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SACRAMENTO MUNICIPAL UTILITY DISTRICT
UPPER AMERICAN RIVER PROJECT

HYDRO LICENSE IMPLEMENTATION

NEW SLAB CREEK POWERHOUSE HYDRO LICENSING ENVIRONMENTAL SUPPORT: WATER TEMPERATURE ASSESSMENT

PREPARED BY:

STILLWATER SCIENCES
DAVIS, CALIFORNIA

PREPARED FOR:

SACRAMENTO MUNICIPAL UTILITY DISTRICT
SACRAMENTO, CALIFORNIA

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1 INTRODUCTION

In October 2011, the Sacramento Municipal Utility District (SMUD) issued an Initial Consultation Document (ICD) for a new Slab Creek Powerhouse project on the South Fork American River (SFAR) in preparation for the filing of an Application for License Amendment for the Upper American River Project, FERC No. 2101 (UARP). Resource Agencies (USDA Forest Service, USDI National Park Service, USDI Bureau of Land Management, USDI Fish and Wildlife Service, California Department of Fish and Game, and California State Department of Parks and Recreation) along with the State Water Resources Control Board (SWRCB) filed response comments in February 2012.

Some of the Resource Agencies and SWRCB comments stated concerns about flows in the bypass reach immediately downstream of the Slab Creek Dam, and specifically, any effects on water temperatures within the bypass reach. An existing Stream Network Temperature Model (SNTEMP) developed for the SFAR downstream of Slab Creek Dam was used to provide input to a simpler Stream Segment Temperature Model (SSTEMP) to investigate the thermal conditions in the short bypass reach. The methods and results of the SSTEMP modeling are presented in this report.

2 METHODS

Water temperatures in the upper 0.25 miles of the SFAR immediately downstream of Slab Creek Dam were evaluated using SSTEMP Version 2.0 (Bartholow 2002). The SSTEMP model is a scaled-down version of the Stream Network Temperature Model (Theurer et. al. 1984) that is designed to provide output useful for evaluating alternative release proposals in simple segments of stream.

Input for the SSTEMP model was derived from the SMUD (2005) SNTEMP model developed for the Slab Creek Dam Reach, an 8-mile reach of the SFAR which extends from immediately downstream of the Slab Creek Dam to just upstream of White Rock Powerhouse. The SNTEMP model input files were examined and data associated with the five uppermost model nodes (comprising four network sub-reaches beginning at the Slab Creek Dam) were used for extracting model input for SSTEMP.

The SSTEMP modeling was designed to examine water temperatures based on specified releases of: 10, 20, 30, 36, and 50 cfs under varying meteorological conditions. Each of the release flows were evaluated using two base scenarios: 1) a “normal” weather condition defined by the median monthly air temperature from April–September 2002, and 2) a “hot” weather condition defined by the 10% exceedance monthly air temperature from the same April–September 2002 period of record. After the exceedance values were determined, the date associated with the exceedance air temperatures was used to obtain the corresponding meteorological data (i.e., relative humidity, wind speed, percent sunshine, and solar radiation). Thus, the two model scenarios were “normal air temperature” days for each month, and “hot air temperature” days for each month.

Release water temperatures were median monthly values derived from the SNTEMP hydrology data files for the April–September 2002 period of record. Stream geometry and shade parameters were also derived from the SNTEMP model. A summary of SSTEMP model input parameters is presented in Table 2-1.

Table 2-1. Summary of input variables for the SSTEMP model.

Variable Description	Setting/Value	Source
Date	Monthly – set to 15th	Arbitrary
Segment Inflow	10, 20, 30, 36, 50 cfs	Prescribed
Inflow Temperature	Median monthly value	SMUD (2005) SNTEMP
Segment Outflow	Set to inflow value	Prescribed
Latitude	38 degrees	SMUD (2005) SNTEMP
Upstream Elevation	1675 feet	SMUD (2005) SNTEMP
Downstream Elevation	1646 feet	SMUD (2005) SNTEMP
Width’s A term	51.185	SMUD (2005) SNTEMP
B Term where W=A*Q^B	0.068	SMUD (2005) SNTEMP
Manning’s n	0.999	SMUD (2005) SNTEMP
Shading variables	Fixed values	SMUD (2005) SNTEMP
Air Temperature	50% or 10% exceedance	SMUD (2005) SNTEMP
Other Meteorology	Based on date of exceedance value	SMUD (2005) SNTEMP

The SSTEMP model for the Slab Creek Dam bypass reach does not include validation nodes and is not considered to be a “calibrated” model used for reach-long operational management decisions (unlike SNTEMP); this is because the segment length is too short to gather the requisite calibration or validation data. Rather, the model provides an investigative means to examine the potential water temperature change (i.e., “sensitivity analysis”) under varying flow and meteorological scenarios over a short, defined reach segment.

3 RESULTS

Model results show water temperatures in the SFAR at 0.25 miles downstream of Slab Creek Dam are warmest during the month of July under most flow and meteorological conditions (Table 3-1). Water temperatures decrease with increasing discharge, and are warmest under the more extreme (10% exceedance) model scenario (Table 3-1).

Table 3-1. Downstream water temperatures predicted from SSTEMP under varying flow and model scenarios, depicting 50% (normal) and 10% (hot) exceedance meteorology for April-September.

Model Scenario	Release Temperature (°C)	Temperature (°C) at 0.25 miles downstream				
		10 cfs	20 cfs	30 cfs	36 cfs	50 cfs
April – normal	8.28	8.88	8.61	8.52	8.48	8.43
April – hot	8.28	9.29	8.83	8.67	8.61	8.53
May – normal	9.50	10.02	9.79	9.71	9.68	9.64
May – hot	9.50	10.52	10.06	9.89	9.84	9.76
June – normal	12.94	13.64	13.33	13.22	13.18	13.12
June – hot	12.94	14.08	13.57	13.38	13.32	13.23
July – normal	13.72	14.62	14.22	14.07	14.02	13.95
July – hot	13.72	15.28	14.58	14.32	14.23	14.11
August – normal	11.28	12.21	11.79	11.64	11.59	11.51
August – hot	11.28	12.46	11.93	11.74	11.67	11.57
September – normal	10.39	10.93	10.69	10.61	10.58	10.53
September – hot	10.39	11.16	10.82	10.69	10.65	10.58

Release water temperature is highest during July (Table 3-1 and Table 3-2). The maximum increase in downstream water temperature relative to release temperature also occurs during July, with the largest incremental change at the lowest discharge and the smallest change at the highest discharge (Table 3-2).

Table 3-2. Relative increase over release temperatures in downstream water temperatures from SSTEMP under varying flow and model scenarios depicting 50% (normal) and 10% (hot) exceedance meteorology for April-September.

Model Scenario	Release Temperature (°C)	Change in temperature (°C) at 0.25 miles				
		10 cfs	20 cfs	30 cfs	36 cfs	50 cfs
April – normal	8.28	0.60	0.33	0.24	0.21	0.16
April – hot	8.28	1.01	0.56	0.39	0.33	0.25
May – normal	9.50	0.52	0.29	0.21	0.18	0.14
May – hot	9.50	1.02	0.56	0.39	0.34	0.26
June – normal	12.94	0.69	0.39	0.27	0.23	0.18
June – hot	12.94	1.13	0.63	0.44	0.38	0.28
July – normal	13.72	0.89	0.49	0.35	0.30	0.23
July – hot	13.72	1.56	0.86	0.60	0.51	0.38
August – normal	11.28	0.93	0.51	0.36	0.31	0.23
August – hot	11.28	1.18	0.65	0.46	0.39	0.29
September – normal	10.39	0.54	0.31	0.22	0.19	0.14
September – hot	10.39	0.77	0.43	0.30	0.26	0.19

The SSTEMP model results for July and August under both the normal (50% exceedance) and hot (10% exceedance) scenarios are shown in Figures 3-1 through 3-4.

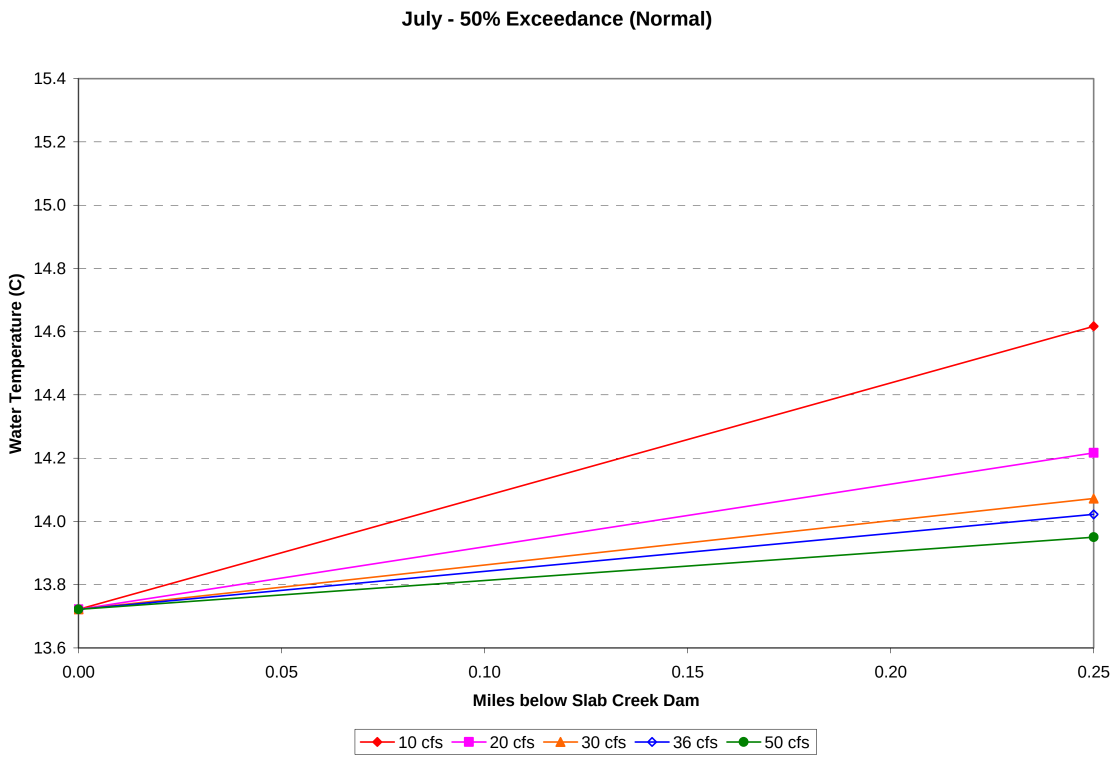

Figure 3-1. SSTEMP results on the South Fork American River downstream of Slab Creek Dam using the July–normal scenario.

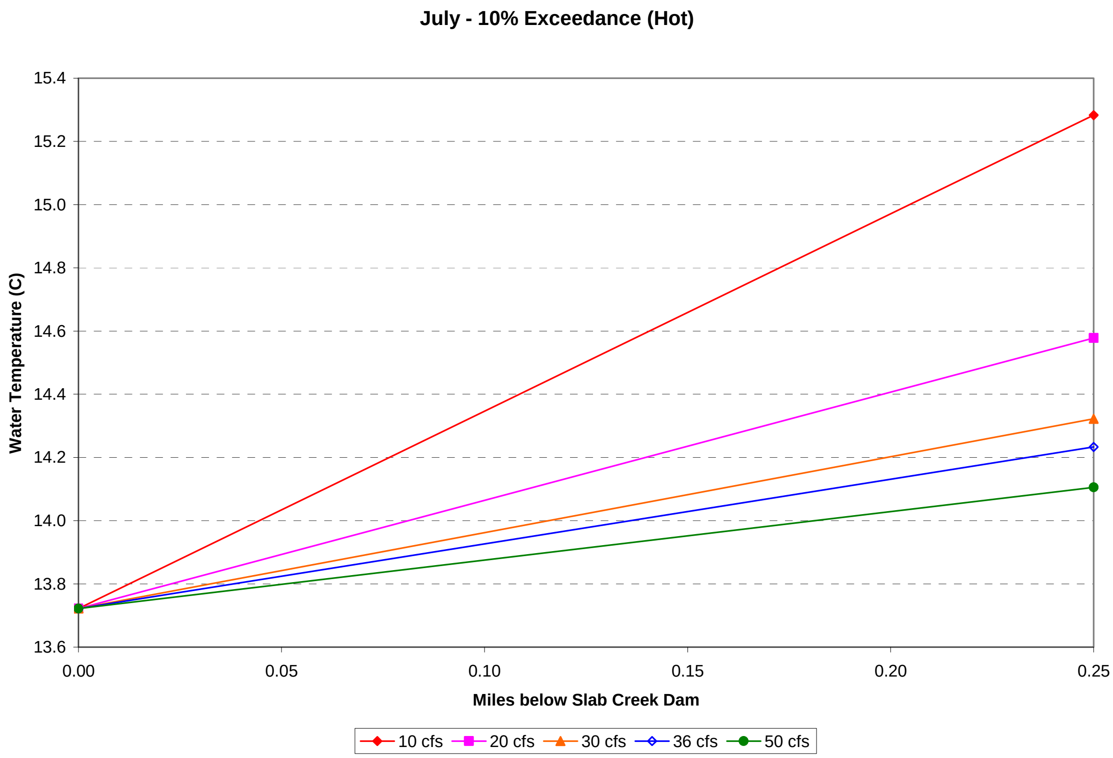

Figure 3-2. SSTEMP results on the South Fork American River downstream of Slab Creek Dam using the July–hot scenario.

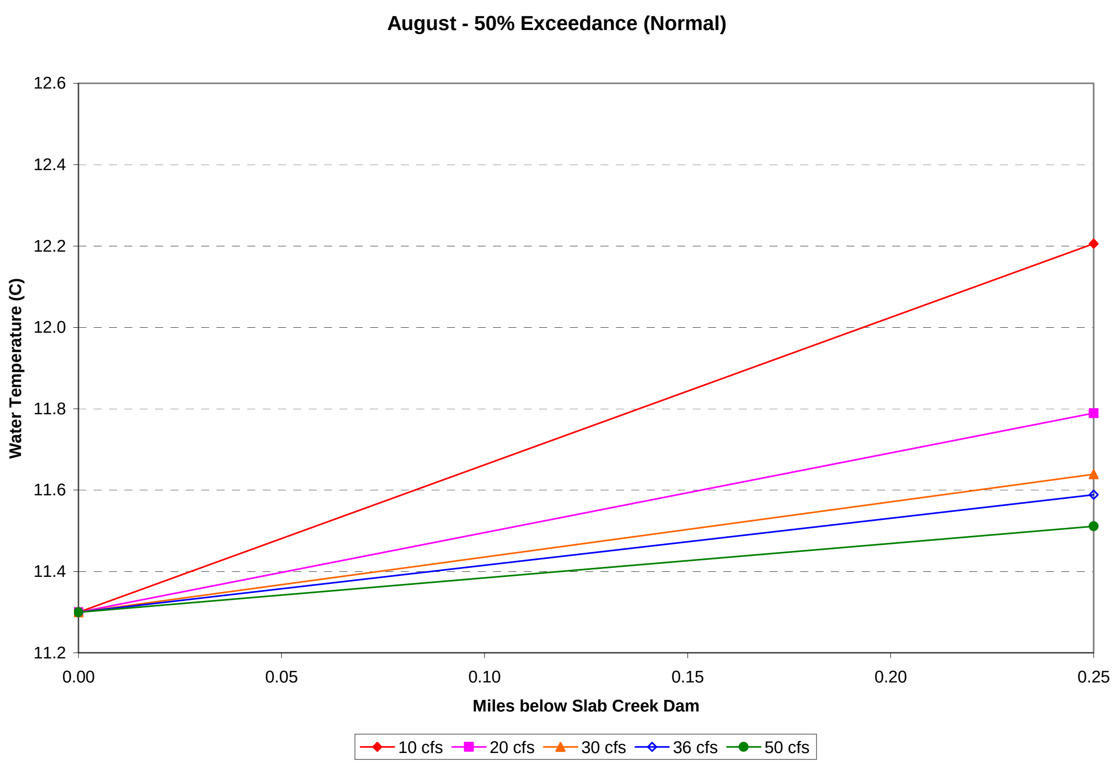

Figure 3-3. SSTEMP results on the South Fork American River downstream of Slab Creek Dam using the August–normal scenario.

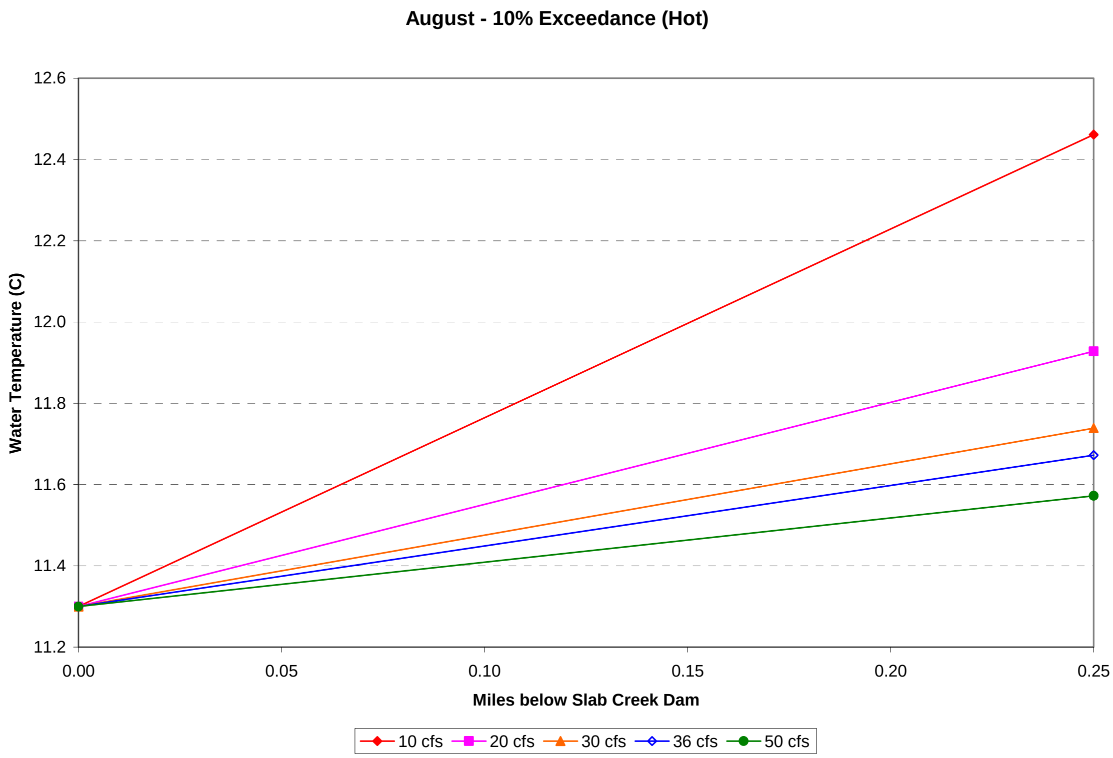

Figure 3-4. SSTEMP results on the South Fork American River downstream of Slab Creek Dam using the August–hot scenario.

4 DISCUSSION

The SSTEMP model as applied to the upper 0.25 mile reach of the SFAR below the Slab Creek Dam was used as a means to investigate relative increases in water temperature under varying flow and meteorological conditions. The maximum increase in downstream water temperatures relative to release temperatures was 1.56 °C, and occurs with the lowest modeled flow release of 10 cfs, in the hottest month (July), under “hot” climate conditions. For comparison, the corresponding increase with a release of 36 cfs under these same conditions was 0.51 °C. Even under this “worst case” scenario, stream temperatures are below 15.4 °C, which would generally be considered in the optimal range for resident salmonids.

This SSTEMP model is considered representative of thermal conditions within the study segment. However, since the model is not calibrated, it should be considered a “sensitivity analysis” of the range of water temperature changes likely to be observed under different flow and meteorological scenarios, rather than a precise temperature prediction under specific operational and weather conditions.

5 LITERATURE CITED

Bartholow, J.M. 2002. SSTEMP for Windows: The Stream Segment Temperature Model (Version 2.0). U.S. Geological Survey computer model and documentation. Available on the Internet at http://www.fort.usgs.gov.

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