An Approach to LFS Mar-May Delta Outflow Requirements

For/with CDFW

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Objectives

- Create new criteria that, when combined with the proposed criteria in the CWF Proposed Action (PA), will result in March, April and May delta outflows approximating recent historical delta outflows, both in frequency and in magnitude in order to minimize Project impacts to LFS.

- The new criteria should be constructed in a way that climate change will not diminish those flows resulting in inadequate minimization of Project impacts on LFS.

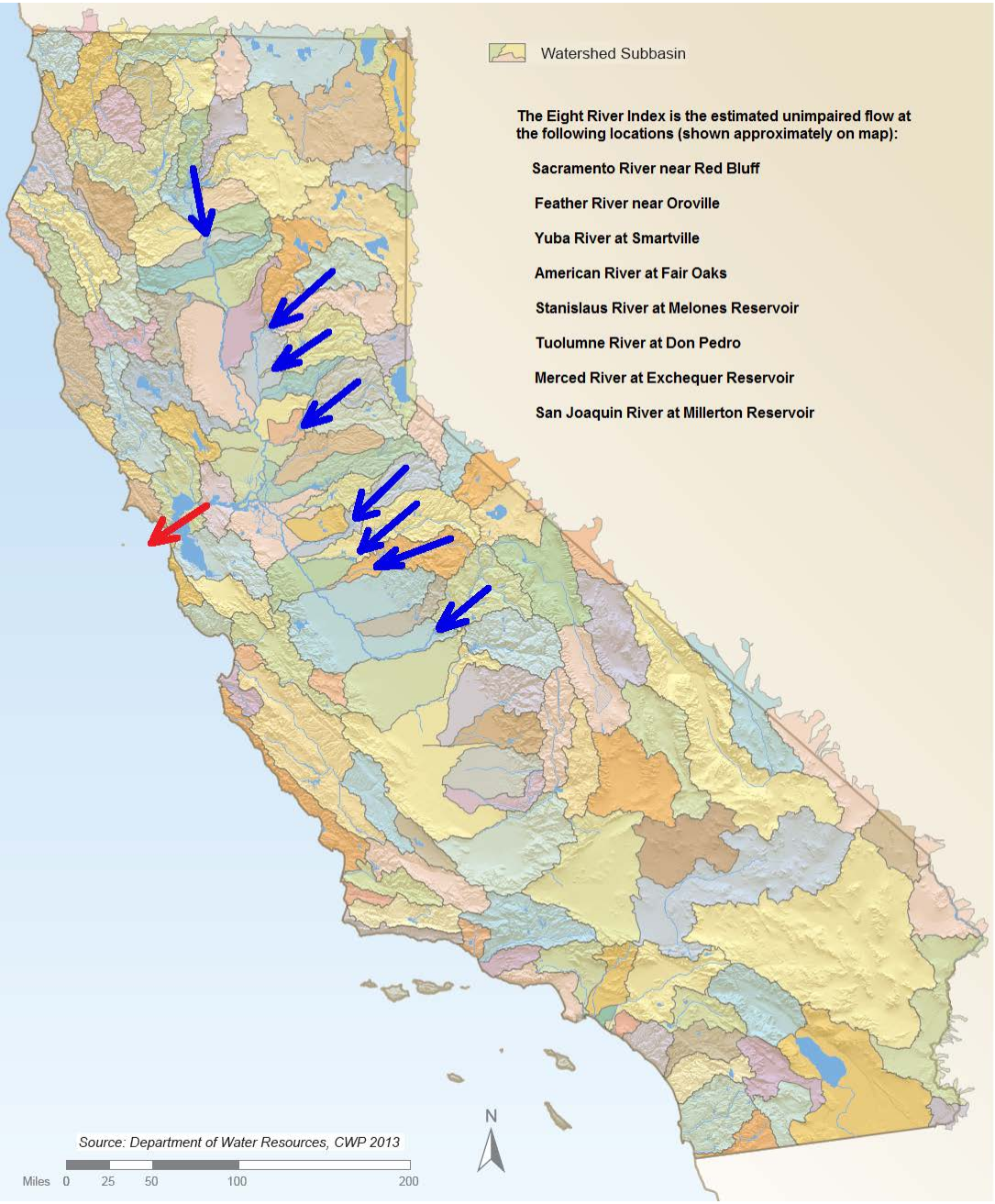
- The new criteria should be implementable and avoid controversies/uncertainties associated with forecasting.

- Ideally delta outflow requirements would be mechanistically (biologically) based with a tether to what can be provided physically, given the water supply available. (Direct approach)

- Practically, the objective is to prevent the CWF Proposed Action from diminishing the frequency or magnitude of the current delta outflows in Mar, Apr and May to ensure adequate protection for LFS. (Indirect approach)

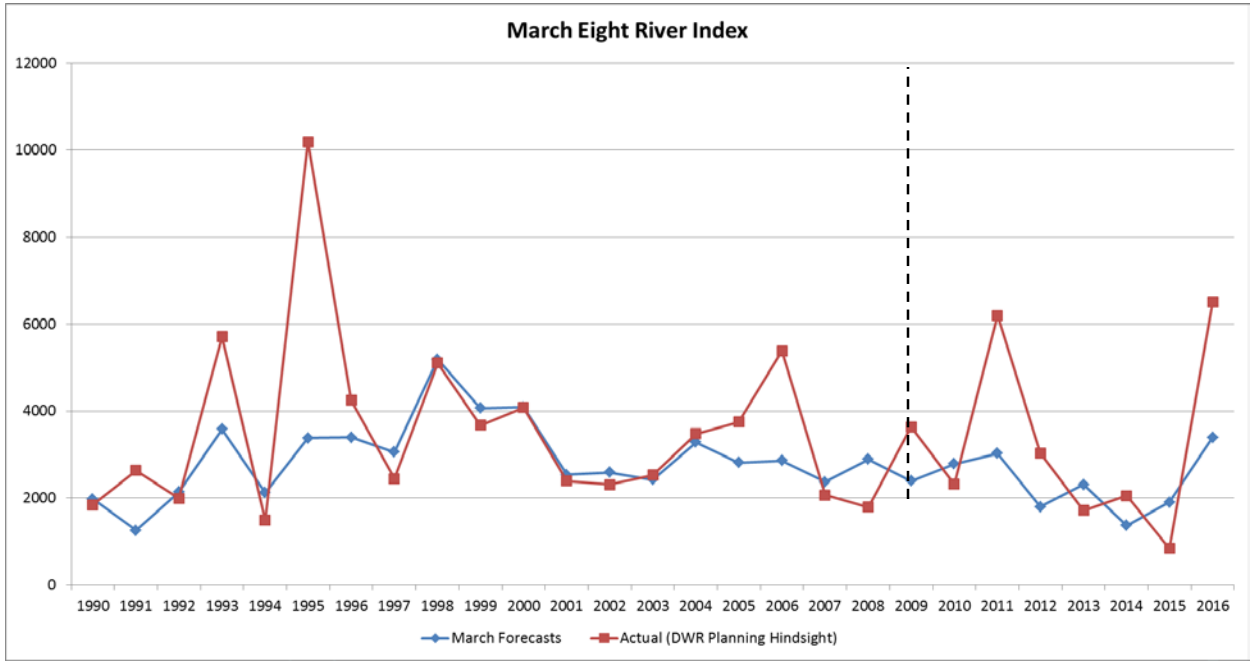
Is there a good predictor of delta outflow?

- Regression analyses suggest that the <u>current</u> month's Eight River Index (the sum of unimpaired runoff estimates from eight large watersheds tributary to the delta) is one of the better variables to predict a month's delta outflow.



Is there a good predictor of delta outflow? (cont)

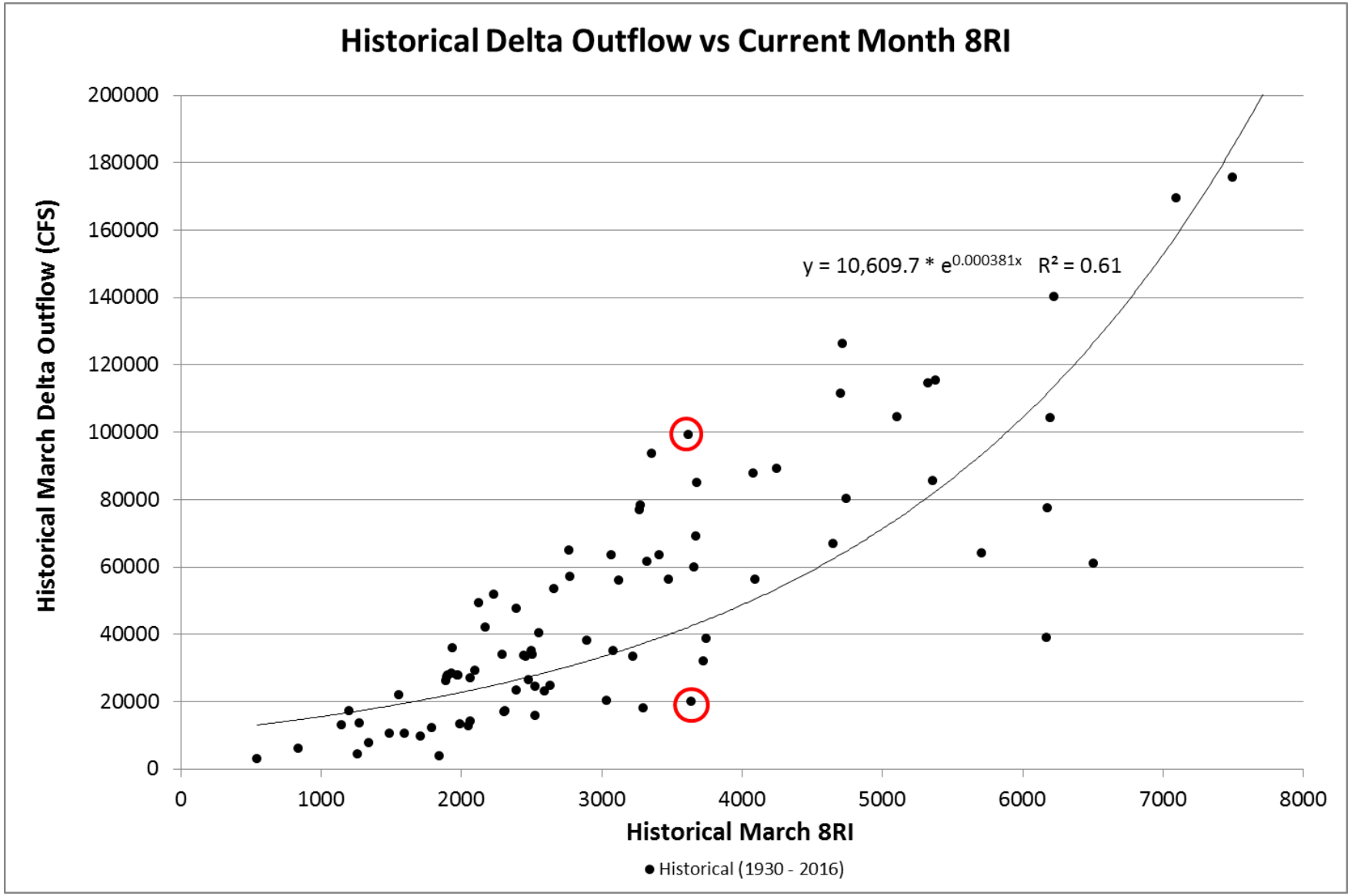
– How well can we predict a month's 8RI near the beginning of that month? Here's how we've done in Marches:



– Even if the Eight River Index (8RI) could be forecasted perfectly, common sense (and modeling) suggests that delta outflow in a given month is the result of many things, not just unimpaired flows, i.e., delta outflow is a function of, among other things,

- numerous regulations affecting upstream operations (instream flow reqts, water temperature reqts, etc),
- reservoir releases to meet in-delta salinity standards which depends on antecedent salinity,
- antecedent hydrology affecting watershed accretions/depletions and flood control criteria,
- regulations affecting delta exports, some of which are related to fish presence,
- current month precipitation

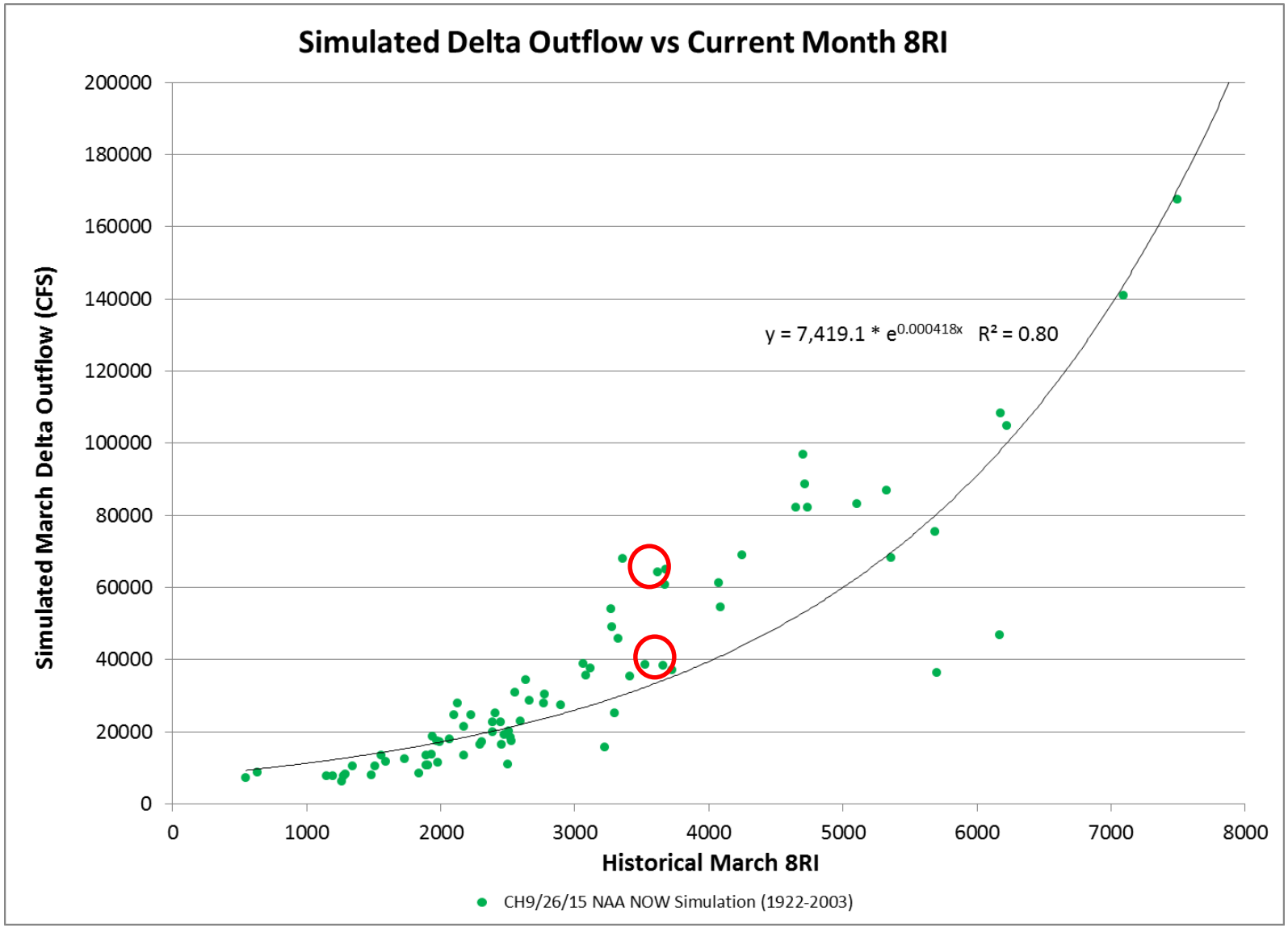
– How well would have a perfectly forecasted 8RI predicted/correlated with delta outflow in the past? Below is the answer for Marches. The historical delta outflow values come from DAYFLOW. The "historical" eight river index values come from DWR reports.



For an 8RI of approximately 3700 TAF, the delta outflow has ranged from 20,000 to 100,000 cfs this month.

Regulations, water use and infrastructure have changed over time ➔ scatter to be expected.

Let's assume a fixed level for each of these ==> simulation modeling.



Tighter fit - makes sense since the simulation has dams and other controls in place for all years.

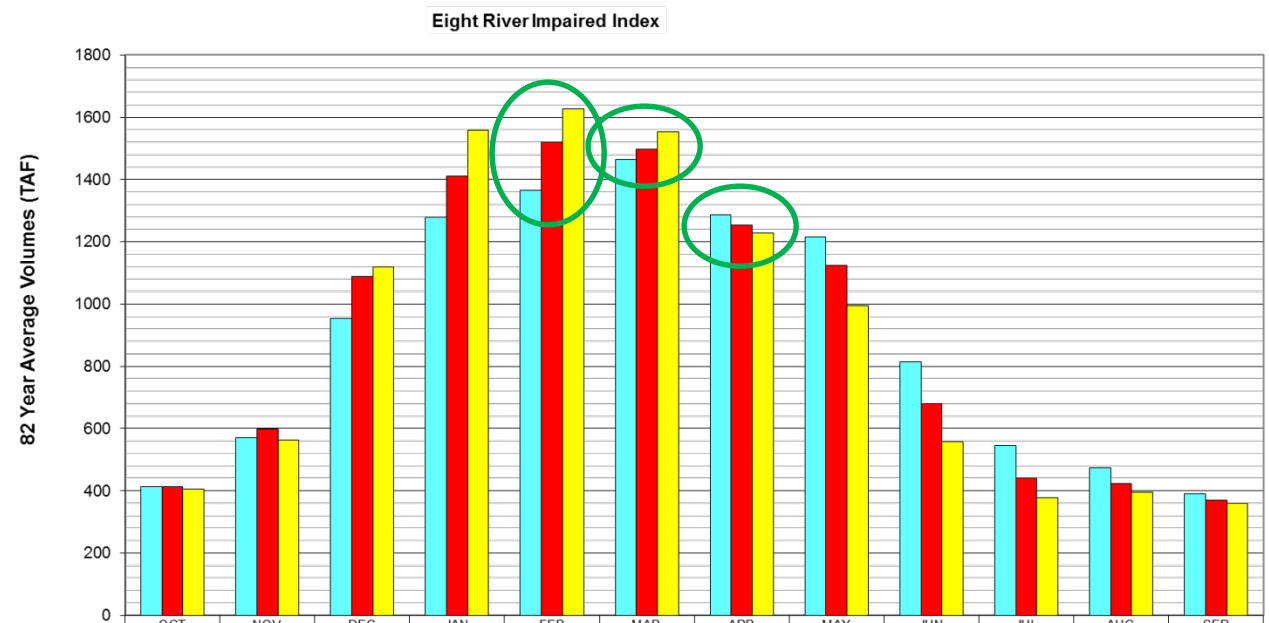
For an 8RI of approximately 3700 TAF, the delta outflow ranges from 38,000 to 65,000 cfs this month.

Considerations

- Perfect 8RI forecasting is not attainable.
- Pitfalls of using an imperfectly forecasted 8RI:
  - Projects typically use a 90% exceedance hydrology in their forecasts leading to lower than appropriate outflow targets more often.
  - Even if 50% exceedance hydrology were used, forecasts are sometimes very inaccurate (first chart)
  - Climate change is expected to reduce the 8RI in May over time, so targets based on May 8RI would be smaller in the future.
  - Forecasts are not usually available until after the 10th of the month.
- Benefits of using the previous month's 8RI (PMI)
  - PMI would be available in a timely fashion
  - PMI avoids the pitfalls of forecasting
  - Although not as highly correlated with current month delta outflow, use of PMI vs delta outflow targets may achieve the stated objectives
  - PMI is already used in determining a regulatory standard (X2).
  - Shifting the independent variable from Mar-May to Feb-Apr may help ensure May delta outflow targets don't lower more than they might otherwise with climate change.

Data Used to Assess Climate Change Influence

– Hypothetical monthly estimated <u>impaired</u> runoff from the eight major streams **<u>8RII</u>** = CalSimII <u>inputs</u> for current, 2025 & 2060 climate/sea level rise scenarios.



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
BDCP NAA NOW	412.8	570.6	953.8	1280.3	1364.8	1464.6	1287.2	1215.7	815.1	546.2	473.1	391.5
BDCP NAA ELT	412.4	598.1	1089.6	1410.4	1520.3	1496.9	1252.9	1124.2	679.7	439.9	424.1	369.0
BDCP NAA LLT	406.5	563.5	1118.3	1558.7	1628.1	1553.2	1227.6	993.7	559.0	376.9	396.1	359.3

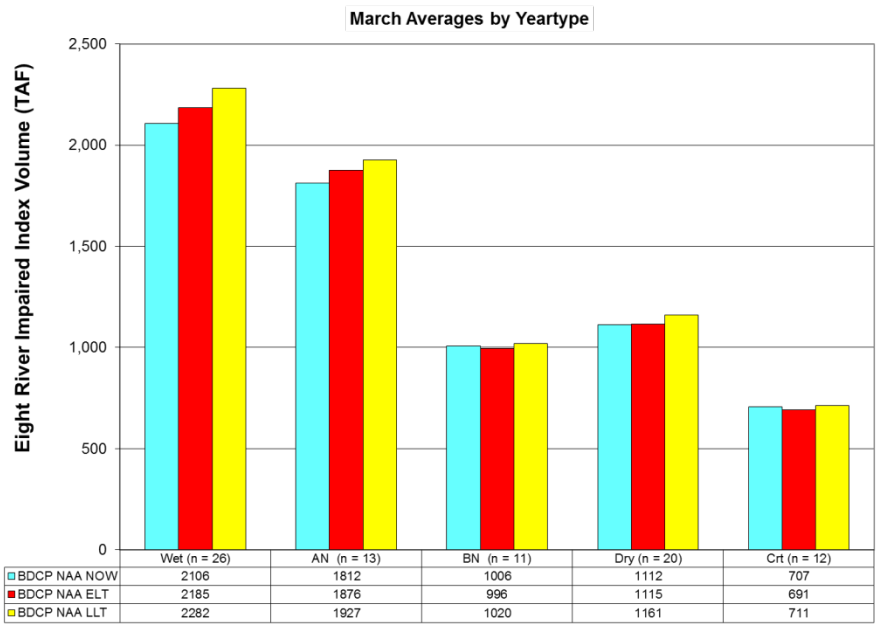
Conclusion: February will likely get wetter and May will likely get drier in terms of runoff.

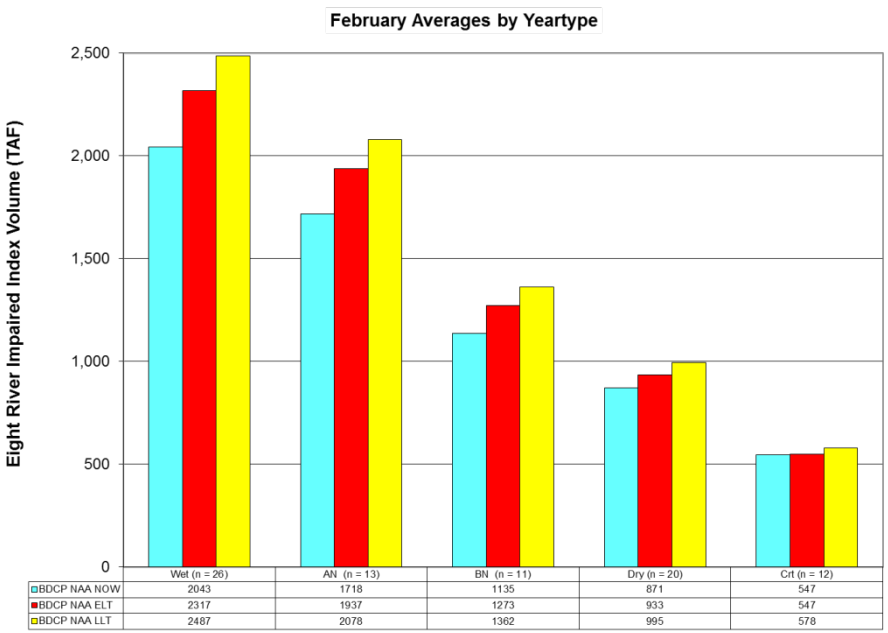
Data Used to Assess Climate Change Influence(continued)

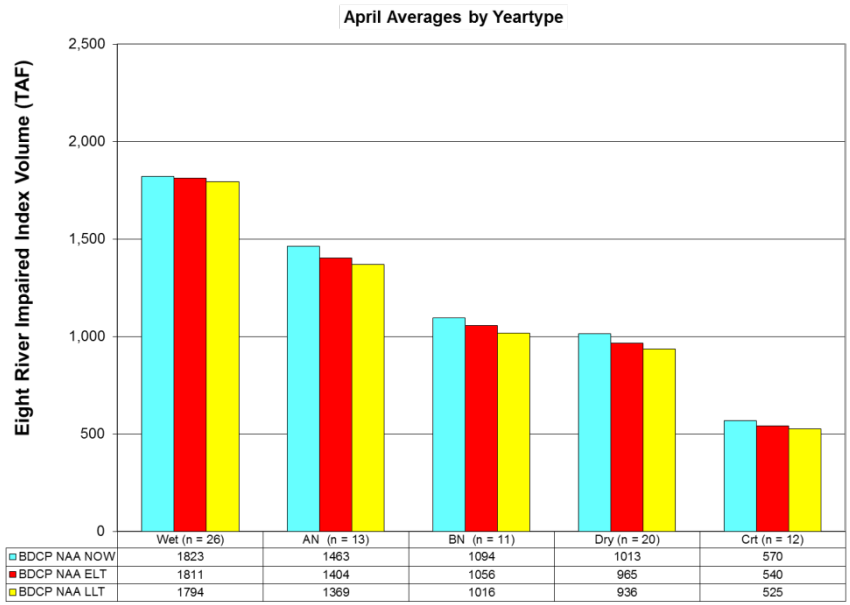
Conclusions:

1. Mar and Apr 8RI are relatively unaffected by climate change, so Apr and May targets should not go down significantly with projected climate change.

2. Feb is affected in a positive way for fish, i.e., Mar target may go up, particularly in wetter years if they aren't already at the cap of 44,500 cfs.





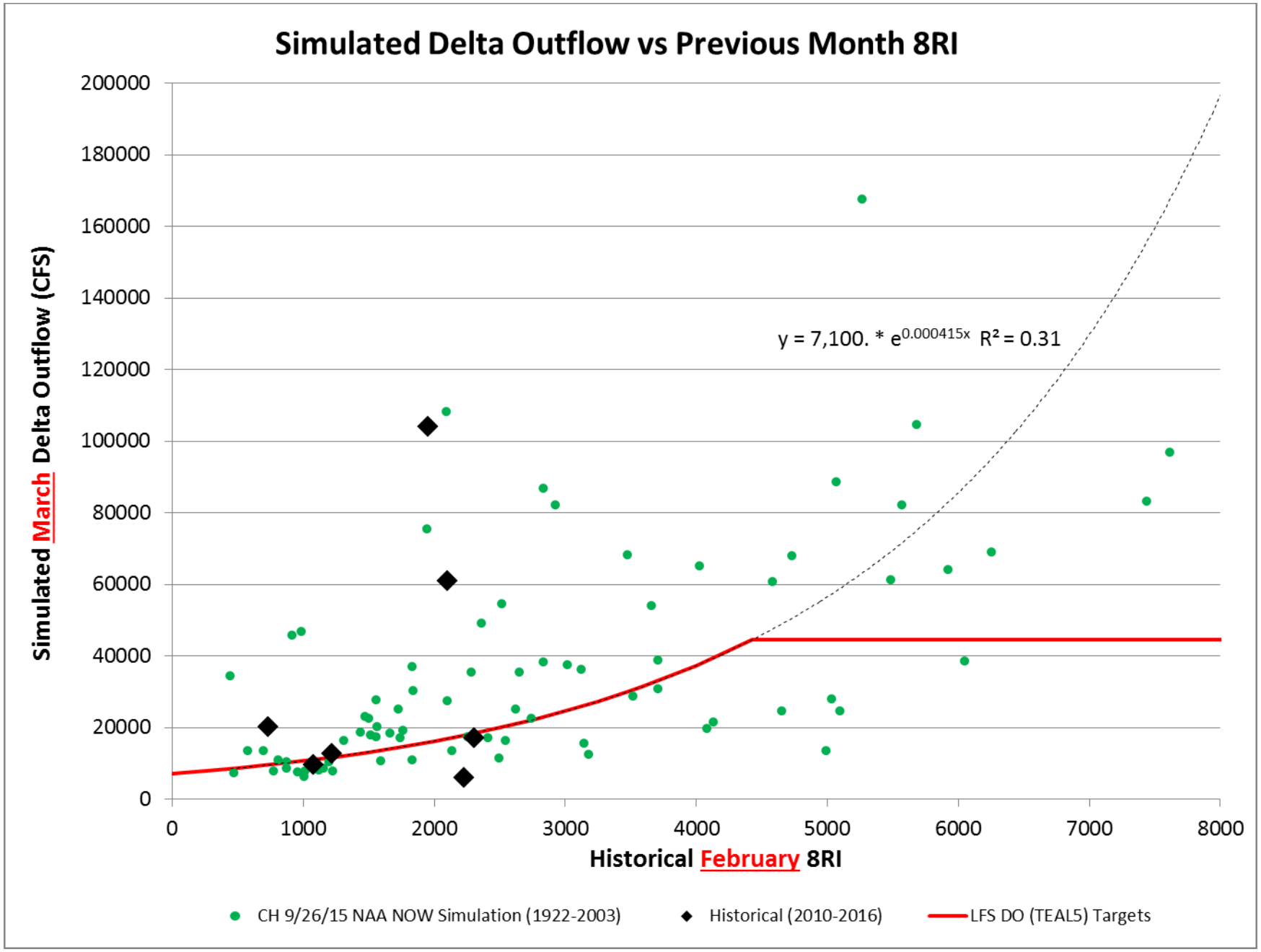


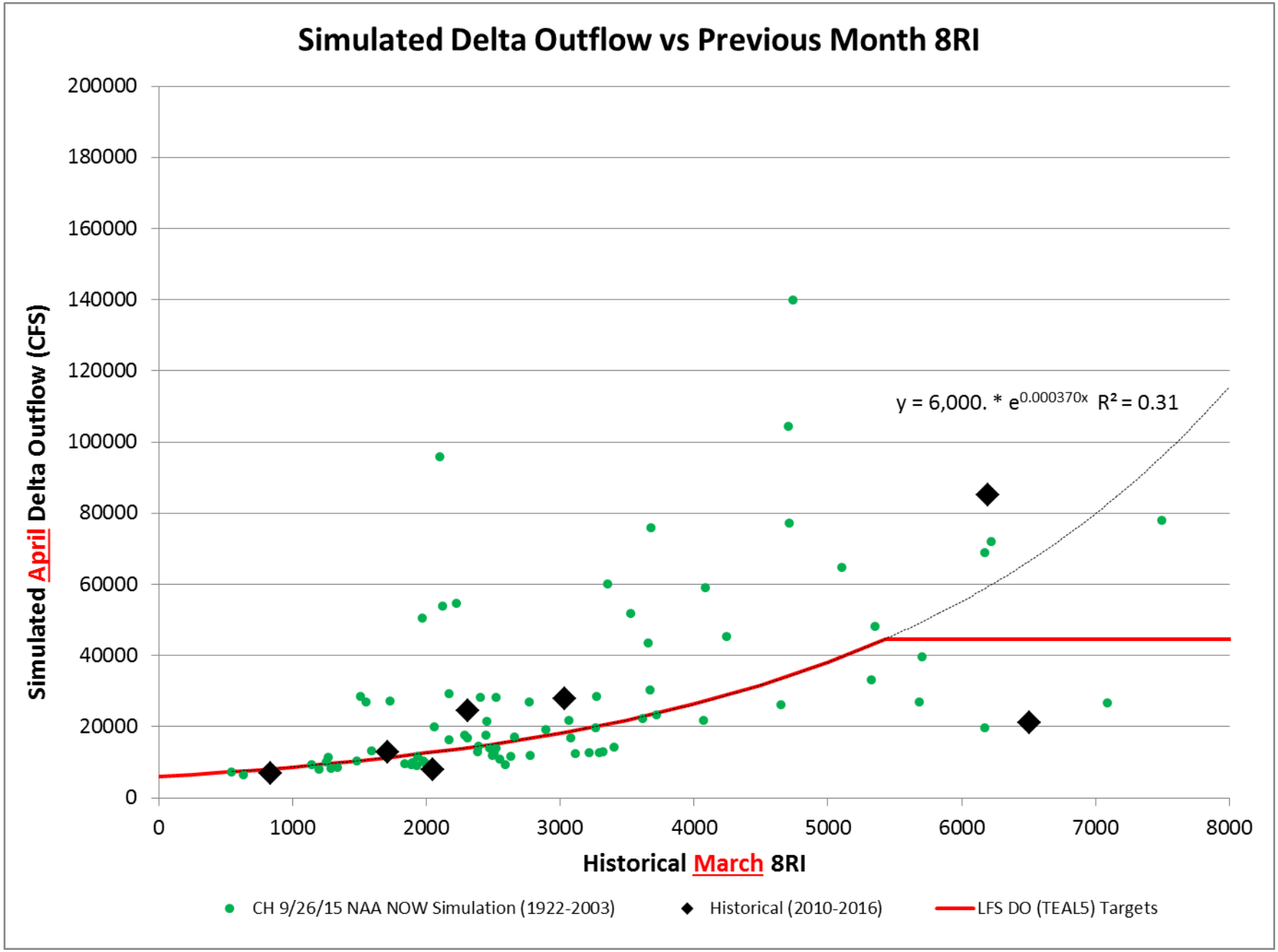
Data Used in this LFS Delta Outflow Approach

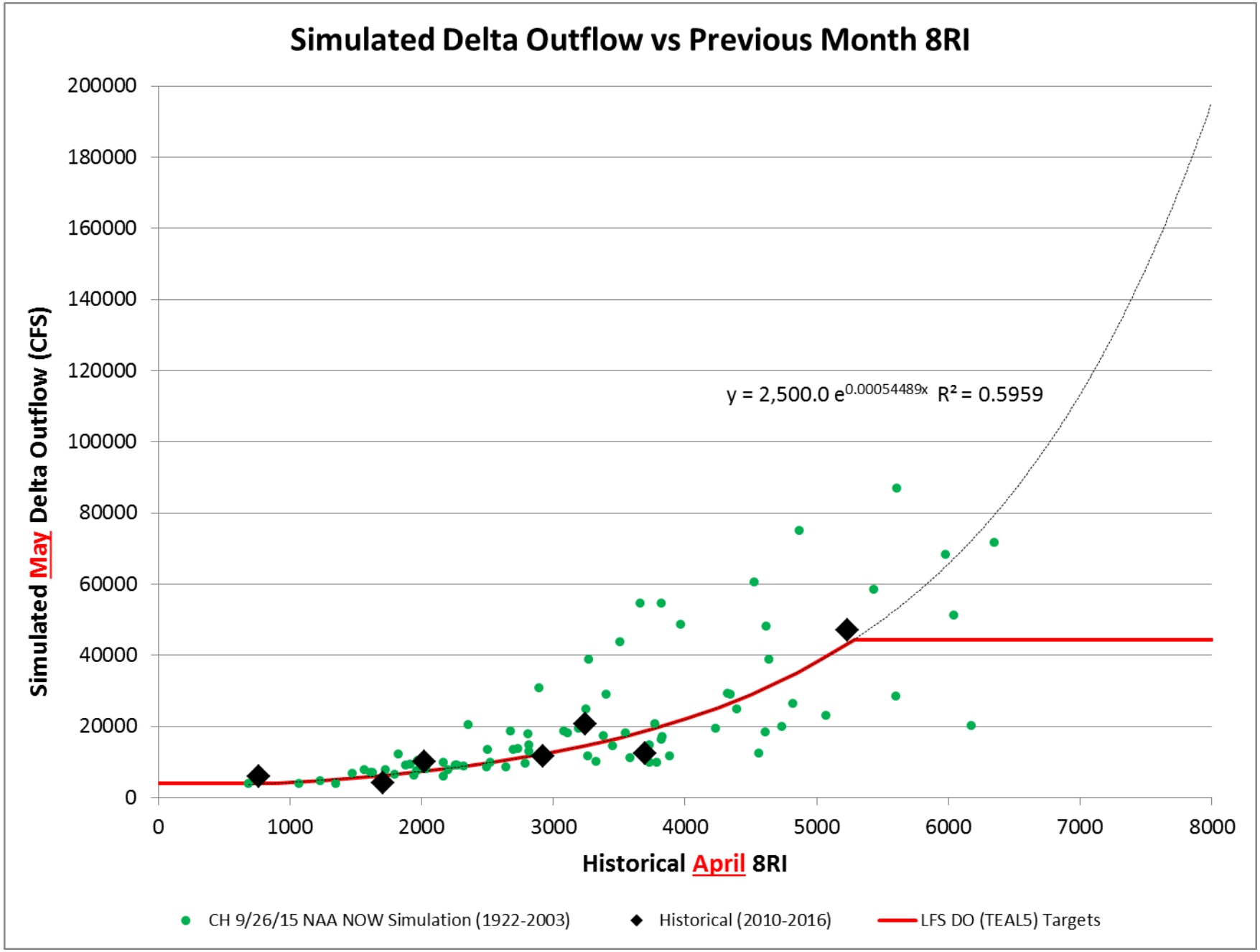
- March, April and May delta outflows from CH2M's 9/26/2015 (CalSimII) monthly simulation of the CWF No-Action Alternative <u>without</u> climate change and sea level rise was used to characterize current delta outflow conditions for comparative purposes. (Validation is currently impossible since simulated years are Water Years 1922-2003 and historical years with the current regulations, level of demand and infrastructure are Water Years 2010-2016.) "CWF NAA NOW 9/26/15 Run"

- <u>Historical</u> monthly estimated unimpaired (hypothetical) runoff from eight major streams feeding the Bay-Delta (sum = 8RI) for February, March and April. Values are at C.D.E.C. starting around Jan 1900 through Dec 2016. (Sensor 65 at stations SBB, FTO, YRS, AMF, SNS, TLG, MRC, SJF)

These simulated delta outflows (along with post-2009 historical delta outflows) are plotted against the previous month's 8RI (PMI) in the following charts. Ignore the red lines for now.


Simulated Delta Outflow vs Previous Month 8RI
Simulated March Delta Outflow (CFS)
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
0
1000
2000
3000
4000
5000
6000
7000
8000
Historical February 8RI
y = 7,100. * e^0.000415x R² = 0.31
CH 9/26/15 NAA NOW Simulation (1922-2003)
Historical (2010-2016)
LFS DO (TEAL5) Targets


Simulated Delta Outflow vs Previous Month 8RI
Simulated April Delta Outflow (CFS)
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
0
1000
2000
3000
4000
5000
6000
7000
8000
Historical March 8RI
y = 6,000. * e^0.000370x R² = 0.31
CH 9/26/15 NAA NOW Simulation (1922-2003)
Historical (2010-2016)
LFS DO (TEAL5) Targets


Simulated Delta Outflow vs Previous Month 8RI
Simulated May Delta Outflow (CFS)
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
0
1000
2000
3000
4000
5000
6000
7000
8000
Historical April 8RI
y = 2,500.0 e^0.00054489x R² = 0.5959
CH 9/26/15 NAA NOW Simulation (1922-2003)
Historical (2010-2016)
LFS DO (TEAL5) Targets

Considerations - revisited

- Scatter increases when plotting simulated March delta outflows against PMI versus plotting them against current month 8RI, but
  - Perfect 8RI forecasting is not attainable.
  - Projects typically use a 90% exceedance hydrology in their imperfect forecasts leading to lower than appropriate outflow targets more often.
  - Even if 50% exceedance hydrology were used, imperfect forecasts are sometimes very inaccurate (first chart)
  - Climate change is expected to reduce the 8RI in May over time, so targets based on May 8RI would be smaller in the future.
  - Forecasts are not usually available until after the 10th of the month.
  - PMI would be available in a timely fashion
  - PMI avoids the pitfalls of forecasting
  - PMI is already used in determining a regulatory standard (X2).
  - Shifting the independent variable from Mar-May to Feb-Apr may help maintain the current March, April May outflows into the future.
- Does use of PMI vs delta outflow targets achieve the stated objectives?

Additional Data Used to Evaluate this LFS Approach

- CH2M's 7/25/2016 CalSimII monthly simulation of the CWF Proposed Action (with ELT climate change and sea level rise) was used as the base model. "CWF PA ELT 7/25/16 Run"

- Modifications (discussed on the next slide) to the base model's LFS spring outflow logic were made to simulate the LFS delta outflow approach proposed herein. "CWF PA ELT LFS 1/17/17 Run C"

- A sensitivity simulation performed to evaluate the base model's relaxation of the SJR I:E criteria during very wet Aprils and Mays was conducted. "CWF PA ELT LFS 1/17/17 Run D"

- A sensitivity simulation performed to evaluate the elimination of the SJR I:E criteria all together was conducted. "CWF PA ELT LFS 1/17/17 Run E"

LFS 1/17/17 Run D's changes from CWF 7/25/2016 PA ELT

- **March** has a PMI-based delta outflow target which can drive total exports down to health & safety level (and still not meet the target)
  - instead of
- **March** has a perfectly forecasted ELT level Mar 8RI-based delta outflow target which can drive total exports down to health & safety level (and still not meet the target)

- **April** has a PMI-based delta outflow target which can drive total exports down to health & safety level (and still not meet the target)
  - instead of
- **April** has no LFS-related delta outflow target

- **May** has a PMI-based delta outflow target which can drive exports down to health & safety level (and still not meet the target)
  - instead of
- **May** has no LFS-related delta outflow target.

LFS 1/17/17 Run C's changes from CWF 7/25/2016 PA ELT

- **March** has a PMI-based delta outflow target which can drive total exports down to health & safety level (and still not meet the target)
  - instead of
- **March** has a perfectly forecasted ELT level Mar 8RI-based delta outflow target which can drive total exports down to health & safety level (and still not meet the target)

- **April** has a PMI-based delta outflow target which can drive total exports down to health & safety level (and still not meet the target) and total exports are also constrained by the SJRi:e
  - instead of
- **April** has no LFS-related delta outflow target. Total exports are constrained by the SJR i:e ratio **if** delta outflow is expected to be below 44,500 cfs and exports from the south delta are always constrained by the SJR i:e ratio. Said another way, there is no LFS-related constraint on the North delta diversion as long as the delta outflow is 44,500 cfs or greater.

- **May** has a PMI-based delta outflow target which can drive exports down to health & safety level (and still not meet the target) and total exports are also constrained by the SJRi:e
  - instead of
- **May** has no LFS-related delta outflow target. Total exports are constrained by the SJR i:e ratio **if** delta outflow is expected to be below 44,500 cfs and exports from the south delta are always constrained by the SJR i:e ratio. Said another way, there is no LFS-related constraint on the North delta diversion as long as the delta outflow is 44,500 cfs or greater.

Proposed Criteria

- A lookup table of PMI vs targets for March capped at 44,500 cfs
- A lookup table of PMI vs targets for April capped at 44,500 cfs
- A lookup table of PMI vs targets for May capped at 44,500 cfs
- The monthly minimum delta outflow requirement is the lesser of

  the month's target

  and

  the delta outflow that would occur if Jones+Banks exports were down at health and safety level (combined 1500 cfs).

- Example 1: Target = 20,000 cfs. Projected Combined Exports = 8000 cfs*. Projected delta outflow expected to be > 20,000 cfs. NO CHANGE.
- Example 2: Target = 20,000 cfs. Projected Combined Exports = 8000 cfs*. Projected delta outflow expected to be 15,000 cfs. Reduce exports to 3000 cfs (5000 cfs reduction) or increase delta inflows by 5000 cfs.
- Example 3: Target = 20,000 cfs. Projected Combined Exports = 8000 cfs*. Projected delta outflow expected to be 10,000 cfs. Reduce exports to H&S level of 1500 cfs (6500 cfs reduction) or increase delta inflows by 6500 cfs.

* complying with all other regulations.

Proposed Criteria

– These criteria (teal boxes) are shown with a red line in the previous charts.

CH 7/25/16 Criteria	
Mar 8RI (TAF)	Mar TARGET (CFS)
0	0
545	6200
1488	8800
1911	12700
2140	17100
2421	20000
2575	25200
3104	35000
3492	43700
4217	44500
5655	44500
Based on CWF NAA w/o SLR or CC	

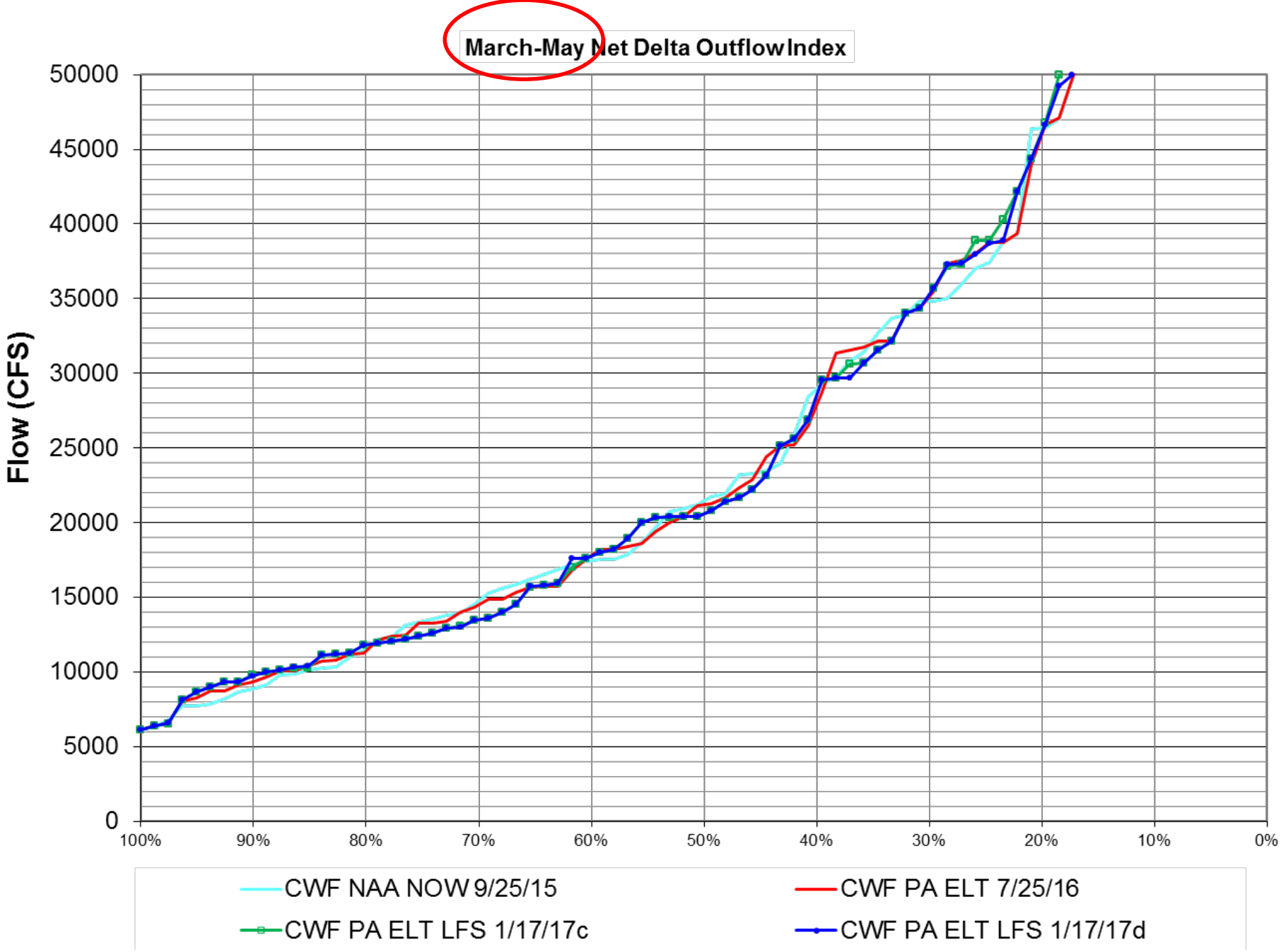
TEAL5 version	
X	Y
Feb 8RI (TAF)	Mar TARGET (CFS)
0	7100
250	7900
500	8700
750	9700
1000	10800
1250	11900
1500	13200
1750	14700
2000	16300
2250	18100
2500	20000
2750	22200
3000	24700
3250	27400
3500	30400
3600	31600
4000	37400
4425	44500
12000	44500

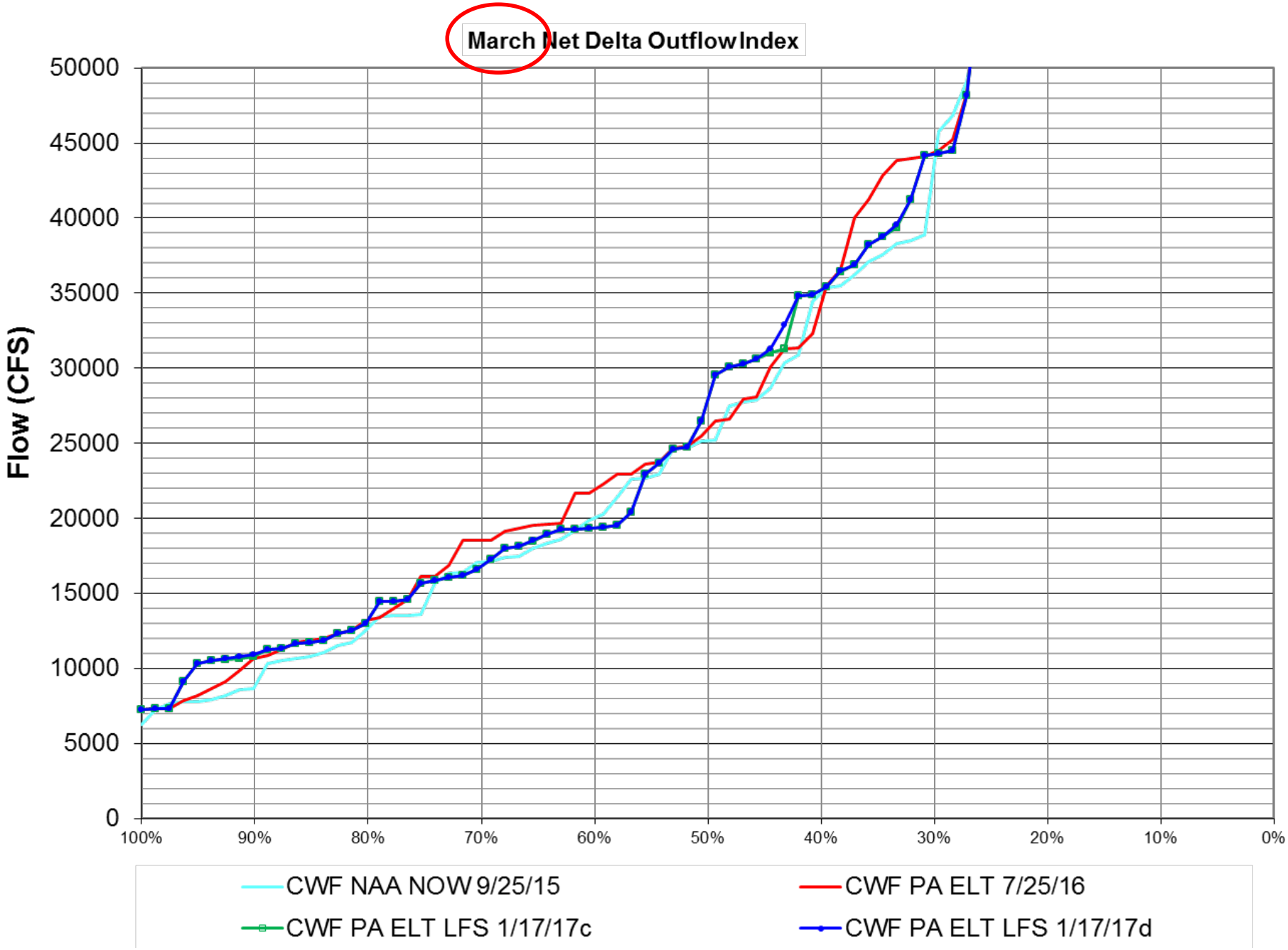
TEAL5 version	
X	Y
Mar 8RI (TAF)	Apr TARGET (CFS)
0	6000
250	6600
500	7200
750	7900
1000	8700
1250	9500
1500	10500
1750	11500
2000	12600
2250	13800
2500	15100
2750	16600
3000	18200
3250	20000
3500	21900
3750	24000
4000	26400
4500	31700
5000	38200
5430	44500
12000	44500

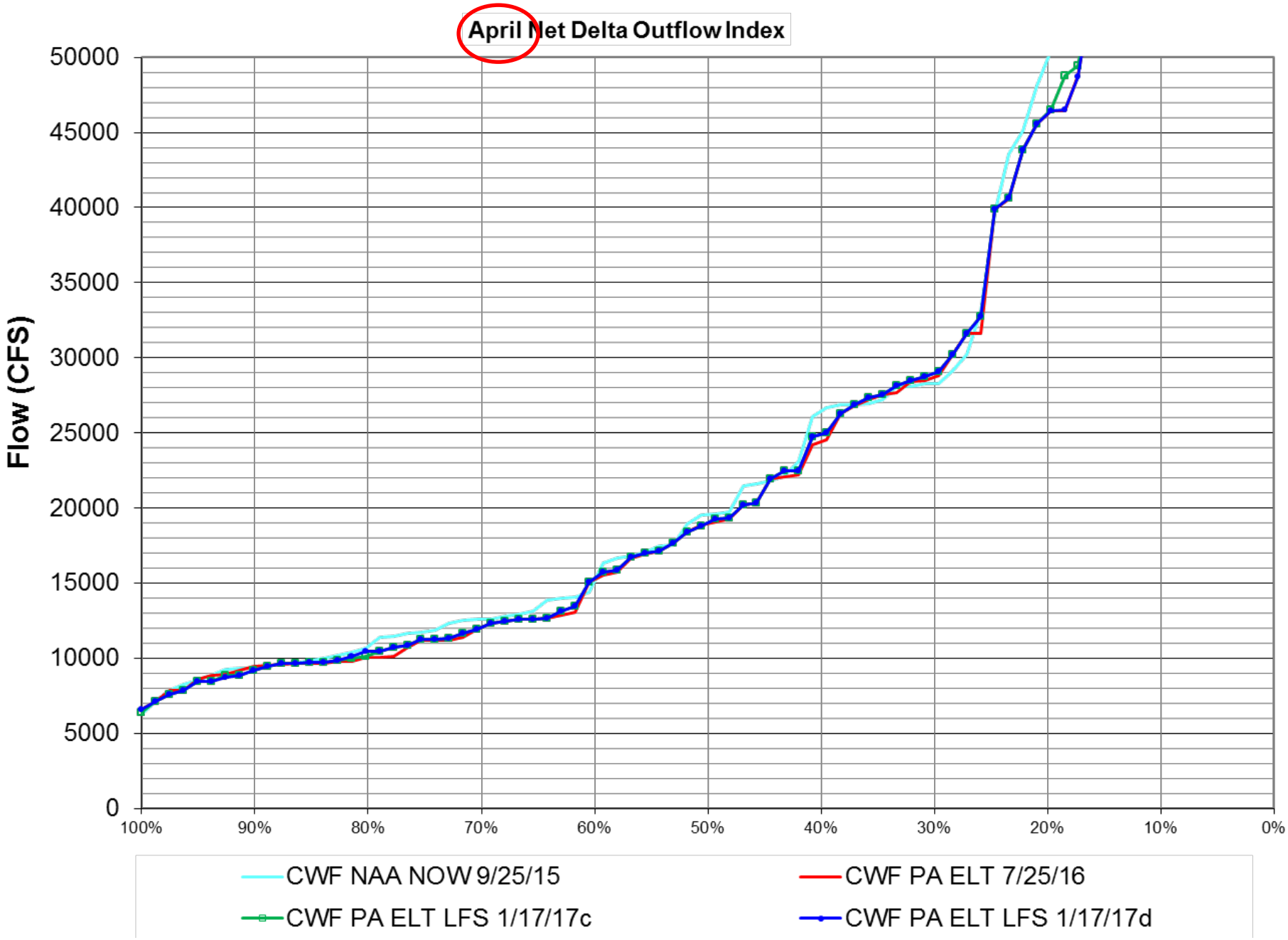
TEAL5 version	
X	Y
Apr 8RI (TAF)	May TARGET (CFS)
0	4000
800	4000
850	4000
900	4100
1000	4300
1250	4900
1500	5700
1750	6500
2000	7400
2250	8500
2500	9800
2750	11200
3000	12800
3250	14700
3500	16800
3750	19300
4000	22100
4250	25300
4500	29000
4750	33300
4850	35100
5000	38100
5285	44500
12000	44500

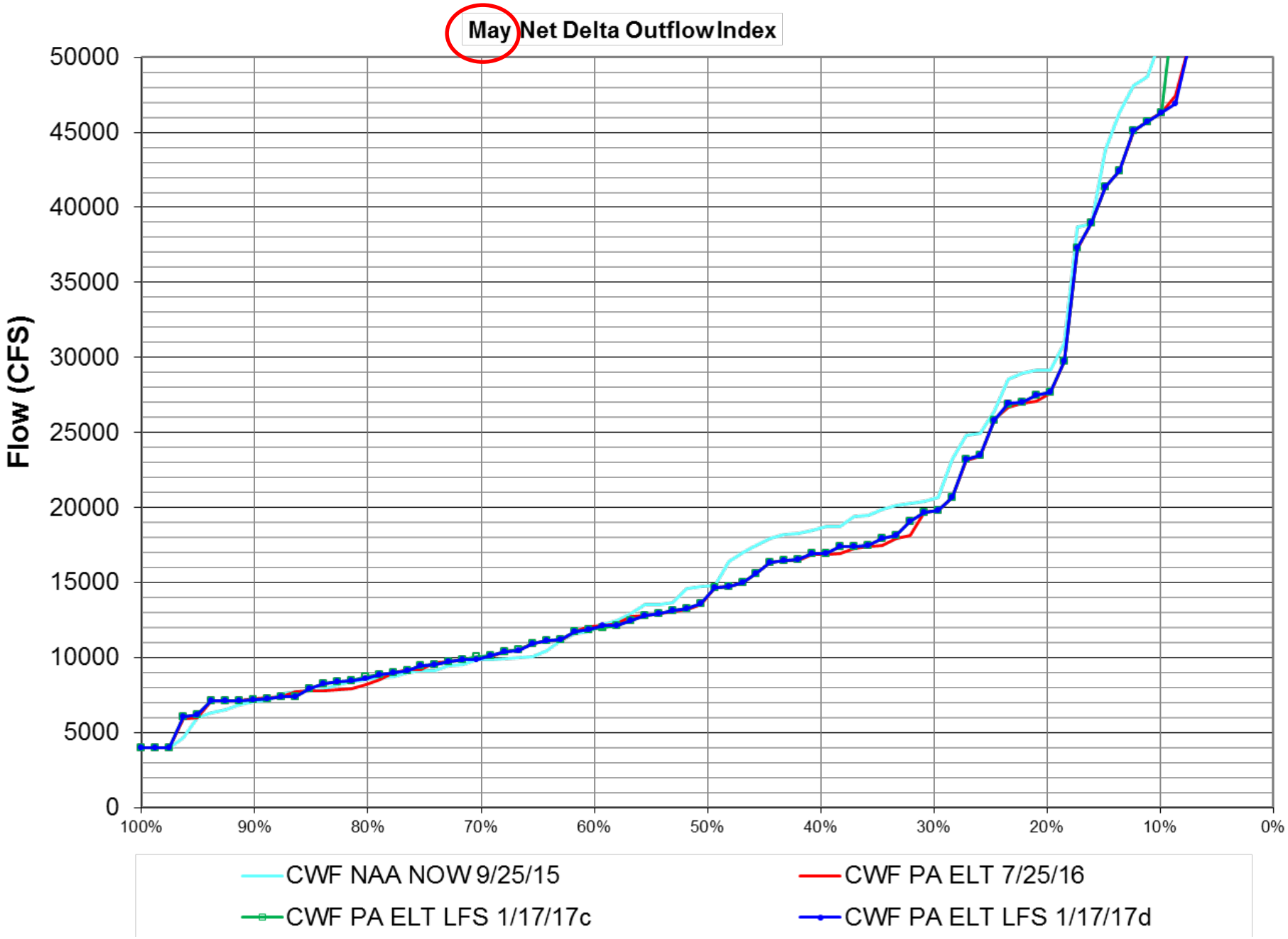
Results

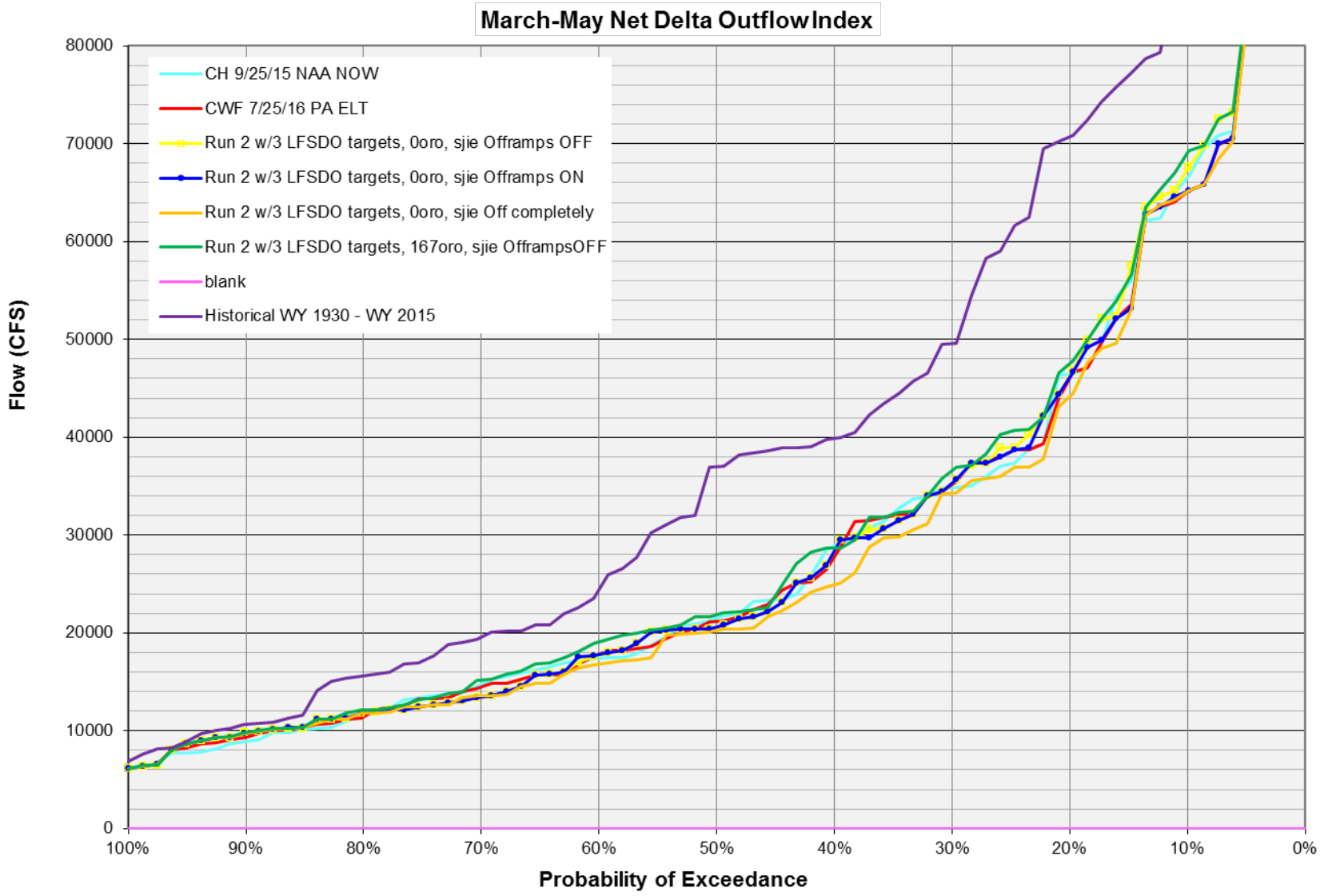
- The following slides show CalSim II simulation results for the following runs:
  - CH 9/26/15 CWF NAA run w/o climate change or sea level rise – "**CWF NAA NOW 9/25/15**" (spring outflows only)
  - CH 7/25/16 CWF PA ELT run – "**CWF PA ELT 7/25/16**"
  - DH 01/17/17 CWF PA ELT alternative C run – "**CWF PA ELT LFS 1/17/17c**"
  - DH 01/17/17 CWF PA ELT alternative D run – "**CWF PA ELT LFS 1/17/15d**"

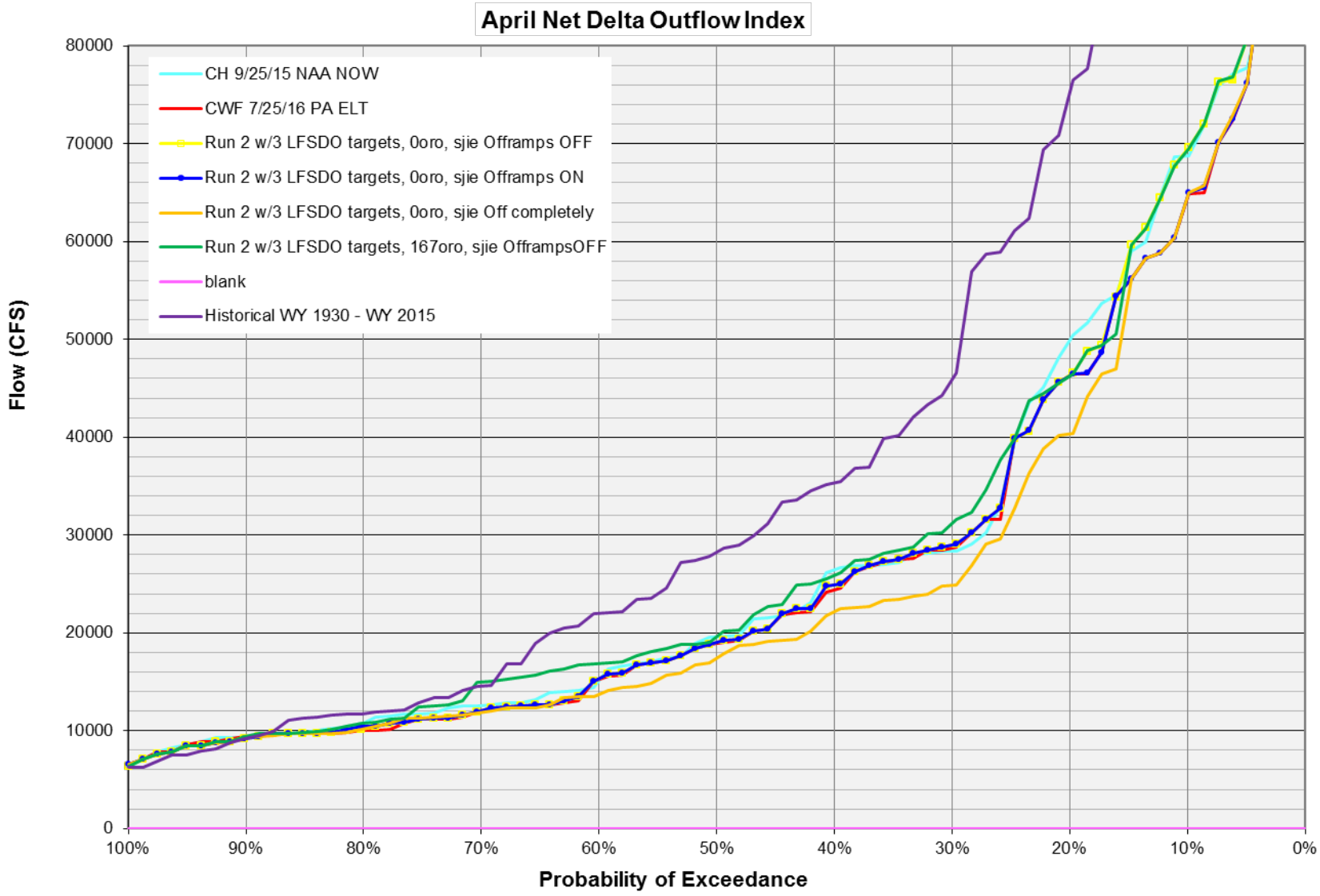

March-May Net Delta Outflow Index
Flow (CFS)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CWF NAA NOW 9/25/15
CWF PA ELT 7/25/16
CWF PA ELT LFS 1/17/17c
CWF PA ELT LFS 1/17/17d

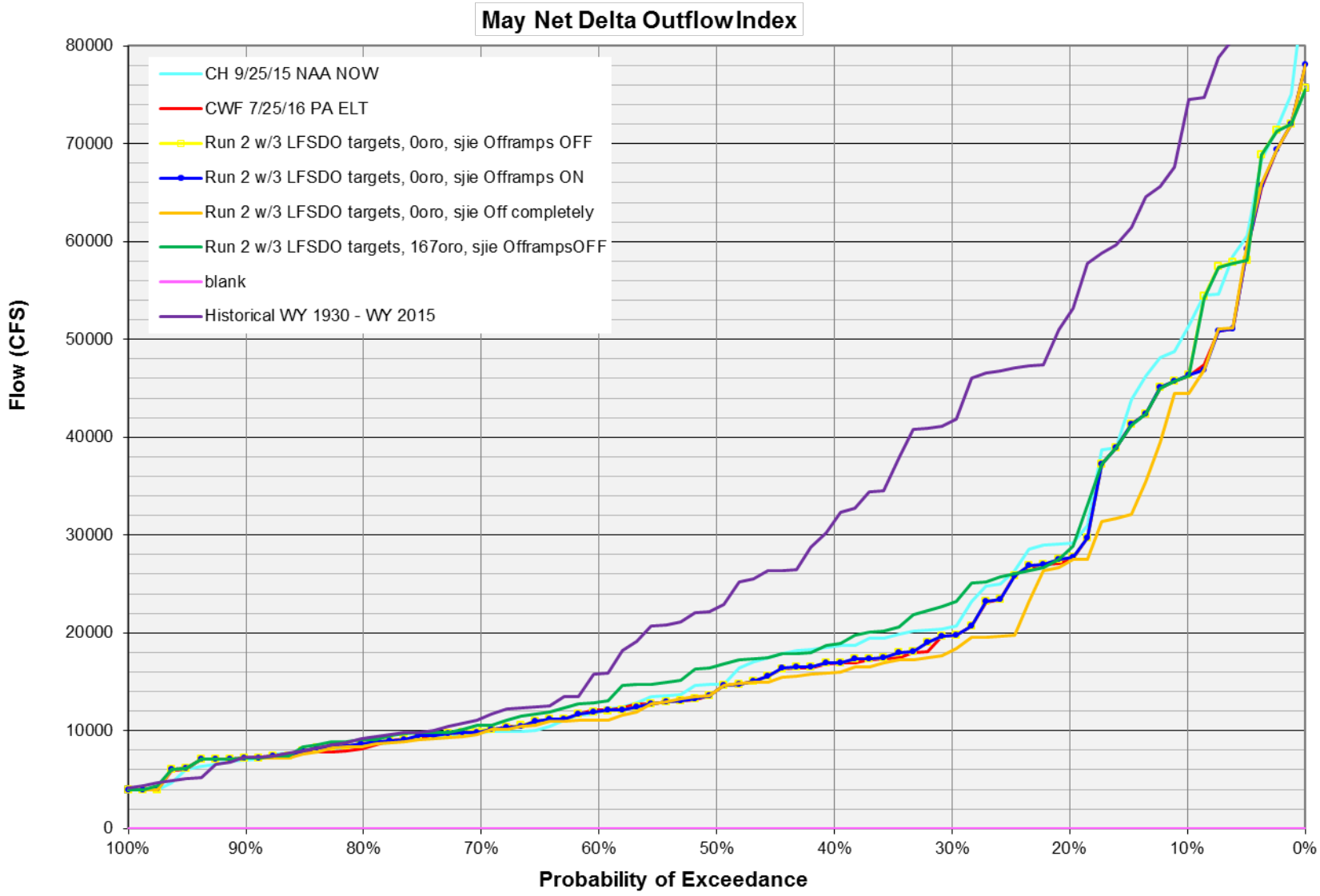

March Net Delta Outflow Index
Flow (CFS)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CWF NAA NOW 9/25/15
CWF PA ELT 7/25/16
CWF PA ELT LFS 1/17/17c
CWF PA ELT LFS 1/17/17d

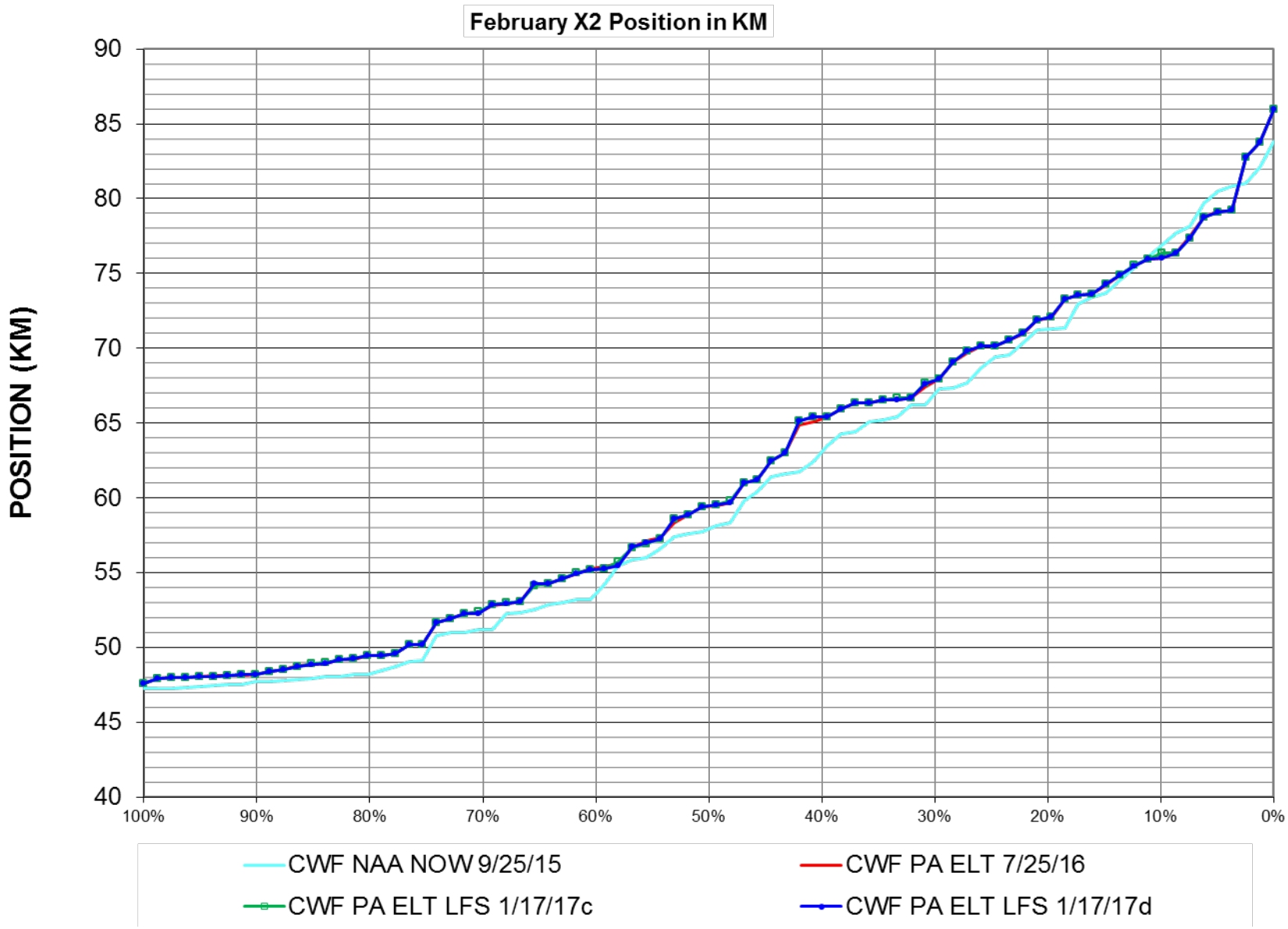

April Net Delta Outflow Index
Flow (CFS)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CWF NAA NOW 9/25/15
CWF PA ELT 7/25/16
CWF PA ELT LFS 1/17/17c
CWF PA ELT LFS 1/17/17d

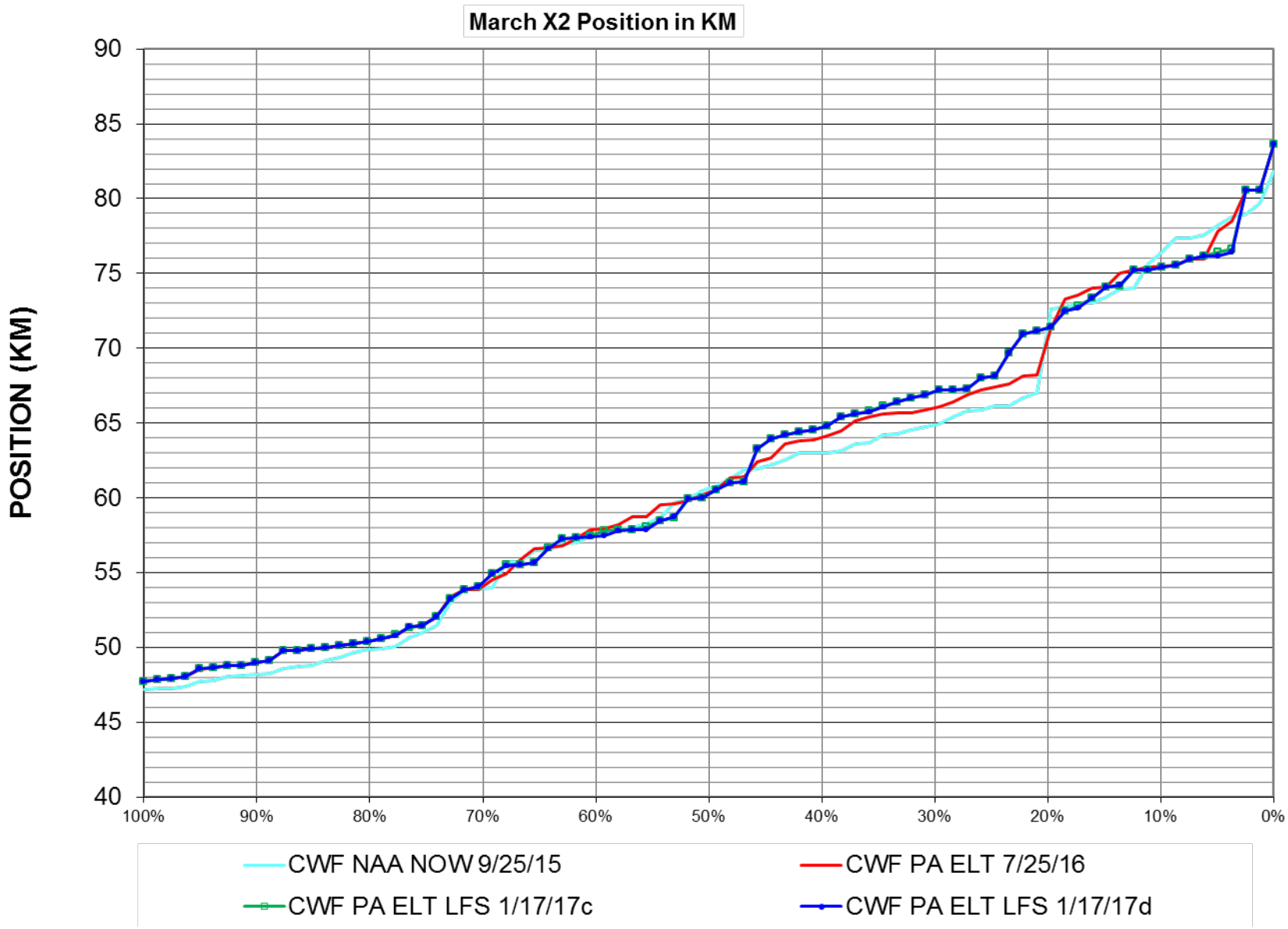

May Net Delta Outflow Index
Flow (CFS)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CWF NAA NOW 9/25/15
CWF PA ELT 7/25/16
CWF PA ELT LFS 1/17/17c
CWF PA ELT LFS 1/17/17d

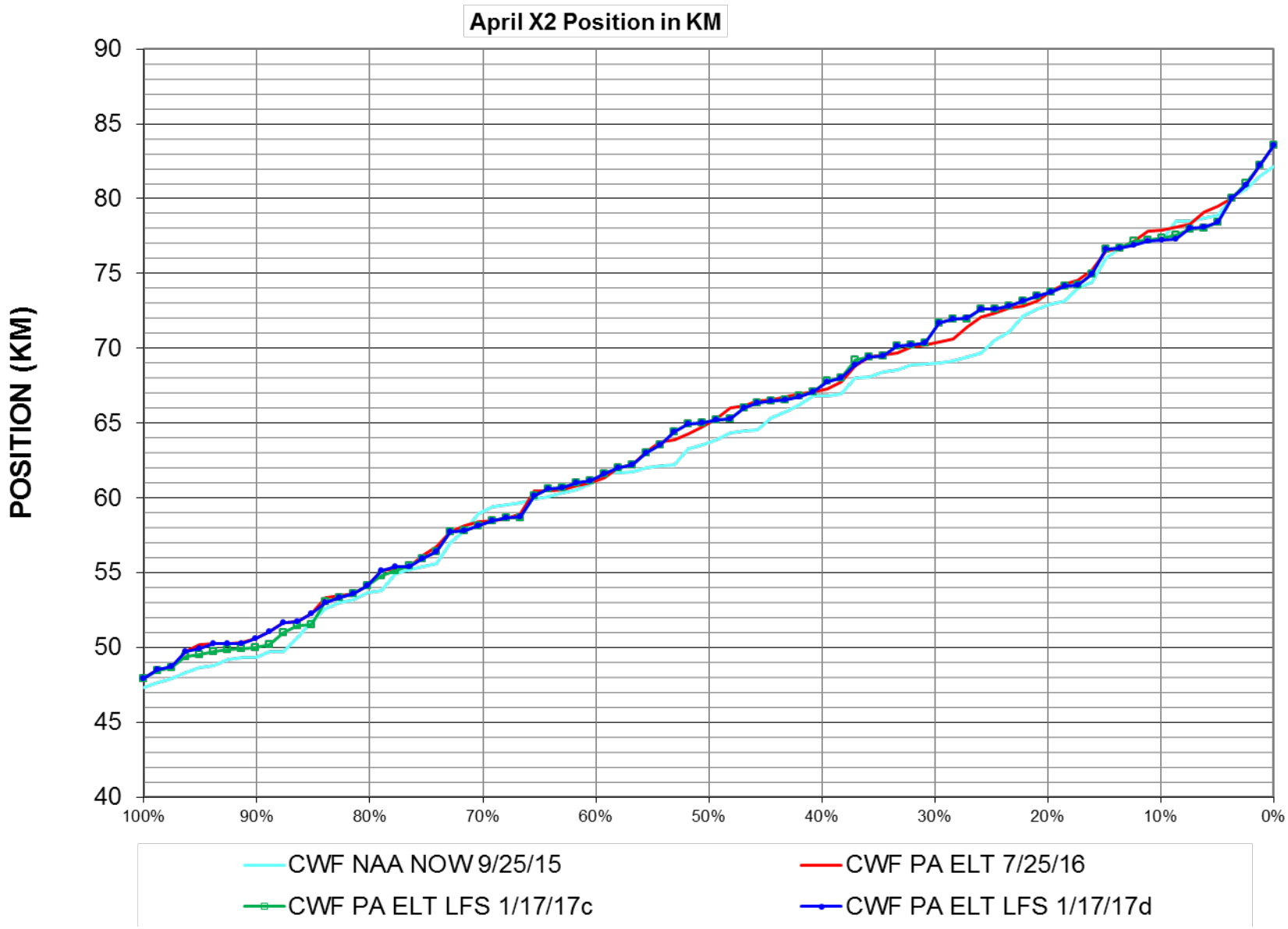

March-May Net Delta Outflow Index
CH 9/25/15 NAA NOW
CWF 7/25/16 PA ELT
Run 2 w/3 LFSDO targets, 0oro, sjie Offramps OFF
Run 2 w/3 LFSDO targets, 0oro, sjie Offramps ON
Run 2 w/3 LFSDO targets, 0oro, sjie Off completely
Run 2 w/3 LFSDO targets, 167oro, sjie OfframpsOFF
blank
Historical WY 1930 - WY 2015
Flow (CFS)
80000
70000
60000
50000
40000
30000
20000
10000
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probability of Exceedance

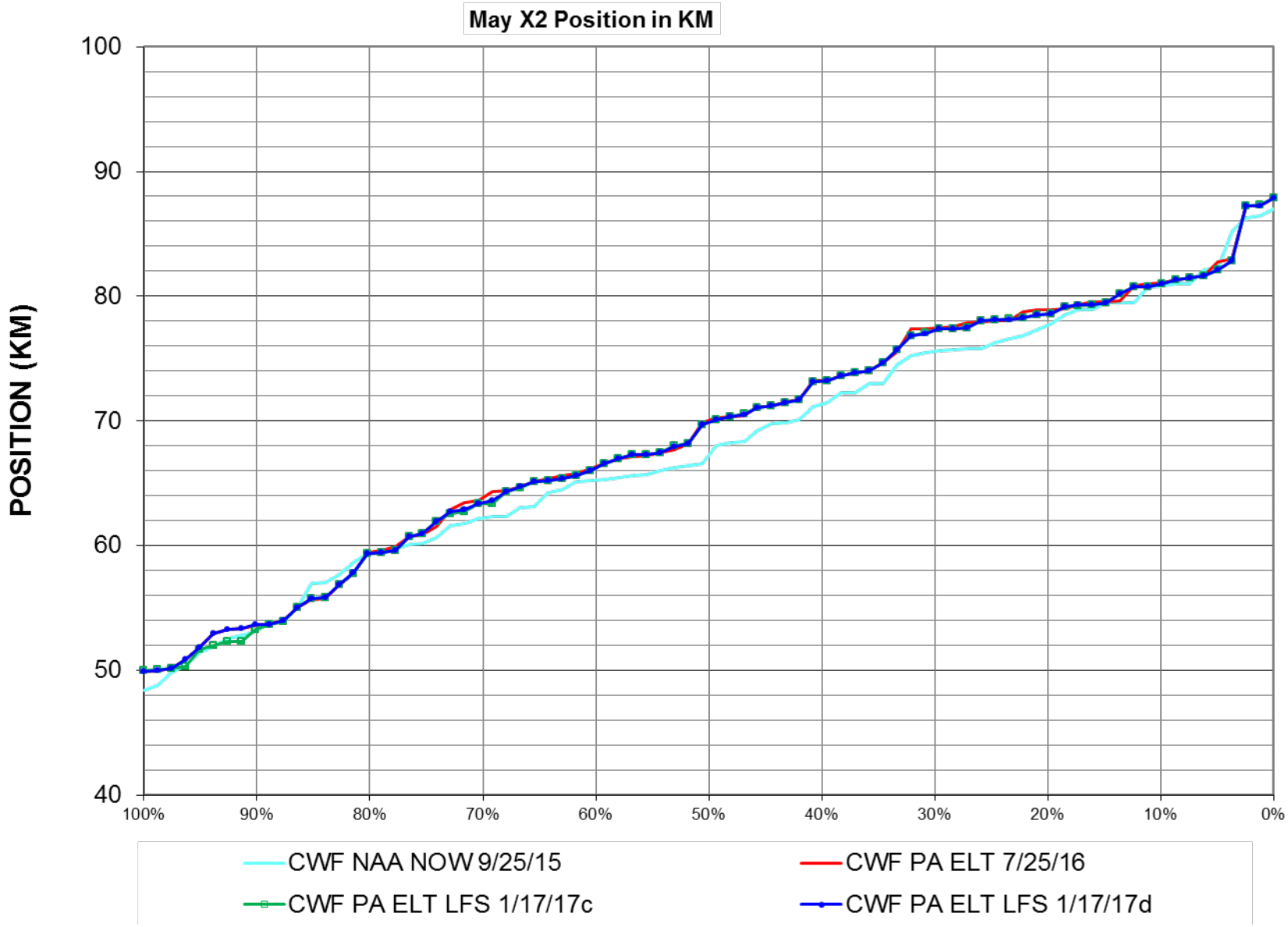

April Net Delta Outflow Index
CH 9/25/15 NAA NOW
CWF 7/25/16 PA ELT
Run 2 w/3 LFSDO targets, 0oro, sjie Offramps OFF
Run 2 w/3 LFSDO targets, 0oro, sjie Offramps ON
Run 2 w/3 LFSDO targets, 0oro, sjie Off completely
Run 2 w/3 LFSDO targets, 167oro, sjie OfframpsOFF
blank
Historical WY 1930 - WY 2015
Flow (CFS)
80000
70000
60000
50000
40000
30000
20000
10000
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probability of Exceedance

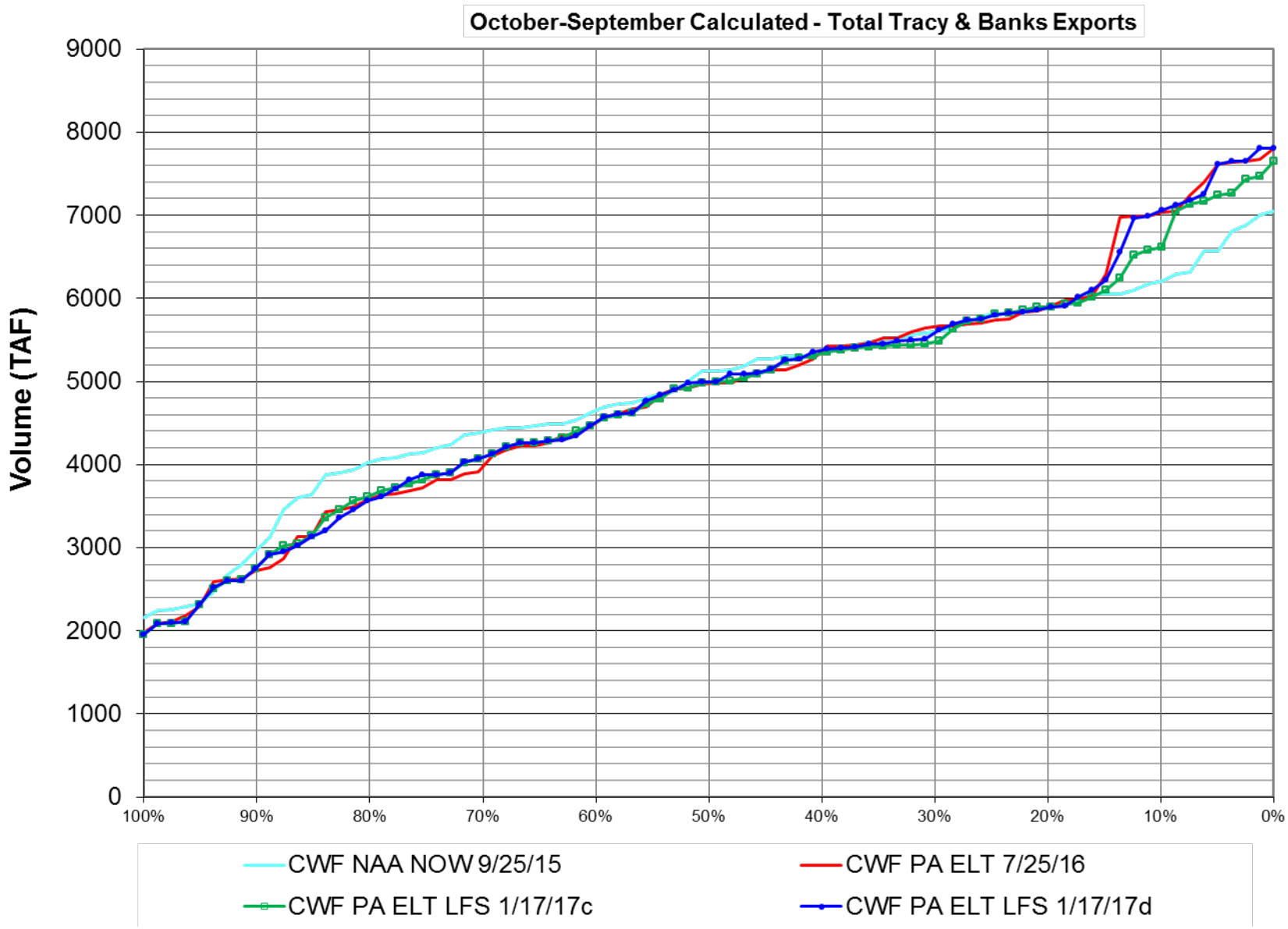

May Net Delta Outflow Index
CH 9/25/15 NAA NOW
CWF 7/25/16 PA ELT
Run 2 w/3 LFSDO targets, 0oro, sjie Offramps OFF
Run 2 w/3 LFSDO targets, 0oro, sjie Offramps ON
Run 2 w/3 LFSDO targets, 0oro, sjie Off completely
Run 2 w/3 LFSDO targets, 167oro, sjie OfframpsOFF
blank
Historical WY 1930 - WY 2015
Flow (CFS)
80000
70000
60000
50000
40000
30000
20000
10000
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probability of Exceedance

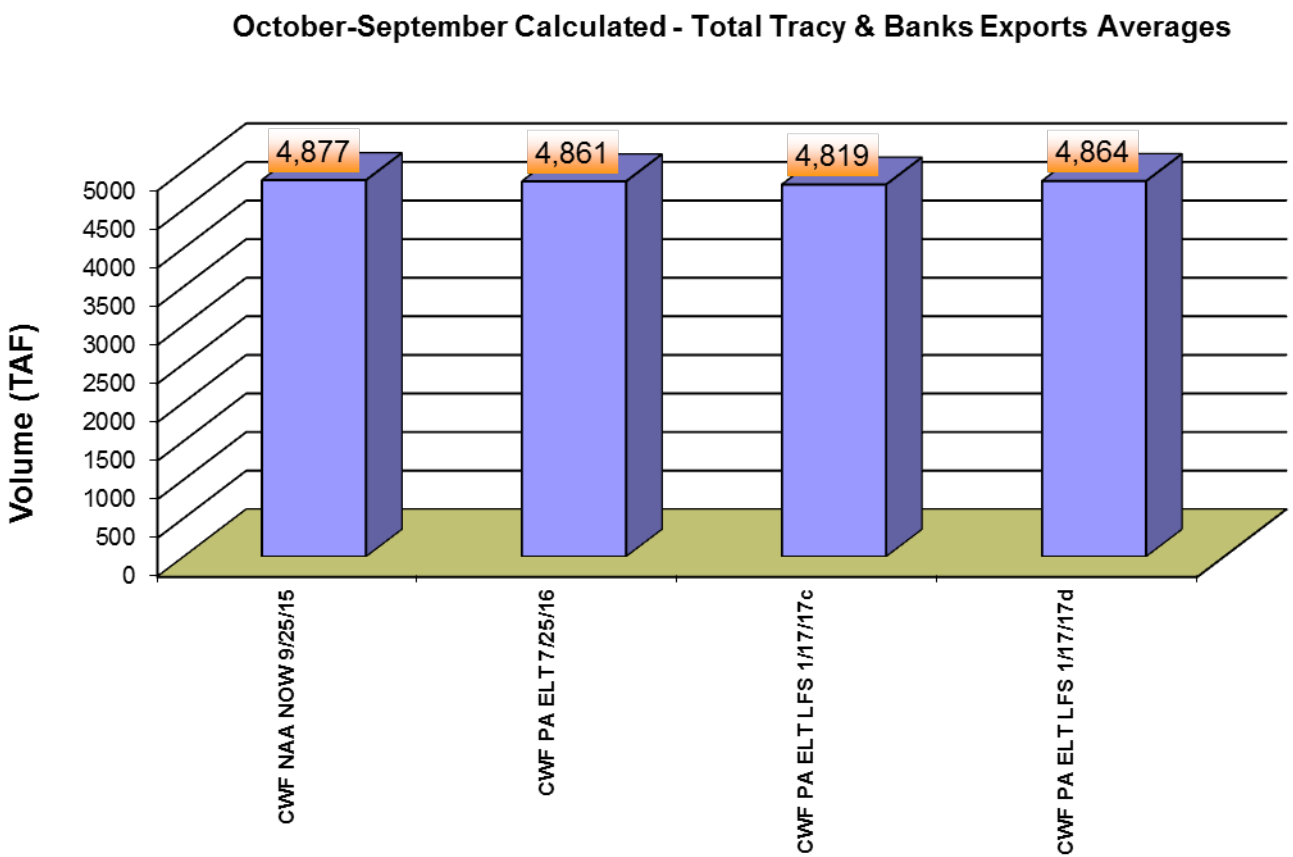

February X2 Position in KM
POSITION (KM)
90
85
80
75
70
65
60
55
50
45
40
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CWF NAA NOW 9/25/15
CWF PA ELT 7/25/16
CWF PA ELT LFS 1/17/17c
CWF PA ELT LFS 1/17/17d

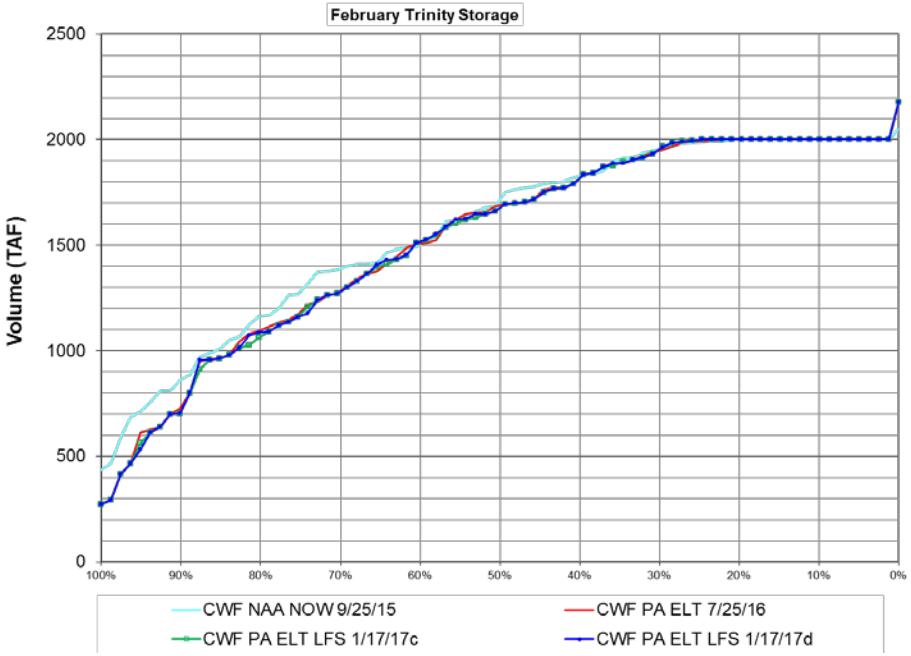

March X2 Position in KM
POSITION (KM)
90
85
80
75
70
65
60
55
50
45
40
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CWF NAA NOW 9/25/15
CWF PA ELT 7/25/16
CWF PA ELT LFS 1/17/17c
CWF PA ELT LFS 1/17/17d

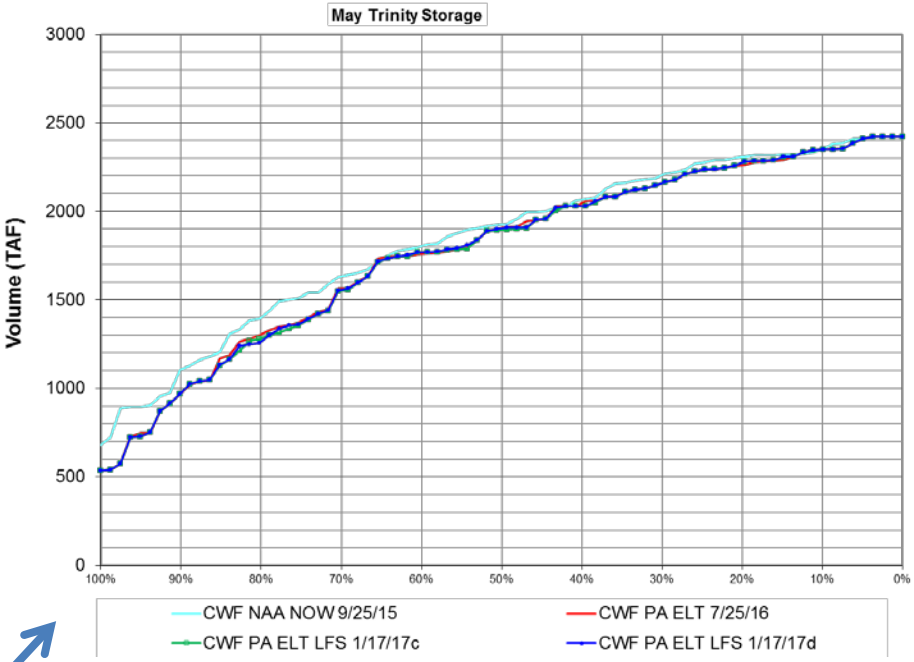

April X2 Position in KM
POSITION (KM)
90
85
80
75
70
65
60
55
50
45
40
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CWF NAA NOW 9/25/15
CWF PA ELT 7/25/16
CWF PA ELT LFS 1/17/17c
CWF PA ELT LFS 1/17/17d


May X2 Position in KM
POSITION (KM)
100
90
80
70
60
50
40
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CWF NAA NOW 9/25/15
CWF PA ELT 7/25/16
CWF PA ELT LFS 1/17/17c
CWF PA ELT LFS 1/17/17d


October-September Calculated - Total Tracy & Banks Exports
Volume (TAF)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CWF NAA NOW 9/25/15
CWF PA ELT 7/25/16
CWF PA ELT LFS 1/17/17c
CWF PA ELT LFS 1/17/17d


October-September Calculated - Total Tracy & Banks Exports Averages
Volume (TAF)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
4,877
4,861
4,819
4,864
CWF NAA NOW 9/25/15
CWF PA ELT 7/25/16
CWF PA ELT LFS 1/17/17c
CWF PA ELT LFS 1/17/17d

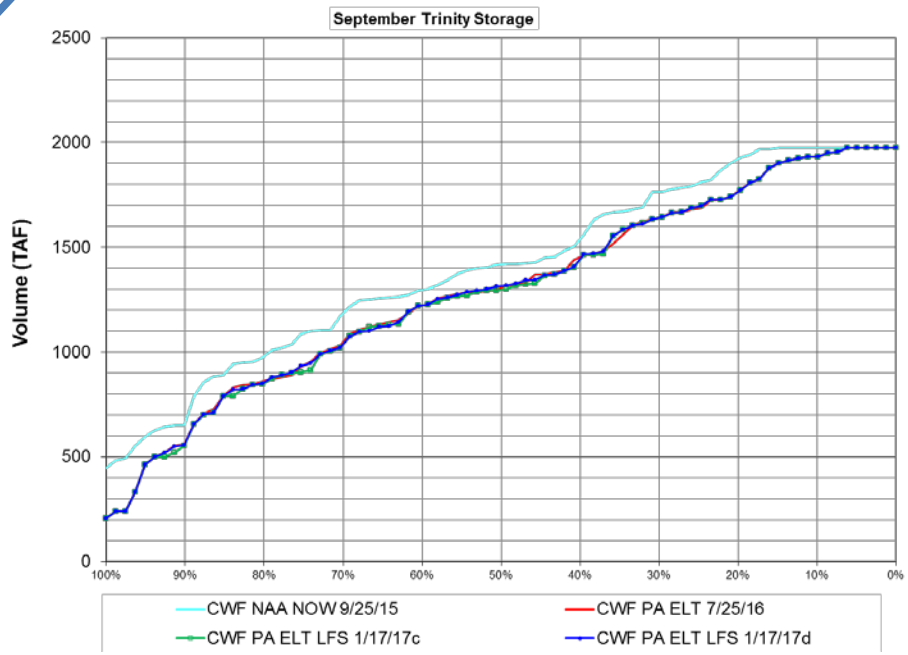


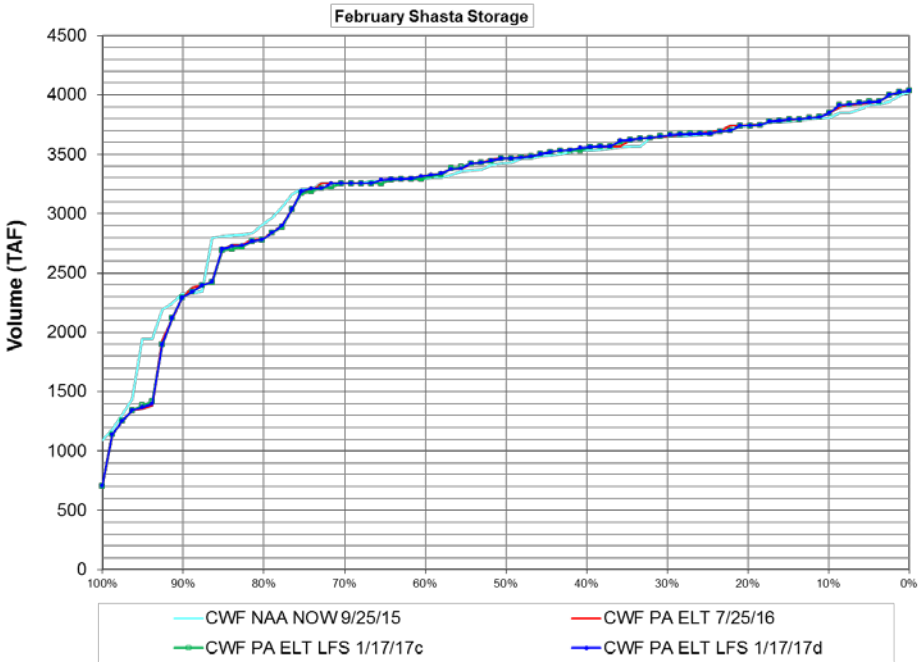


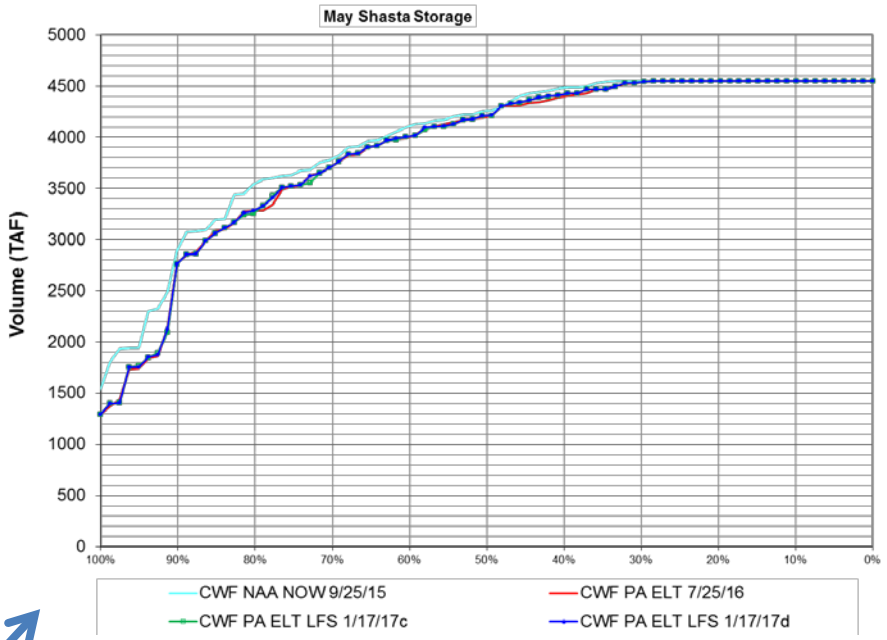
BEFORE

AFTER

AFTER AFTER







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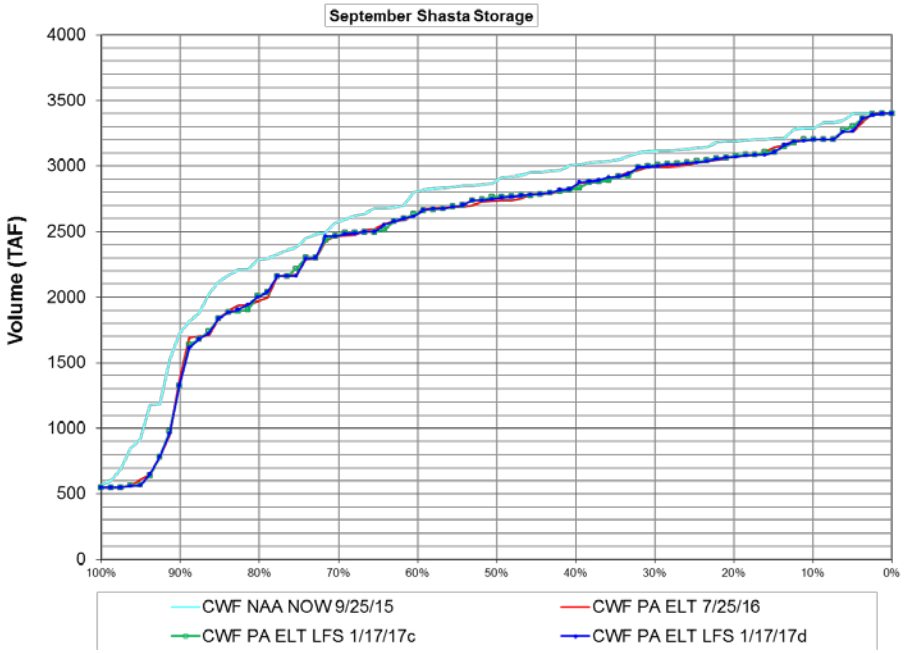
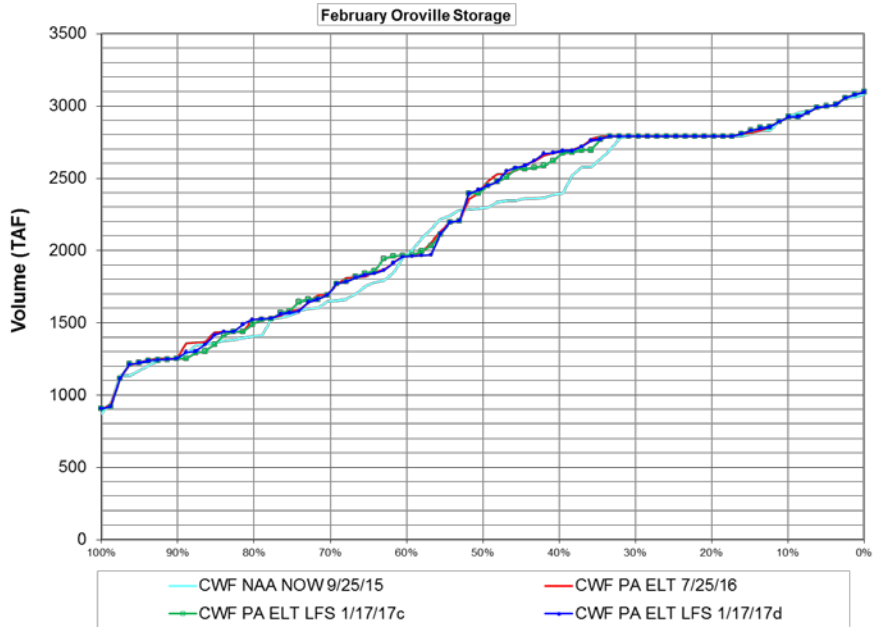
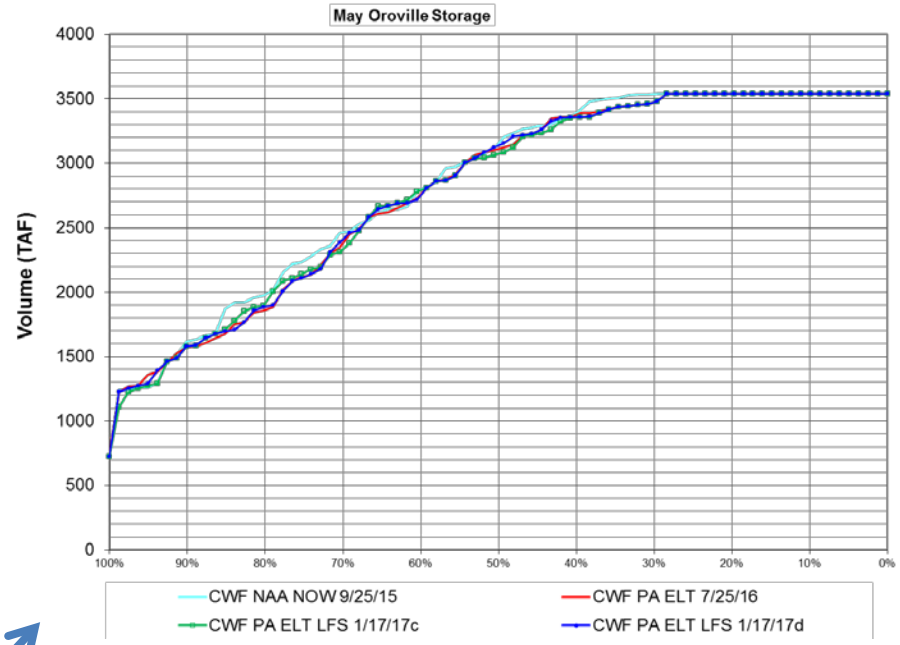
AFTER AFTER







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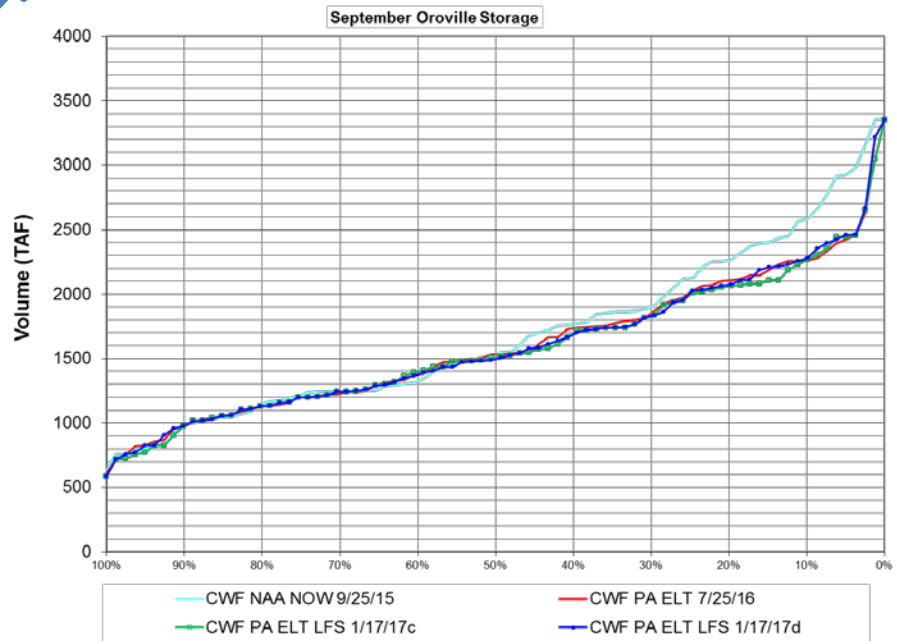

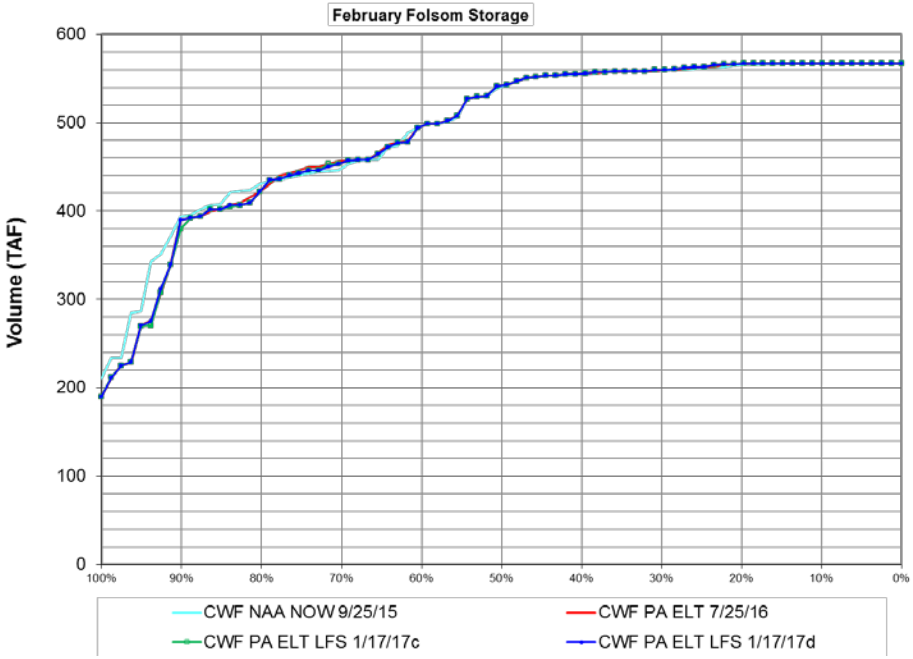

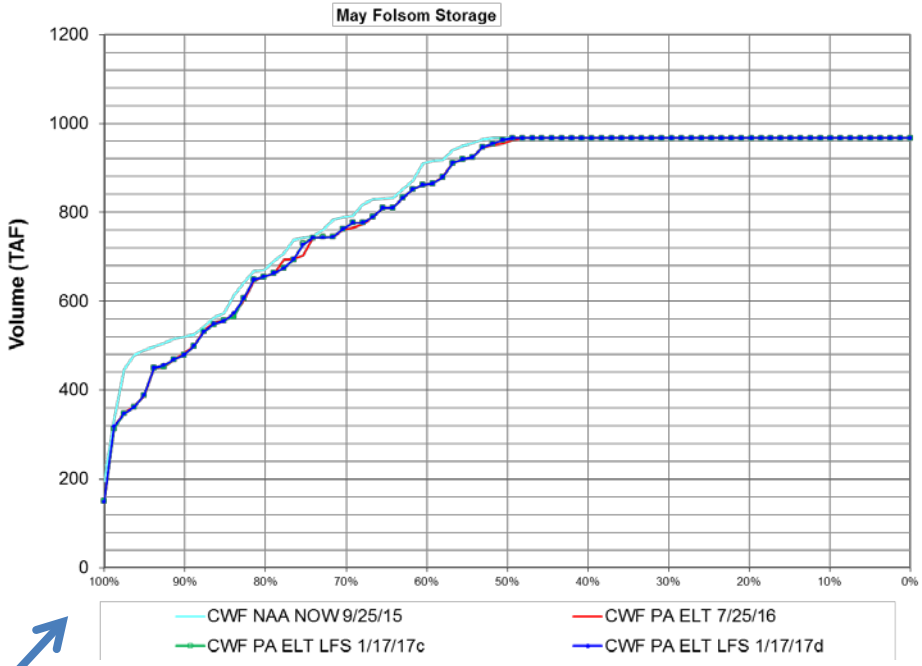

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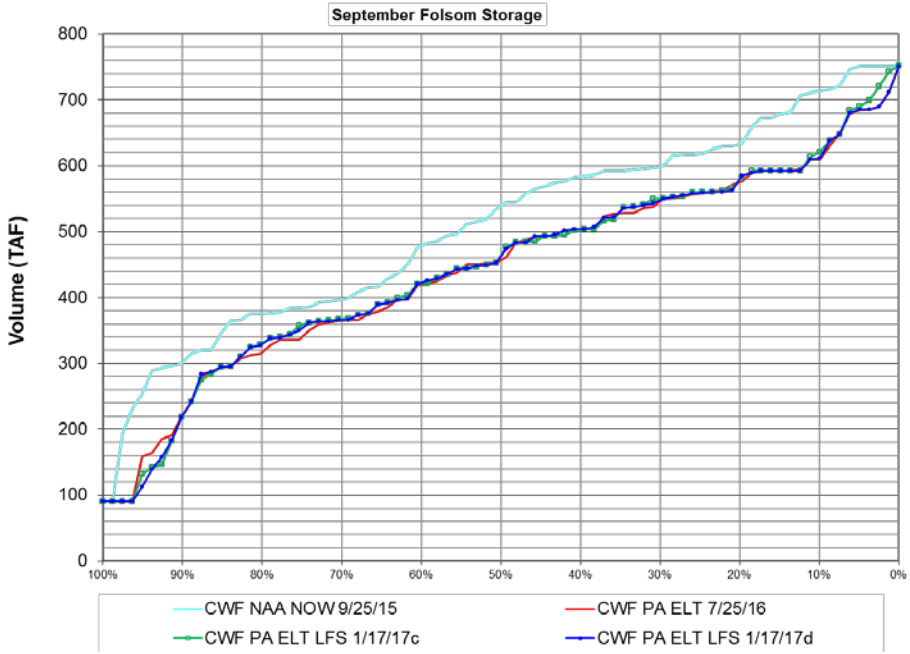

Conclusion

- In combination with all non-LFS criteria proposed in the 7/25/16 CWF PA ELT simulation, the approach outlined for LFS herein provides a similar level of protection to LFS as the 7/25/16 LFS criteria without the pitfalls associated with forecasting.

Questions?