TECHNICAL MEMORANDUM 2-2

Water Temperature Monitoring
2008 Progress Report

Yuba-Bear Hydroelectric Project
FERC Project No. 2266-096

Drum-Spaulding Project
FERC Project No. 2310-173

March 2009

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Water Temperature Monitoring Executive Summary

This technical memorandum presents results of Licensees water temperature monitoring (Study 2.2.2) in 2008 on Nevada Irrigation District's (NID) Yuba-Bear Hydroelectric Project and Pacific Gas and Electric Company's (PG&E) Drum-Spaulding Project. Water temperature monitoring will continue in 2009.

During 2008, 81 water temperature monitoring sites, including 70 stream temperature sites, 7 conduit sites, and 4 reservoir sites, were established in 11 river sub-basins. In 28 of the stream reach sites, duplicate temperature loggers were installed to guard against vandalism in higher use areas. In addition, 13 Leveloggers were installed to record continuous stage data at designated monitoring locations. At 14 of the stream temperature locations, field discharge measurements were taken. Data collected went through a QA/QC process to identify data gaps caused by vandalism or recorder malfunction. Data were organized into plots that included: 1) mean daily water temperature; 2) minimum daily water temperature; 3) maximum daily water temperature; 4) mean daily air temperature; and 5) mean daily flow, if available. Average air temperatures were provided from local California Data Exchange Center (CDEC) meteorological stations (CDEC 2008). Streamflows were provided from either permanent gages or estimated using the spot discharge and stage data.

Reservoir water temperature profiles and dissolved oxygen were recorded at seven project reservoirs: Sawmill Lake, Bowman Lake, Meadow Lake, Fordyce Lake, Lake Spaulding, Rollins Reservoir, and Lake Valley Reservoir. Water temperature (±0.2 degrees Celsius, or °C) and dissolved oxygen (±0.2 milligrams per liter, or mg/l) were recorded using a Hydrolab multi-parameter water quality monitoring system. Data were recorded in the deepest part of the reservoir at approximately 10 foot intervals, except near the thermocline where smaller intervals were used. Water temperature profiles were plotted with elevation in order to show the presence of thermoclines as well as water temperatures in proximity to each reservoirs low level outlet.

There were a small number of variances from the Study Plan (e.g., missing data) in 2008 due to adverse weather conditions, unsafe sampling conditions, and equipment malfunction.

The Study is on schedule.

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List of Attachments

Attachment 2-2A	2008 Stream Temperature Location Map (.pdf)
Attachment 2-2B	2008 Stream Temperature Plots (.pdf)
	[Attachment 2-2B is 80 pages long and is formatted to print on 8 ½ x 11 paper.]
Attachment 2-2C	2008 Stream Temperature DSS Data (.pdf, .dss)
Attachment 2-2D	2008 Stream Temperature Raw Data (.xls)

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Water Temperature Monitoring[1]

1.0 Goals and Objectives

The goal of this study was to characterize water temperatures within project reservoirs and project-affected stream reaches.

2.0 Methods

The study was conducted in four general steps: 1) install stream temperature and stage recorders; 2) monitor stream temperature and stage recorders; 3) collect reservoir temperature profiles; and 4) perform quality assurance and quality control (QA/QC) of data. Each of these steps is described below.

Install Stream Water Temperature and Stage Recorders

In the spring of 2008, 81 water temperature monitoring sites, including 77 stream temperature sites and 4 reservoir sites, were established. Table 1 provides a list of monitoring locations and their respective station identification codes (*e.g.*, WT2), approximate elevation, UTM coordinates, installation date and removal date. A map showing the locations of the stream temperature monitoring stations is provided in Attachment 2-2A.

At each monitoring location, a HOBO Water Temp Pro V2 logger manufactured by Onset Corporation, was installed in a durable protective housing (Figure 2) that permitted the active flow of water in and around the unit. Each recorder was placed in the active channel and secured by a steel cable or chain tethered to a stable root mass, tree trunk or man-made structure such that the recorder was secured in the channel during high flow periods. The recorder was installed in the channel thalweg and the housing and cable disguised as much as possible while ensuring the ability to retrieve the unit for future downloads. In addition, a location of suitable channel gradient and shading was selected at each site such that the logger was not subjected to excessive pool warming or solar radiation. Each recorder was set to record water temperature at 15 minute intervals. In 28 of the stream reach sites, duplicate temperature loggers were installed to guard against vandalism in higher use areas.

[1] This technical memorandum presents the 2008 results for Study 2.2.2 Water Temperature Modeling, as submitted to FERC in Licensees' Revised Study Plan. This study applies to NID's Yuba-Bear Hydroelectric Project and PG&E's Drum-Spaulding Project. The study does not apply to PG&E's Rollins Transmission Line Project because that project does not include any reservoirs, impoundments or stream diversions.

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Table 1. Continuous stream and reservoir water temperature monitoring location information.

Reach/Location (Responsible Licensee(s))	Location	Map/Station ID	River Mile	Approximate Elevation (nearest 10 feet)	UTM Coordinates		Installation Date	Removal Date
					Easting	Northing		
MIDDLE YUBA RIVER SUB-BASIN								
Wilson Creek Diversion Reach (NID)	Wilson Creek above Wilson Creek Diversion Dam	WT10	0.3	5,740	707309	4377027	6/3/08	10/10/08
Milton Diversion Dam Reach (NID)	MYR below Milton Diversion Dam	WT8	44.4	5,640	706904	4377488	6/3/08	10/10/08
Milton Diversion Dam Reach (NID)	MYR above East Fork Creek	WT7	34.6	4,100	698955	4375845	7/1/08	10/7/08
East Fork Creek (NID)	East Fork Creek above MYR	WT6	34.6	5,260	700463	4373149	7/1/08	10/15/08
Milton Diversion Dam Reach (NID)	MYR above Wolf Creek	WT5	26.9	2,980	688857	4367781	6/3/08	10/21/0/8
Wolf Creek (NID)	Wolf Creek above MYR	WT4	26.9	2,980	688840	4367829	6/3/08	10/21/0/8
Milton Diversion Dam Reach (NID)	MYR above Kanaka Creek	WT3	17.5	2,200	677071	4365376	5/13/08	10/21/0/8
Kanaka Creek (NID)	Kanaka Creek above MYR	WT2	17.5	2,200	677004	4365400	5/13/08	10/21/0/8
Milton Diversion Dam Reach (NID)	MYR above Our House Diversion Impoundment	WT1	12.8	2,020	672684	4364578	5/13/08	10/21/0/8
DEER CREEK SUB-BASIN								
Deer Creek Powerhouse Reach (PG&E)	South Fork Deer Creek above Deer Creek PH	WT55	3.0	3,600	677761	4339377	5/14/08	10/15/08
Deer Creek Powerhouse Reach (PG&E)	South Fork Deer Creek below Deer Creek PH	WT54	3.0	3,600	685889	4352084	5/14/08	10/15/08
CANYON CREEK SUB-BASIN								
French Lake Dam Reach (NID)	Canyon Creek above Faucherie Reservoir	WT42	17.1	6,230	709812	4366892	6/3/08	10/10/08[1]
Faucherie Lake Dam Reach (NID)	Canyon Creek above Sawmill Lake	WT43	14.8	5,900	707380	4368403	6/3/08	10/10/08
Sawmill Lake Dam Reach (NID)	Canyon Creek above Bowman Lake	WT44	13.3	5,570	705564	4369888	6/3/08	10/10/08[1]
Jackson Lake Dam Reach (NID)	Jackson Creek below Prairie Creek and Bowman Reservoir	WT45	0.3	5,580	705842	4370148	6/3/08	10/10/08
Milton-Bowman Tunnel (NID)	Milton-Bowman Tunnel at outfall to Bowman Lake	WT46	--	5,620	705526	4370594	6/3/08	10/10/08
Bowman-Spaulding Diversion Dam Reach (NID)	Canyon Creek below Bowman-Spaulding Diversion Dam	WT47	9.7	5,290	701252	4368132	6/3/08	10/8/08[1]
Bowman-Spaulding Conduit (NID)	Bowman-Spaulding Conduit below BSC Diversion Dam	WT48	--	5,430	701446	4368154	6/3/08	10/8/08
Lower Rock Lake Dam Reach #1 (PG&E)	Texas Creek below Culbertson Lake	WT49	4.3	6,400	704293	4366349	6/4/08	10/8/08
Lower Lindsey Lake Dam Reach (PG&E)	Lindsey Creek above Texas Creek confluence	WT50	0.1	5,840	701164	4365100	6/4/08	10/8/08
Lower Rock Lake Dam Reach #1 (PG&E)	Texas Creek above Lindsey Creek confluence	WT51	1.2	5,840	701029	4365183	6/4/08	10/8/08

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Table 1. (continued)

Reach/Location (Responsible Licensee(s))	Location	Map/Station ID	River Mile	Approximate Elevation (nearest 10 feet)	UTM Coordinates		Installation Date	Removal Date
					Easting	Northing		
CANYON CREEK SUB-BASIN (continued)								
Bowman-Spaulding Diversion Dam Reach (NID)	Canyon Creek above Texas Creek confluence	WT52	6.2	4,660	699294	4364373	7/1/08	10/7/08
Little Canyon Creek (NID and PG&E)	Little Canyon Creek above Canyon Creek	WT53	1.2	3,100	694756	4360397	7/13/08	10/15/08
FALL CREEK SUB-BASIN								
above Clear Creek Diversion Dam Reach (NID)	Clear Creek above B-S Canal	WT31	0.9	5,400	699749	4361808	6/4/08	9/17/08
above Trap Creek Diversion Dam Reach (NID)	Trap Creek above B-S Canal	WT28	0.1	5,360	699890	4360018	6/4/08	9/17/08
Fall Creek Diversion Dam Reach (NID and PG&E)	Fall Creek above SYR confluence	WT29	0.2	3,200	698390	4358592	5/14/08	10/7/08
Carr Lake Dam Reach #2 (PG&E)	Fall Creek above Fall Creek Diversion Dam	WT30	2.1	5,370	700142	4360845	6/4/08	10/8/08
RUCKER CREEK SUB-BASIN								
Blue Lake Dam Reach (PG&E)	Rucker Creek above Rucker Lake	WT35	2.3	5,900	703585	4359263	6/4/08	10/8/08
Rucker Lake Dam Reach (PG&E)	Rucker Creek above B-S Canal	WT34	1.4	5,350	701219	4358851	6/4/08	10/8/08
Bowman-Spaulding Conduit (NID and PG&E)	B-S Canal at Rucker Creek	WT33	1.2	5,350	701215	4358975	6/4/08	10/8/08
Rucker Creek Diversion Dam Reach (NID and PG&E)	Rucker Creek above SYR	WT32	0.1	3,600	700003	4357584	5/14/08	10/7/08
FORDYCE CREEK SUB-BASIN								
Meadow Lake Dam Reach (PG&E)	Meadow Lake Dam Reach above Fordyce Lake	WT41	0.1	6,410	716649	4363474	6/23/08	10/9/08
White Rock Lake Dam Reach #1 (PG&E)	White Rock Creek below White Rock Dam	WT40	2.0	7,600	724046	4365752	6/23/08	10/10/08[1]
White Rock Lake Dam Reach #2 (PG&E)	North Creek above Fordyce Lake	WT39	0.1	6,410	719053	4363603	6/23/08	10/9/08
Lake Sterling Dam Reach (PG&E)	Bloody Creek above Fordyce Lake	WT38	0.1	6,410	715548	4359620	6/23/08	10/9/08
Fordyce Lake Dam Reach (PG&E)	Fordyce Creek below Fordyce Dam	WT37	--	6,250	715371	4361888	6/23/08	10/9/08[1]
Fordyce Lake Dam Reach (PG&E)	Fordyce Creek above Lake Spaulding	WT36	0.3	5,040	705339	4358726	6/11/08	10/8/08[1]
SOUTH YUBA RIVER SUB-BASIN								
South Yuba Below Spaulding Dam Reach (PG&E)	SYR below Spaulding Main Dam	WT26	40.8	4,680	701085	4372731	7/3/08	10/21/08[1]
South Yuba below Spaulding No. 2 Powerhouse Reach (PG&E)	SYR above Jordan Creek	WT25	40.3	4,480	702179	4355046	6/4/08	10/8/08[1]

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Table 1. (continued)

Reach/Location (Responsible Licensee(s))	Location	Map/Station ID	River Mile	Approximate Elevation (nearest 10 feet)	UTM Coordinates		Installation Date	Removal Date
					Easting	Northing		
SOUTH YUBA RIVER SUB-BASIN (continued)								
Bowman-Spaulding Conduit (NID and PG&E)	B-S Canal below Fuller Lake	WT27	--	5,350	702840	4357520	6/4/08	10/8/08
Jordan Creek Diversion Reach (PG&E and NID)	Jordan Creek above SYR	WT24	0.2	4,480	702280	4355320	6/4/08	10/8/08[1]
South Yuba Reach #3 (PG&E and NID)	SYR above Canyon Creek	WT22	32.5	2,840	693956	4359014	5/14/08	10/15/08[1]
Canyon Creek below Texas Creek Confluence Reach (NID and PG&E)	Canyon Creek above SYR	WT21	0.1	2,840	693808	4359372	5/14/08	10/15/08[1]
Diamond Creek (PG&E and NID)	Diamond Creek above SYR	WT23	33.2	2,990	695270	4358454	6/3/08	10/7/08
Spring Creek (PG&E and NID)	Spring Creek above SYR	WT16	14.9	1,940	673365	4355611	5/13/08	10/17/08
Rock Creek (PG&E and NID)	Rock Creek above SYR	WT15	10.1	1,580	668195	4353202	5/15/08	10/30/08
South Yuba Reach #4 (PG&E and NID)	SYR above Poorman Creek	WT20	28.1	2,500	688516	4358331	5/14/08	10/15/08
Poorman Creek (PG&E and NID)	Poorman Creek above SYR	WT19	28.1	2,500	688539	4358372	5/14/08	10/15/08
South Yuba Reach #5 (PG&E and NID)	SYR above Humbug Creek	WT18	19.6	2,150	678382	4356343	5/13/08	10/7/08[1]
Humbug Creek (PG&E and NID)	Humbug Creek above SYR	WT17	19.5	2,150	678236	4356406	5/13/08	10/7/08
South Yuba Reach #6 (PG&E and NID)	SYR above Rush Creek	WT14	6.2	1,070	663480	4350925	5/15/08	10/17/08
Rush Creek (PG&E and NID)	Rush Creek above SYR	WT13	6.2	1,070	663470	4350862	5/15/08	10/17/08
Shady Creek (PG&E and NID)	Shady Creek above SYR	WT12	5.0	1,000	661817	4351261	5/18/08	10/7/08
South Yuba Reach #6 (PG&E and NID)	SYR above Englebright Reservoir	WT11	0.1	550	655873	4350818	5/15/08	10/17/08
BEAR RIVER SUB-BASIN								
above Bear River Reach #1 (PG&E)	Bear River near Bowman Lake Road crossing (above Drum Canal waste gate)	WT56	35.1	4,640	701372	4353792	6/4/08	10/8/08[1]
Bear River Reach #2 (PG&E)	Bear River at Hwy 20 crossing (YB-198)	WT57	34.0	4,550	700145	4353373	6/4/08	10/8/08
Bear River Reach #2 (PG&E)	Bear River above Drum Afterbay	WT58	27.4	3,360	692708	4347838	5/13/08	10/7/08[1]
Drum Afterbay Reach (PG&E and NID)	Bear River below Drum Afterbay	WT59	25.1	3,320	691895	4347189	5/13/08	10/7/08
Drum Afterbay Reach (PG&E and NID)	Bear River above Dutch Flat Afterbay	WT60	23.8	2,730	687324	4344075	7/3/08	10/24/08
Dutch Flat Afterbay Dam Reach (NID)	Little Bear River below PCWA's Lower Boardman Canal (YB-98)	WT61	1.8	3,590	689470	4343006	5/13/08	10/7/08
Dutch Flat Afterbay Dam Reach (NID)	Bear River above Chicago Park PH	WT62	16.1	2,220	682350	4338602	5/14/08	10/7/08

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Table 1. (continued)

Reach/Location (Responsible Licensee(s))	Location	Map/Station ID	River Mile	Approximate Elevation (nearest 10 feet)	UTM Coordinates		Installation Date	Removal Date
					Easting	Northing		
BEAR RIVER SUB-BASIN (continued)								
Steephollow Creek Reach (NID)	Steephollow Creek above Bear River	WT63	15.5	2,220	676415	4333356	5/14/08	10/7/08[1]
Chicago Park Powerhouse Reach (NID)	Bear River above Steephollow Creek	WT64	15.7	2,220	681991	4338426	5/14/08	10/7/08
Greenhorn Creek Reach (NID)	Greenhorn Creek above Rollins Reservoir	WT65	--	2,220	677767	4339426	5/14/08	10/7/08
Chicago Park Powerhouse Reach (NID)	Bear River above Rollins Reservoir	WT66	15.3	2,220	681582	4338334	5/14/08	10/7/08[1]
Bear River Canal Diversion Dam Reach (PG&E and NID)	Bear River below BRC Diversion Dam (YB-196)	WT67	10.0	1,950	676409	4333348	4/22/08	10/7/08[1]
Bear River Canal Diversion Dam Reach (PG&E and NID)	Bear River near Milk Ranch Road	WT68	5.5	1,820	673625	4327323	5/15/08	10/6/08
Bear River Canal Diversion Dam Reach (PG&E and NID)	Bear River above Lake Combie	WT69	0.5	1,610	670939	4322924	6/9/08	10/6/08[1]
Bear River Canal (PG&E and NID)	Bear River Canal at YB-58 (Placer Hills Road)	WT70	--	1,860	671105	4316707	5/15/08	10/6/08
NORTH FORK AMERICAN RIVER SUB-BASIN								
Lake Valley Reservoir Dam Reach (PG&E)	NFNFAR above Lake Valley Canal Diversion	WT71	14.5	5,440	704342	4352736	5/13/08	10/7/08[1]
Lake Valley Reservoir Diversion Dam Reach (PG&E)	NFNFAR above Fulda Creek and East Branch American River confluence	WT72	7.1	4,740	701838	4349214	6/11/08	10/25/08
Canyon Creek above Towle Canal Diversion Dam Reach (PG&E)	Canyon Creek above Towle Diversion Inflow (YB-280)	WT73	9.3	4,650	695603	4347830	5/13/08	10/7/08
COON CREEK SUB-BASIN								
Dry Creek (PG&E)	Dry Creek above Halsey Afterbay	WT74	--	1,520	670067	4313740	5/15/08	10/6/08
Wise Canal (PG&E)	Wise Canal below Halsey Afterbay (YB-61)	WT75	--	1,520	669517	4313663	5/15/08	10/6/08
AUBURN RAVINE SUB-BASIN								
Auburn Ravine (PG&E)	Auburn Ravine above Wise PH	WT76	27.6	940	664985	4306297	5/15/08	10/6/08[1]
Wise Powerhouse Overflow Reach (PG&E)	South Canal below Wise PH	WT77	--	890	664638	4306224	5/23/08	10/6/08[1]
RESERVOIR WATER TEMPERATURE GAGES								
	Dutch Flat Afterbay (Dam)	WT80	21.3	2,730	686410	4342793	5/13/08	10/7/08
	Chicago Park Forebay (Dam)	WT81	--	2,750	683401	4340317	5/14/08	10/7/08
	Rock Creek Reservoir (Dam)	WT82	2.1	1,440	665521	4312430	5/15/08	10/6/08
	Wise Forebay (Dam)	WT83	--	1,400	666021	4308767	5/15/08	10/6/08

[1] Water temperature logger was left in the water at the end of 2008 to collect winter temperature data.

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Figure 1. Photograph of water temperature recorder housing.

In addition, 13 Solinst® Model 3001 Leveloggers were installed to record continuous stage data at designated monitoring locations as specified in the Water Temperature Monitoring study plan. Their primary function is to measure absolute pressure, which is a combination of water pressure and atmospheric pressure. Four Solinst® Barologgers were installed: 1) one in the Middle Yuba River upstream of YCWA's Our House Diversion Dam; 2) one in the Middle Yuba River near Wolf Creek; 3) one in South Yuba River near Rush Creek; and 4) one in the South Yuba River near the confluence of Canyon Creek. The atmospheric pressure values from the Solinst® Barologgers are used to calculate the true net water levels of the submerged water level loggers. Table 2 lists the locations of each logger, along with the corresponding water temperature monitoring ID.

Table 2. Location of stage recorder installations.

Location	Station ID
Middle Yuba River above our House Dam	WT1
Kanaka Creek above Middle Yuba River	WT2
Middle Yuba River above Kanaka Creek	WT3
Wolf Creek above Middle Yuba River	WT4
Middle Yuba River above Wolf Creek	WT5
East Fork Creek above Middle Yuba River	WT6
South Yuba River above Rush Creek	WT14
Humbug Creek above South Yuba River	WT17
South Yuba River above Humbug Creek	WT18
Poorman Creek above South Yuba River	WT19
South Yuba River above Poorman Creek	WT20
Canyon Creek above South Yuba River	WT21
South Yuba River above Canyon Creek	WT22

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During each download period, care was taken to record the exact time of level logger removal and replacement within the stream channel. In addition, the logger location was marked or photographed to ensure that the device was replaced as close to its original position as was possible.

Monitor Water Temperature Recorders

During each visit, data were downloaded to an optic shuttle or directly to a personal computer. Also, prior to each download of data, a National Institute of Standards and Technology (NIST) traceable digital thermometer was used to determine the instantaneous water temperature at the recorder. The water temperature reading from the NIST-traceable thermometer was compared to the last logger reading to check for accuracy drift of the recorder. In addition, operation/calibration, battery life, and general housing condition of the temperature loggers were checked. In instances where a logger was found out of the water due to reduced flow or vandalism, the unit was redeployed in a new area to guard against further problems with data collection.

Discharge at select study tributaries were measured based on the USGS velocity-area method described by Wahl, Thomas, and Hirsch (1995). Field personnel were able to wade each tributary and measure velocities and depth with calibrated digital Swoffer® brand flow meters mounted on a standard USGS top-set wading rod. To ensure accurate discharge measurements, the number of verticals at each transect was adjusted in the field to limit the discharge in any one cell to no more than 10% of the total discharge. Temporary staff gage levels were recorded at the beginning and end of each discharge measurement to note potential changes in stage. In some instances, discharges were not taken due to equipment malfunctions or access issues (examples during the 2008 field season included forest fires and road closures). Table 3 shows the locations and months where discharge measurements were taken.

Table 3. Locations where discharge measurements were taken during 2008 monitoring.

Location	Station/Map ID	Discharge Date(s)
Middle Yuba River above Our House Dam	WT1	8/14/08, 9/16/08, 10/21/08
Kanaka Creek above Middle Yuba River	WT2	9/16/08, 10/21/08
Wolf Creek above Middle Yuba River	WT4	8/14/08, 9/16/08, 10/21/08
East Fork Creek above Middle Yuba River	WT6	8/15/08
Rush Creek above South Yuba River	WT13	5/13/08
Rock Creek above South Yuba River	WT15	5/15/08, 6/17/08, 8/21/08
Spring Creek above South Yuba River	WT16	5/13/08, 6/18/08, 7/7/08, 8/12/08, 9/17/08, 10/17/08
Humbug Creek above South Yuba River	WT17	8/21/08
Poorman Creek above South Yuba River	WT19	9/17/08
Canyon Creek above South Yuba River	WT21	7/8/08, 8/13/08, 9/16/08
Jordan Creek above South Yuba River	WT24	10/8/08
South Yuba River above Jordan Creek	WT25	10/8/08
Fall Creek above South Yuba River	WT29	5/13/08, 8/13/08, 9/17/08
Rucker Creek above South Yuba River	WT32	6/3/08

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Collect Reservoir Temperature and Dissolved Oxygen Profiles

Water temperature and dissolved oxygen profiles were taken at seven project reservoirs. Water temperature (±0.2 degrees Celsius, or °C) and dissolved oxygen (±0.2 milligrams per liter, or mg/l) were recorded using a Hydrolab multi-parameter water quality monitoring system. Data were recorded in 10 foot intervals starting from 0.5 to 1 foot below the surface and continuing to the bottom. The location and timing of reservoir profiles are presented in Table 4.

Table 4. Reservoir water temperature and dissolved oxygen monitoring locations and timing.

Location (Responsible Licensee(s))	Profile Date(s)
Sawmill Lake (NID)	7/27/08
Bowman Lake (NID)	7/18/08, 8/20/08, 9/24/08, 10/24/08
Meadow Lake (PG&E)	7/27/08
Fordyce Lake (PG&E)[1]	7/21/08, 9/10/08, 10/9/08
Lake Spaulding (PG&E and NID)[2]	7/16/08, 8/21/08, 9/24/08
Rollins Reservoir (NID and PG&E)	5/23/08, 6/13/08, 7/17/08, 8/25/08, 9/11/08, 10/24/08
Lake Valley Reservoir (PG&E)	6/13/08, 8/25/08

[1] No data collected in August due to equipment issues
[2] No data collected in October due to access issues and weather

QA/QC Data

QA/QC was performed on the data for each thermograph prior to data analyses, including detailed review of field notes, and graphical representations of data points. In addition, time periods when the thermographs were not recording *in situ* conditions (*e.g.*, during downloads or when exposed to air) were excluded from data reports. For all excluded periods, a detailed explanation was provided to the extent possible. During the 2008 monitoring period, there were data gaps caused by vandalism, equipment failure or fluctuating water levels at 13 of the stations. While this represents 16 percent of the total monitoring locations, a much smaller percentage of the total data points collected were lost to these issues. Table 5 shows monitoring locations where there are data gaps and an explanation for each gap.

Table 5. Stream monitoring locations and associated data gaps with explanations.

Site	Location	Data Gaps (Reason)
11	South Yuba River above Englebright	6/18 - 7/7 (Vandalism and recorder malfunction)
16	Spring Creek above South Yuba River	8/17-8/19 (Vandalism)
23	Diamond Creek above South Yuba River	7/12 - 8/13 (Recorder malfunction)
27	Bowman-Spaulding Canal below Fuller Lake	6/8 - 6/20 (Canal outage), 9/22 - 9/24 (Canal outage)
28	Trap Creek above Bowman-Spaulding Canal	6/8 - 6/20 (Canal outage), 8/14 - 9/17 (Equipment malfunction), 9/22 - 9/24 (Canal outage)
41	Meadow Creek above Fordyce Lake	8/13 - 9/3 (Reduced flow)
43	Canyon Creek above Sawmill Lake	6/19 - 7/10 (Reduced flow)
48	Bowman-Spaulding Canal below Bowman-Spaulding Canal Diversion Dam	6/8 - 6/20 (Canal outage), 9/22 - 9/24 (Canal outage)
63	Steephollow Creek above Bear River	6/12 - 7/8 (Vandalism), 7/25 - 9/15 (Vandalism and recorder malfunction)
64	Bear River above Steephollow Creek	6/23 - 7/6 (Reduced flow)
66	Bear River above Rollins Reservoir	6/23 - 7/6 (Reduced flow)
68	Bear River near Milk Ranch Road	8/11 - 9/15 (Vandalism or equipment malfunction)
77	South Canal below Wise Powerhouse	8/12 - 9/15 (Equipment malfunction)

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Table 5. (continued)

Site	Location	Data Gaps (Reason)
80	Dutch Flat Afterbay (Dam)	6/13 - 7/3 (Reduced water level)
82	Rock Creek Reservoir (Dam)	6/13 - 6/15 (Vandalism), 8/17 - 8/18 (Reduced water level), 9/30 - 10/2 (Reduced water level)

Data analyses included the calculation of the mean daily minimum, mean, and maximum water temperature at each location. The daily mean temperatures at each of the monitoring locations were also compared to the daily mean air temperature available from various gages in the Project Area. When available, flow data in proximity to each monitoring location was used to help explain water temperature conditions.

3.0 Results

Stream Temperature Monitoring

Plots of the daily water temperature data for the 70 stream temperature sites, seven conduit sites, and four reservoir sites are provided in Attachment 2-2B. There are two plots for each site: one shows the daily average minimum, mean, and maximum, and one shows the daily average water temperature, daily average air temperature, and daily flow, when available. Table 6 provides a summary of the minimum and maximum mean daily temperatures by month at each of the stream monitoring sites. In addition, air and water temperature data are presented in DSS format in Attachment 2-2C. Flow data are also available for comparison in DSS format on Licensees' Relicensing Website (www.nid-relicensing.com) under the "Environmental Data – Relicensing" link on the Quick Launch Bar.

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Table 6. Range of mean daily stream temperatures, May-October 2008.

Location	Map/Station ID	May		June		July		August		September		October	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
MIDDLE YUBA RIVER SUB-BASIN													
Wilson Creek above Wilson Creek Diversion Dam	WT10	No Data	No Data	6.26	11.48	10.73	12.78	10.66	13.14	7.35	10.55	5.81	8.9
MYR below Milton Diversion Dam	WT8	No Data	No Data	9.16	11.9	11.54	12.91	10.58	14.77	8.73	11.38	8.53	9.17
MYR above East Fork Creek	WT7	No Data	No Data	No Data	No Data	12.84	14.12	12.38	13.7	9.96	12.12	9.13	10.07
East Fork Creek above MYR	WT6	No Data	No Data	No Data	No Data	12.24	14.94	11.93	14.99	10.01	12.78	5.61	10.97
MYR above Wolf Creek	WT5	No Data	No Data	11.8	18.05	17.99	20.32	18.06	20.46	14.02	17.58	7.53	13.09
Wolf Creek above MYR	WT4	No Data	No Data	10.6	15.69	15.03	17.17	14.4	17.29	11.56	14.61	6.18	13.19
MYR above Kanaka Creek	WT3	9.44	13.46	13.49	21.14	21.02	23.44	20.61	23.49	18.03	20.04	No Data	No Data
Kanaka Creek above MYR	WT2	9.8	16.65	13.67	19.97	19.47	21.85	18.98	21.75	14.85	18.64	7.84	16.06
MYR above Our House Diversion Impoundment	WT1	10.11	14.37	14.26	21.91	21.8	24.21	21.49	24.38	16.78	21.09	8.62	16.41
DEER CREEK SUB-BASIN													
South Fork Deer Creek above Deer Creek PH	WT55	No Data	No Data	10.79	12.16	12.13	15.8	16.01	18.41	14.6	16.58	10.6	14.71
South Fork Deer Creek below Deer Creek PH	WT54	6.75	10.41	8.76	14.63	14.07	15.98	13.33	15.92	10.11	15.12	5.51	14.76
CANYON CREEK SUB-BASIN													
Canyon Creek above Faucherie Reservoir	WT42	No Data	No Data	9	15.39	10.46	17.37	14.76	17.53	11.69	15.26	11.48	15.05
Canyon Creek above Sawmill Lake	WT43	No Data	No Data	11.1	14.18	15.99	18.6	17.24	19.51	15.37	19.05	13.14	15.46
Canyon Creek above Bowman Lake	WT44	No Data	No Data	9.44	16.88	12.42	17.95	17.02	19.79	15.92	19.69	13.61	15.84
Jackson Creek below Prairie Creek and Bowman Reservoir	WT45	No Data	No Data	8.38	11.08	10.34	11.46	10.43	11.89	9.37	11	8.55	10.23
Milton-Bowman Tunnel at outfall to Bowman Lake	WT46	No Data	No Data	6.8	8.6	8.34	9.33	8.58	14.53	8.03	10.5	8.65	9.85
Canyon Creek below Bowman-Spaulding Diversion Dam	WT47	No Data	No Data	9.71	13.64	11.03	12.56	11.1	15.72	13.98	15.65	13.14	14.89
Bowman-Spaulding Conduit below BSC Diversion Dam	WT48	No Data	No Data	8.09	8.93	8.81	10.45	10.57	15.09	15.17	16.11	14.31	15.26
Texas Creek below Culbertson Lake	WT49	No Data	No Data	10.21	14.49	14.48	17.73	15.45	18.23	13.5	16.82	10.87	13.98
Lindsey Creek above Texas Creek confluence	WT50	No Data	No Data	9.78	13.4	12.45	14.73	11.88	14.71	9.47	12.91	8.76	10.81
Texas Creek above Lindsey Creek confluence	WT51	No Data	No Data	10.34	13.99	12.82	15.34	12.31	14.92	9.04	12.6	8.06	10.5
Canyon Creek above Texas Creek confluence	WT52	No Data	No Data	No Data	No Data	14.31	17.38	13.74	17.5	12.44	15.25	11.36	13.75

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Table 6. (continued)

Location	Map/Station ID	May		June		July		August		September		October	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
CANYON CREEK SUB-BASIN (continued)													
Little Canyon Creek above Canyon Creek	WT53	No Data	No Data	No Data	No Data	No Data	No Data	15.24	17.33	13.68	16	8.81	14.81
FALL CREEK SUB-BASIN													
Clear Creek above B-S Canal	WT31	No Data	No Data	7.72	12.6	12.4	15.22	11.67	14.54	10.39	12.98	No Data	No Data
Trap Creek above B-S Canal	WT28	No Data	No Data	6.57	11.11	11.04	14.08	14.08	14.64	No Data	No Data	No Data	No Data
Fall Creek above SYR confluence	WT29	8.28	13.37	9.79	16.21	14.71	17.86	12.78	17.29	11.38	13.78	11.11	13.47
Fall Creek above Fall Creek Diversion Dam	WT30	No Data	No Data	7.52	12.87	12.41	15.16	12.92	16.83	9.23	12.82	8.17	10.41
RUCKER CREEK SUB-BASIN													
Rucker Creek above Rucker Lake	WT35	No Data	No Data	12.41	18.42	18.42	20.75	19.41	20.99	16.85	18.84	15.44	16.87
Rucker Creek above B-S Canal	WT34	No Data	No Data	13.43	18.15	17.32	19.86	17.47	20.41	14.11	17.83	11.66	15.08
B-S Canal at Rucker Creek	WT33	No Data	No Data	8.55	9.77	9.39	10.85	10.96	12.58	14.84	15.86	14.07	15.25
Rucker Creek above SYR	WT32	No Data	No Data	9.49	14.43	13.96	16.35	14.06	16.25	11.99	14.31	10.95	13.22
FORDYCE CREEK SUB-BASIN													
Meadow Lake Dam Reach above Fordyce Lake	WT41	No Data	No Data	12.34	14.67	13.74	16.47	13.15	15.27	12.43	15.58	10.14	13.06
White Rock Creek below White Rock Dam	WT40	No Data	No Data	12.71	15.01	14.39	16.73	14.2	17.42	8.44	15.08	9.09	12.06
North Creek above Fordyce Lake	WT39	No Data	No Data	13	15.91	14.75	17.43	14.42	17.22	10.35	13.91	8.02	11.2
Bloody Creek above Fordyce Lake	WT38	No Data	No Data	12.9	14.29	13.33	16.53	13.07	16.81	12.35	17.06	11.8	14.32
Fordyce Creek below Fordyce Dam	WT37	No Data	No Data	7.26	7.42	7.45	8.03	7.52	8.8	8.57	14.26	13.6	14.36
Fordyce Creek above Lake Spaulding	WT36	No Data	No Data	12.64	16.43	15.33	17.83	9.9	16.94	9.85	14.45	12.45	14.4
SOUTH YUBA RIVER SUB-BASIN													
SYR below Spaulding Main Dam	WT26	No Data	No Data	No Data	No Data	9.16	10.73	8.71	10.8	8.35	9.46	6.77	9.82
SYR above Jordan Creek	WT25	No Data	No Data	8.72	11.76	10.5	12.35	9.71	12.18	8.47	10.16	8.19	10.53
B-S Canal below Fuller Lake	WT27	No Data	No Data	10.22	14.38	11.37	12.44	12.59	16.18	15.35	16.31	14.48	15.82
Jordan Creek above SYR	WT24	No Data	No Data	11.54	16.29	15.62	17.93	16.22	18.8	13.95	17.16	12.34	14.93
SYR above Canyon Creek	WT22	10.6	16.93	15.37	21.04	21.05	23.44	20.18	23.43	15.74	19.63	9.21	16.91
Canyon Creek above SYR	WT21	9.54	16.23	13.25	19.38	19.21	21.73	17.63	21.76	14.57	18.72	7.9	15.88
Diamond Creek above SYR	WT23	No Data	No Data	13.34	17.14	16.94	18.74	18.12	19.97	15.39	18.11	14.38	16.2
Spring Creek above SYR	WT16	11.34	17.2	12.19	17.79	16.03	19.03	15.21	18.6	12.22	14.39	6.75	14.25
Rock Creek above SYR	WT15	13.46	18.88	14.79	19.71	18.47	20.93	17.61	19.97	13.32	16.83	7.79	14.82
SYR above Poorman Creek	WT20	11.33	17.86	15.97	21.84	21.8	23.99	21.33	23.92	15.51	20.58	9.85	17.38
Poorman Creek above SYR	WT19	8.1	12.61	12.15	18.48	18.19	20.62	17.73	20.77	13.74	17.57	7.22	15.35

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Table 6. (continued)

Location	Map/Station ID	May		June		July		August		September		October	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
SOUTH YUBA RIVER SUB-BASIN (continued)													
SYR above Humbug Creek	WT18	11.62	17.94	16.39	22.79	22.65	25.01	21.68	24.58	15.92	20.98	15.2	17.61
Humbug Creek above SYR	WT17	9.92	16.6	11.77	17.86	16.81	19.34	16.22	19.2	12.82	16.25	12.4	14.75
SYR above Rush Creek	WT14	13.74	20.08	17.87	23.7	23.14	25.4	22.44	24.91	16.73	21.59	10.2	18.5
Rush Creek above SYR	WT13	No Data	No Data	15.54	18.33	17.4	19.52	17.63	19.68	14.58	17.5	9.52	16.29
Shady Creek above SYR	WT12	14.65	20.97	17.07	22.89	21.39	24.9	21.02	24.62	18.19	22.31	15.49	21.06
SYR above Englebright Reservoir	WT11	14.74	21.27	18.74	22.19	23.55	25.93	23.04	25.67	17.47	22.41	11.08	19.48
BEAR RIVER SUB-BASIN													
Bear River near Bowman Lake Road crossing (above Drum waste gate)	WT56	No Data	No Data	9.99	12.96	12.52	14	13.35	15.53	12.93	14.72	11.9	12.04
Bear River at Hwy 20 crossing (YB-198)	WT57	No Data	No Data	9.26	12.02	11.61	14.2	14.12	16.59	13.05	15.02	12.37	13.79
Bear River above Drum Afterbay	WT58	7.52	13.09	11.25	16.13	15.56	17.54	14.48	17.97	12.23	15.13	10.93	13.64
Bear River below Drum Afterbay	WT59	6.79	8.08	8.06	10.84	10.95	15.01	15.13	17.68	13.06	16.29	12.1	14.59
Bear River above Dutch Flat Afterbay	WT60	No Data	No Data	No Data	No Data	15.74	17.92	16.37	19.4	13.48	16.83	7.77	14.86
Little Bear River below PCWA's Lower Boardman Canal (YB-98)	WT61	8.04	16.17	10.32	13.25	13.13	15.67	15.75	18.95	14.96	16.86	13.24	17.2
Bear River above Chicago Park PH	WT62	8.15	10.24	9.39	18.79	18.13	20.16	18.47	21.28	15.99	19.3	15.36	16.7
Steephollow Creek above Bear River	WT63	12.43	18.23	15.36	17.1	18.4	20.53	No Data	No Data	15.7	18.53	15.21	16.43
Bear River above Steephollow Creek	WT64	No Data	No Data	9.97	10.77	12.94	16.41	16.57	19.02	16.2	18.13	14.59	16.9
Greenhorn Creek above Rollins Reservoir	WT65	12.96	21.1	16.4	21.99	20.62	24.77	18.92	23.92	14.87	20.81	14.9	17.85
Bear River above Rollins Reservoir	WT66	No Data	No Data	10.79	11.96	13.32	16.1	16.25	18.63	16.29	17.93	14.21	17.03
Bear River below BRC Diversion Dam (YB-196)	WT67	7.21	9.99	10.09	11.5	11.56	14.22	14.37	18.03	18.11	18.75	18.68	18.78
Bear River near Milk Ranch Road	WT68	No Data	No Data	13.38	14.94	14.89	16.73	16.78	17.58	18.02	19.23	16.08	18.85
Bear River above Lake Combie	WT69	No Data	No Data	14.9	16.79	16.69	18.04	17.89	20.37	17.85	20.18	17.31	18.91
Bear River Canal at YB-58 (Placer Hills Road)	WT70	9.14	10.54	10.64	12.24	12.27	12.59	16.16	18.29	17.98	18.81	18.37	18.72
NORTH FORK AMERICAN RIVER SUB-BASIN													
NFNFAR above Lake Valley Canal Diversion	WT71	7.61	12.17	11.93	18.7	17.07	19.79	16.38	20.12	13.89	18.41	12.26	16.08
NFNFAR above Fulda Creek and East Branch American River	WT72	No Data	No Data	13.16	16.84	15.96	18.57	15.51	18.96	12.23	16.08	6.46	14.13

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Table 6. (continued)

Location	Map/Station ID	May		June		July		August		September		October	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
NORTH FORK AMERICAN RIVER SUB-BASIN (continued)													
Canyon Creek above Towle Diversion Inflow (YB-280)	WT73	6.95	9.04	8.07	11.14	11.15	12.79	11.78	14.83	10.76	13.68	9.87	12.83
COON CREEK SUB-BASIN													
Dry Creek above Halsey Afterbay	WT74	15.28	21.58	17.16	21.18	14.5	24.02	15.55	24.15	18.74	22.24	17.96	19.88
Wise Canal below Halsey Afterbay (YB-61)	WT75	9.51	11.16	11.29	12.91	12.98	15.58	15.69	16.59	18.52	19.2	18.34	19.08
AUBURN RAVINE SUB-BASIN													
Auburn Ravine above Wise PH	WT76	14.6	20.29	15.99	20.24	19.12	22.12	19.22	22.13	16.6	20.54	16.26	18.87
South Canal below Wise PH	WT77	10.22	12.38	12.6	14.37	14.45	16.72	16.89	17.85	18.7	19.84	18.25	19.57
RESERVOIRS													
Dutch Flat Afterbay (Dam)	WT80	7.03	9.16	9.17	10.09	12.5	15.89	15.99	18.44	16.65	17.39	No Data	No Data
Chicago Park Forebay (Dam)	WT81	15.21	22.29	9.81	25.44	12.18	15.97	16.02	18.43	16.55	20.53	17.8	20.72
Rock Creek Reservoir (Dam)	WT82	10.18	12.52	12.61	14.18	14.36	16.53	16.68	20.15	18.46	19.93	18.01	18.22
Wise Forebay (Dam)	WT83	10.2	12.35	12.57	14.32	14.4	16.69	16.87	19.83	18.62	19.88	18.21	19.49

Notes: Shaded cells represent temperatures equal or greater than 20°C.

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Reservoir Water Temperature Profiles and Dissolved Oxygen

Reservoir water temperature and dissolved oxygen data analyses included generating temperature plots and estimating thermocline locations at the time of sampling. The thermocline is a transition layer in which temperature changes more rapidly with depth than it does in the layers above or below. Reservoir water temperature profiling data collected in 2008 are provided below (Figures 2-9).

Table 7 provides the minimum and maximum dissolved oxygen (DO) concentrations recorded by month at each of the reservoirs. Tables 8 – 14 provide the complete DO concentrations recorded by month at each reservoir.

Table 7. Minimum and maximum dissolved oxygen concentrations, May-October 2008.

Reservoir	May		June		July		August		September		October	
	min	max	min	max	min	max	min	max	min	max	min	max
YUBA-BEAR HYDROELECTRIC PROJECT												
Sawmill Lake	--	--	--	--	5.7	7.5	--	--	--	--	--	--
Bowman Lake	--	--	--	--	7.1	8.9	6.7	8.0	7.0	7.6	9.1	9.2
Rollins Reservoir	7.1	8.5	no data	no data	6.7	7.4	3.6	6.9	5.2	8.6	1.1	8.5
DRUM-SPAULDING PROJECT												
Meadow Lake	--	--	--	--	no data	no data	--	--	--	--	--	--
Fordyce Lake	--	--	--	--	7.7	9.0	no data	no data	6.8	9.2	4.5	9.8
Lake Spaulding Dam Site	--	--	--	--	7.7	8.4	4.5	8.0	0.8	7.2	--	--
Lake Spaulding Upper Site	--	--	--	--	7.9	8.2	7.7	8.1	--	--	--	--
Lake Valley Reservoir	--	--	no data	no data	--	--	1.2	6.0	--	--	--	--

Notes:
-- Data not required by study plan.
no data: Data not collected due to equipment malfunction or access issues.

Sawmill Lake (NID)

One temperature profile was taken in Sawmill Lake approximately 2 weeks after the reservoir stopped spilling in late July 2008 (Figure 2). A weak thermocline was present 25 feet below the water surface; water temperatures declined from 21.2°C at the surface to 17.2°C at the bottom.

DO declined from 7.4 mg/L at the surface to 5.9 mg/L at the bottom (Table 8).

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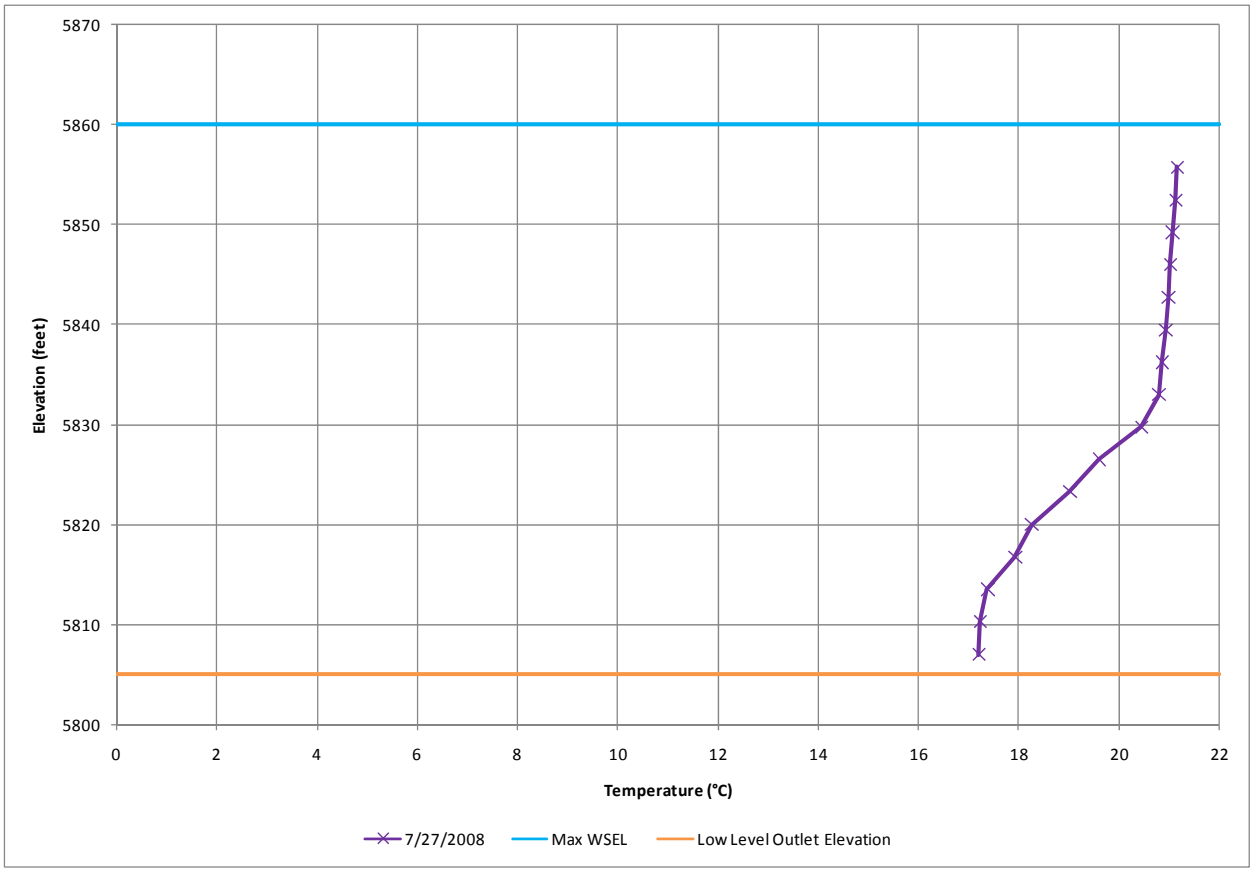

Figure 2. Sawmill Lake water temperature profiles, July 2008.

Table 8. Sawmill Lake DO concentrations, July 2008.

July		
Depth(ft)	**WSEL (ft)**	**DO (mg/L)**
3.3	5855.8	7.4
6.5	5852.5	7.4
9.8	5849.3	7.4
13.0	5846.0	7.5
16.3	5842.8	7.5
19.5	5839.5	7.4
22.8	5836.3	7.3
26.0	5833.0	7.3
29.3	5829.8	7.3
32.5	5826.5	7.3
35.8	5823.3	7.2
39.0	5820.0	6.4
42.3	5816.8	5.7
45.5	5813.5	5.9
48.8	5810.3	5.9
52.0	5807.0	5.9

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Bowman Lake (NID)

Reservoir profiles were taken monthly from July through October 2008 at one location near the dam, in the thalweg of the reservoir (Figure 3). In July and August, a thermocline was present at approximately 30 feet and 40 feet below the water surface, respectively. The September and October profiles show a slight decline in temperatures from top to bottom, with no definitive thermocline. Water temperatures at the surface ranged from 11.6°C in October to 18.5°C in July and at the bottom from 8.6°C in July to 15.5°C in September.

DO levels were similar from July – September and increased in October. The minimum concentration recorded was 6.7 mg/L in August and the maximum was 9.2 mg/L in October. DO concentrations during the October sampling only varied by 0.1 mg/L (Table 9).

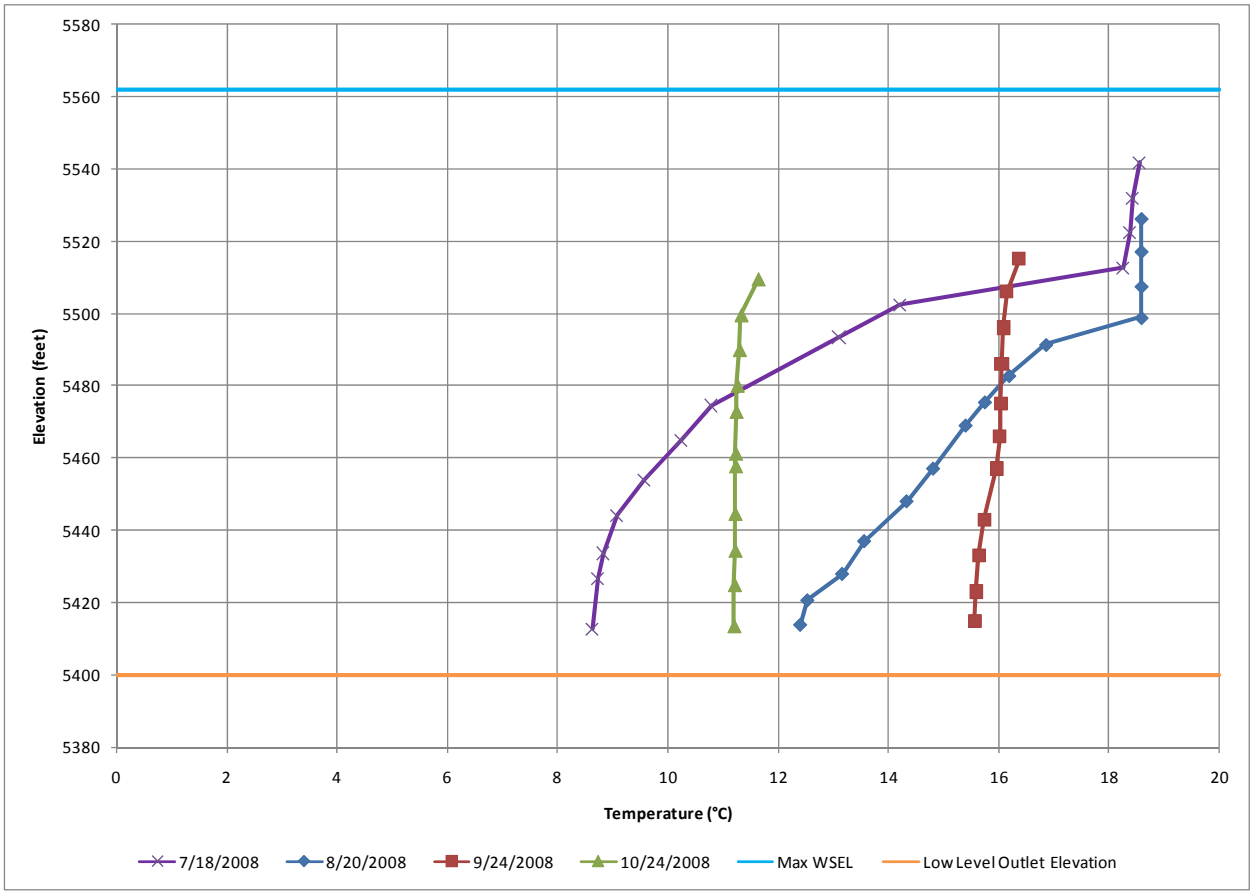

Figure 3. Bowman Lake water temperature profiles, July-October 2008.

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Table 9. Bowman Lake DO concentrations, July-October 2008.

July			August			September			October		
Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)
0.2	5541.8	7.9	0.8	5526.2	7.8	1.0	5515	7.1	0.5	5509.5	9.1
9.9	5532.1	7.9	9.9	5517.1	7.7	10.0	5506	7.2	10.5	5499.5	9.1
19.4	5522.6	7.9	19.6	5507.4	7.7	20.0	5496	7.1	20.1	5489.9	9.1
29.4	5512.6	8.2	28.2	5498.8	7.7	30.0	5486	7.1	30.0	5480.0	9.1
39.6	5502.4	8.9	35.7	5491.3	8.0	41.0	5475	7.1	37.2	5472.8	9.1
48.4	5493.6	8.7	44.3	5482.7	7.9	50.0	5466	7.1	48.8	5461.2	9.1
67.4	5474.6	8.3	51.6	5475.4	7.8	59.0	5457	7.0	52.3	5457.7	9.1
77.0	5465.0	8.2	58.0	5469.0	7.7	73.0	5443	7.0	65.5	5444.5	9.1
88.0	5454.0	8.0	69.9	5457.1	7.6	83.0	5433	7.1	75.7	5434.3	9.1
97.9	5444.1	8.1	78.9	5448.1	7.6	93.0	5423	7.3	85.2	5424.8	9.1
108.3	5433.7	7.5	90.0	5437.0	7.3	101.0	5415	7.6	96.6	5413.4	9.2
115.2	5426.8	7.1	99.1	5427.9	7.1						
129.2	5412.8	7.4	106.4	5420.6	6.7						
			113.2	5413.8	6.9						

Rollins Reservoir (NID)

Water temperature and DO data were collected at one location near Rollins Reservoir Dam from May through October 2008 (Figure 4). A thermocline was present in each of the sampling months, but was the most definite during June, July, August, and September at depths of approximately 10 feet, 20 feet, 30 feet and 150 feet respectively. Surface water temperatures ranged from a minimum of 16.3°C in October to a high of 23.0°C in August. Water temperatures near the bottom ranged from 8.3°C in May, July, and August to 9.3°C in June. However, it is important to note that the low level intake elevation is significantly higher than the bottom of the reservoir, and temperatures at this elevation varied from 8.5°C in May to 18.3°C in September.

DO concentrations were collected in May, July, August, September, and October. During the June sampling event, the DO probe malfunctioned; consequently, no data were collected at that time. The minimum DO concentration recorded was 1.1 mg/L in October and the maximum was 8.6 mg/L in September (Table 10 and 11).

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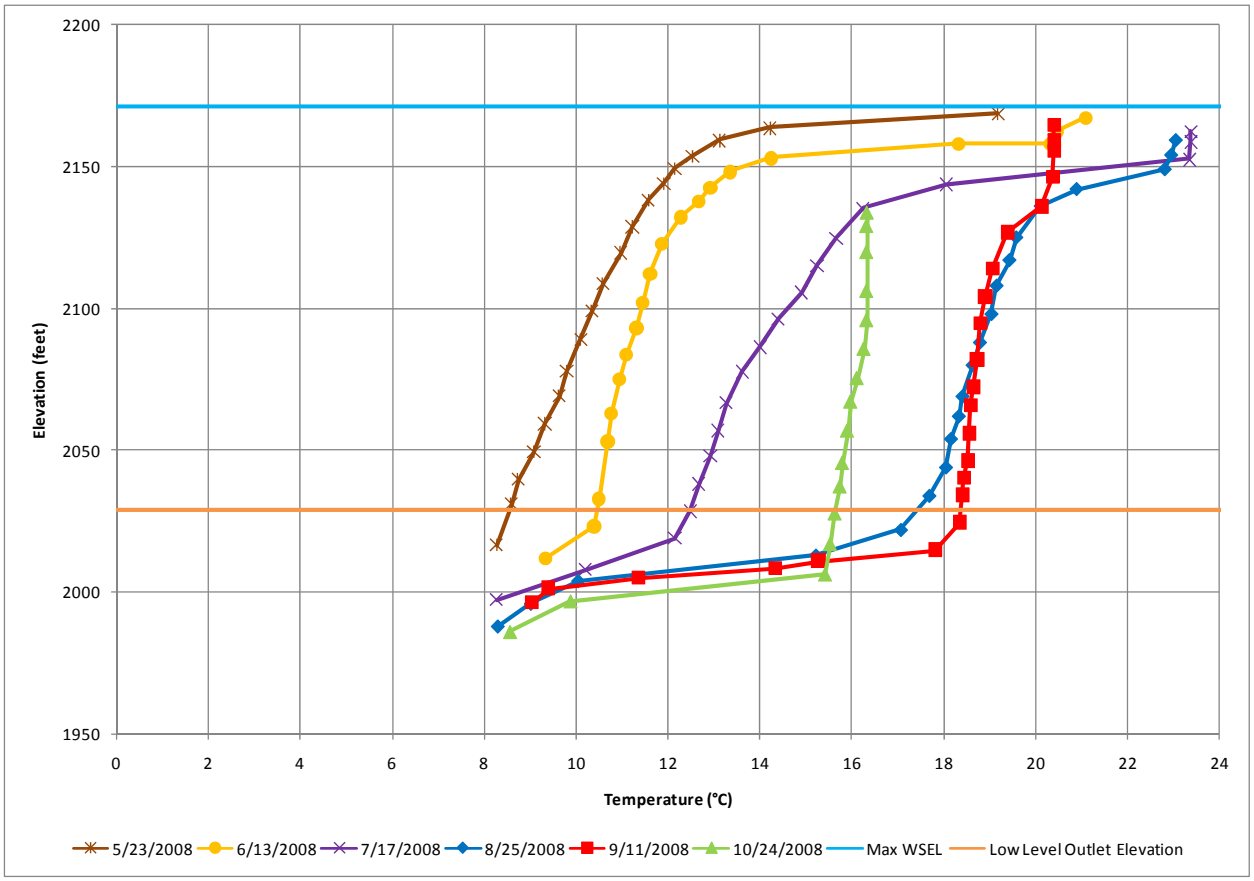

Figure 4. Rollins Reservoir water temperature profiles, May-October 2008

Table 10. Rollins Reservoir DO concentrations, May-August 2008.

May			July			August		
Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)
0.4	2168.6	7.1	0.6	2162.5	7.4	0.8	2159.2	6.7
5.4	2163.6	8.6	4.0	2159.0	7.4	6	2154	6.7
9.7	2159.3	8.3	10.3	2152.7	7.3	11	2149	6.6
15.2	2153.8	8.1	19.1	2143.9	7.2	18	2142	6.9
19.8	2149.2	8.1	27.7	2135.3	7.0	24	2136	6.6
24.9	2144.1	8.2	38.0	2125.0	7.0	35	2125	6.5
30.6	2138.4	8.2	48.0	2115.0	6.9	43	2117	6.3
40.1	2128.9	8.2	57.3	2105.7	6.9	52	2108	6.3
49.3	2119.7	8.2	66.6	2096.4	6.9	62	2098	6.2
60.1	2108.9	8.2	76.6	2086.4	6.9	72	2088	6.1
69.8	2099.2	8.1	85.3	2077.7	6.9	80	2080	6.2
80	2089	8.2	96.2	2066.8	6.9	91	2069	6.1
91.2	2077.8	8.2	106.0	2057.0	6.9	98	2062	6.1
99.9	2069.1	8.2	115.1	2047.9	6.9	106	2054	6.1
109.8	2059.2	8.2	124.9	2038.1	6.8	116	2044	5.9
119.5	2049.5	8.2	134.5	2028.5	6.8	126	2034	5.7
129.2	2039.8	8.3	144.0	2019.0	6.8	138	2022	5.1
137.9	2031.1	8.4	155.0	2008.0	6.7	147	2013	4.5

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Table 10. (continued)

May			July			August		
Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)
152.4	2016.6	8.5	165.7	1997.3	6.7	156	2004	3.9
						164	1996	3.6
						172	1988	3.7

Table 11. Rollins Reservoir DO concentrations, September-October 2008.

September			October		
Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)
0.5	2164.5	8.6	1.2	2133.8	8.5
6.0	2159.0	8.6	5.9	2129.1	8.5
9.7	2155.3	8.6	15.1	2119.9	8.4
18.8	2146.2	8.5	28.8	2106.2	8.3
29.1	2135.9	7.9	39.1	2095.9	8.1
38.3	2126.7	7.5	49.2	2085.8	7.9
50.9	2114.1	7.5	59.5	2075.5	7.9
60.9	2104.1	7.5	67.8	2067.2	7.8
70.5	2094.5	7.4	78	2057	7.6
83.2	2081.8	7.5	89.4	2045.6	7.3
92.8	2072.2	7.8	97.7	2037.3	7.2
99.3	2065.7	8.2	107.2	2027.8	6.2
109.1	2055.9	8.2	118	2017	5.2
118.8	2046.2	8.1	128.7	2006.3	3.5
124.9	2040.1	7.8	138.2	1996.8	1.1
130.9	2034.1	7.9	149	1986	1.6
140.5	2024.5	7.6			
150.1	2014.9	6.1			
154.1	2010.9	5.6			
156.7	2008.3	5.8			
160.0	2005.0	5.7			
163.7	2001.3	5.2			
168.7	1996.3	5.9			

Meadow Lake (PG&E)

One water temperature profile was collected in late July 2008 near Meadow Lake Dam (Figure 5). At the time of the sample there was no thermocline present and temperatures ranged from 17.3°C at the surface to 15.9°C at the bottom.

No dissolved oxygen readings were taken due to an equipment malfunction.

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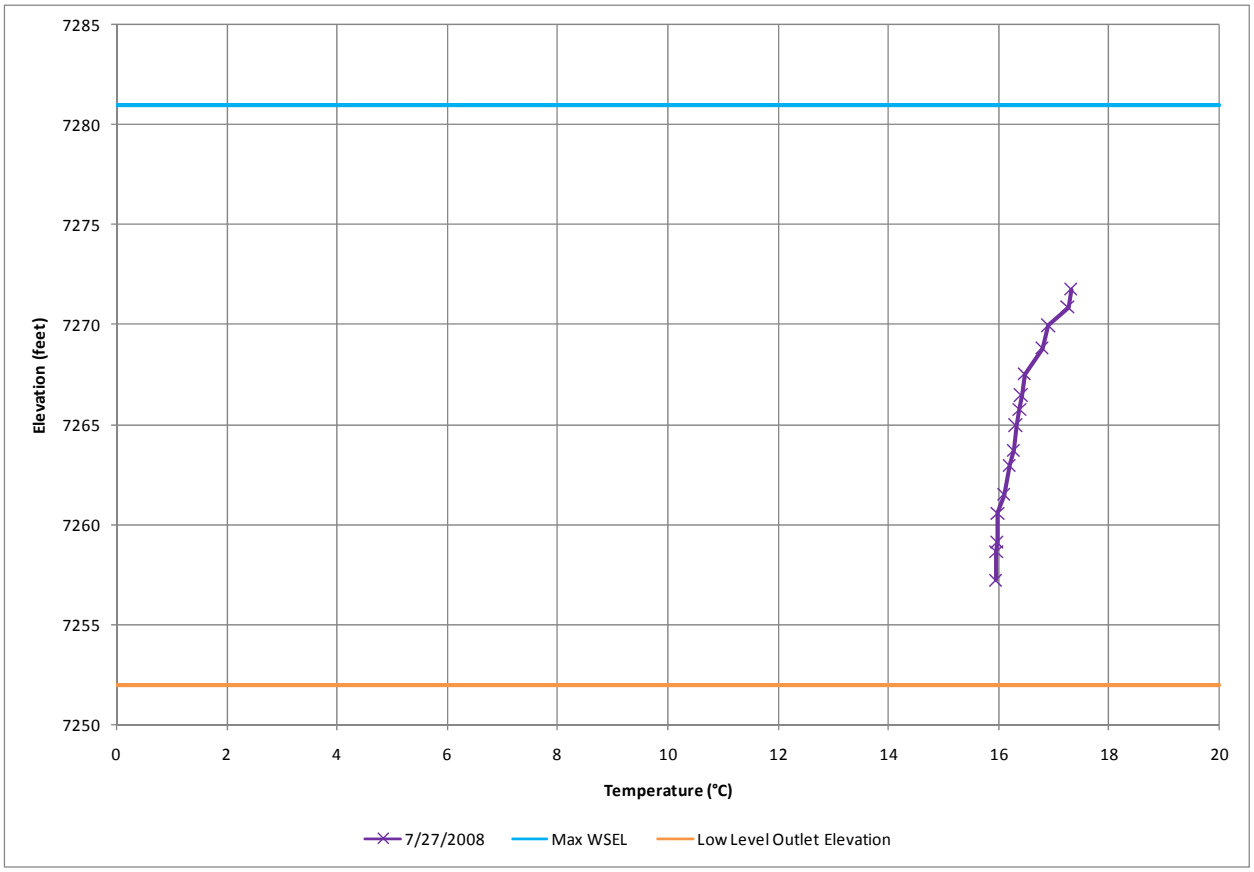

Figure 5. Meadow Lake water temperature profile, July 2008.

Fordyce Lake (PG&E)

Water temperature profiles were taken in July, September, and October 2008 (Figure 6). No sample was taken in August due to an equipment malfunction. A thermocline was present in each of the three samples occurring at approximately 20 feet in July, 50 feet in September, and 55 feet in October. Water temperatures at the surface ranged from 13.6°C in October to 18.9°C in July and at the bottom from 6.3°C in July to 7.8°C in October.

The minimum DO concentration recorded was 4.5 mg/L in October and the maximum was 9.8 mg/L in October (Table 12).

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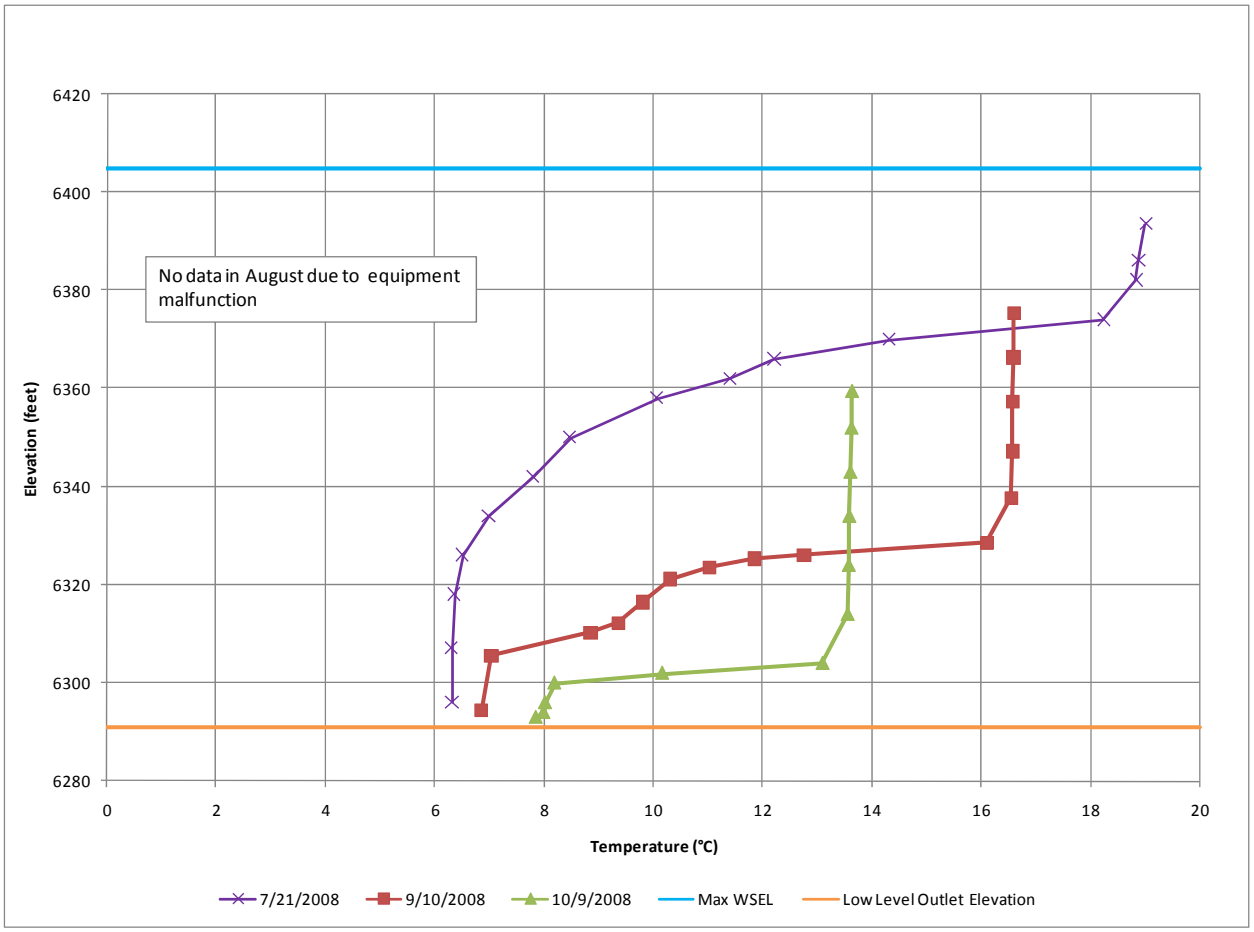

Figure 6. Fordyce Lake water temperature profiles, July-October 2008.

Table 12. Fordyce Lake DO concentrations, July-October 2008.

July			September			October		
Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)
0.5	6393.5	7.7	0.6	6375.4	7.9	0.5	6359.5	4.5
8	6386	7.8	9.6	6366.4	7.9	8	6352	5.7
12	6382	8.1	18.6	6357.4	7.9	17	6343	6.3
20	6374	8.9	28.7	6347.3	7.9	26	6334	7.2
24	6370	8.8	38.2	6337.8	7.8	36	6324	7.8
28	6366	9.0	47.4	6328.6	9.2	46	6314	8.1
32	6362	9.0	49.9	6326.1	8.9	56	6304	8.1
36	6358	9.0	50.6	6325.4	8.8	58	6302	9.4
44	6350	9.0	52.5	6323.5	8.8	60	6300	9.5
52	6342	8.6	54.8	6321.2	8.8	64	6296	9.6
60	6334	8.4	59.5	6316.5	8.5	66	6294	9.7
68	6326	8.2	63.7	6312.3	8.2	67	6293	9.8
76	6318	8.1	65.7	6310.3	7.3			
87	6307	8.1	70.4	6305.6	6.8			
98	6296	8.1	81.5	6294.5	8.6			

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Lake Spaulding (PG&E)

Water temperature profiles were taken in Lake Spaulding at two locations between July and September 2008 (Figures 7 and 8). The first location was near the dam and the second was at the approximate mid-point in the reservoir, offshore of the Spaulding No. 3 Powerhouse outflow. Samples were not taken at the mid-point of the reservoir in September or at either location in October due to inclement weather and unsafe boating conditions.

Near the dam, a thermocline was present each month occurring between 20 feet (July) and 90 feet (September) below the water surface. Water temperatures at the surface ranged from 16.1°C in September to 19.7°C in July. Near the bottom, temperatures ranged from 6.2°C in August to 11.0°C in July. The July sampling depth was only 91 feet indicating the sample was not taken within the thalweg.

The minimum DO concentration recorded was 0.8 mg/L in September and the maximum was 8.4 mg/L in July (Table 13).

At the mid-point in the reservoir, a weak thermocline was present in July but not in August. The maximum depths measured were 75 feet in July and 60 feet in August. Surface water temperatures ranged from 18.4°C in August to 19.3°C July and temperatures near the bottom were 13.4°C in July to 16.5°C in August.

The minimum DO concentration recorded was 7.7 mg/L in August and the maximum was 8.2 mg/L in July (Table 14).

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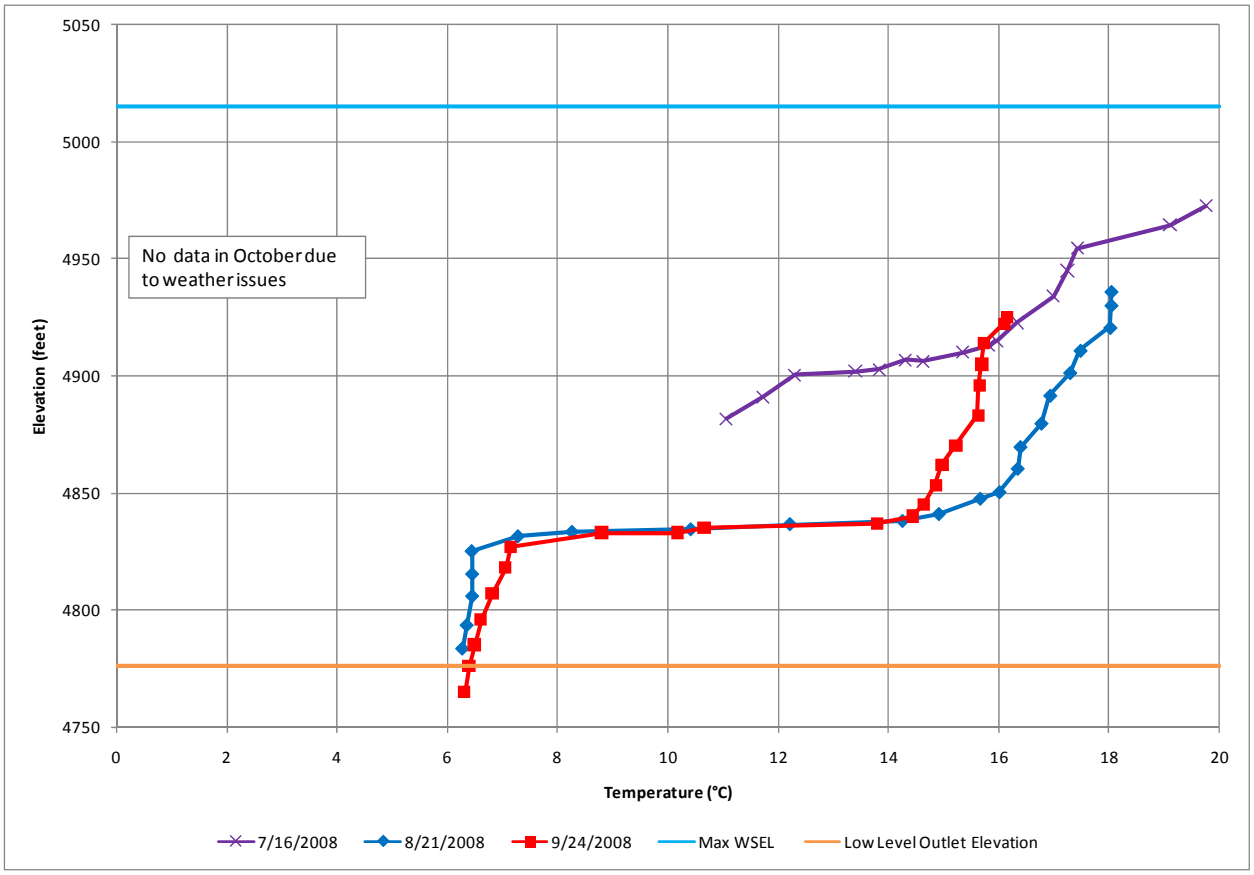

Figure 7. Lake Spaulding near dam water temperature profiles, July-September 2008.

Table 13. Lake Spaulding near dam water temperature profiles, July-September 2008.

July			August			September		
Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)
0.5	4972.5	8.0	1.0	4936.0	8.0	1	4925	7.2
8.8	4964.2	8.0	6.8	4930.2	8.0	4	4922	7.1
18.5	4954.5	8.3	16.4	4920.6	8.0	12	4914	7.0
28.1	4944.9	8.2	26.2	4910.8	7.9	21	4905	6.9
38.9	4934.1	7.9	35.7	4901.3	7.7	30	4896	6.7
50.3	4922.7	7.7	45.4	4891.6	7.4	43	4883	6.3
58.1	4914.9	7.8	57.3	4879.7	7.2	56	4870	6.0
60.0	4913.0	7.8	67.4	4869.6	7.1	64	4862	5.3
62.9	4910.1	7.9	76.7	4860.3	7.1	73	4853	4.7
66.8	4906.2	8.0	86.7	4850.3	6.7	81	4845	3.8
66.3	4906.7	8.0	89.5	4847.5	6.6	86	4840	3.4
70.3	4902.7	8.1	96.0	4841.0	6.3	89	4837	3.1
71.1	4901.9	8.2	99.0	4838.0	6.3	91	4835	3.1
72.5	4900.5	8.4	100.4	4836.6	6.7	93	4833	2.9
82.0	4891.0	8.4	102.6	4834.4	6.3	93	4833	3.0
91.3	4881.7	8.4	103.6	4833.4	6.8	99	4827	3.1
			105.5	4831.5	6.3	108	4818	3.1
			111.9	4825.1	6.0	119	4807	2.6

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Table 13. (continued)

July			August			September		
Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)
			121.7	4815.3	5.5	130	4796	1.2
			131.2	4805.8	5.4	141	4785	0.8
			143.6	4793.4	4.5	150	4776	1.0
			153.6	4783.4	4.9	161	4765	1.5

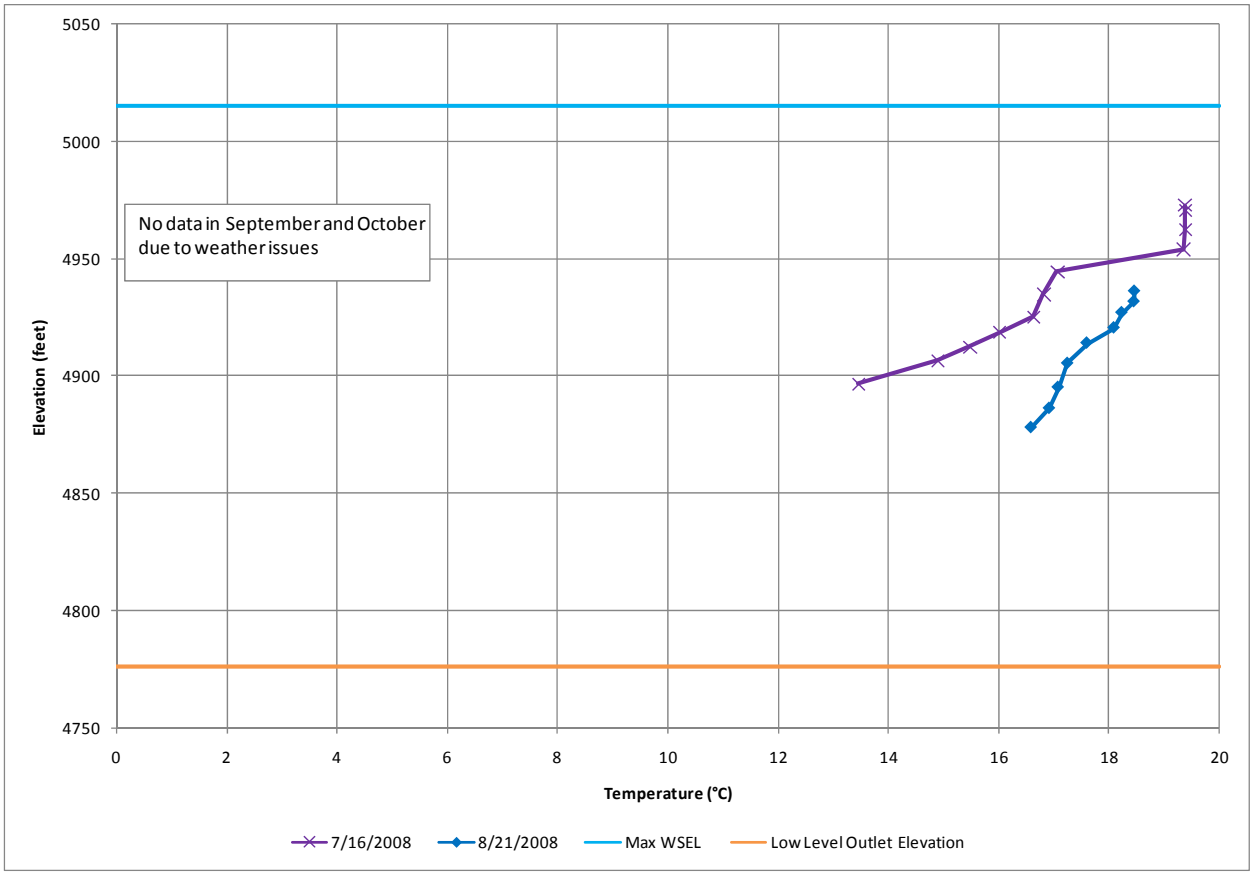

Figure 8. Lake Spaulding at mid-reservoir water temperature profiles, July-August 2008.

Table 14. Lake Spaulding at mid-reservoir DO concentrations, July-August 2008.

July			August		
Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)
0.3	4972.7	8.0	0.9	4936.1	8.0
2.5	4970.5	7.9	5.3	4931.7	8.0
10.8	4962.2	7.9	10.0	4927.0	7.9
19.1	4953.9	7.9	16.5	4920.5	8.0
28.6	4944.4	8.2	22.9	4914.1	8.1
38.2	4934.8	8.2	31.6	4905.4	7.7
47.8	4925.2	8.0	41.8	4895.2	7.7
54.3	4918.7	8.0	50.7	4886.3	7.7

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Table 14. (continued)

July			August		
Depth (ft)	WSEL (ft)	DO (mg/L)	Depth (ft)	WSEL (ft)	DO (mg/L)
60.6	4912.4	7.9	58.8	4878.2	7.8
66.4	4906.6	8.0			
76.2	4896.8	8.1			

Lake Valley Reservoir (PG&E)

Two profiles were taken in Lake Valley Reservoir at a location near the dam in 2008 (Figure 9). In both instances, depths were approximately 45 feet. In June, a maximum temperature of 15.8°C at the surface and a minimum of 10.7°C at the bottom were observed. The August sample had a more definite thermocline occurring approximately 35 feet below the water surface. Temperatures ranged from 21.5°C to 12.8°C.

Dissolved oxygen levels were not collected in June due to an equipment malfunction. The minimum and maximum DO concentrations recorded in August were 1.2 mg/L and 6.0 mg/L, respectively (Table 15).

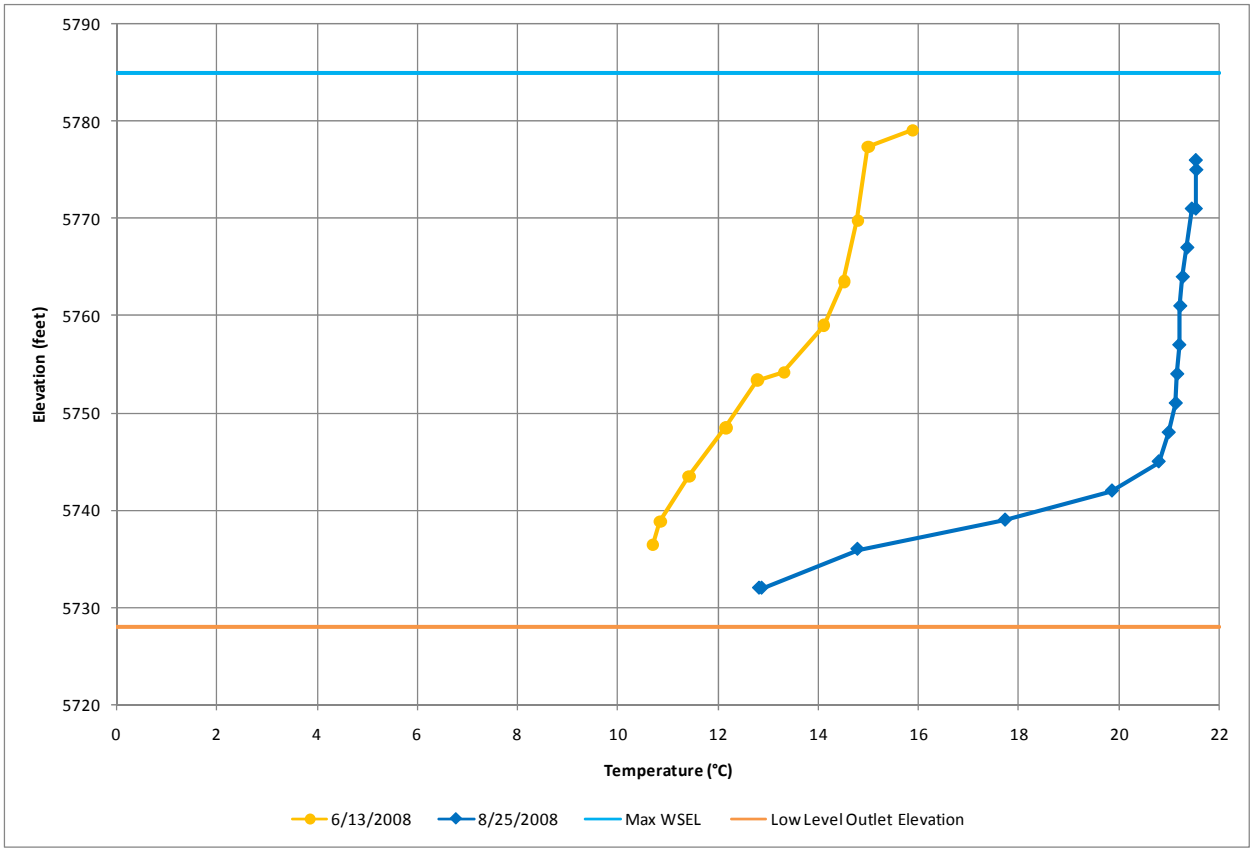

Figure 9. Lake Valley Reservoir water temperature profiles, June-August 2008.

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Table 15. Lake Valley Reservoir DO concentrations, August 2008.

August		
Depth (ft)	**WSEL (ft)**	**DO (mg/L)**
0	5776	6.0
1	5775	5.9
5	5771	5.9
5	5771	5.8
9	5767	5.7
12	5764	5.6
15	5761	5.7
19	5757	5.3
22	5754	5.0
25	5751	4.5
28	5748	3.9
31	5745	3.0
34	5742	1.9
37	5739	1.2
40	5736	1.2
44	5732	1.2
44	5732	1.3

Meteorological Data and Flow Data

Mean air temperatures during the 2008 monitoring period as measured at the Blue Canyon California Data Exchange Center (CDEC) station were compared to long-term averages at Blue Canyon by month and are shown in Table 16 below. The Blue Canyon station was selected as representative for project climatology due to its location (situated fairly central to the geographic extent of project facilities) and elevation (approximately 5,300 feet above mean sea level). The data suggest that the peak air temperatures of the summer months were not as extreme as the historical average, but that for the overall May-October period, the mean daily air temperatures in 2008 were typical when compared to the 1971-2000 averages.

Table 16. 2008 and historical monthly mean of daily mean air temperatures at Blue Canyon.

Month	2008 Mean Monthly Temperature (°C)	Historical Mean Monthly Temperature (°C)[1]
May	11.5	11.3
June	16.1	16.8
July	19.8	20.4
August	19.6	20.4
September	16.8	16.5
October	12.3	11.2

[1] Historical Average Data = 1971 - 2000

Daily mean air temperature data for the 2008 monitoring period were downloaded from the CDEC. For each stream temperature monitoring location, the nearest CDEC station was identified based on elevation and linear distance. These data are included on the water temperature plots in Attachment 2-2B. Table 17 provides the CDEC station codes, station description, and elevation for each reporting station used.

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Table 17. CDEC stations reporting daily mean air temperatures.

CDEC Station Code	Station Description	Elevation (nearest 10 feet)
BRE	Bear River below Rollins Reservoir	1,950
SRT	Secret Town Road (above Rollins Reservoir)	2,720
DRC	Deer Creek Forebay	4,460
DPH	Drum Powerhouse (Bear River)	3,400
BLC	Blue Canyon (near Hwy 80)	5,280
LSP	Lake Spaulding	5,150
MDW	Meadow Lake	7,200
BOL	Bowman Lake	5,390
OHD	Our House Dam (Middle Yuba River)	1,960
RDH	Reader Ranch (near Jones Bar/Hwy 49)	2,020
ADR	Auburn Dam Ridge	1,200
WTC	White Cloud (Hwy 20 near Deer Creek Forebay)	4,320

Flow data from the 2008 monitoring period was from a combination of permanent gages operated by Licensees and some estimated flows using discharge and stage data collected in the field. At the time of this progress report, flow data was available for almost all permanent gages within the study area. Data at locations where flows were estimated using measured discharge and stage data will be presented in the Initial Study Report. When available at stream temperature monitoring locations, flow data were added to the water temperature data plots presented in Attachment 2-2B and the gage code is noted on the plot title (*e.g.*, YB301).

Stage Recorders

Stage recorded data were retrieved for all 13 sites. The period of the data collected are provided by location in Table 18.

Table 18. Period of stage recorder data collected in 2008.

Location	Station ID	Installation Date	Removal Date
Middle Yuba River above our House Dam	WT1	7/10/08	10/20/08
Kanaka Creek above Middle Yuba River	WT2	7/10/08	10/20/08
Middle Yuba River above Kanaka Creek	WT3	7/10/08	10/20/08
Wolf Creek above Middle Yuba River	WT4	7/10/08	10/20/08
Middle Yuba River above Wolf Creek	WT5	7/10/08	10/20/08
East Fork Creek above Middle Yuba River	WT6	7/13/08	10/15/08
South Yuba River above Rush Creek	WT14	7/8/08	10/17/08
Humbug Creek above South Yuba River	WT17	8/21/08	10/7/08
South Yuba River above Humbug Creek	WT18	8/21/08	10/7/08
Poorman Creek above South Yuba River	WT19	7/8/08	10/16/08
South Yuba River above Poorman Creek	WT20	7/8/08	10/16/08
Canyon Creek above South Yuba River	WT21	7/8/08	10/15/08
South Yuba River above Canyon Creek	WT22	7/8/08	10/15/08

Stage recorder data were rectified through the use of barometric pressure data, using Solinst Barologgers installed at four locations. In addition, data were checked during each download period and adjusted where necessary to achieve a consistent stage (a common source of error in

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stage recorder data is the differential pressure on the recorder when it is re-deployed in a slightly different location within the stream).

4.0 Discussion

This section presents discussion of the results of the 2008 monitoring period, comparing it to historical data when possible, or providing explanations for any anomalous data points where possible.

Stream Temperature Monitoring

In general, the water temperatures within the project reservoirs and project-affected stream reaches increased from the time of logger installation in May or June through August and early September 2008, before declining in late September and October 2008. This temperature trend is consistent with typical seasonal patterns in the inland portion of northern California. On a daily scale, most monitoring locations showed a diurnal pattern. This phenomenon was especially evident in locations with lower flows and/or increasing distance from reservoir outlets. In addition, the trends in the water temperature data tended to closely follow trends seen in the daily mean air temperatures in the area; this trend was also stronger at those locations with lower flows or increased distance from reservoir outlets.

Monitoring locations directly downstream of project facilities or in project conduits did not necessarily follow these trends. These locations exhibited less daily fluctuations in temperature and were not correlated as closely to air temperatures in the area. However, water temperatures were affected by changes in flow releases from the nearby upstream facilities. In addition, water temperatures at monitoring locations downstream of project reservoirs tended to increase as water temperatures in the reservoir increased.

Additional discussion is provided below for the Middle and South Yuba rivers where atypical streamflows occurred for short periods (provided to inform other relicensing studies).

Middle Yuba River

The water temperature monitoring locations in the Middle Yuba River were all downstream of Milton Diversion Dam, the last Yuba-Bear Hydroelectric Project facility on the Middle Yuba River. In general, temperatures in the Middle Yuba River increased from the upstream to the downstream locations. Figure 10 shows the daily mean temperatures for five locations in the Middle Yuba River. In late August, a rapid rise in daily mean water temperatures occurred at the monitoring location in the Middle Yuba River below Milton Diversion Dam (WT8). A similar rise is seen in the water temperatures recorded at the Milton-Bowman Tunnel Outlet (WT46) over this same time period (available in Attachment 2-2B). These data correspond with a reduction in flows into the Middle Yuba River from Jackson Meadows Reservoir for the purposes of low calibration flow PHABSIM data collection; a component of the Instream Flow Study being conducted as part of the Relicensings. This increase in water temperatures is shown to be buffered by atmospheric conditions and accretion flows by the next downstream station in the Middle Yuba River (MYR above East Fork Creek). It is likely that the temperature increases

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that were seen below Jackson Meadows Reservoir and Milton Diversion Dam were due to a combination of the following factors:

- Reduced cross-sectional flow area in Middle Yuba River relative to wetted perimeter, leading to increased heat transfer from sources such as solar radiation and channel bedrock
- Reduced velocity and travel time, leading to a longer residence time in the stream channel and increased exposure to heat sources listed above
- Increased residence time within Milton Diversion Dam impoundment, leading to increased exposure to heat sources listed above

Flows below Milton Diversion Dam increased from 4 cfs to around 8 cfs for a week in early September, and this led to a slight reduction in instream temperatures directly below the dam. However, as seen in Figure 10 thermal impacts on the reach were limited to the section between Milton and the confluence with East Fork Creek. In late September, flows in the Middle Yuba River below Milton increased to over 100 cfs in support of instream flow studies; however, during this time period the daily average air temperatures at the upstream portion of the reach were relatively close to released water temperatures. During this period when air and water temperatures were similar, the magnitude of flow had a relatively small impact on water temperatures. Approximately 10 miles downstream (where daily average air temperatures were higher), the impacts of the increased flow on water temperature in the Middle Yuba River were more apparent.

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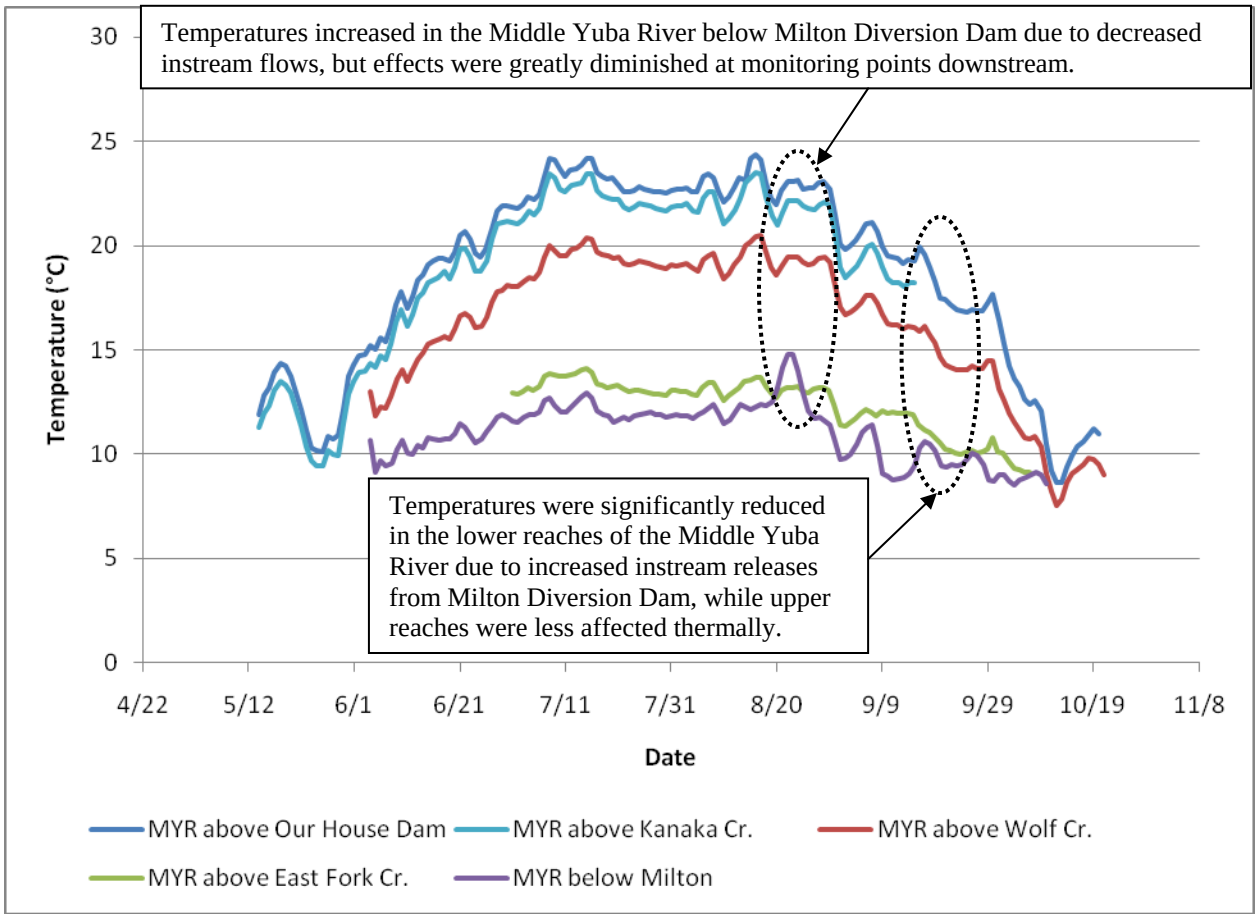

Figure 10. Mean daily water temperatures at Middle Yuba River monitoring sites, May-October 2008.

South Yuba River

The South Yuba River sites in 2008 all occurred downstream of Lake Spaulding, the last Drum-Spaulding Project facility on the South Yuba River. The confluence with Canyon Creek provides the last inflow of Yuba-Bear Hydroelectric Project affected water to the South Yuba River. In general, temperatures in the South Yuba River increased from the upstream to the downstream locations. Figure 11 shows the daily mean temperatures for site locations in the South Yuba River.

The most apparent temperature phenomenon derived from the data is the large increase in summer mean daily water temperatures on an eight-mile stretch of the South Yuba River between the confluences of Jordan Creek (RM 40.2) and Canyon Creek (RM 32.4). Temperatures consistently increased by 6°C - 10°C between these two monitoring stations during the months of June through September, with the increase peaking in mid-July. Another, more subtle temperature phenomenon identified by the data was the decrease in daily mean water temperature in late July and late September recorded at the monitoring location in the South Yuba River above Poorman Creek (WT20). These data correspond with an increase in flows

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into Canyon Creek, a tributary to the South Yuba River, which confluences upstream of Poorman Creek. This trend in water temperatures was much less apparent at the next downstream station (South Yuba River upstream of Humbug Creek). In addition, the three monitoring stations in Canyon Creek between Bowman Lake and the South Yuba River all show a decrease in daily temperatures during this period. These temperature decreases are due to a 5-day increase in flows released down Canyon Creek in support of the Relicensing Instream Flow study.

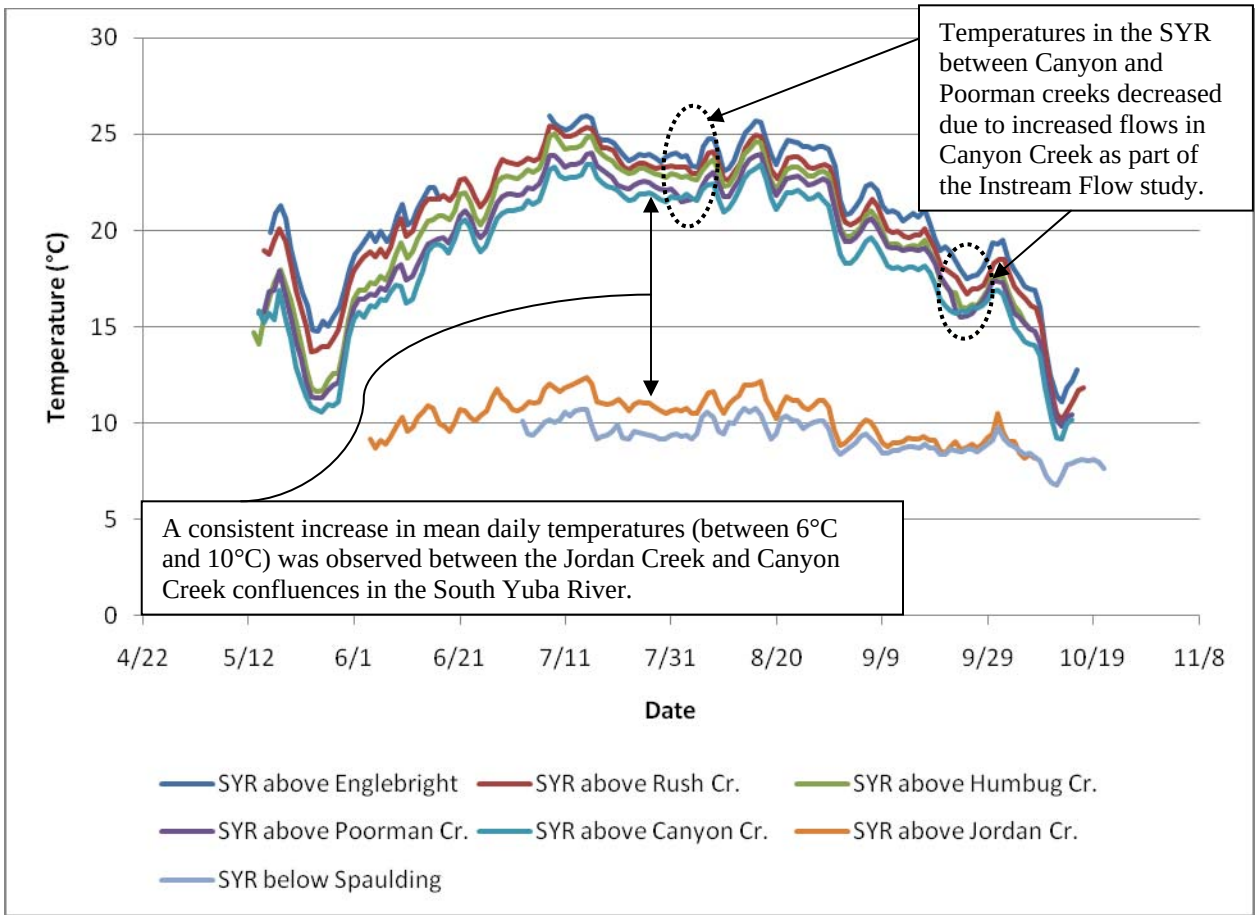

Figure 11. Mean daily water temperatures at South Yuba River monitoring sites, May-October 2008.

Reservoir Water Temperature Profile

In general, water temperature profiles collected during the 2008 monitoring period were consistent with historical profiles taken in the same reservoirs and general trends expected in larger reservoirs. Profiles taken in Bowman Lake, Fordyce Lake, and Lake Spaulding were similar to those in the Upper Yuba River Studies Program Report (UYRSP 2007). In addition, similar profiles were collected in these three reservoirs as well as Rollins Reservoir in 2007. Historical water temperature profiles collected prior to 2008 by the Licensees and the UYRSP can be found in Licensees' Pre-Application Documents (PAD).

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5.0 Study Proposal Consultation

On May 27, 2008, Licensees invited Relicensing Participants into the field to comment on specific sampling locations for stream temperature monitoring and reservoir profile locations.

6.0 Variances from the Study Proposal

The following items were variances from the study proposal. In each instance, an explanation is provided as well as how the variance affected the overall study goals.

Stream Temperature Monitoring

In general, some high elevation monitoring locations were not installed until early July 2008 due to remnant snow and road access. In October 2008, Licensees installed some loggers for overwintering and to capture the spring 2009 runoff period even if access to the sites is delayed. Sites installed for overwintering are listed in Table 1 in the beginning of this technical memorandum. Additional sites may be installed by helicopter if road access is an issue in spring 2009.

No temperature logger was installed in Wilson Creek below the Wilson Creek Diversion Dam. When Licensees arrived at this location in June 2008, the streambed was dry. Water temperatures above the Wilson Creek Diversion were reordered for the entire monitoring period.

Spot discharge measurements were not taken in the Middle and South Yuba Rivers due to difficulty in accurately measuring discharge with the equipment used for smaller tributaries (propeller-type velocimeter on rod). However, stages and discharges in the Middle Yuba River were measured in 2008 as part of the Instream Flow Study. It is anticipated that similar stage-discharge measurements will be taken in the South Yuba River in 2009 as part of the Instream Flow Study. In addition, some spot discharge measurements were not taken due to equipment failure, but at least one measurement was taken at each of the required locations. Stream flow estimates from adjacent drainages with similar hydrologic characteristics will be used to provide additional calibration at these locations.

Reservoir Water Temperature Profiling

Water temperature profiles were not recorded at Lake Spaulding at both the near-dam and mid-reservoir location in October and the mid-reservoir location in September due to unsafe boating conditions and access. While the data in 2008 did not include the fall turnover in Lake Spaulding, historical profiles are available from 2004 and 2007 and can be found in the PADs. Dissolved oxygen was not measured at the above locations where access was an issue. In addition, DO was not collected in Lake Valley (June) and Meadow Lake (July) due to a malfunction of the DO sensor.

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7.0 Schedule

The study is on schedule.

8.0 Attachments to this Technical Memorandum

This section includes the following attachments on CD:

Attachment 2-2A	2008 Stream Temperature Location Map (.pdf)
Attachment 2-2B	2008 Stream Temperature Plots (.pdf)
Attachment 2-2C	2008 Stream Temperature DSS Data (.pdf, .dss)
Attachment 2-2D	2008 Stream Temperature Raw Data (.xls)

9.0 References Cited

California Data Exchange Center, 2009, Selected Meteorological Data. http://cdec.water.ca.gov. Accessed December 2008.

Upper Yuba River Studies Program Study Team. 2007. Upper Yuba River Watershed Chinook Salmon and Steelhead Habitat Assessment. Prepared for California Department of Water Resources.

Wahl, K.L., Thomas Jr., W.O., and Hirsch, R.M., 1995, Stream-Gaging Program of the U.S. Geological Survey: U.S. Geological Survey Circular 1123, Reston, Va. From http://pubs.water.usgs.gov/circ1123. Accessed December 5, 2008.

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