



## United States Department of the Interior

BUREAU OF RECLAMATION  
Central Valley Operations Office  
3310 El Camino Avenue, Suite 300  
Sacramento, California 95821

APR 16 2019



IN REPLY  
REFER TO:  
CVO-400  
2.2.1.06

VIA ELECTRONIC MAIL

Ms. Maria Rea  
Assistant Regional Administrator  
California Central Valley Area Office  
650 Capital Mall, suite 5-100  
Sacramento, CA 95814

Subject: Transmittal of April 2019 Central Valley Project (CVP) Operations Forecasts

Dear Ms. Rea:

Pursuant to Reasonable and Prudent Alternative Action I.2.3 of the 2009 National Marine Fisheries Service (NMFS) Biological Opinion (BiOp), this transmittal provides the Bureau of Reclamation's preliminary CVP operational forecasts and Sacramento River temperature model results for projected operations this spring and summer. Enclosed are the CVP operational forecast summaries (Enclosure 1) and a projection of Sacramento temperature performance for the projected 90 percent exceedance operation (Enclosure 2).

The enclosed outlooks and modeling run are based on forecasts of reservoir inflows assuming a 90 percent exceedance hydrology using information provided by the California Department of Water Resources April 1 hydrologic conditions report. The outlooks and modeling have also taken into account the runoff conditions and changes in reservoir volume that have occurred thus far in the month of April. Temperature modeling results are based on the operational forecasts and a Shasta Lake temperature profile taken on April 9, 2019, and are a conservative representation of future conditions. In order to provide an additional level of conservatism a 25 percent Climate Prediction Center local 3-month temperature outlook meteorology was used for the modeling. It is important to note that the enclosed outlooks and projections do not suggest a certain actual future outcome, but rather the statistical likelihood of projected outcomes including, but not limited to, projected storage and releases as well as temperature performance. Thus, the outlooks do not provide exact end-of-month storages, flow rates, or anticipated water temperatures, but general projections that will likely fall within the range of uncertainty based on the different hydrologic runoff conditions between the 90 percent and 50 percent hydrology.

The Sacramento Basin hydrology has improved considerably over the March 1 hydrology and the results of the 90 percent exceedance hydrology temperature modeling indicate the ability to meet a 56-degree daily average temperature at a compliance location of Balls Ferry for the remainder of the temperature control season (Enclosure 2). The model run is still showing the

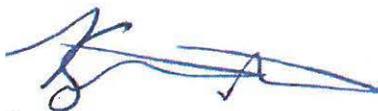
Ms. Maria Rea

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possibility of warm runoff from local creeks downstream of Clear Creek during May, however, Reclamation believes that this can be discussed and managed within the Sacramento River Temperature Task Group (SRTTG), should it occur in actuality. Under this hydrology, the projected end of September Shasta Lake storage is 2.9 million acre-feet. These conditions remain consistent with the criteria for Action I.2.3.A in the NMFS BiOp as both agencies had determined last month, and Reclamation continues to be confident that the performance goals in Action I.2.3.A will be met.

We look forward to continued coordination as we work on this year's temperature management plan. Reclamation is still completing other model runs in support of this effort, and a full set of updated model runs will be provided in advance of the next scheduled SRTTG meeting on April 25, 2019. Please contact me at (916) 979-2197 or [jrieker@usbr.gov](mailto:jrieker@usbr.gov) if you have any questions regarding this transmittal.

Sincerely,



FOR Jeffrey D. Rieker  
Operations Manager

Enclosures

**Estimated CVP Operations 50% Exceedance**

**Storages**

**Federal End of the Month Storage/Elevation (TAF/Feet)**

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Trinity		1932	2070	2227	2269	2158	2012	1875	1849	1836	1863	1927	2121
	Elev.	2346	2356	2359	2352	2342	2332	2330	2329	2331	2336	2343	2349
Whiskeytown		216	238	238	238	238	238	206	206	206	206	206	206
	Elev.	1209	1209	1209	1209	1209	1209	1199	1199	1199	1199	1199	1199
Shasta		4028	4235	4448	4301	3947	3464	3198	3036	2995	3081	3195	3773
	Elev.	1056	1063	1058	1046	1027	1016	1009	1008	1011	1016	1029	1039
Folsom		735	841	927	938	904	715	704	625	595	584	581	750
	Elev.	453	461	462	459	441	440	431	428	427	426	428	444
New Melones		2001	1898	1998	2090	2034	1980	1945	1901	1912	1929	1954	1969
	Elev.	1043	1052	1060	1055	1050	1047	1043	1044	1046	1048	1052	1049
San Luis		965	868	644	451	212	74	91	85	118	317	481	724
	Elev.	520	481	452	434	415	425	407	399	434	462	475	488
<b>Total</b>		10150	10482	10288	9492	8482	8052	7701	7662	7980	8344	8949	9543

**State End of the Month Reservoir Storage (TAF)**

Oroville		2839	3179	3453	3559	3114	2673	2205	1987	1920	1936	2115	2467	2453
	Elev.	877	895	902	872	840	801	781	775	777	793	824	823	
San Luis		1063	878	652	546	608	574	643	495	399	499	609	633	646
<b>Total San Luis (TAF)</b>		2028	1746	1296	997	819	647	734	580	517	816	1090	1234	1370

**Monthly River Releases (TAF/cfs)**

Trinity	TAF	136	197	133	66	53	52	23	18	18	18	17	18
	cfs	2,286	3,204	2,235	1,073	857	870	373	300	300	300	300	300
Clear Creek	TAF	13	13	17	9	9	9	12	12	12	15	11	12
	cfs	218	216	288	150	150	200	200	200	200	240	200	200
Sacramento	TAF	892	523	595	707	799	565	430	357	307	492	444	615
	cfs	15000	8500	10000	11500	13000	9500	7000	6000	5000	8000	8000	10000
American	TAF	476	553	357	184	297	119	154	119	123	154	250	154
	cfs	8000	9000	6000	3000	4835	2000	2500	2000	2000	2500	4500	2500
Stanislaus	TAF	222	123	65	61	25	24	52	18	18	22	20	101
	cfs	3734	2001	1100	1000	400	400	842	300	300	358	364	1648
Feather	TAF	714	492	268	529	504	571	246	104	108	108	97	461
	cfs	12000	8000	4500	8600	8200	9600	4000	1750	1750	1750	1750	7500

**Trinity Diversions (TAF)**

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Carr PP	21	9	41	99	100	89	13	25	12	0	2	45
Spring Crk. PP	10	10	30	90	90	80	35	20	15	20	35	70

**Delta Summary (TAF)**

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Tracy	122	86	258	270	268	258	149	114	260	235	230	260
USBR Banks	0	0	0	31	31	31	0	0	0	0	0	0
Contra Costa	12.7	12.7	9.8	11.1	12.7	14.0	16.8	18.4	18.3	14.0	14.0	12.7
<b>Total USBR</b>	134	99	268	312	312	303	166	132	278	249	244	273
<b>State Export</b>	83	55	250	440	323	350	100	100	260	175	160	220
<b>Total Export</b>	218	153	518	752	635	653	266	232	538	424	404	493
<b>COA Balance</b>	0	0	0	0	0	0	0	0	0	0	0	0
<b>Old/Middle River Std.</b>												
<b>Old/Middle R. calc.</b>	2,773	1,589	-5,753	-8,895	-7,687	-8,189	-3,006	-2,805	-6,532	-4,971	-4,975	-5,068
<b>Computed DOI</b>	72500	41921	17566	8313	12998	12271	12819	11397	10183	20415	26853	32307
<b>Excess Outflow</b>	45066	16153	1412	309	0	874	1415	0	5677	14413	15453	20903
<b>% Export/Inflow</b>	4%	5%	29%	49%	37%	42%	22%	23%	45%	25%	21%	19%
<b>% Export/Inflow std.</b>	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%	35%

**Hydrology**

Water Year Inflow (TAF)	Trinity	Shasta	Folsom	New Melones
Year to Date + Forecasted	1592	7,119	3,967	1661
% of mean	132%	129%	146%	157%

CVP actual operations do not follow any forecasted operation or outlook; actual operations are based on real-time conditions.

CVP operational forecasts or outlooks represent general system-wide dynamics and do not necessarily address specific watershed/tributary details.

CVP releases or export values represent monthly averages.

CVP Operations are updated monthly as new hydrology information is made available December through May.

**Estimated CVP Operations 90% Exceedance**

**Storages**

**Federal End of the Month Storage/Elevation (TAF/Feet)**

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
Trinity		1932	2061	2153	2176	2059	1906	1786	1754	1735	1744	1776	1861	1938
	Elev.	2345	2351	2353	2345	2334	2326	2323	2322	2322	2322	2325	2331	2337
Whiskeytown		216	238	238	238	238	238	206	206	206	206	206	206	206
	Elev.	1209	1209	1209	1209	1209	1209	1199	1199	1199	1199	1199	1199	1199
Shasta		4028	4235	4328	4082	3653	3192	2896	2719	2684	2737	2888	3193	3622
	Elev.	1056	1059	1051	1035	1016	1003	995	993	996	1003	1016	1033	
Folsom		735	871	932	966	852	667	611	522	443	382	383	444	593
	Elev.	456	462	462	465	454	436	430	419	409	400	400	409	428
New Melones		2001	1890	1931	1961	1897	1824	1780	1731	1736	1744	1748	1755	1689
	Elev.	1042	1046	1046	1049	1043	1036	1032	1027	1027	1028	1029	1029	1023
San Luis		965	836	607	449	251	137	143	53	165	380	536	633	763
	Elev.	520	483	454	438	431	422	394	409	446	470	484	497	
<b>Total</b>		10131	10189	9873	8950	7963	7454	6984	6968	7193	7536	8092	8811	

**State End of the Month Reservoir Storage (TAF)**

Oroville		2839	3178	3495	3473	2993	2524	2124	1943	1826	1782	1902	2153	2433
	Elev.	877	898	896	864	828	794	777	766	761	773	797	821	
San Luis		1063	903	707	562	609	654	561	421	430	552	646	697	711
<b>Total San Luis (TAF)</b>		2028	1740	1314	1011	860	791	704	474	595	932	1182	1330	1474

**Monthly River Releases (TAF/cfs)**

Trinity	TAF	136	197	133	66	53	52	23	18	18	18	17	18
	cfs	2,286	3,204	2,235	1,073	857	870	373	300	300	300	300	300
Clear Creek	TAF	13	13	17	9	9	9	12	12	12	12	11	12
	cfs	218	216	288	150	150	150	200	200	200	200	200	200
Sacramento	TAF	892	523	625	738	738	535	430	297	277	246	222	246
	cfs	15000	8500	10500	12000	12000	9000	7000	5000	4500	4000	4000	4000
American	TAF	446	369	238	223	286	149	123	119	123	111	100	92
	cfs	7500	6000	4000	3634	4653	2500	2000	2000	2000	1800	1800	1500
Stanislaus	TAF	222	123	65	26	25	24	52	18	18	22	20	101
	cfs	3734	2001	1100	429	400	400	842	300	300	358	364	1648
Feather	TAF	595	215	238	461	443	476	209	104	108	108	97	108
	cfs	10000	3500	4000	7500	7200	8000	3400	1750	1750	1750	1750	1750

**Trinity Diversions (TAF)**

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Carr PP	30	17	45	100	101	70	18	21	12	3	2	35
Spring Crk. PP	10	10	30	90	90	60	40	15	12	10	20	50

**Delta Summary (TAF)**

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Tracy	77	61	255	268	268	229	60	187	270	220	200	258
USBR Banks	0	0	0	26	26	26	0	0	0	0	0	0
Contra Costa	12.7	12.7	9.8	11.1	12.7	14.0	16.8	18.4	18.3	14.0	14.0	12.7
<b>Total USBR</b>	89	74	265	305	307	269	77	205	288	234	214	271
<b>State Export</b>	53	47	180	392	357	148	66	174	240	160	160	190
<b>Total Export</b>	142	120	445	697	664	417	143	379	528	394	374	461
<b>COA Balance</b>	0	0	0	0	0	0	0	0	0	0	0	0
Old/Middle River Std.												
Old/Middle R. calc.	1,505	929	-5,149	-8,463	-8,050	-5,134	-1,656	-5,003	-6,611	-4,903	-5,045	-5,033
Computed DOI	62817	27134	12305	8004	10004	13784	12282	5850	6946	11891	11545	13941
Excess Outflow	35384	7694	303	0	0	773	878	0	2440	5889	144	2538
% Export/Inflow	3%	6%	32%	48%	43%	29%	13%	47%	54%	36%	37%	34%
% Export/Inflow std.	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%	35%

**Hydrology**

Water Year Inflow (TAF)	Trinity	Shasta	Folsom	New Melones
Year to Date + Forecasted	1506	6,804	3,598	1483
% of mean	125%	123%	132%	140%

CVP actual operations do not follow any forecasted operation or outlook; actual operations are based on real-time conditions.

CVP operational forecasts or outlooks represent general system-wide dynamics and do not necessarily address specific watershed/tributary details.

CVP releases or export values represent monthly averages.

CVP Operations are updated monthly as new hydrology information is made available December through May.

April 15, 2019

## Upper Sacramento River – April 2019 Preliminary Temperature Analysis

**Summary of Temperature Results by Month (Monthly Average Temperature °F)**

Location (°F DAT)	APR	MAY	JUN	JUL	AUG	SEP*	OCT*
<b>April 90%-Exceedance Outlook – 25% L3MTO Meteorology</b>							
<b>Keswick Dam KWK</b>	52.3	52.6	52.5	52.9	53.0	See Figures 1 and 2	See Figures 1 and 2
<b>Sac. R. abv Clear Creek CCR</b>	52.5	53.2	53.1	53.4	53.4	See Figures 1 and 3	See Figures 1 and 3
<b>Balls Ferry BSF</b>	53.9	56.6	55.9	55.6	55.1	See Figures 1 and 4	See Figures 1 and 4

Model Run	End of September Cold Water Pool <56°F (TAF)	First Side Gate	Full Side Gates
90% Hydro, 25% Met	853	10/5	11/26

Model Run Date April 15, 2019

\* The HEC5Q model output is displayed above for the months April through August. Based on past analysis, the temperature model does not perform well in late September and October. One factor is that the modeled release temperatures are cooler than has historically been achieved when all release is through the side gates (lowest gates), especially when there's a large temperature gradient between the pressure relief gates (PRG) and the side gates.

For the months of September and October, ranges in possible outcomes are illustrated with the Fall Temperature Index (graphics above Figures 2-4). This relationship is an end of September Lake Shasta Volume less than 56°F and likely downstream temperature performance for the early fall months. Estimated temperatures for September and October may fall into a range indicated within the Fall Temperature Index (graphical chart), illustrating historical performance. However, this range should be viewed as an element of uncertainty based on past performance, not a simulation or projection of temperature management operations or results.

### **Temperature Analysis Results:**

Modeling runs explore Sacramento River compliance performance above Clear Creek confluence and Balls Ferry locations by varying hydrology and meteorology. The temperature results for the Sacramento River between Keswick Dam and Balls Ferry are shown in Figure 1. The relationship between end-of-September lake volume below 56°F and a downstream Sacramento River compliance location through fall is based on the Figures 2-4.

### **Temperature Model Inputs, Assumptions, Limitations and Uncertainty:**

1. The latest available profiles for Shasta, Trinity, and Whiskeytown were taken on April 9, April 10, and April 9, respectively. Model results are sensitive to initial reservoir temperature conditions and the model performs best under highly stratified conditions. The April 2019 temperature profile does not yet exhibit conditions for ideal model computations (still nearly isothermal conditions). The model performs well after the reservoir stratifies, typically in late spring (i.e. end of April). The concern this year is assuming over or under estimations with variable hydrologic and meteorological conditions and not capturing the stratification with sufficient detail to project into the future with confidence.
2. Guidance on forecasted flows from the creeks (e.g., Cow, Cottonwood, Battle, etc.) between Keswick Dam and Bend Bridge are not available beyond 5 days. Creek flows developed from the historical record that most closely reflects current conditions were used for all model runs. The resulting creek flows cause significant additional warming in the upper Sacramento River during spring.
3. Operation is based on the April 2019 Operation Outlooks (monthly flows, reservoir release, and end-of-month reservoir storage) for the 90%- and 50%-exceedances, with minor modifications to accommodate for flood management. Trinity Lake inflows are updated with the CNRFC 90% runoff exceedance for the 90% and DWR Bulletin 120 for the 50% runoff exceedance studies.
4. Although mean daily flows and releases are temperature model inputs, they are based on the mean monthly values from the operation outlooks. Mean daily flow patterns are user defined and are generalized representations. It is important to note that these outlooks do not suggest a certain actual future outcome, but rather the statistical likelihood of an event occurring, including, but not

limited to, projected storage and releases. Thus, the outlooks do not provide exact end of month storages or flow rates but general projections that will likely fall within the range of uncertainty based on the different hydrologic runoff conditions between the 90% and 50% runoff exceedance hydrology.

5. Cottonwood Creek flows, Keswick to Bend Bridge local flows, and ACID diversions are mean daily synthesized flows based on the available historical record for a 1922-2002 study period. Side-flows were adjusted to a 25% historical exceedance for both the 90% and 50% runoff exceedance studies.

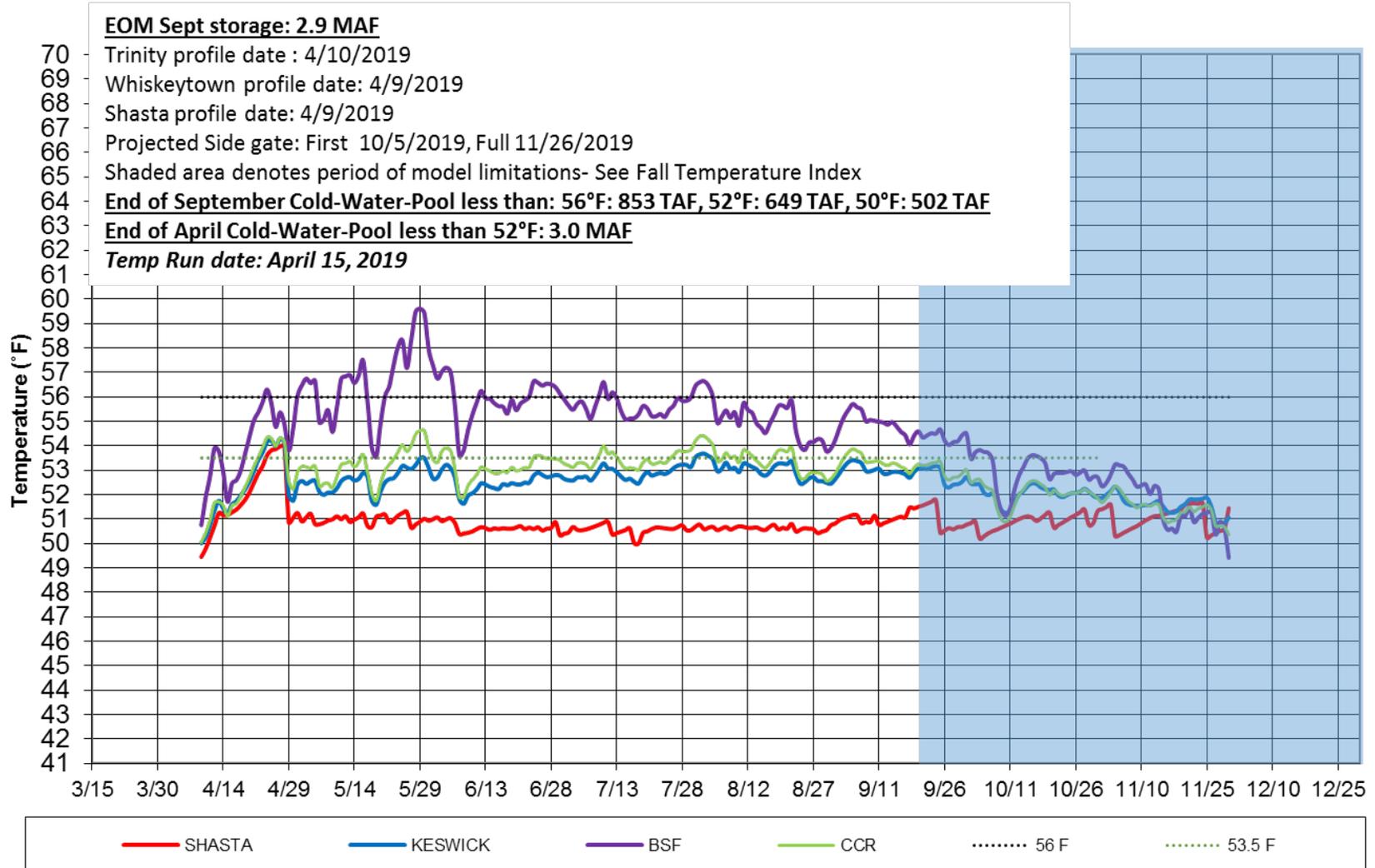
6. Meteorological inputs represent historical (1985 – 2017) monthly mean equilibrium temperature exceedance at 30% and 50% patterned after like months on a 6-hour time-step (for months prior to April). Assumed inflows temperature remain static inputs and do not vary with the assumed meteorology. Tools to use local three-month-temperature outlooks, driven by the NOAA NWS Climate Prediction Center (CPC) are used beginning in April.

7. Meteorology, as well as the flow volume and pattern, significantly influences reservoir inflow temperatures and downstream tributary temperatures; and consequently, the development of the cold-water pool during winter and early spring, which is still uncertain prior to the end of April.

8. Modified model coefficients more closely represent actual Keswick Dam temperatures. As a result, temperature predictions downstream of Keswick Dam are likely to be warmer than actual.

9. The model is specifically being applied to generate the most accurate results at the Sacramento River above Clear Creek confluence location.

## Sacramento River Modeled Temperature 2019 April 90%-Exceedance Water Outlook - 25% L3MTO Meteorology

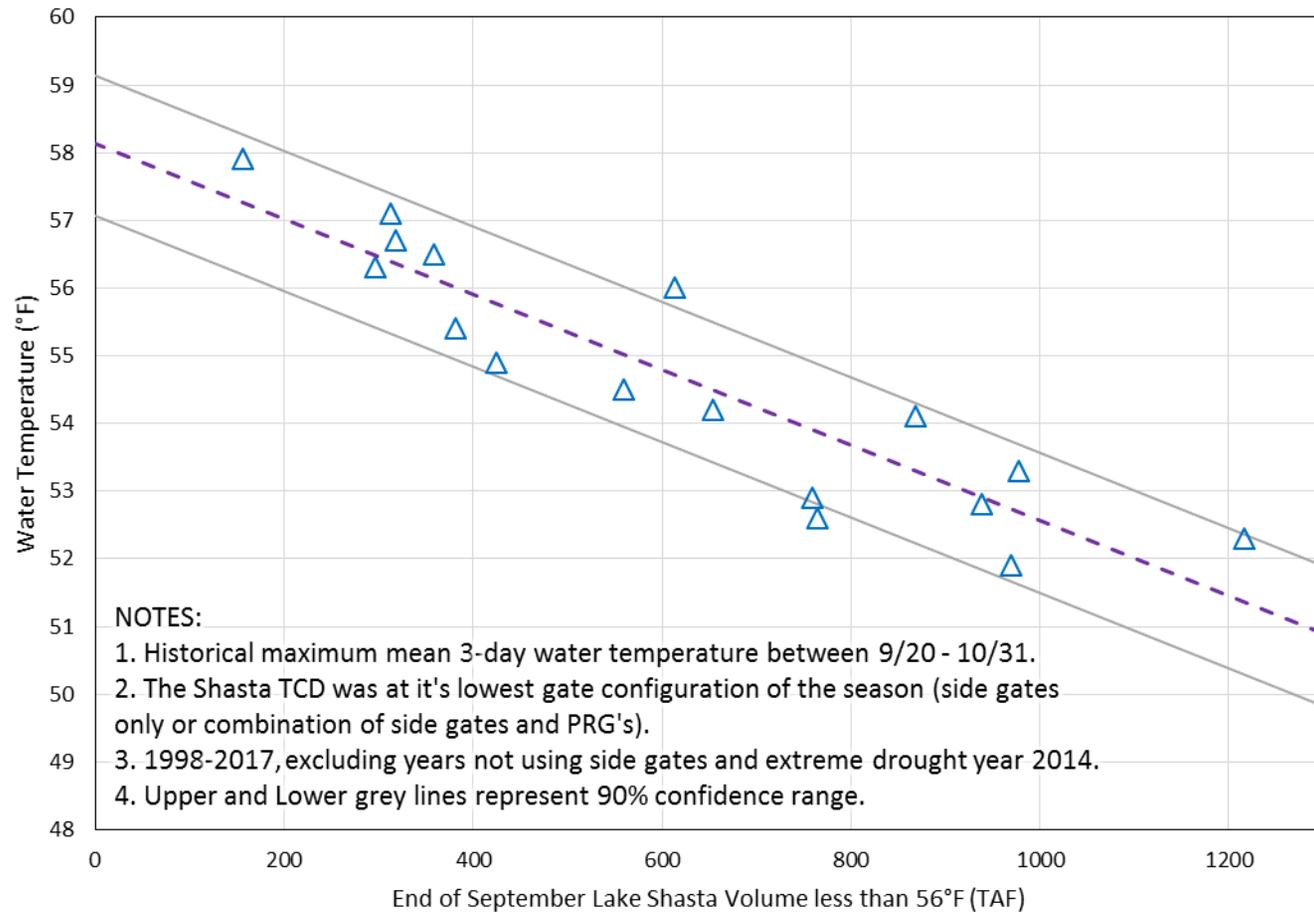


**Figure 1.** March 2019 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 30% historical meteorology.

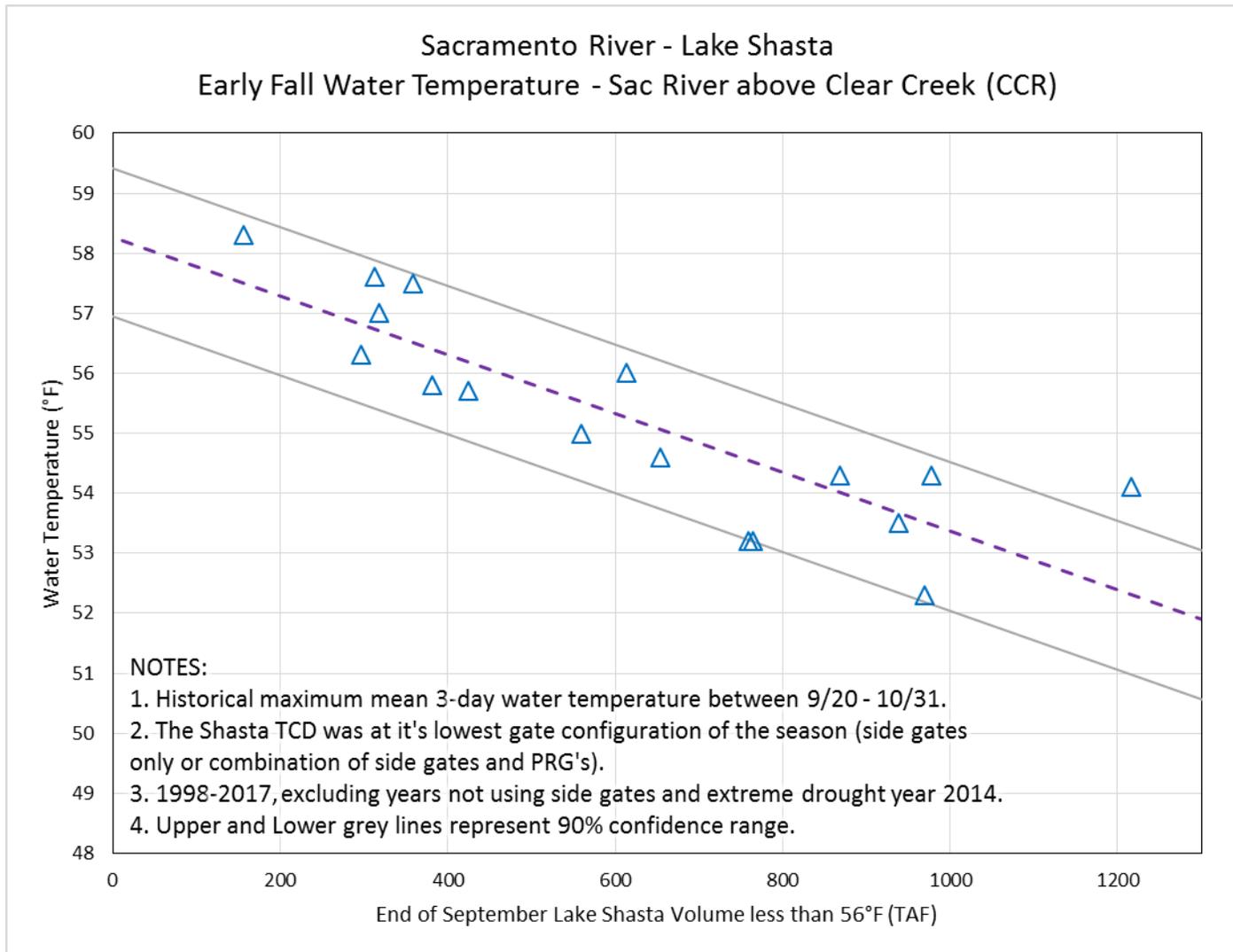
**Figure 2-4 Model Performance and Fall Temperature Index:**

1. Based on past analyses, the temperature model does not perform well in late September and October. One factor is that the modeled release temperatures are cooler than has historically been achieved when all release is through the side gates (lowest gates), especially when there's a large temperature gradient between the pressure relief gates (PRG) and the side gates.
2. Based on historical records, the end-of-September Lake Shasta volume below 56°F is a good indicator of fall water temperature in the river reach to Balls Ferry.
3. Based on these records and estimates, the charts below illustrates a range of uncertainty in the expected river temperatures based on the end-of-September lake volume less than 56°F.

Sacramento River - Lake Shasta  
Early Fall Water Temperature - Keswick (KWK)

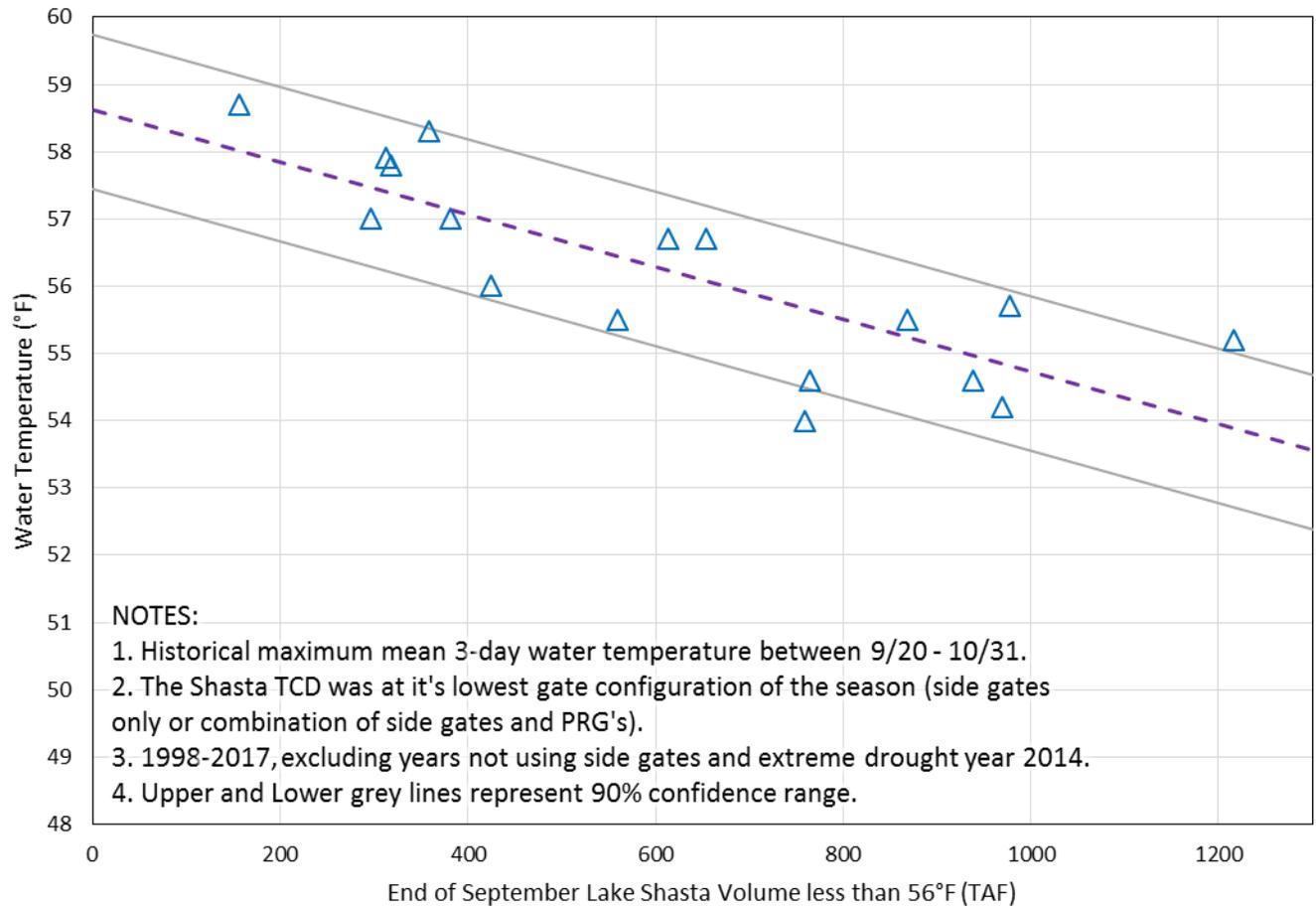


**Figure 2.** Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Keswick water temperature.



**Figure 3.** Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Sacramento River above Clear Creek confluence water temperature.

Sacramento River - Lake Shasta  
 Early Fall Water Temperature - Balls Ferry (BSF)



**Figure 4.** Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Balls Ferry water temperature.