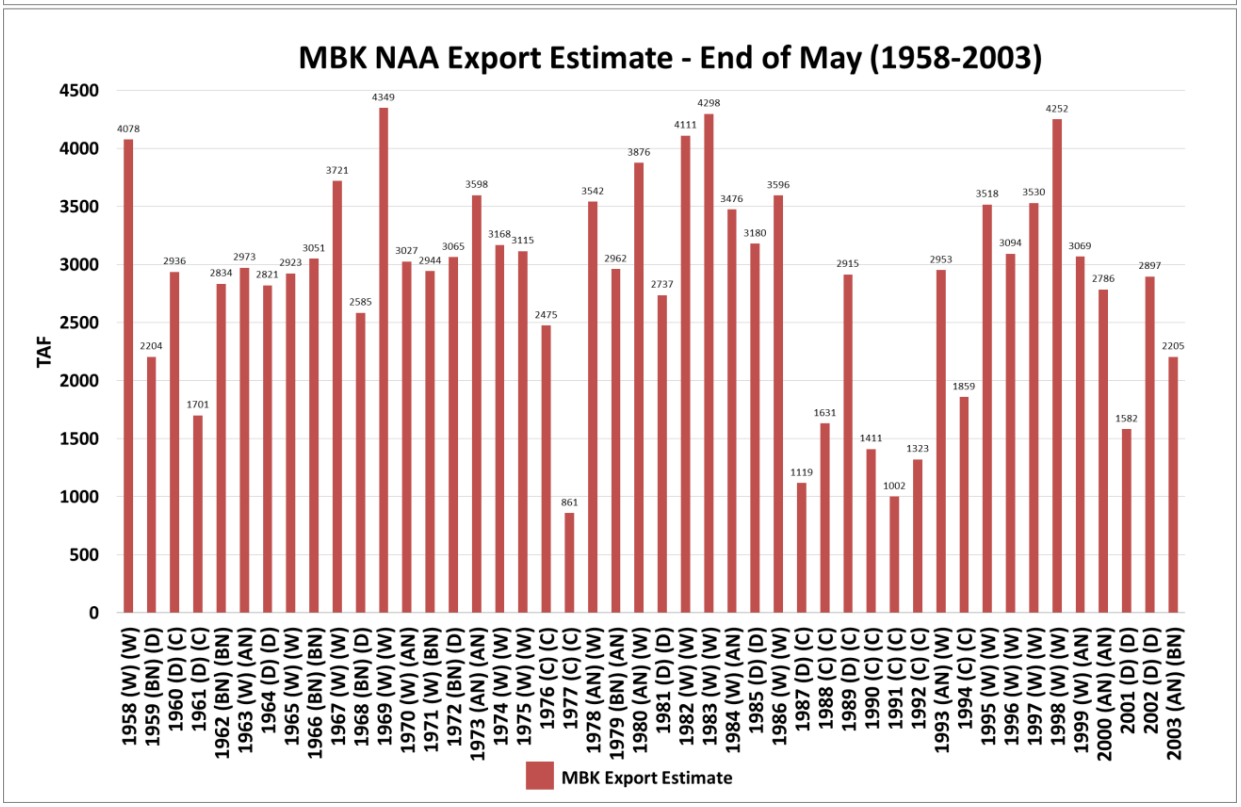


Figure 3: Export estimate for MBK NAA. Export estimate was not bypassed in any year.

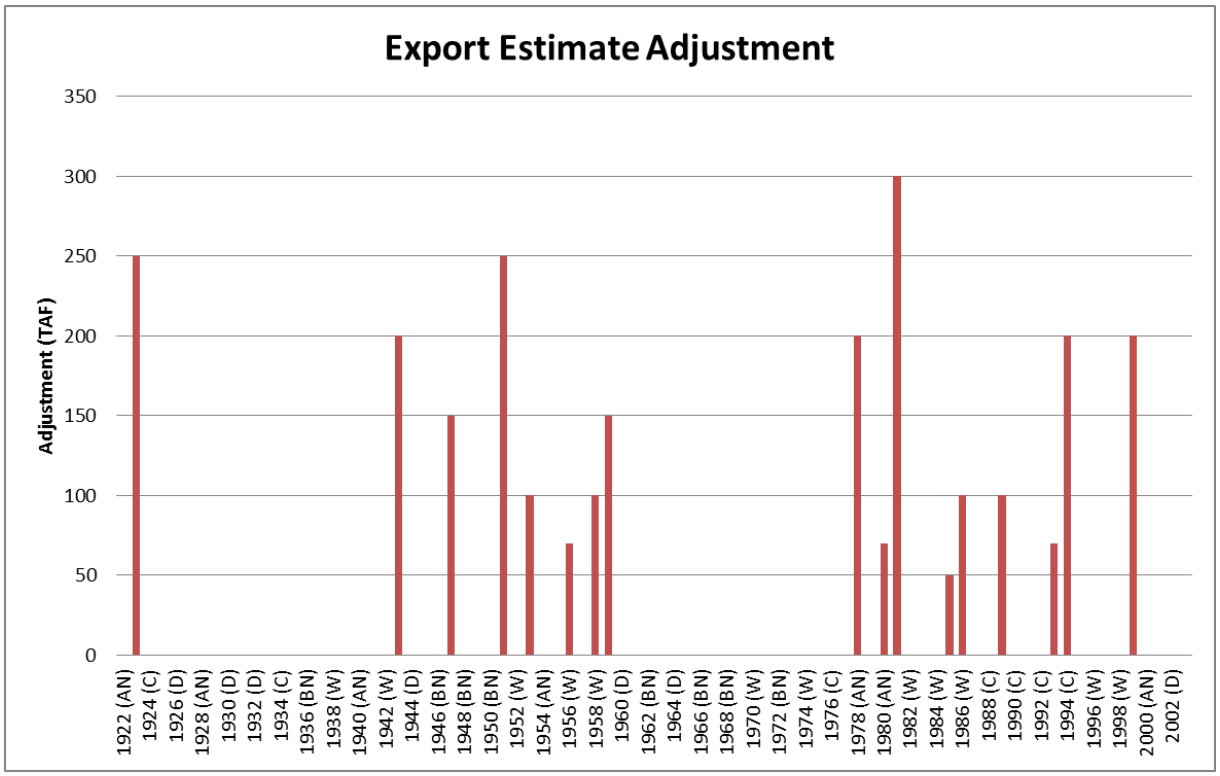




2.2.2 MBK further manipulates the model by making manual adjustments to their export estimate timeseries

MBK further adjusted the magnitude of the export estimate timeseries used in MBK Alternative 4a to manually increase export estimates in 17/82 years, as shown in Figure 4. MBK NAA does not contain these manual export adjustments. Again, this shows an inconsistent implementation of their own methodology between studies. These discretionary and irreproducible adjustments are made based on inspection of modeled results. Experienced modelers like Dan Easton and Walter Bourez have worked with the model enough to have a sound institutional knowledge on the hydrologic trends in the historical hydrology. So, by modifying the export estimate timeseries in an irreproducible way based on their experience, they are incorporating foresight into the export estimate timeseries.

Figure 4: Manual adjustments made to MBK Alternative 4a export estimate timeseries



3. Petitioner's Export Estimate Development

DWR/USBR BA Alternative 4a uses a conceptually different method, where it sets export estimates based on a set of guidelines from lookup tables. Those tables relate San Joaquin River flow and month to an estimated export capacity due to OMR and SJR I/E requirements from the 2008/2009 Biological Opinions. The model operates based on these guidelines consistently from year to year (and between comparative model runs), and in lieu of a high degree of foresight, the monthly export estimates are generally set conservatively. (See also testimony of John Leahigh, DWR-78.) The Petitioner's modeling does not use foresight to develop an export estimate, as that is impossible in real time operations.

Developing an export estimate in actual operations is very similar to the Petitioners' modeling, where export constraints in months to come are based on very conservative assumptions on future hydrology and regulatory requirements. In the case of estimating export limitations due to OMR and SJR I/E restrictions, a conservative level is assumed and the resulting export constraint depends on a conservative forecast of San Joaquin River flow.

Table 4: Comparison of MBK and the Petitioners' export estimate methodology

	MBK Modeling	Petitioners' Modeling
Methodology	Export estimates based on a static time series trained through iterative runs and modeler input. Export estimate changes year to year.	Export estimates determined dynamically during the model run, based on a consistent function that is not manipulated by the modeler.
Available Information to determine export estimate	Actual exports from previous modeled iterations.	Export estimate is a function of: -SJR 60-20-20 Index -San Joaquin River Flow -Timing of export restrictions

4. Conclusion

Incorporating foresight into the model, through iterative training and manual manipulation, is an unrealistic portrayal of real-time operations and is not appropriate for use in a planning model. The Petitioners develops export estimates based on a set of principled and reproducible guidelines, which is more reflective of the methodology used in real-time operations.