United States Department of the Interior

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

MAY 13 2019

151422-SWR2006-SA00268

#2229

IN REPLY
REFER TO:

CVO-100
2.2.1.06

VIA ELECTRONIC MAIL

Ms. Maria Rea
Assistant Regional Administrator
California Central Valley Area Office
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento, CA 95814

Subject: Transmittal of 2019 Sacramento River Temperature Management Plan per Reasonable and Prudent Alternative (RPA) I.2.4 of the National Marine Fisheries Service (NMFS) 2009 Coordinated Long-term Operation of the Central Valley Project (CVP) and State Water Project (SWP) Biological Opinion (NMFS 2009 BiOp)

Dear Ms. Rea:

This letter transmits the Sacramento River Temperature Management Plan (SRTMP) for Water Year 2019. The Bureau of Reclamation is requesting concurrence from NMFS on the SRTMP as required by NMFS 2009 BiOp RPA Action I.2.4.

NMFS 2009 BiOp RPA Action I.2.4 requires Reclamation to submit a series of forecasts of CVP operations and corresponding Sacramento River temperature modeling runs to NMFS for review and concurrence. In accordance with this requirement, Reclamation has provided several sets of forecasts and temperature model runs and worked with NMFS during the spring of 2019 to develop a SRTMP to protect the cold water pool in Shasta Reservoir.

The SRTMP represents a balanced approach to management of the cold water pool in Shasta Reservoir during the spring, summer, and fall of 2019. Reclamation is recommending a plan that includes input and recommendations from the Sacramento River Temperature Task Group (SRTTG) meetings on March 28, 2019, and April 25, 2019, as well as a public stakeholder meeting held on May 6, 2019. The approach focuses on utilizing the cold water pool resource available this year, leveraging the Shasta Temperature Control Device capabilities, and maintaining reasonable temperature targets that will maximize protection of the species, while ensuring cold water will be able to be effectively utilized through the season. This approach will also help Reclamation meet other obligations and maintain commitments for operation of the CVP and SWP.

Preliminary temperature operation modeling results were distributed to the SRTTG this year on February 28, March 28, and April 24. In addition, Reclamation has provided additional modeling results and model output files throughout the spring to NMFS as part of the processes outlined under Action I.2.3. Reclamation solicited feedback from SRTTG members as well as stakeholders and interested parties throughout the Central Valley on the proposed operation/simulation results. Reclamation has developed the following plan based on recommendations from SRTTG members. No modifications to the plan were recommended by stakeholders and interested parties in response to the May 6 public stakeholder meeting.

The proposed SRTMP consists of a compliance point at Balls Ferry, using 56°F daily average temperature (DAT) metric from May 15 through October 31. The proposed temperature management operation also includes the continuation of the evaluation studies conducted in recent years, targeting 53.5°F DAT at the Sacramento River-Clear Creek (CCR) gauging station during the same time frame. Use of this location provides for targeting consistent temperatures closer to the location of actual anticipated spawning, as our agencies have discussed over the past several years.

Reclamation will monitor the cold water pool projections and compare to actual performance. The primary "off-ramp" criterion is defined as a deficient cold water pool volume less than 49°F which deviates more than 10% projected. In addition, ongoing modeling results will be completed for each monthly SRTTG meeting and more often as necessary. These results will be considered should those results indicate increased (or decreased) risk to fall temperature performance. In the event that actual cold water pool conditions vary from what is projected, and the fall temperature performance appears at risk, Reclamation will reconvene the SRTTG in preparation for an "off-ramp" of the evaluation study. If the "off-ramp" conditions are met and/or other indicators warrant as discussed by the SRTTG, then the evaluation study will conclude and operations will revert to the compliance location at Balls Ferry using 56°F DAT metric for the remainder of the season to protect fall temperatures. As in past years, Reclamation will work with NMFS and the other members of the SRTTG during fall operations to address the potential for redd dewatering.

Enclosed are the operational forecasts as well as the latest temperature modeling results targeting 53.5°F DAT at the CCR gauging station May 15 through October 31. The runs include both the April 50 percent and 90 percent exceedance hydrology forecasts and operational outlooks, with meteorological forecasts at 50 percent and 25 percent exceedances. Operational release performance was based on the two probabilistic hydrologic assumptions rather than fixed flowrates; actual release operations are expected to be within the specified ranges on an average monthly basis based on the hydrologic and operational considerations at that time. For this reason, daily operations may vary higher or lower from the projected monthly averages. Results using the 90 percent exceedance hydrology forecast illustrate a projected end of September storage in Shasta Reservoir of approximately 2.9 million acre-feet. The simulation results indicated confidence in accomplishing temperature management, as proposed, with an end of September cold water pool less than 56°F of at least 700,000 acre-feet, and that the first side gate use of the Shasta Reservoir Temperature Control Device would begin between late September and early October, and full side gate use expected in late October or November.

RPA Action I.2.4 requires that Reclamation achieve DATs between May 15 and October 31 "[n]ot in excess of 56°F at compliance locations between Balls Ferry and Bend Bridge." It also requires Reclamation to manage Shasta Reservoir in a way that provides "cold water releases from Shasta Reservoir to provide suitable habitat temperatures . . . in the Sacramento River between Keswick Dam and Bend Bridge, while retaining sufficient carryover storage to manage for next year's cohorts." Given the terms of RPA Action I.2.4 and the commitments above, Reclamation believes, the proposed SRTMP is fully compliant with the NMFS 2009 BiOp. We therefore request your concurrence of the SRTMP as required under RPA Action I.2.4. Reclamation proposes to conduct monitoring, updated modeling, and tracking of the performance of this SRTMP through the SRTTG.

We look forward to working with you and your staff as we manage water resources and temperature this water year. Should you have questions or wish to discuss further, please feel free to contact me at jrieker@usbr.gov or (916) 979-2197.

Sincerely,

Jeffrey D. Rieker
Operations Manager

Enclosure

Estimated CVP Operations 90% Exceedance
65% Ag, 90% M

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	2325	2331	2337
Whiskeytown	**216**	**238**	**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**	**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	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	1049	1043	1036	1032	1027	1027	1028	1029	1029	1023
San Luis	**965**	**830**	**591**	**419**	**190**	**59**	**49**	**-44**	**66**	**278**	**431**	**525**	**651**
	Elev.	519	481	451	432	423	411	381	397	435	460	473	487
Total		10125	10172	9843	8889	7886	7360	6888	6869	7091	7432	7983	8698

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**

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
Total USBR	89	74	265	305	307	269	77	205	288	234	214	271
COA Balance	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

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	1506		6,804		3,598		1483	
Year to Date + Forecasted % 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.

4/12/2019

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**	**2037**	**2121**
	Elev.	2346	2356	2359	2352	2342	2332	2330	2329	2331	2336	2343	2349
Whiskeytown	**216**	**238**	**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**	**3513**	**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**	**593**	**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**	**2000**	**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**	**601**	**724**
	Elev.	520	481	452	434	415	425	407	399	434	462	475	488
Total		10150	10482	10288	9492	8482	8052	7701	7662	7980	8344	8949	9543

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**	**150**	**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**

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
Total USBR	134	99	268	312	312	303	166	132	278	249	244	273
COA Balance	0	0	0	0	0	0	0	0	0	0	0	0
Old/Middle River Std.												
Old/Middle R. calc.	2,773	1,589	-5,753	-8,895	-7,687	-8,189	-3,006	-2,805	-6,532	-4,971	-4,975	-5,068
Computed DOI	72500	41921	17566	8313	12998	12271	12819	11397	10183	20415	26853	32307
Excess Outflow	45066	16153	1412	309	0	874	1415	0	5677	14413	15453	20903
% Export/Inflow	4%	5%	29%	49%	37%	42%	22%	23%	45%	25%	21%	19%
% Export/Inflow std.	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%	35%

Hydrology

	Trinity	Shasta	Folsom	New Melones
Water Year Inflow (TAF)	1592	7,119	3,967	1661
Year to Date + Forecasted % 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.

4/16/2019

April 24, 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*
April 90%-Exceedance Outlook – 25% L3MTO Meteorology							
Keswick Dam KWK	53.1	52.7	52.4	52.8	53.0	See Figures 1 and 5	See Figures 1 and 5
Sac. R. abv Clear Creek CCR	53.4	53.4	53.1	53.3	53.4	See Figures 1 and 6	See Figures 1 and 6
Balls Ferry BSF	55.6	57.2	55.9	55.5	55.1	See Figures 1 and 7	See Figures 1 and 7
April 90%-Exceedance Outlook – 50% L3MTO Meteorology							
Keswick Dam KWK	52.8	52.5	52.7	52.9	52.8	See Figures 2 and 5	See Figures 2 and 5
Sac. R. abv Clear Creek CCR	52.7	53.1	53.1	53.5	53.2	See Figures 2 and 6	See Figures 2 and 6
Balls Ferry BSF	53.7	56.3	55.3	55.6	54.8	See Figures 2 and 7	See Figures 2 and 7

Location (°F DAT)	APR	MAY	JUN	JUL	AUG	SEP*	OCT*
April 50%-Exceedance Outlook – 25% L3MTO Meteorology							
Keswick Dam KWK	53.4	52.7	52.4	52.9	52.9	See Figures 3 and 5	See Figures 3 and 5
Sac. R. abv Clear Creek CCR	53.9	53.4	53.0	53.5	53.3	See Figures 3 and 6	See Figures 3 and 6
Balls Ferry BSF	56.3	57.2	56.0	55.7	54.8	See Figures 3 and 7	See Figures 3 and 7
April 50%-Exceedance Outlook – 50% L3MTO Meteorology							
Keswick Dam KWK	53.1	52.8	52.4	52.9	53.0	See Figures 4 and 5	See Figures 4 and 5
Sac. R. abv Clear Creek CCR	53.0	53.4	52.9	53.5	53.3	See Figures 4 and 6	See Figures 4 and 6
Balls Ferry BSF	54.0	56.6	55.2	55.7	54.8	See Figures 4 and 7	See Figures 4 and 7

Model Run	End of September Cold Water Pool <56°F (TAF)	First Side Gate	Full Side Gates
90% Hydro, 25% Met	716	9/22	11/1
90% Hydro, 50% Met	903	10/3	11/28
50% Hydro, 25% Met	707	9/20	10/31
50% Hydro, 50% Met	944	10/5	11/27

Model Run Date April 24, 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 5-7). 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 Figures 1 through 4. 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 5-7.

Temperature Model Inputs, Assumptions, Limitations and Uncertainty:
1. The latest available profiles for Shasta, Trinity, and Whiskeytown were taken on April 23, 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 25% 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.

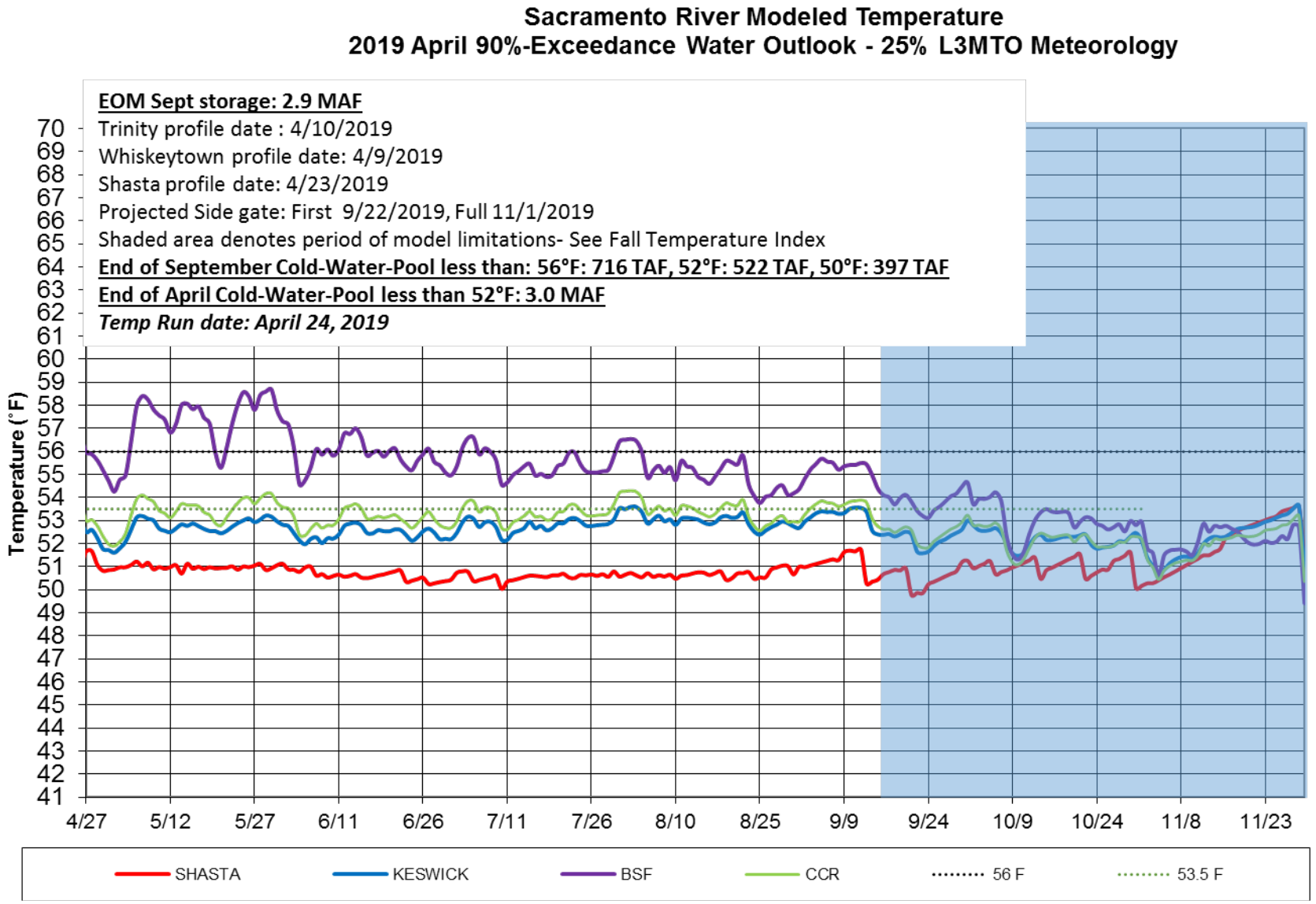

Figure 1. April 2019 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology.

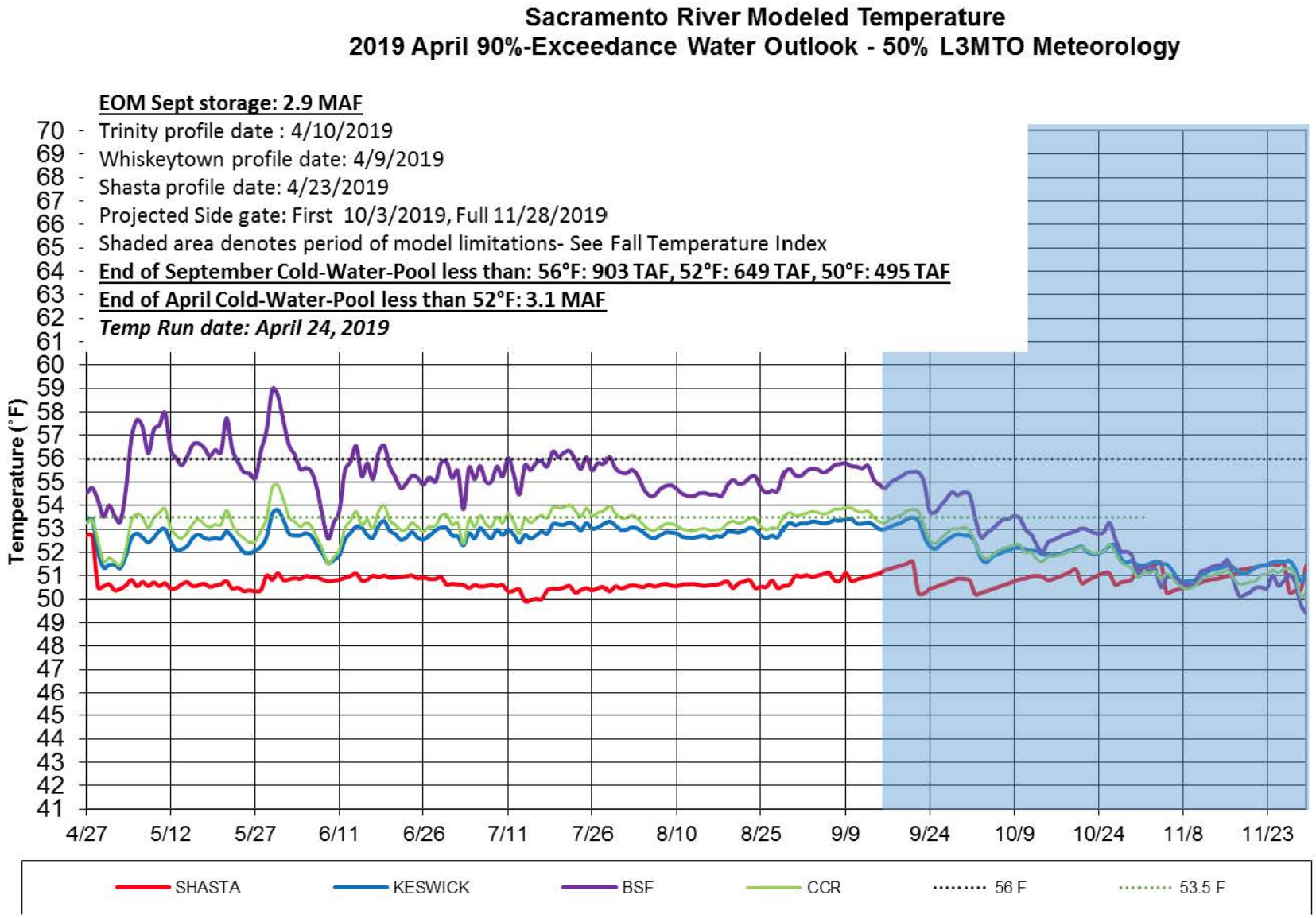

Figure 2. April 2019 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 50% L3MTO meteorology.

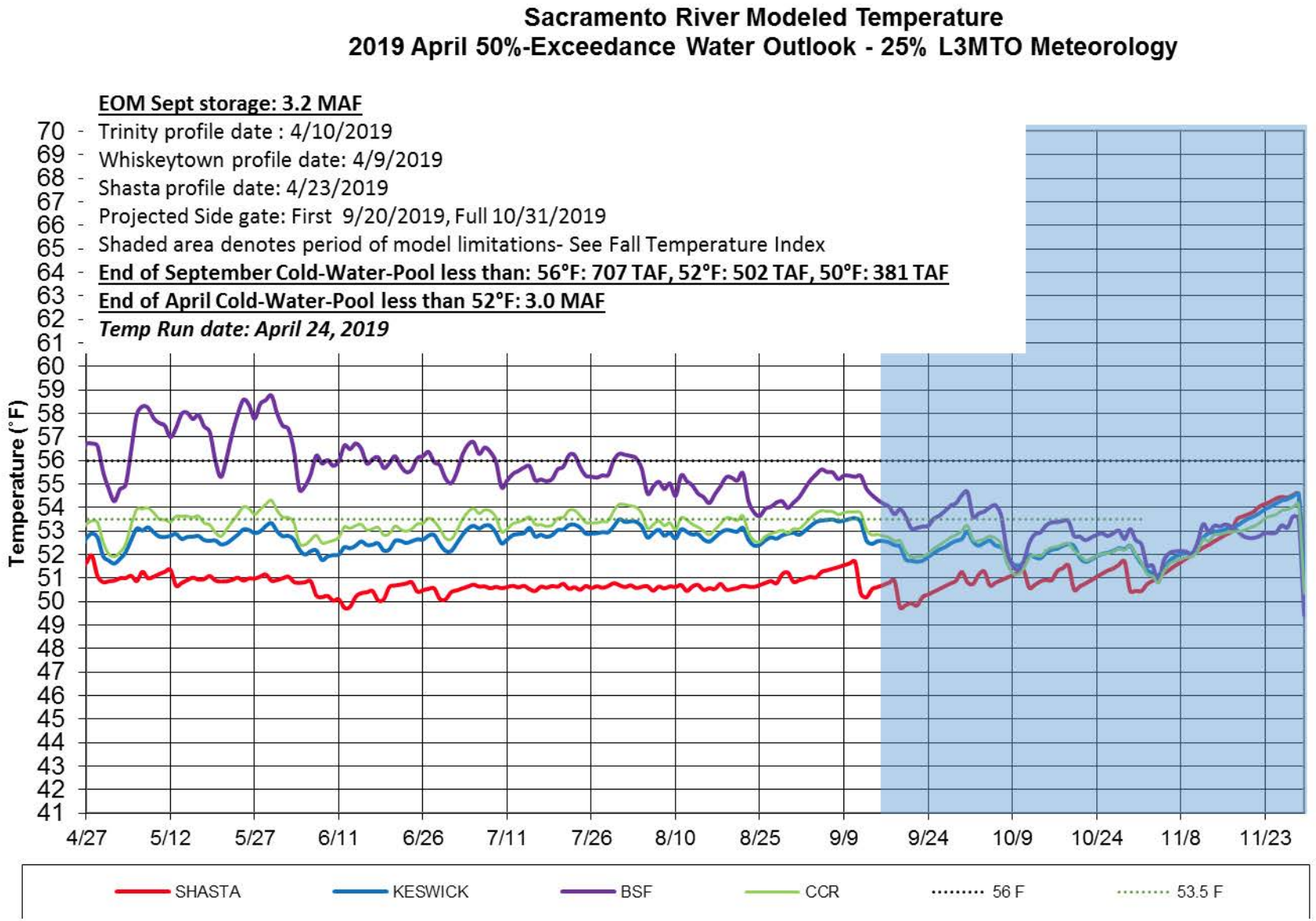

Figure 3. April 2019 simulated Sacramento River temperatures 50% runoff exceedance hydrology and 30% L3MTO meteorology.

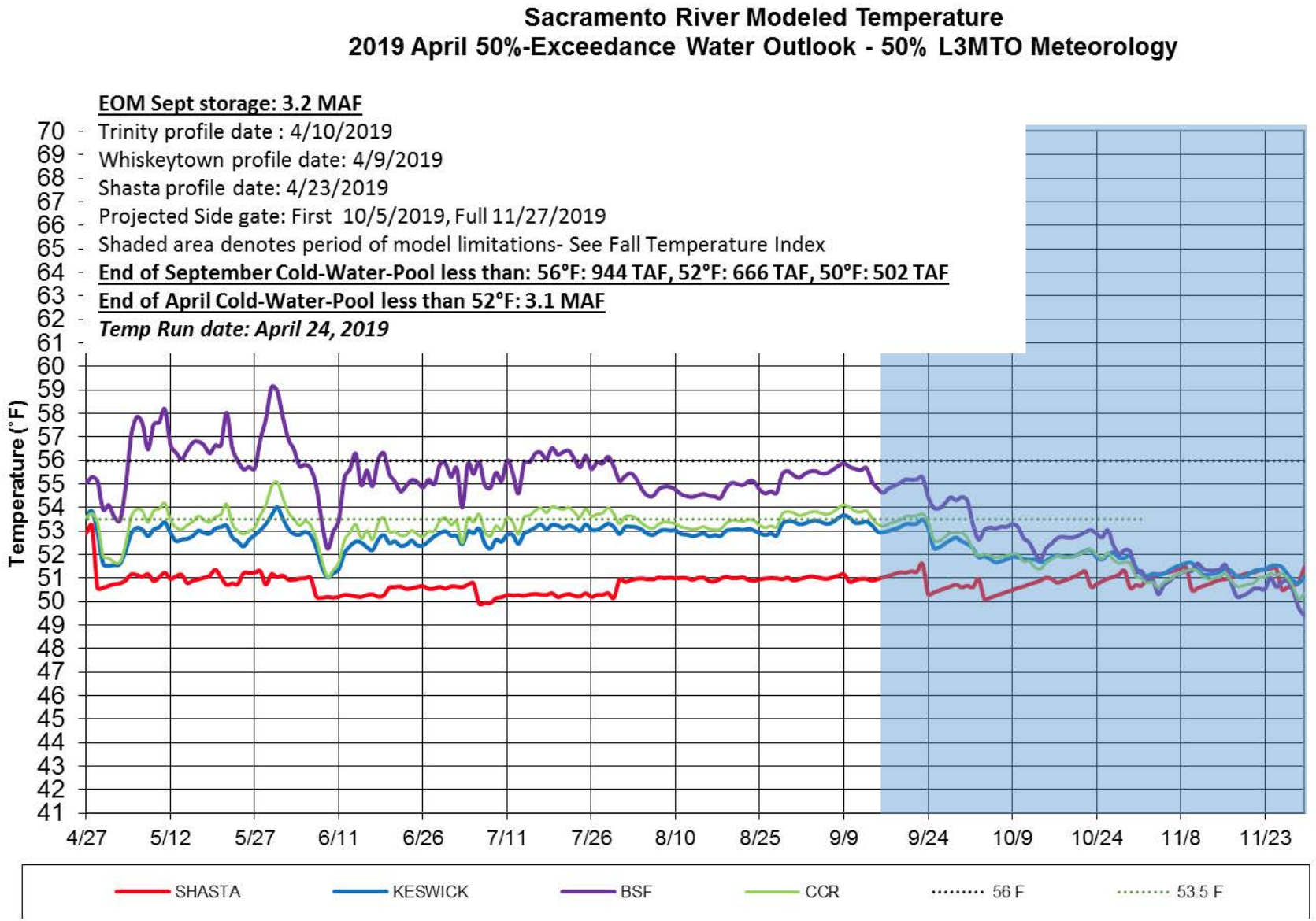

Figure 4. April 2019 simulated Sacramento River temperatures 50% runoff exceedance hydrology and 50% L3MTO meteorology

Figure 5-7 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.

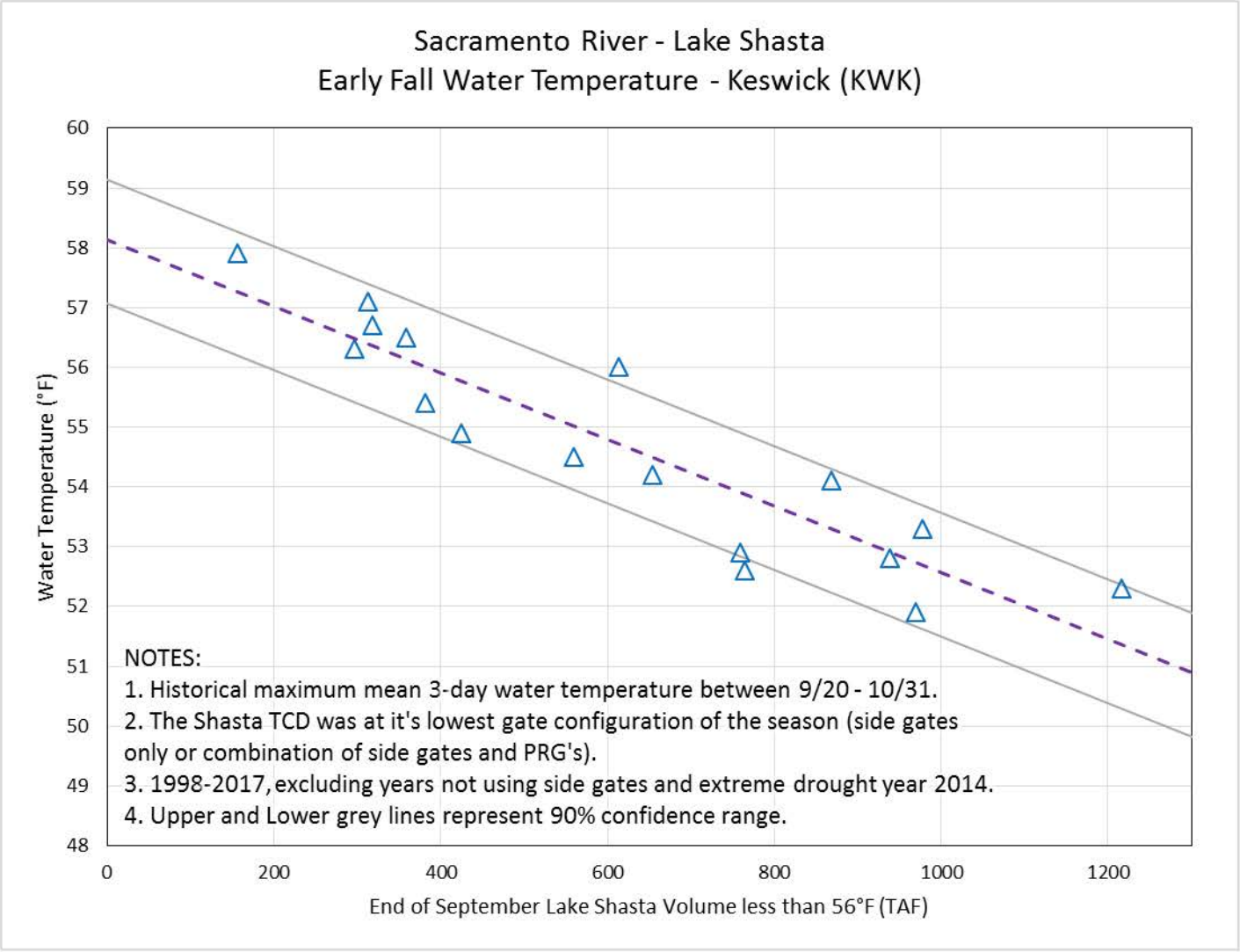

Figure 5. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Keswick water temperature.

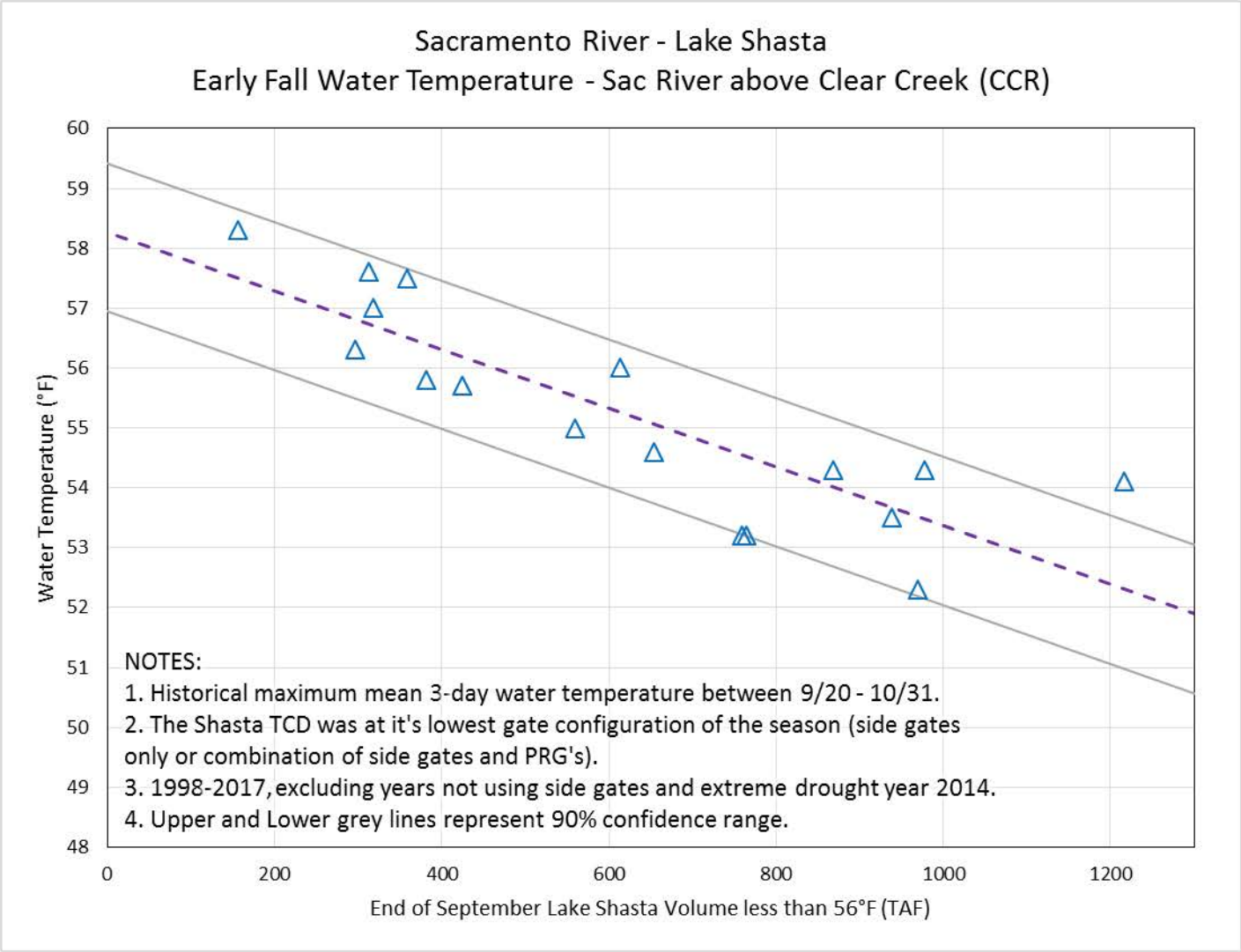

Figure 6. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Sacramento River above Clear Creek confluence water temperature.

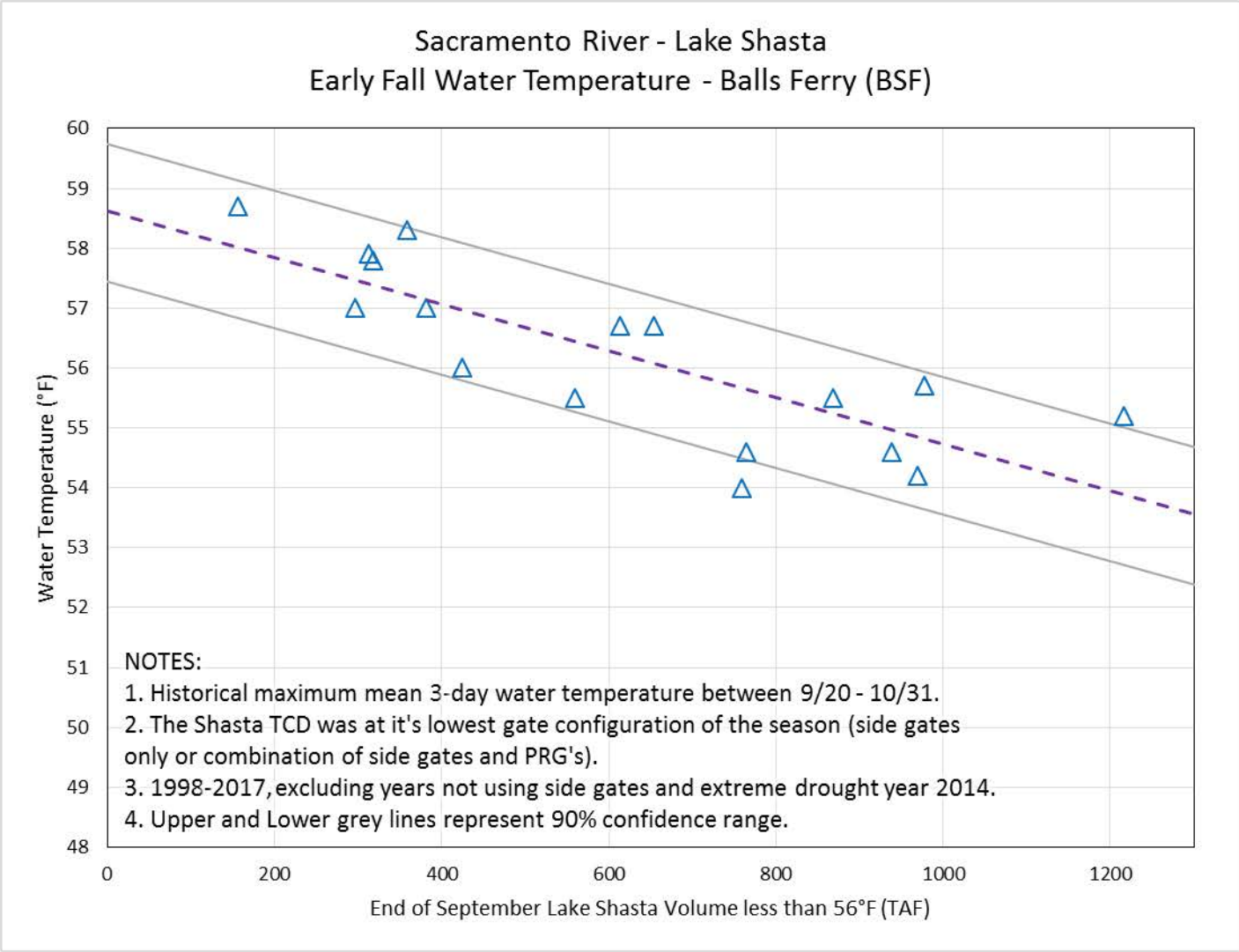

Figure 7. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Balls Ferry water temperature.

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