TECHNICAL MEMORANDUM 2-2

Water Temperature Monitoring

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

Drum-Spaulding Project
FERC Project No. 2310-173

February 2010

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TECHNICAL MEMORANDUM 2-2

Executive Summary

During 2008 and 2009, Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E), collectively referred to as "Licensees," monitored water temperature at 81 sites in 11 river basins potentially affected by NID's Yuba-Bear Hydroelectric Project and PG&E's Drum-Spaulding Project. The sites included 73 stream temperature sites, 7 water conveyance conduit sites, and 4 reservoir sites. In approximately half of the stream reach sites, duplicate temperature loggers were installed to guard against vandalism in higher use areas. In addition, continuous stream stage recorders were installed and field discharge measurements were taken at designated monitoring locations to develop estimates of discharge in ungaged stream locations. This study was conducted according to Study 2.2.2, Water Temperature Monitoring, and FERC's Study Determination.

Data collected went through a QA/QC process to identify data gaps caused by vandalism, recorder malfunction, or partial recorder dewatering due to low flows. 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 and 2009) and some Licensees-collected data. Stream flows were provided from either permanent Licensee gages or were estimated using spot discharge and stage data.

Reservoir water temperature and dissolved oxygen (DO) vertical profiles were recorded at eight project reservoirs: the Yuba-Bear Hydroelectric Project's Jackson Meadows Reservoir, Sawmill Lake, Bowman Lake and Rollins Reservoir and Drum-Spaulding Project's Meadow Lake, Fordyce Lake, Lake Valley Reservoir and Lake Spaulding. Water temperature (±0.2 degrees Celsius, [°C]) and DO (±0.2 milligrams per liter [mg/L]) were recorded using a Hydrolab multi-parameter water quality monitoring sonde. Data were recorded in the deepest part of the reservoir at approximately 10-foot (ft) intervals, except near the thermocline, where smaller intervals were used. Water temperature profiles were plotted with elevation in order to accurately compare profiles taken on different dates and to describe water temperatures in proximity to each reservoir's low-level outlet.

Mean daily water temperature in streams below project facilities was less than 20°C with the following exceptions:

- Generally from June through August in the Middle Yuba River from immediately above Wolf Creek to Yuba County Water Agency's Our House Diversion Dam (maximum mean daily water temperature recorded was 25.01°C in July 2009)
- In August in Rucker Creek above the Bowman-Spaulding Conduit (maximum mean daily water temperature recorded was 20.41°C in 2008)

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- Generally from June through September in the South Yuba River from above Canyon Creek to United States Army Corps of Engineer's Englebright Reservoir (maximum mean daily water temperature recorded was 26.50°C in July 2009)
- In July and August in Canyon Creek immediately upstream of the confluence with the South Yuba River (maximum mean daily water temperature recorded was 22.2°C in July 2009)
- In July and August in the Bear River immediately upstream of the Chicago Park Powerhouse (maximum mean daily water temperature recorded was 21.28°C in July 2009)
- In August and September in the Bear River immediately upstream of Combie Lake (maximum mean daily water temperature recorded was 20.37°C in July 2008)

In addition, surface water in some project reservoirs is greater than 20°C in summer months.

Licensees found there was no usable storage below the 5°C isotherm in the six larger project reservoirs. Jackson Meadows Reservoir had approximately 2,100 ac-ft in July and 761 ac-ft in August 2009 below the 5°C isotherm, all of which was below the elevation of the low-level outlet. Jackson Meadows Reservoir had a maximum of 38,176 ac-ft below the 15°C isotherm in October 2009 and 29,628 ac-ft below the 10°C isotherm in July 2009. Bowman Lake had a maximum of 41,217 ac-ft below the 15°C isotherm in October 2009 and 8,300 ac-ft below the 10°C isotherm in July 2008. Rollins Reservoir had a maximum of 58,682 ac-ft below the 15°C isotherm and 33,900 below the 10°C in May 2009. Lake Spaulding had a maximum of 50,952 ac-ft below the 15°C isotherm in October 2009 and 3,300 ac-ft below the 10°C isotherm in July 2009. Fordyce Lake had a maximum of 27,600 ac-ft below the 15°C isotherm and 20,600 ac-ft below the 10°C isotherm in July 2008. Lake Valley Reservoir had a maximum of 5,600 ac-ft below the 15°C isotherm in June 2008 and 1,500 ac-ft below the 10°C isotherm in June 2009.

There were a small number of variances from the FERC-approved study (e.g., missing data) in 2008 due to adverse weather conditions, unsafe sampling conditions, and equipment malfunction. Licensees were able to realize a substantial reduction in variances in 2009 due to improved logistics and additional duplicate recorders at high-traffic locations. The variances are minor and did not affect the study.

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Attachment 2-2A	Stream Temperature and Reservoir Profile Location Map [1 Adobe PDF file: 9 MB; 1 page formatted to print on 36 by 52 paper]
Attachment 2-2B	Stream Temperature Plots [1 Adobe PDF file: 16 MB; 164 pages formatted to print double sided on 8 ½ by 11 paper]
Attachment 2-2C	Reservoir Water Temperature and Dissolved Oxygen Data [1 Microsoft Word file: 1.5 MB; 22 pages formatted to print double sided on 8 ½ by 11 paper]
Attachment 2-2D	Stream Temperature DSS Data [1 Adobe PDF file: 22 kB; 2 pages formatted to print single sided on 8 ½ by 11 paper and 1 dss file: 1.5 MB]
Attachment 2-2E	Stream Temperature and Reservoir Profile Raw Data [1 Adobe PDF file: 7 kB; 1 page formatted to print on 8 ½ by 11 paper, and 1 CD available upon request]

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TECHNICAL MEMORANDUM 2-2

Water Temperature Monitoring[1]

1.0 Goals and Objectives

The goal of this study was to characterize water temperatures within reservoirs and stream reaches potentially affected by Nevada Irrigation District's (NID) Yuba-Bear Hydroelectric Project and Pacific Gas and Electric Company's (PG&E) Drum-Spaulding Project.[2] The results of this study were also intended to be used in water temperature models being developed by Licensees as part of the Water Temperature Modeling Study (Study 2.2.3).

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.

2.1 Install Stream Water Temperature Recorders

In spring 2008 and 2009, 81 water temperature monitoring sites—including 70 stream temperature sites, 7 conduit sites, and 4 reservoir sites—were established. Table 2.1-1 provides a list of monitoring locations and their respective station identification codes (e.g., WT2), approximate elevation, Universal Transverse Mercator (UTM) coordinates, installation date, and removal date. A map showing the locations of the stream temperature monitoring stations is provided in Attachment 2-2A. Three additional stream temperature sites were installed in 2009, one each in the Middle Yuba River below Jackson Meadows Reservoir, in the South Yuba River above Lake Spaulding and the Bear River below Dutch Flat Afterbay.

At each monitoring location, a HOBO Water Temp Pro V2 logger manufactured by Onset Corporation was installed in a durable protective housing (Figure 2.1-1) 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 was disguised as much as possible while ensuring the ability to retrieve the unit for future downloads.

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[1] This technical memorandum presents results for Study 2.2.2 Water Temperature Monitoring, that was included in Licensees' Revised Study Plans filed with FERC on January 23, 2009, and approved by FERC's Study Determination on February 23, 2009. 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.

[2] Within this technical memorandum, NID and PG&E are referred to individually as "Licensee" and collectively as "Licensees," and the Yuba-Bear Hydroelectric Project and Drum-Spaulding Project are referred to individually as "Project" and jointly as "projects."

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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.

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Table 2.1-1. Continuous stream and reservoir water temperature monitoring location information.

Reach/Location (Responsible Licensee[s])	Location	Map/Station ID	River Mile	Approximate Elevation (nearest 10 ft)	UTM Coordinates		Installation Date	Removal Date
					Easting	Northing		
MIDDLE YUBA RIVER SUB-BASIN								
Jackson Meadows Diversion Dam Reach (NID)	MYR below Jackson Meadows Dam	JM1	46.7	5,800	709801	4366891	6/10/09	10/15/09
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
							6/12/09	10/15/09
Milton Diversion Dam Reach (NID)	MYR below Milton Diversion Dam	WT8	44.4	5,640	706904	4377488	6/3/08	10/10/08
							6/12/09	10/15/09
Milton Diversion Dam Reach (NID)	MYR above East Fork Creek	WT7	34.6	4,100	698955	4375845	7/1/08	10/7/08
							6/11/09	9/22/09
East Fork Creek (NID)	East Fork Creek above MYR	WT6	34.6	5,260	700463	4373149	7/1/08	10/15/08
							6/12/09	10/15/09
Milton Diversion Dam Reach (NID)	MYR above Wolf Creek	WT5	26.9	2,980	688857	4367781	6/3/08	10/21/08
							5/15/09	10/12/09
Wolf Creek (NID)	Wolf Creek above MYR	WT4	26.9	2,980	688840	4367829	6/3/08	10/21/08
							5/15/09	10/12/09
Milton Diversion Dam Reach (NID)	MYR above Kanaka Creek	WT3	17.5	2,200	677071	4365376	5/13/08	10/21/08
							5/15/09	10/13/09
Kanaka Creek (NID)	Kanaka Creek above MYR	WT2	17.5	2,200	677004	4365400	5/13/08	10/21/08
							5/15/09	10/13/09
Milton Diversion Dam Reach (NID)	MYR above Our House Diversion Impoundment	WT1	12.8	2,020	672684	4364578	5/13/08	10/21/08
							5/14/09	10/13/09
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
							5/15/09	10/14/09
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
							4/15/09	8/20/09
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
							4/1/09	10/16/09
Faucherie Lake Dam Reach (NID)	Canyon Creek above Sawmill Lake	WT43	14.8	5,900	707380	4368403	6/3/08	10/10/08
							6/12/09	10/16/09
Sawmill Lake Dam Reach (NID)	Canyon Creek above Bowman Lake	WT44	13.3	5,570	705564	4369888	6/3/08	10/10/08
							6/12/09	10/16/09
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
							6/12/09	10/16/09

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Table 2.1-1. (continued)

Reach/Location (Responsible Licensee[s])	Location	Map/Station ID	River Mile	Approximate Elevation (nearest 10 ft)	UTM Coordinates		Installation Date	Removal Date
					Easting	Northing		
Milton-Bowman Tunnel (NID)	Milton-Bowman Tunnel at outfall to Bowman Lake	WT46	--	5,620	705526	4370594	6/3/08	10/10/08
							6/12/09	10/16/09
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
							4/1/09	10/15/09
Bowman-Spaulding Conduit (NID)	Bowman-Spaulding Conduit below BSC Diversion Dam	WT48	--	5,430	701446	4368154	6/3/08	10/8/08
							5/20/09	10/15/09
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
							6/11/09	10/15/09
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
							5/18/09	10/15/08
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
							5/18/09	9/30/09
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
							6/11/09	9/22/09
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
							5/15/09	10/14/09
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
							5/18/09	9/11/09
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
							5/18/09	10/15/09
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
							5/14/09	10/14/09
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
							5/18/09	10/14/09
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
							5/18/09	8/7/09
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
							5/18/09	10/7/09
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
							5/18/09	10/15/09
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
							5/18/09	9/11/09

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Table 2.1-1. (continued)

Reach/Location (Responsible Licensee[s])	Location	Map/Station ID	River Mile	Approximate Elevation (nearest 10 ft)	UTM Coordinates		Installation Date	Removal Date
					Easting	Northing		
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
							6/9/09	10/14/09
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
							6/11/09	10/16/09
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
							6/9/09	10/11/09
Lake Sterling Dam Reach (PG&E)	Bloody Creek above Fordyce Lake	WT38	0.1	6,410	715548	4359620	6/23/08	10/9/08
							6/9/09	10/11/09
Fordyce Lake Dam Reach (PG&E)	Fordyce Creek below Fordyce Dam	WT37	10.3	6,250	715371	4361888	6/23/08	10/9/08
							4/1/09	10/11/09
Fordyce Lake Dam Reach (PG&E)	Fordyce Creek above Lake Spaulding	WT36	0.3	5,040	705339	4358726	6/11/08	10/8/08
							6/10/09	10/14/09
SOUTH YUBA RIVER SUB-BASIN								
Upper South Yuba Reach #2 (PG&E)	SYR above Lake Spaulding	SYR1	43.4	5,140	706853	4356514	6/10/09	10/11/09
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
							4/1/09	10/13/09
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
							5/12/09	10/13/09
Bowman-Spaulding Conduit (NID and PG&E)	B-S Canal below Fuller Lake	WT27	--	5,350	702840	4357520	6/4/08	10/8/08
							5/12/09	10/14/09
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
							5/12/09	10/13/09
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
							4/1/09	10/12/09
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
							4/1/09	10/14/09
Diamond Creek (PG&E and NID)	Diamond Creek above SYR	WT23	33.2	2,990	695270	4358454	6/3/08	10/7/08
							4/14/09	10/14/09
Spring Creek (PG&E and NID)	Spring Creek above SYR	WT16	14.9	1,940	673365	4355611	5/13/08	10/17/08
							4/15/09	10/12/09
Rock Creek (PG&E and NID)	Rock Creek above SYR	WT15	10.1	1,580	668195	4353202	5/15/08	10/30/08
							5/13/09	10/13/09

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Table 2.1-1. (continued)

Reach/Location (Responsible Licensee[s])	Location	Map/Station ID	River Mile	Approximate Elevation (nearest 10 ft)	UTM Coordinates		Installation Date	Removal Date
					Easting	Northing		
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
							5/2/09	10/11/09
Poorman Creek (PG&E and NID)	Poorman Creek above SYR	WT19	28.1	2,500	688539	4358372	5/14/08	10/15/08
							4/15/09	10/12/09
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
							5/14/09	10/11/09
Humbug Creek (PG&E and NID)	Humbug Creek above SYR	WT17	19.5	2,150	678236	4356406	5/13/08	10/7/08
							5/13/09	10/11/09
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
							4/15/09	10/11/09
Rush Creek (PG&E and NID)	Rush Creek above SYR	WT13	6.2	1,070	663470	4350862	5/15/08	10/17/08
							4/15/09	10/12/09
Shady Creek (PG&E and NID)	Shady Creek above SYR	WT12	5.0	1,000	661817	4351261	5/18/08	10/7/08
							5/25/09	10/25/09
South Yuba Reach #6 (PG&E and NID)	SYR above Englebright Reservoir	WT11	0.1	550	655873	4350818	5/15/08	10/17/08
							4/1/09	10/13/09
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
							5/13/09	10/12/09
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
							5/12/09	10/13/09
Bear River Reach #2 (PG&E)	Bear River above Drum Afterbay	WT58	27.4	3,360	692708	4347838	5/13/08	10/7/08
							4/1/09	10/12/09
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
							5/12/09	10/13/09
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
							6/13/09	9/22/09
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
							5/13/09	10/14/09
Dutch Flat Afterbay Dam Reach (NID)	Bear River below Dutch Flat Afterbay	BR1	21.3	2,600	685934	4342700	5/13/09	10/28/09
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
							5/14/09	10/14/09
Steephollow Creek Reach (NID)	Steephollow Creek above Bear River	WT63	15.5	2,220	676415	4333356	5/14/08	10/7/08
							5/12/09	10/14/09

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Table 2.1-1. (continued)

Reach/Location (Responsible Licensee[s])	Location	Map/Station ID	River Mile	Approximate Elevation (nearest 10 ft)	UTM Coordinates		Installation Date	Removal Date
					Easting	Northing		
Chicago Park Powerhouse Reach (NID)	Bear River above Steephollow Creek	WT64	15.7	2,220	681991	4338426	5/14/08	10/7/08
							4/8/09	10/14/09
Greenhorn Creek Reach (NID)	Greenhorn Creek above Rollins Reservoir	WT65	--	2,220	677767	4339426	5/14/08	10/7/08
							4/8/09	10/12/09
Chicago Park Powerhouse Reach (NID)	Bear River above Rollins Reservoir	WT66	15.3	2,220	681582	4338334	5/14/08	10/7/08
							4/1/09	10/14/09
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
							4/8/09	10/14/09
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
							4/16/09	10/14/09
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
							4/16/09	9/16/09
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
							4/16/09	10/14/09
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
							5/12/09	10/12/09
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
							5/12/09	10/14/09
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
							5/12/09	10/12/09
COON CREEK SUB-BASIN								
Dry Creek (PG&E)	Dry Creek above Halsey Afterbay	WT74	--	1,520	670067	4313740	5/15/08	10/6/08
							5/11/09	10/14/09
Wise Canal (PG&E)	Wise Canal below Halsey Afterbay (YB-61)	WT75	--	1,520	669517	4313663	5/15/08	10/6/08
							4/16/09	10/14/09
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
							5/11/09	10/14/09
Wise Powerhouse Overflow Reach (PG&E)	South Canal below Wise PH	WT77	--	890	664638	4306224	5/23/08	10/6/08
							4/16/09	10/14/09
RESERVOIR WATER TEMPERATURE GAGES								
(NID)	Dutch Flat Afterbay (Dam)	WT80	21.3	2,730	686410	4342793	5/13/08	10/7/08
							4/8/09	10/14/09

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Table 2.1-1. (continued)

Reach/Location (Responsible Licensee[s])	Location	Map/Station ID	River Mile	Approximate Elevation (nearest 10 ft)	UTM Coordinates		Installation Date	Removal Date
					Easting	Northing		
(NID)	Chicago Park Forebay (Dam)	WT81	--	2,750	683401	4340317	5/14/08	10/7/08
							5/13/09	10/14/09
(PG&E)	Rock Creek Reservoir (Dam)	WT82	2.1	1,440	665521	4312430	5/15/08	10/6/08
							4/16/09	10/14/09
(PG&E)	Wise Forebay (Dam)	WT83	--	1,400	666021	4308767	5/15/08	10/6/08
							4/16/09	10/14/09

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Figure 2.1-1. Photograph of water temperature recorder housing.

2.2 Install Stage Recorders

Solinst® Model 3001 Leveloggers with internal data loggers were used to measure stage and temperature every 15 minutes. These loggers are factory calibrated and have a level accuracy of ±0.010 ft and a temperature accuracy ±0.05°C. The accuracy of each logger was checked at least once a month by comparing the instrument reading to the actual water depth. Air and water temperatures were checked against instantaneous readings taken during discharge measurements.

For this type of instrumentation, stream stage is related to absolute pressure, which is a combination of water pressure and atmospheric pressure. Readings were taken to continuously measure stream stage. At each site, a level logger was submerged at a fixed location within a stilling well (Figure 2.2-1) to measure the submerged water pressure. At three of the sites at the low and high elevations of the Middle Yuba River and South Yuba River, Solinst® Barologgers were installed to measure atmospheric pressure and temperature. The atmospheric pressure values were used to calculate the true net water levels of the submerged loggers.

Table 2.2-1. 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

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Table 2.2-1. (continued)

Location	Station ID
East Fork Creek above Middle Yuba River	WT6
Middle Yuba River above East Fork Creek	WT7
South Yuba River above Englebright Reservoir	WT11
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

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 re-placed as close to its original position as was possible.

Figure 2.2-1. Photograph of stage recorder stilling well housing.

2.3 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)

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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. Raw data is available in Attachment 2-2E.

2.3.1 Collect Stream Discharge Measurements

Stream discharge (i.e., stream flow) measurements were taken at each site following United States Geological Survey (USGS)-approved methods. Measurements were performed by wading the wetted stream channel at each monitoring site. Licensees did not take high flow measurements when flows were considered unsafe to wade.

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 2.3-1 shows the locations where discharge measurements were taken. The equipment used to take flow measurements included a 4-ft top-set wading rod, JBS Instruments AquaCalc Pro 5000 Stream Flow Computer, and either a Scientific Instruments Price AA or Pygmy mechanical velocity meter.

For water depths less than 2.5 ft, a velocity was measured at each vertical (station along the cross-section) at six-tenths of the total depth and taken as mean column velocity. For water depths between 2.5 and 4 ft, the velocity was measured at two-tenths and eight-tenths depth in accordance with USGS methods. For channels with wetted widths wider than 5 ft, a total of 18–25 readings were taken across the channel. For narrower channels, particularly those with wetted widths less than 2 ft, velocity readings were taken per the USGS Width-Depth Ratio method.

Discharge measurements were entered and cataloged into a standard format using the AquaCalc Pro 5000 Stream Flow Computer. Discharge measurements were calculated in the field to validate that no one vertical had more than 10 percent of the total flow (with the exception of small streams). If more than 10 percent was measured in any one cell, then, if possible, additional velocity measurements were made to maintain measurement accuracy standards. A goal of the study was to achieve ±10 percent accuracy for discharge measurements. Although discharge measurements were made at the best possible location, irregular, steep, rocky stream channels often have a limited number of channel cross-sections with uniform and laminar flow. These areas are often narrow, limiting the number of velocity readings that can be made, thereby reducing the measurement accuracy.

Licensees' hydrologists classified the quality of each discharge measurement taken. This classification considered several site conditions, including channel and bed uniformity, number of verticals, and flow turbulence. All of the discharge measurements were included in the final rating tables. Each measurement was classified as good, fair, or poor. Poor measurements were qualified in the rating curve database and are considered less accurate (±20 percent error) than

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good measurements (±10 percent). Several of the sites are rated as poor; at these sites, no fair or good measurements were possible due to stream channel irregularities and turbulence caused by boulders.

Indirect discharge measurement methods were used to estimate discharge when one of the following conditions occurred: the stream channel was unsafe to wade due to high stage and/or velocity; highly irregular stream channel cross-sections limited discharge measurement quality (e.g., boulder bedrock channels), or data points were missing. Because neither cross-sectional nor longitudinal stream channel data were available at these sites, the unit discharge method was used to estimate discharge. This method established a ratio between the quotient of measured discharge and drainage area of an adjacent or upstream watershed, multiplied by the drainage area of the unmeasured site to estimate discharge for a given time and/or stage.

Table 2.3-1. Locations where discharge measurements were taken during 2008 and 2009 monitoring.

Location	Station/Map 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
Middle Yuba River above East Fork Creek	WT7
South Yuba River above Englebright	WT11
Rush Creek above South Yuba River	WT13
South Yuba River above Rush Creek	WT14
Rock Creek above South Yuba River	WT15
Spring Creek above South Yuba River	WT16
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
Diamond Creek above South Yuba River	WT23
Jordan Creek above South Yuba River	WT24
South Yuba River above Jordan Creek	WT25
Fall Creek above South Yuba River	WT29
Rucker Creek above South Yuba River	WT32

2.4 Collect Reservoir Temperature and Dissolved Oxygen Profiles

Water temperature and dissolved oxygen (DO) profiles were taken at eight project reservoirs. Water temperature (±0.2 degrees Celsius [°C]) and DO (±0.2 milligrams per liter [mg/L]) were recorded using a Hydrolab multi-parameter water quality monitoring sonde. Data were recorded in 10-ft intervals starting from 0.5 to 1 ft below the surface and continuing to the bottom. The location and timing of reservoir profiles are presented in Table 2.4-1.

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Table 2.4-1. Reservoir water temperature and dissolved oxygen monitoring locations and timing.

Location (Facility Owner)	Profile Date(s)
YUBA-BEAR HYDROELECTRIC PROJECT	
Jackson Meadows Reservoir	Monthly from July-October 2009
Sawmill Lake	Two weeks after spill; July 2008 and 2009
Bowman Lake	Monthly from July–October, 2008 and 2009
Rollins Reservoir	Monthly from May–October, 2008 and 2009
DRUM-SPAULDING PROJECT	
Meadow Lake	One profile in September 2008 and 2009
Fordyce Lake[1]	Monthly from July–October, 2008 and 2009
Lake Spaulding[2]	Monthly from July–October, 2008 and 2009
Lake Valley Reservoir	One profile in June and August, 2008 and 2009

[1] No data collected in August 2008 due to equipment issues
[2] No data collected in October 2008 due to access issues and weather

2.4.1 Estimate Useable Storage Below 5°C, 10°C, and 15°C Isotherms

An estimate of the useable storage below the 5°C, 10°C, and 15°C isotherms was generated for Jackson Meadows Reservoir, Bowman Lake, Rollins Reservoir, Fordyce Lake, Lake Spaulding, and Lake Valley Reservoir. Reservoir pool and low-level outlet elevations were compared against elevations where the observed water temperature crossed the 5°C, 10°C, and 15°C thresholds. The useable storage differential between the temperature threshold elevation and the low-level outlet elevation was then calculated. As temperature isotherms are typically not completely horizontal across a reservoir (especially where influenced by lower-level releases), additional mid-reservoir profiles were utilized, where available, to improve the accuracy of the volume estimates. The results of this analysis should be considered to be gross estimates, and water temperature models being built for the larger reservoirs listed in Table 2.4-1 will be able to provide more accurate estimates of isothermal surfaces and associated useable volumes.

2.4.2 Lake Spaulding Thermal Underflow/Stratification Analysis

Licensees collected underwater velocity measurements in the vicinity of the Spaulding No. 3 Powerhouse outfall within Lake Spaulding in August 2008. In addition, measurements were taken in the submerged channel thalweg near Spaulding Dam No. 1 and at the mouths of Fordyce Creek and South Yuba River at the upstream end of the reservoir (Fordyce Creek represented an even more significant source of cold water at the time of the study due to whitewater boating survey flows, and the South Yuba River was used as a control). A split-beam Acoustic Doppler Current Profiler (ADCP) was used to generate vertical profiles of velocity fields in the x-y plane at multiple locations. Water temperature profiles were taken coincident to all ADCP locations using a Hydrolab multi-parameter water quality monitoring sonde to provide a better understanding of the local thermodynamics (Figure 2.4-1).

In 2009, based on the inconclusive results of the ADCP methods for determining underflow currents and thermal mixing potential, Licensees collected additional temperature profiles during a range of release flows from Fordyce Creek.

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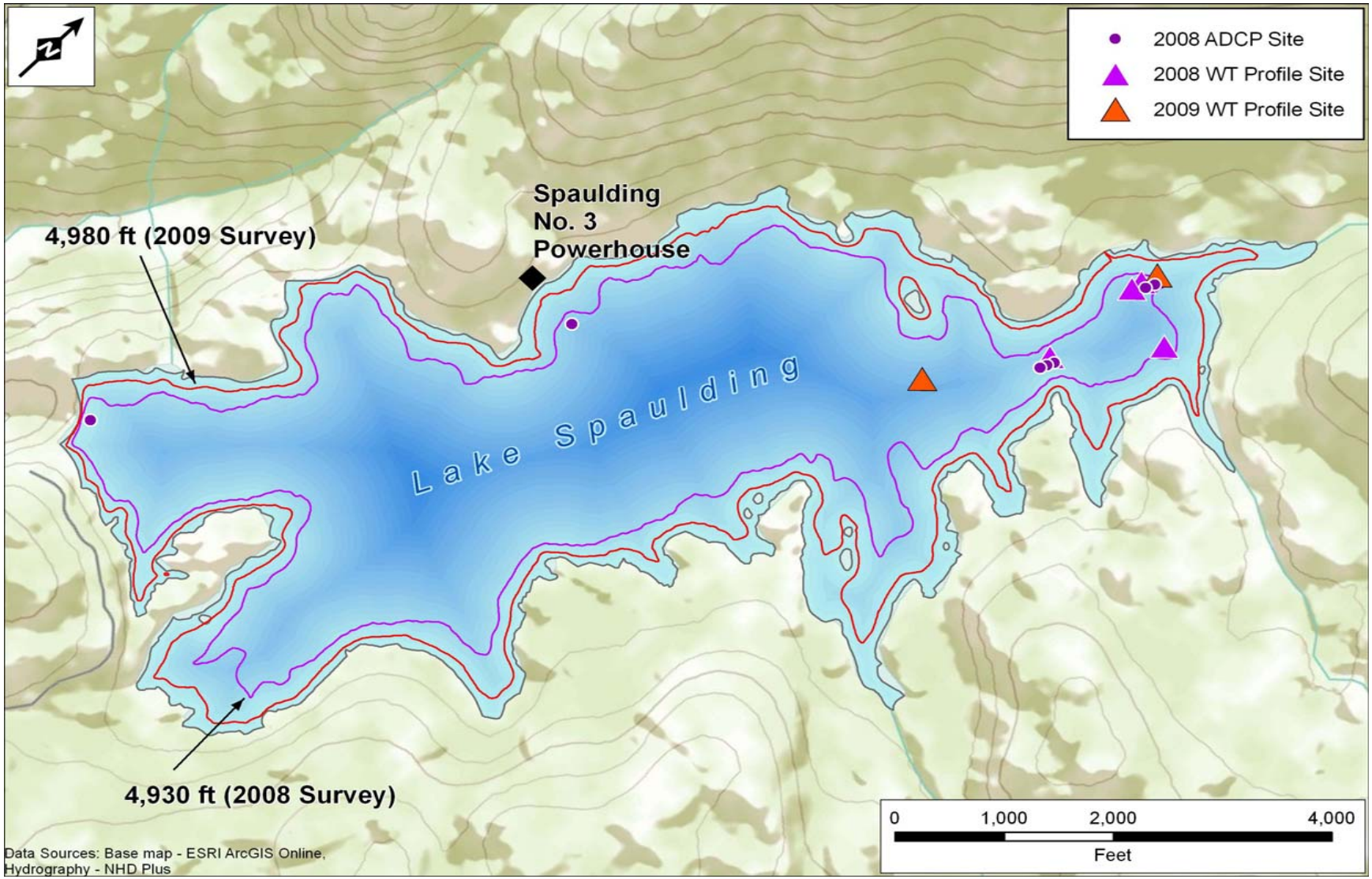

Figure 2.4-1. Overview map of ADCP and water temperature profile locations for Lake Spaulding Thermal Underflow/Stratification Analysis.

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2.5 QA/QC of Stream Water Temperature Data

QA/QC was performed on the data for each thermograph, including a 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 is provided to the greatest extent possible. During the 2008 and 2009 monitoring period, there were data gaps caused by vandalism, equipment failure, or fluctuating water levels. In a few instances, recorders were installed or serviced during a high-flow period and were not able to be placed directly into the thalweg; this led to short durations of recorders being out of water until the following month's visit. These gaps represent a small percentage of the total data points collected throughout the monitoring period. Table 2.5-1 shows monitoring locations where there are data gaps and an explanation for each gap.

Table 2.5-1. 2008 and 2009 stream monitoring locations and associated data gaps with explanations.

Site	Location	Data Gaps (Reason)
11	South Yuba River above Englebright	6/18/08–7/7/08 (vandalism and recorder malfunction)
16	Spring Creek above South Yuba River	8/17/08–8/19/08 (vandalism)
23	Diamond Creek above South Yuba River	7/12/08–8/13/08 (logger malfunction), 6/7/09–6/11/09 (logger out of water), 6/11/09–7/22/09 (logger malfunction)
24	Jordan Creek above South Yuba River	6/6/09–6/10/09 (logger out of water)
27	Bowman-Spaulding Canal below Fuller Lake	6/8/08–6/20/08 (canal outage), 9/22/08–9/24/08 (canal outage), 6/8/09–6/20/09 (Canal outage), 9/27/09–10/7/09 (canal outage)
28	Trap Creek above Bowman-Spaulding Canal	6/8/08–6/20/08 (canal outage), 8/14/08–9/17/08 (equipment malfunction), 9/22/08–9/24/08 (canal outage), 8/19/09 (Trap Creek found dry after this date)
30	Fall Creek above Fall Creek Diversion	6/5/09–6/11/09 (logger malfunction)
31	Clear Creek above Bowman-Spaulding Canal	8/27/09 (Clear Creek found dry after this date)
33	Bowman-Spaulding Canal at Rucker Creek	6/7/09–6/18/09 (canal outage)
34	Rucker Creek above Bowman-Spaulding Canal	8/7/09–9/11/09 (vandalism), 9/11/09–10/13/09 (equipment malfunction)
38	Sterling Creek above Fordyce Lake	8/8/09–8/18/09 (logger out of water)
40	White Rock Creek below White Rock	8/21/09–9/5/09 (logger out of water)
41	Meadow Creek above Fordyce Lake	8/13/08–9/3/08 (reduced flow)
43	Canyon Creek above Sawmill Lake	6/19/08–7/10/08 (reduced flow)
48	Bowman-Spaulding Canal below Bowman-Spaulding Canal Diversion Dam	6/8/08–6/20/08 (canal outage), 9/22/08–9/24/08 (canal outage), 6/7/09–6/18/09 (canal outage)
51	Texas Creek above Lindsey Creek	9/10/09 (No data after this data due to logger vandalism)
54	South Fork Deer Creek below Deer Creek Powerhouse	7/1/09–7/20/09 (logger out of water), 8/20/09 (No data after this date due to logger malfunction)
61	Little Bear River below PCWA Diversion	5/10/09–5/12/09 (logger out of water)
63	Steephollow Creek above Bear River	6/12/08–7/8/08 (vandalism), 7/25/08–9/15/08 (vandalism and logger malfunction)
64	Bear River above Steephollow Creek	6/23/08–7/6/08 (reduced flow)
66	Bear River above Rollins Reservoir	6/23/08–7/6/08 (reduced flow)
68	Bear River near Milk Ranch Road	8/11/08–9/15/08 (vandalism or equipment malfunction)
69	Bear River above Lake Combie	5/11/09–6/12/09 (logger vandalism), 9/15/09 (no data after this date due to logger malfunction)
71	North Fork North Fork American River above Lake Valley Canal Diversion Dam	5/28/09–5/31/09 (logger out of water)
76	Auburn River above Wise Powerhouse	6/4/09–6/11/09 (logger out of water)
77	South Canal below Wise Powerhouse	8/12/08–9/15/08 (equipment malfunction)

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Table 2.5-1. (continued)

Site	Location	Data Gaps (Reason)
80	Dutch Flat Afterbay (Dam)	6/13/08–7/3/08 (reduced water level), 8/26/09, 9/19/09–10/5/09 (reduction in afterbay water level)
81	Chicago Park Forebay	9/20/09–10/5/09 (project outage at forebay)
82	Rock Creek Reservoir (Dam)	6/13/08–6/15/08 (vandalism), 8/17/08–8/18/08 (reduced water level), 9/30/08–10/2/08 (reduced water level)
SYR1	SYR above Lake Spaulding	7/3/09-7/18/09 (vandalism)

Data analyses included the calculation of the daily minimum, mean, and maximum water temperatures at each location. The daily mean temperatures at each of the monitoring locations were also compared to the daily mean air temperatures 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.

2.5.1 Stream Flow Record Computation

Over the 2009 study period, at least four discharge measurements were taken at each of the 23 sites to calibrate and maintain the stage-discharge rating curves in accordance with standard USGS stream gaging methods (Wahl et. al, 1995). At each site, a stage-discharge rating curve was developed by plotting the stage-discharge data pairs and electronically fitting a curve. Microsoft Excel and Golden Software's Grapher were used to manage and compute all stage and discharge rating curves.

Stream flow record computations were done according to USGS methods. The stage-discharge rating curves were used to compute flow for each 15-minute stage reading. A rating curve was developed and calibrated for each site. Typically, a power function was fit to the stage and discharge data pairs. The shape of the rating curve changes with additional discharge measurements over a wide range of flows or with stream channel geometry shifts. The range of stream flows measured at a given site limits the accuracy and application of each rating curve. For example, when stage exceeds the maximum discharge reading, the corresponding stream flow cannot be calculated as accurately. In this case, indirect methods were used to estimate peak stream flow. For this project, the unit area method was used to predict the peak stream flow event and a set of high-flow rating curves was developed.

The stream flow records are more accurate during baseflow periods. The goal was to achieve a stream flow record accuracy of less than ±15 percent during baseflow and less than ±25 percent during high flow. The accuracy of the flow records depends on the accuracy of the stage readings and discharge measurements. Again, the stage recorders have an accuracy of ±0.010 ft, and the accuracy of the discharge measurements ranges from ±15 percent to ±20 percent. In streams with wider cross-sections, the depth accuracy of the stage recorder will play a larger role in the overall accuracy of the discharge measurement.

For data collected in 2008, Licensees summarized the unshifted daily average stage readings, shifted them, and recalculated the stream flow records using discharge measurements taken in

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2008 and 2009. Given the completeness of the 2009 stream flow data set, the 2008 data were reanalyzed and improved using stage discharge relationships between the two years. Within-site and between-site relationships were used to improve the completeness and accuracy of the 2008 data set.

Licensees also used indirect discharge estimates to develop usable rating curves for the 2008 stage data. The rating curves used for these data are classified as synthetic in that they used all the available site-specific discharge measurements and data from the closest site with a calibrated rating curve. Due to the lack of discharge measurements and manual stage measurements in 2008, most of this record is rated as poor, with an accuracy that ranges from ±20 percent to ±30 percent.

3.0 Results

3.1 Meteorological Data

To provide background and context to the water temperature monitoring results below, mean air temperatures during the 2008 and 2009 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. These statistics are shown in Table 3.1-1 below. The Blue Canyon station was selected as representative for project climatology due to its location (situated fairly central to the Project Vicinity) and elevation (approximately 5,300 ft above mean sea level).

The data suggest that 2009 had a much wider seasonal distribution of high temperatures as compared to 2008 (May through September all had maximum daily means above 24°C), while no heat spell in 2009 matched that which occurred in July 2008. May 2009 was one of the warmest on record, while October 2009 was significantly cooler than average.

Table 3.1-1. 2008, 2009, and historical monthly mean of daily mean air temperatures at Blue Canyon.

Month	2008 Monthly Temperature (°C)			2009 Monthly Temperature (°C)			Historical Monthly Temperature (°C)[1]
	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Mean
May	2.5	11.4	22.2	8.5	17.4	25.1	11.3
June	9.8	16.8	21.8	7.6	15.4	25.0	16.8
July	16.0	20.4	26.6	11.1	20.7	25.1	20.4
August	14.9	20.4	25.1	8.4	19.3	24.7	20.4
September	10.2	16.5	22.3	7.3	18.6	24.1	16.5
October	1.3	11.0	17.6	1.2	9.3	15.7	11.2

[1] Historical Average Data = 1971–2000

Daily mean air temperature data for the 2008 and 2009 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. In some cases, Licensees-collected air temperature data were used if a local CDEC station was unavailable. These data are included on

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the water temperature plots in Attachment 2-2B. Table 3.1-2 provides the CDEC station codes, station description, and elevation for each reporting station used.

Table 3.1-2. CDEC stations reporting daily mean air temperatures.

CDEC Station Code	Station Description	Elevation (nearest 10 ft)
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

3.2 Stream Temperature Monitoring

Plots of the daily water temperature data for the 73 stream temperature sites, 7 conduit sites, and 4 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 3.2-1 provides a summary of the minimum and maximum mean daily temperatures by month at each of the stream monitoring sites. Mean daily water temperatures greater than 20°C are shaded. Locations with an asterisk indicate sites that are upstream of the Project influence. In addition, air and water temperature data are presented in DSS format in Attachment 2-2D. 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 3.2-1. 2008 and 2009 minimum and maximum daily average stream temperatures (°C) by month.

Location	River Mile	Year(s)	May		June		July		August		September		October	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
MIDDLE YUBA RIVER SUB-BASIN														
MYR below Jackson Meadows Dam	46.7	2009	No Data	No Data	5.51	6.39	5.89	7.04	6.29	7.33	7.0	7.97	6.94	8.53
Wilson Creek above Wilson Creek Diversion Dam*	0.3	2008	No Data	No Data	6.26	11.48	10.73	12.78	10.66	13.14	7.35	10.55	5.81	8.90
		2009	No Data	No Data	7.49	11.73	9.64	13.24	9.50	13.29	6.59	11.37	3.96	6.60
MYR below Milton Diversion Dam	44.4	2008	No Data	No Data	9.16	11.9	11.54	12.91	10.58	14.77	8.73	11.38	8.53	9.17
		2009	No Data	No Data	8.29	11.74	10.25	12.53	9.54	12.67	8.01	11.27	6.41	7.93
MYR above East Fork Creek	34.6	2008	No Data	No Data	No Data	No Data	12.84	14.12	12.38	13.7	9.96	12.12	9.13	10.07
		2009	No Data	No Data	9.91	13.37	12.01	14.05	11.81	13.97	10.00	12.28	5.97	9.55
East Fork Creek above MYR*	34.6	2008	No Data	No Data	No Data	No Data	12.24	14.94	11.93	14.99	10.01	12.78	5.61	10.97
		2009	No Data	No Data	8.93	14.26	12.49	15.35	12.16	15.24	8.74	12.98	6.8	8.88
MYR above Wolf Creek	26.9	2008	No Data	No Data	11.80	18.05	17.99	20.32	18.06	20.46	14.02	17.58	7.53	13.09
		2009	10.98	13.37	11.24	17.99	16.69	20.59	16.96	20.46	12.68	17.71	10.1	12.17
Wolf Creek above MYR*	26.9	2008	No Data	No Data	10.6	15.69	15.03	17.17	14.4	17.29	11.56	14.61	6.18	13.19
		2009	10.7	13.29	10.57	14.85	12.65	16.7	13.03	16.38	10.1	14.71	7.53	9.54
MYR above Kanaka Creek	17.5	2008	9.44	13.46	13.49	21.14	21.02	23.44	20.61	23.49	18.03	20.04	No Data	No Data
		2009	12.64	15.56	13.11	21.25	19.37	23.94	18.89	23.61	13.89	20.28	10.7	12.97
Kanaka Creek above MYR*	17.5	2008	9.8	16.65	13.67	19.97	19.47	21.85	18.98	21.75	14.85	18.64	7.84	16.06
		2009	13.91	17.36	13.18	19.88	17.5	22.25	17.12	21.74	13.28	18.75	10.12	12.48
MYR above Our House Diversion Impoundment	12.8	2008	10.11	14.37	14.26	21.91	21.8	24.21	21.49	24.38	16.78	21.09	8.62	16.41
		2009	12.53	16.49	13.91	22.21	20.43	25.01	20.1	24.63	15.25	21.43	11.89	14.44
DEER CREEK SUB-BASIN														
South Fork Deer Creek * above Deer Creek PH	3.0	2008	No Data	No Data	10.79	12.16	12.13	15.8	16.01	18.41	14.6	16.58	10.6	14.71
		2009	9.94	11.92	9.37	14.09	12.04	16.11	11.96	15.75	8.75	13.31	6.45	14.13
South Fork Deer Creek below Deer Creek PH	3.0	2008	6.75	10.41	8.76	14.63	14.07	15.98	13.33	15.92	10.11	15.12	5.51	14.76
		2009	6.88	10.06	8.05	13.12	13.95	18.59	13.95	16.74	No Data	No Data	No Data	No Data
CANYON CREEK SUB-BASIN														
Canyon Creek above Faucherie Reservoir	17.1	2008	No Data	No Data	9.0	15.39	10.46	17.37	14.76	17.53	11.69	15.26	11.48	15.05
		2009	2.21	11.57	9.7	16.49	14.58	18.34	13.89	18.16	9.59	14.87	8.47	11.07
Canyon Creek above Sawmill Lake	14.8	2008	No Data	No Data	11.1	14.18	15.99	18.6	17.24	19.51	15.37	19.05	13.14	15.46
		2009	No Data	No Data	12.38	16.66	14.52	17.98	14.32	18.52	14.37	19.22	9.21	13.9
Canyon Creek above Bowman Lake	13.3	2008	No Data	No Data	9.44	16.88	12.42	17.95	17.02	19.79	15.92	19.69	13.61	15.84
		2009	No Data	No Data	12.97	15.54	12.08	16.25	14.0	19.09	15.04	19.14	10.5	14.75
Jackson Creek below Prairie Creek and Bowman Reservoir	0.3	2008	No Data	No Data	8.38	11.08	10.34	11.46	10.43	11.89	9.37	11.00	8.55	10.23
		2009	No Data	No Data	8.46	10.93	9.8	12.06	9.69	11.94	8.73	11.24	7.64	9.47
Milton-Bowman Tunnel at outfall to Bowman Lake	--	2008	No Data	No Data	6.80	8.6	8.34	9.33	8.58	14.53	8.03	10.5	8.65	9.85
		2009	No Data	No Data	6.94	9.05	8.15	9.59	7.71	12.15	8.22	10.15	7.19	8.98

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Table 3.2-1. (continued)

Location	Station ID	Year(s)	May		June		July		August		September		October	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Canyon Creek below Bowman-Spaulding Diversion Dam	9.7	2008	No Data	No Data	9.71	13.64	11.03	12.56	11.1	15.72	13.98	15.65	13.14	14.89
		2009	6.1	7.56	7.43	12.91	10.18	12.63	11.12	14.11	12.99	15.27	11.23	13.41
Bowman-Spaulding Conduit below BSC Diversion Dam	--	2008	No Data	No Data	8.09	8.93	8.81	10.45	10.57	15.09	15.17	16.11	14.31	15.26
		2009	6.78	7.05	7.05	14.91	7.87	10.06	10.15	13.56	13.72	15.52	12.92	15.53
Texas Creek below Culbertson Lake	4.3	2008	No Data	No Data	10.21	14.49	14.48	17.73	15.45	18.23	13.5	16.82	10.87	13.98
		2009	No Data	No Data	9.85	14.79	13.76	18.64	13.73	18.87	14.07	17.8	8.56	13.81
Lindsey Creek above Texas Creek confluence	0.1	2008	No Data	No Data	9.78	13.4	12.45	14.73	11.88	14.71	9.47	12.91	8.76	10.81
		2009	10.15	12.99	9.66	14.39	11.84	15.82	12.11	16.34	9.60	15.85	5.72	9.99
Texas Creek above Lindsey Creek confluence	1.2	2008	No Data	No Data	10.34	13.99	12.82	15.34	12.31	14.92	9.04	12.60	8.06	10.5
		2009	10.89	13.16	8.65	14.39	11.43	15.47	10.68	15.16	10.52	12.91	No Data	No Data
Canyon Creek above Texas Creek confluence	6.2	2008	No Data	No Data	No Data	No Data	14.31	17.38	13.74	17.50	12.44	15.25	11.36	13.75
		2009	No Data	No Data	11.17	15.35	13.69	17.39	14.04	17.35	12.71	15.37	8.56	11.77
Little Canyon Creek above Canyon Creek*	1.2	2008	No Data	No Data	No Data	No Data	No Data	No Data	15.24	17.33	13.68	16.00	8.81	14.81
		2009	10.75	13.75	10.77	14.74	13.28	17.15	14.38	16.93	13.03	16.04	10.47	12.55
FALL CREEK SUB-BASIN														
Clear Creek above B-S Canal*	0.9	2008	No Data	No Data	7.72	12.6	12.4	15.22	11.67	14.54	10.39	12.98	No Data	No Data
		2009	8.49	10.63	7.86	13.38	11.61	15.57	12.38	15.54	No Data	No Data	No Data	No Data
Trap Creek above B-S Canal*	0.1	2008	No Data	No Data	6.57	11.11	11.04	14.08	14.08	14.64	No Data	No Data	No Data	No Data
		2009	7.38	9.02	7.59	11.63	10.86	15.86	12.06	15.76	No Data	No Data	No Data	No Data
Fall Creek above SYR confluence	0.2	2008	8.28	13.37	9.79	16.21	14.71	17.86	12.78	17.29	11.38	13.78	11.11	13.47
		2009	11.37	14.41	10.25	15.51	13.13	17.92	13.66	17.53	11.15	15.28	8.47	11.0
Fall Creek above Fall Creek Diversion Dam	2.1	2008	No Data	No Data	7.52	12.87	12.41	15.16	12.92	16.83	9.23	12.82	8.17	10.41
		2009	7.33	10.25	8.44	13.7	11.65	15.96	11.54	15.72	9.06	13.16	6.21	8.68
RUCKER CREEK SUB-BASIN														
Rucker Creek above Rucker Lake	2.3	2008	No Data	No Data	12.41	18.42	18.42	20.75	19.41	20.99	16.85	18.84	15.44	16.87
		2009	12.93	16.12	14.31	18.57	18.14	21.76	19.78	21.81	14.85	16.65	19.59	12.71
Rucker Creek above B-S Canal	1.4	2008	No Data	No Data	13.43	18.15	17.32	19.86	17.47	20.41	14.11	17.83	11.66	15.08
		2009	14.45	15.91	8	14.8	8.5	10.56	10.55	10.8	No Data	No Data	No Data	No Data
B-S Canal at Rucker Creek	1.2	2008	No Data	No Data	8.55	9.77	9.39	10.85	10.96	12.58	14.84	15.86	14.07	15.25
		2009	7.78	8.37	7.26	15.28	8.5	10.56	10.55	13.64	13.78	15.35	12.21	14.91
Rucker Creek above SYR	0.1	2008	No Data	No Data	9.49	14.43	13.96	16.35	14.06	16.25	11.99	14.31	10.95	13.22
		2009	8.49	10.63	7.86	13.38	11.61	15.57	12.38	15.54	9.23	13.25	7.51	11.67
FORDYCE CREEK SUB-BASIN														
Meadow Lake Dam Reach above Fordyce Lake	0.1	2008	No Data	No Data	12.34	14.67	13.74	16.47	13.15	15.27	12.43	15.58	10.14	13.06
		2009	No Data	No Data	8.74	14.65	12.15	17.23	11.69	17.05	8.9	14.91	5.06	20.4

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Table 3.2-1. (continued)

Location	Station ID	Year(s)	May		June		July		August		September		October	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
White Rock Creek below White Rock Dam	2.0	2008	No Data	No Data	12.71	15.01	14.39	16.73	14.2	17.42	8.44	15.08	9.09	12.06
		2009	No Data	No Data	4.03	15.27	14.19	18.35	15.73	18.52	12.65	15.81	7.63	12.18
North Creek above Fordyce Lake	0.1	2008	No Data	No Data	13.0	15.91	14.75	17.43	14.42	17.22	10.35	13.91	8.02	11.2
		2009	No Data	No Data	5.96	15.13	13.69	18.93	12.7	19.13	8.51	16.23	4.84	8.0
Bloody Creek above Fordyce Lake	0.1	2008	No Data	No Data	12.9	14.29	13.33	16.53	13.07	16.81	12.35	17.06	11.8	14.32
		2009	No Data	No Data	10.04	13.18	12.39	17.39	13.98	17.54	9.16	14.71	7.38	10.71
Fordyce Creek below Fordyce Dam	10.3	2008	No Data	No Data	7.26	7.42	7.45	8.03	7.52	8.8	8.57	14.26	13.6	14.36
		2009	1.92	5.15	5.22	6.79	6.22	7.7	7.78	15.81	14.22	16.98	9.7	13.67
Fordyce Creek above Lake Spaulding	0.3	2008	No Data	No Data	12.64	16.43	15.33	17.83	9.9	16.94	9.85	14.45	12.45	14.4
		2009	No Data	No Data	8.34	14.95	9.16	14.76	11.19	19.37	14.55	19.54	10	13.55
SOUTH YUBA RIVER SUB-BASIN														
SYR above Lake Spaulding	43.4	2009	No Data	No Data	10.85	19.36	19.24	22.34	16.87	22.19	12.60	18.46	8.76	11.76
SYR below Spaulding Main Dam	40.8	2008	No Data	No Data	No Data	No Data	9.16	10.73	8.71	10.8	8.35	9.46	6.77	9.82
		2009	5.37	7.86	6.47	9.09	8.22	10.71	8.71	10.33	7.61	9.82	7.17	8.78
SYR above Jordan Creek	40.3	2008	No Data	No Data	8.72	11.76	10.5	12.35	9.71	12.18	8.47	10.16	8.19	10.53
		2009	5.56	9.08	6.97	10.52	9.29	11.99	9.48	11.78	7.91	10.63	7.13	8.7
B-S Canal below Fuller Lake	--	2008	No Data	No Data	10.22	14.38	11.37	12.44	12.59	16.18	15.35	16.31	14.48	15.82
		2009	8.4	10.7	8.33	11.16	10.41	12.67	11.9	14.73	8.36	18.33	4.4	14.16
Jordan Creek above SYR	0.2	2008	No Data	No Data	11.54	16.29	15.62	17.93	16.22	18.8	13.95	17.16	12.34	14.93
		2009	8.34	13.22	11.35	15.71	14.9	18.29	14.36	18.22	13.01	16.74	10.52	13.07
SYR above Canyon Creek	32.5	2008	10.6	16.93	15.37	21.04	21.05	23.44	20.18	23.43	15.74	19.63	9.21	16.91
		2009	7.46	15.31	12.58	21.49	19.33	23.79	18.55	23.45	14.49	20.31	11.33	13.58
Canyon Creek above SYR	32.5	2008	9.54	16.23	13.25	19.38	19.21	21.73	17.63	21.76	14.57	18.72	7.90	15.88
		2009	7.50	12.54	11.42	19.57	17.29	22.2	17.38	21.94	13.76	19.02	10.52	12.8
Diamond Creek above SYR*	33.2	2008	No Data	No Data	13.34	17.14	16.94	18.74	18.12	19.97	15.39	18.11	14.38	16.2
		2009	7.44	13.85	11.30	13.78	14.44	17.36	14.06	15.26	12.21	14.85	11.53	12.52
Spring Creek above SYR*	14.9	2008	11.34	17.20	12.19	17.79	16.03	19.03	15.21	18.6	12.22	14.39	6.75	14.25
		2009	10.28	16.34	13.17	17.09	14.22	19.26	14.66	18.73	10.51	16.2	8.08	10.3
Rock Creek above SYR*	10.1	2008	13.46	18.88	14.79	19.71	18.47	20.93	17.61	19.97	13.32	16.83	7.79	14.82
		2009	14.56	19.63	16	20.25	17.2	21.31	16.94	20.96	12.43	17.42	9.70	11.47
SYR above Poorman Creek	28.1	2008	11.33	17.86	15.97	21.84	21.8	23.99	21.33	23.92	15.51	20.58	9.85	17.38
		2009	8.02	15.44	13.4	22.2	20.19	24.8	19.88	24.58	15.94	21.5	12.53	14.99
Poorman Creek above SYR*	28.1	2008	8.10	12.61	12.15	18.48	18.19	20.62	17.73	20.77	13.74	17.57	7.22	15.35
		2009	6.59	15.61	11.76	18.17	15.74	20.79	15.72	20.46	11.96	17.56	9.00	11.25
SYR above Humbug Creek	19.6	2008	11.62	17.94	16.39	22.79	22.65	25.01	21.68	24.58	15.92	20.98	15.20	17.61
		2009	11.19	16.43	14.58	23.22	20.94	25.46	20.43	25.13	15.45	21.45	11.85	14.47

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Table 3.2-1. (continued)

Location	Station ID	Year(s)	May		June		July		August		September		October	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Humbug Creek above SYR*	19.6	2008	9.92	16.6	11.77	17.86	16.81	19.34	16.22	19.20	12.82	16.25	12.40	14.75
		2009	11.00	15.53	12.31	17.13	14.37	19.51	15.04	19.19	11.81	16.37	8.87	10.88
SYR above Rush Creek	6.2	2008	13.74	20.08	17.87	23.7	23.14	25.4	22.44	24.91	16.73	21.59	10.20	18.5
		2009	9.61	17.15	16.36	24.1	21.37	25.82	21.15	25.58	16.02	21.66	12.53	14.89
Rush Creek above SYR*	6.2	2008	No Data	No Data	15.54	18.33	17.40	19.52	17.63	19.68	14.58	17.50	9.52	16.29
		2009	11.44	18.08	15.02	18.45	16.16	19.87	16.78	19.7	13.68	17.68	11.16	12.88
Shady Creek above SYR*	5.0	2008	14.65	20.97	17.07	22.89	21.39	24.9	21.02	24.62	18.19	22.31	15.49	21.06
		2009	12.29	25.21	16.73	21.63	18.81	24.13	20.12	24.15	17.28	22.51	11.99	19.19
SYR above Englebright Reservoir	0.1	2008	14.74	21.27	18.74	22.19	23.55	25.93	23.04	25.67	17.47	22.41	11.08	19.48
		2009	12.62	19.31	17.80	24.85	22.15	26.50	21.86	26.22	17.20	22.44	11.98	16.07
BEAR RIVER SUB-BASIN														
Bear River above Drum Canal waste gate	35.1	2008	No Data	No Data	9.99	12.96	12.52	14.0	13.35	15.53	12.93	14.72	11.9	12.04
		2009	8.55	11.01	9.37	11.57	10.5	12.05	10.42	11.78	9.23	11.38	8.57	9.93
Bear River at Hwy 20 crossing (YB-198)	34.0	2008	No Data	No Data	9.26	12.02	11.61	14.2	14.12	16.59	13.05	15.02	12.37	13.79
		2009	9.16	11.91	9.01	12.52	11.26	14.52	12.50	15.14	12.69	15.04	11.19	13.10
Bear River above Drum Afterbay	27.4	2008	7.52	13.09	11.25	16.13	15.56	17.54	14.48	17.97	12.23	15.13	10.93	13.64
		2009	7.79	13.93	10.32	16.17	13.56	17.84	13.05	17.37	10.24	15.13	8.10	10.61
Bear River below Drum Afterbay	25.1	2008	6.79	8.08	8.06	10.84	10.95	15.01	15.13	17.68	13.06	16.29	12.10	14.59
		2009	6.65	7.89	7.44	10.83	10.88	14.71	14.21	16.60	12.09	17.12	10.72	14.46
Bear River above Dutch Flat Afterbay	23.8	2008	No Data	No Data	No Data	No Data	15.74	17.92	16.37	19.40	13.48	16.83	7.77	14.86
		2009	No Data	No Data	11.92	15.47	14.07	18.02	14.57	17.91	14.62	17.13	7.99	13.36
Little Bear River below PCWA's Lower Boardman Canal (YB-98)	1.8	2008	8.04	16.17	10.32	13.25	13.13	15.67	15.75	18.95	14.96	16.86	13.24	17.20
		2009	10.33	21.7	9.68	14.44	12.55	16.33	13.95	17.24	14.04	17.35	10.84	13.82
Bear River below Dutch Flat Afterbay Dam	21.3	2009	7.11	8.17	7.77	11.22	11.14	14.42	14.48	16.37	15.67	16.67	12.51	15.48
Bear River above Chicago Park PH	16.1	2008	8.15	10.24	9.39	18.79	18.13	20.16	18.47	21.28	15.99	19.30	15.36	16.7
		2009	12.62	17.35	13.96	19.52	18.11	21.28	17.95	20.95	14.42	19.47	12.8	14.54
Steephollow Creek above Bear River*	15.5	2008	12.43	18.23	15.36	17.10	18.40	20.53	No Data	No Data	15.70	18.53	15.21	16.43
		2009	9.27	17.75	14.27	19.50	17.98	20.74	17.78	20.44	15.15	18.77	12.1	15.05
Bear River above Steephollow Creek	15.7	2008	No Data	No Data	9.97	10.77	12.94	16.41	16.57	19.02	16.20	18.13	14.59	16.9
		2009	6.62	8.64	8.00	13.74	11.93	16.1	15.23	18.41	15.21	18.15	13.88	15.27
Greenhorn Creek above Rollins Reservoir*	--	2008	12.96	21.1	16.4	21.99	20.62	24.77	18.92	23.92	14.87	20.81	14.9	17.85
		2009	10.58	19.19	14.69	21.02	18.65	23.53	17.66	22.47	13.48	20.86	10.92	13.98
Bear River above Rollins Reservoir	15.3	2008	No Data	No Data	10.79	11.96	13.32	16.1	16.25	18.63	16.29	17.93	14.21	17.03
		2009	7.42	10.02	8.91	12.57	12.59	15.47	14.08	17.54	15.16	17.87	10.48	15.16
Bear River below BRC Diversion Dam (YB-196)	10.0	2008	7.21	9.99	10.09	11.5	11.56	14.22	14.37	18.03	18.11	18.75	18.68	18.78
		2009	7.22	11.94	9.67	10.88	10.9	13.72	13.87	17.15	17.24	18.08	16.43	18.01

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Table 3.2-1. (continued)

Location	Station ID	Year(s)	May		June		July		August		September		October	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Bear River near Milk Ranch Road	5.5	2008	No Data	No Data	13.38	14.94	14.89	16.73	16.78	17.58	18.02	19.23	16.08	18.85
		2009	8.01	12.52	10.79	15.09	12.65	16.75	15.37	18.67	16.46	19.6	13.99	17.04
Bear River above Lake Combie	0.5	2008	No Data	No Data	14.9	16.79	16.69	18.04	17.89	20.37	17.85	20.18	17.31	18.91
		2009	8.21	12.15	11.89	17.41	13.37	18.51	16.38	19.48	18.12	20.2	No Data	No Data
Bear River Canal at YB-58 (Placer Hills Road)	--	2008	9.14	10.54	10.64	12.24	12.27	12.59	16.16	18.29	17.98	18.81	18.37	18.72
		2009	7.25	10.1	9.8	11.75	11.75	14.31	14.44	17.4	17.37	18.18	16.13	17.63
NORTH FORK AMERICAN RIVER SUB-BASIN														
NFNFAR above Lake Valley Canal Diversion	14.5	2008	7.61	12.17	11.93	18.7	17.07	19.79	16.38	20.12	13.89	18.41	12.26	16.08
		2009	8.02	11.54	8.94	18.74	15.53	19.88	13.01	19.26	11.38	17.81	11.1	13.43
NFNFAR above Fulda Creek and East Branch American River	7.1	2008	No Data	No Data	13.16	16.84	15.96	18.57	15.51	18.96	12.23	16.08	6.46	14.13
		2009	8.71	14.74	10.2	18.08	14.87	19.76	13.85	19.19	10.44	16.58	7.49	10.73
Canyon Creek above Towle Diversion Inflow (YB-280)	9.3	2008	6.95	9.04	8.07	11.14	11.15	12.79	11.78	14.83	10.76	13.68	9.87	12.83
		2009	6.9	9.3	8.04	11.02	10.01	12.77	10.07	13.47	8.91	13.83	6.62	9.58
COON CREEK SUB-BASIN														
Dry Creek above Halsey Afterbay*	--	2008	15.28	21.58	17.16	21.18	14.5	24.02	15.55	24.15	18.74	22.24	17.96	19.88
		2009	9.28	20.95	12.6	23.2	12.54	24.07	17.02	22.49	14.74	21.38	12.56	15.14
Wise Canal below Halsey Afterbay (YB-61)	--	2008	9.51	11.16	11.29	12.91	12.98	15.58	15.69	16.59	18.52	19.2	18.34	19.08
		2009	7.58	10.83	10.34	12.95	12.48	14.88	14.98	17.73	17.22	18.46	15.83	17.54
AUBURN RAVINE SUB-BASIN														
Auburn Ravine above Wise PH*	27.6	2008	14.6	20.29	15.99	20.24	19.12	22.12	19.22	22.13	16.6	20.54	16.26	18.87
		2009	15.52	20.18	16.75	21.76	18.87	22.64	18.59	21.85	14.69	20.55	12.56	15.14
South Canal below Wise PH	--	2008	10.22	12.38	12.60	14.37	14.45	16.72	16.89	17.85	18.70	19.84	18.25	19.57
		2009	8.41	12.63	11.39	15.05	13.98	16.51	16.04	18.72	17.31	19.34	15.63	17.57
RESERVOIRS														
Dutch Flat Afterbay (Dam)	21.3	2008	7.03	9.16	9.17	10.09	12.5	15.89	15.99	18.44	16.65	17.39	No Data	No Data
		2009	6.36	8.13	7.64	11.87	11.22	15.57	14.66	17.18	15.48	28.2	11.39	21.23
Chicago Park Forebay (Dam)	--	2008	15.21	22.29	9.81	25.44	12.18	15.97	16.02	18.43	16.55	20.53	17.80	20.72
		2009	7.33	8.42	7.80	11.85	11.69	15.80	14.97	17.42	16.23	17.77	14.24	14.93
Rock Creek Reservoir (Dam)	2.1	2008	10.18	12.52	12.61	14.18	14.36	16.53	16.68	20.15	18.46	19.93	18.01	18.22
		2009	8.14	12.13	11.11	14.54	13.56	16.09	15.78	18.44	17.23	19.11	15.53	17.48
Wise Forebay (Dam)	--	2008	10.2	12.35	12.57	14.32	14.400	16.69	16.87	19.83	18.62	19.88	18.21	19.49
		2009	8.39	12.55	11.35	14.95	13.91	16.44	15.99	18.66	17.30	19.30	15.60	17.55

Shading = Temperatures above 20°C.
* = Monitoring location outside of Project Affect.

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3.3 Stream Flow Monitoring

For data collected by Licensees, plots of the daily stream flow for the stream temperature sites where stage recorders were installed are provided as combined charts in Attachment 2-2B.

From April through October in 2008 and 2009, stream flow was measured monthly at selected sites in the Middle Yuba River and South Yuba River Sub-Basins (Attachment 2-2A). Stream stage was also measured continuously at a subset of these sites. Synoptic stream flow measurements were taken at the other sites once a month from April through October. The length of the stream flow records varies by site, with some starting in April and some starting in June; all of them ended in October 2009. At some locations, monthly flow data was not taken due to conditions that prevented safe wading in the river or, in lesser instances, equipment malfunction.

In 2009, late April and early May were wet, and a high-flow event occurred in early May, peaking at about 10,000 cfs at the Jones Bar gage along the lower South Yuba River (i.e., WT-1 and USGS JBR). This high-flow event prevented Licensees from installing monitoring equipment and measuring stream discharge at sites along the main South Yuba and Middle Yuba Rivers. Several of the sites that were installed in April 2009 were disturbed by the high flows and had to be reinstalled. However, usable data were recorded at some of these sites. The low-flow period began in late June 2009, and all sites were operational by then. The records are summarized as such, with most starting in early June. At least four stream flow measurements were taken at each site, and as many as seven measurements were taken at some sites.

Figures 3.3-1 through 3.3-6 show the daily average flow in 2008 and 2009 for select locations in the Middle Yuba River, Canyon Creek, and South Yuba River, respectively. In Figure 3.3-1, daily average flows from below Yuba County Water Agency's (YCWA) Our House Diversion Dam (NY-19), combined with the inflow to YCWA's Lohman Ridge Tunnel (NY-18), are included for comparison with Licensees-calculated flows in the Middle Yuba River. In Figure 3.3-2, daily average flows from the gage at Jones Bar (NY-29) are included for comparison with Licensees-calculated flows in the South Yuba River.

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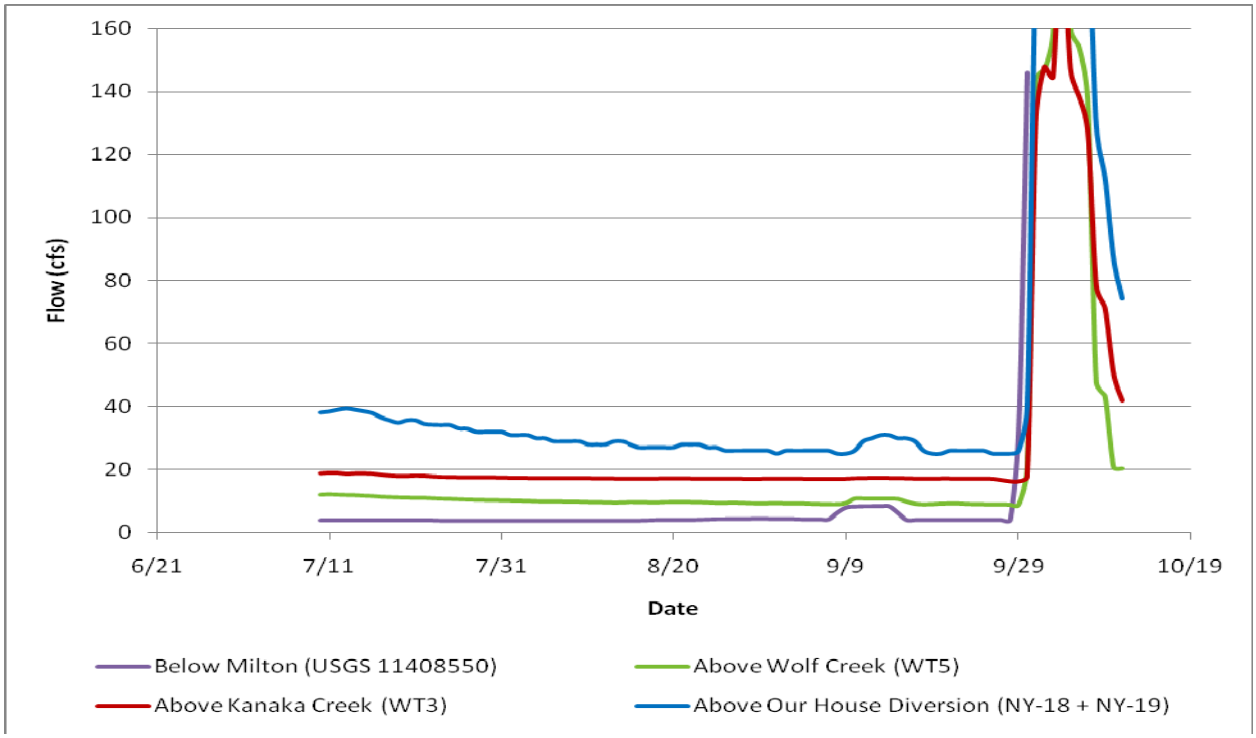

Figure 3.3-1. Mean daily flow hydrographs at sites on the Middle Yuba River, 2008. Hydrograph has been truncated to provide resolution at low flows.

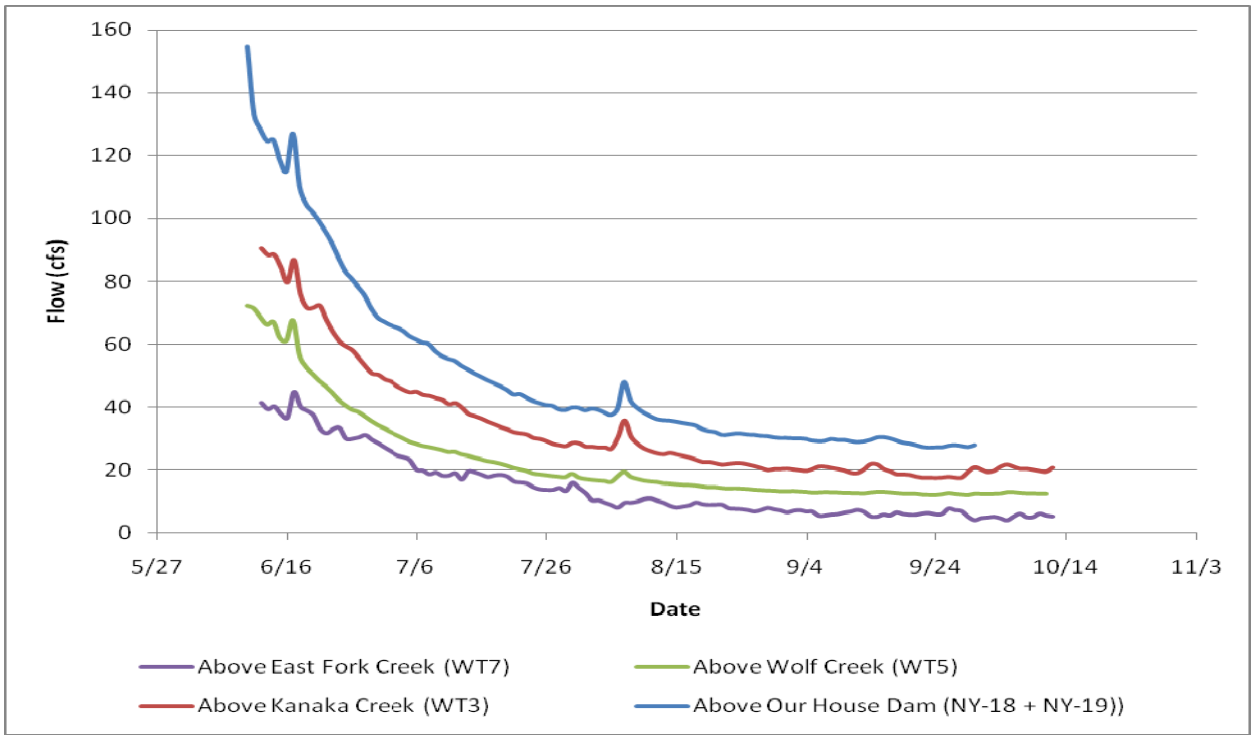

Figure 3.3-2. Mean daily flow hydrographs at sites on the Middle Yuba River, 2009.

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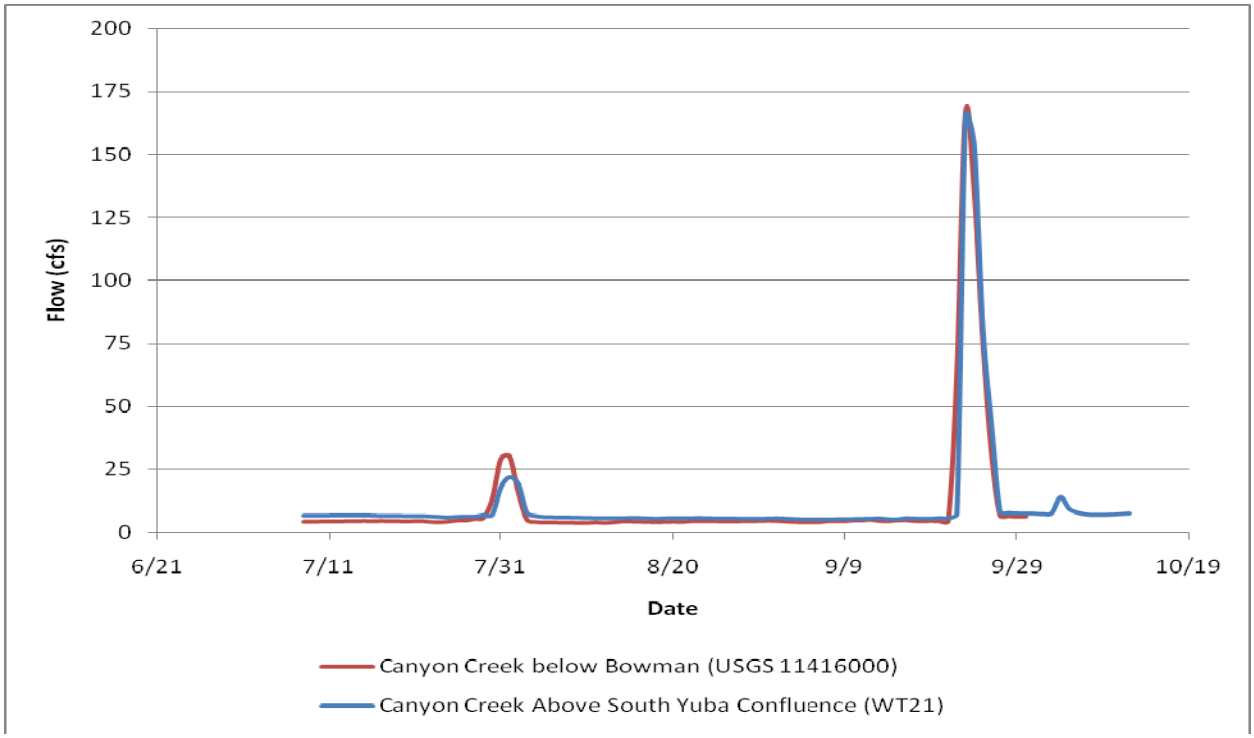

Figure 3.3-3. Mean daily flow hydrographs at sites on Canyon Creek, 2008.

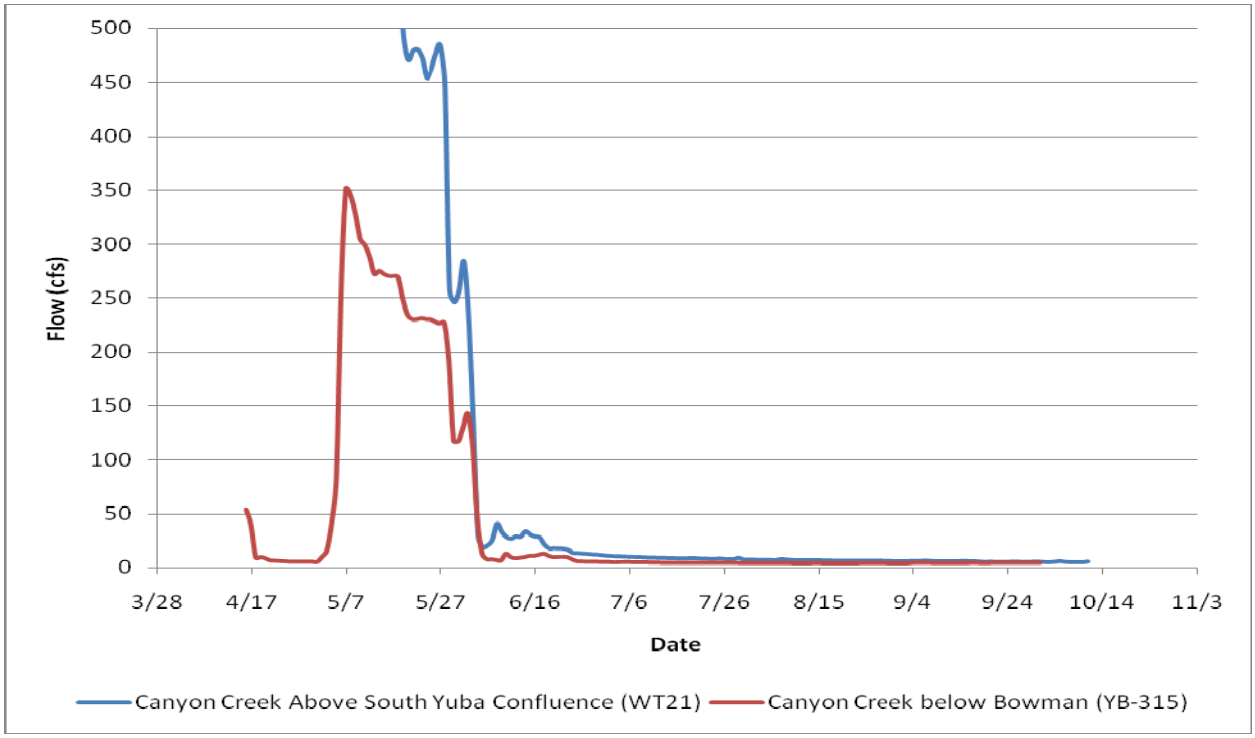

Figure 3.3-4. Mean daily flow hydrographs at sites on Canyon Creek, 2009.

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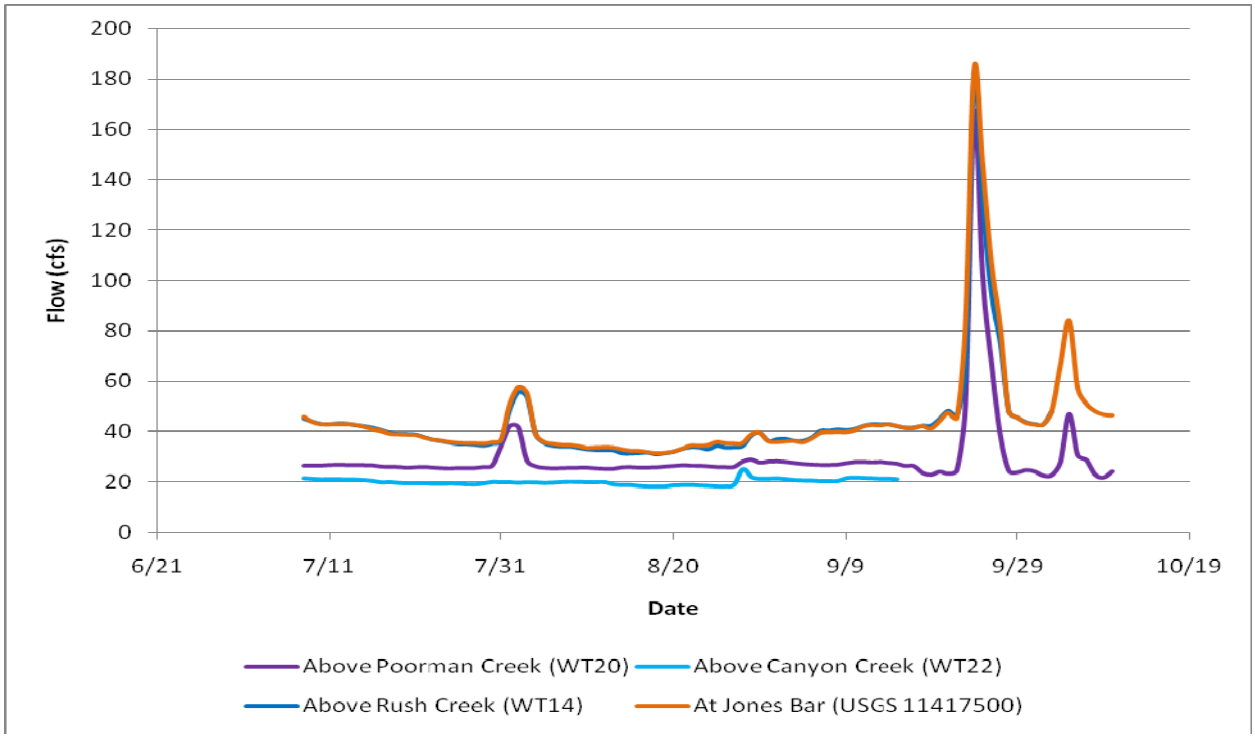

Figure 3.3-5. Mean daily flow hydrographs at sites on the South Yuba River, 2008.

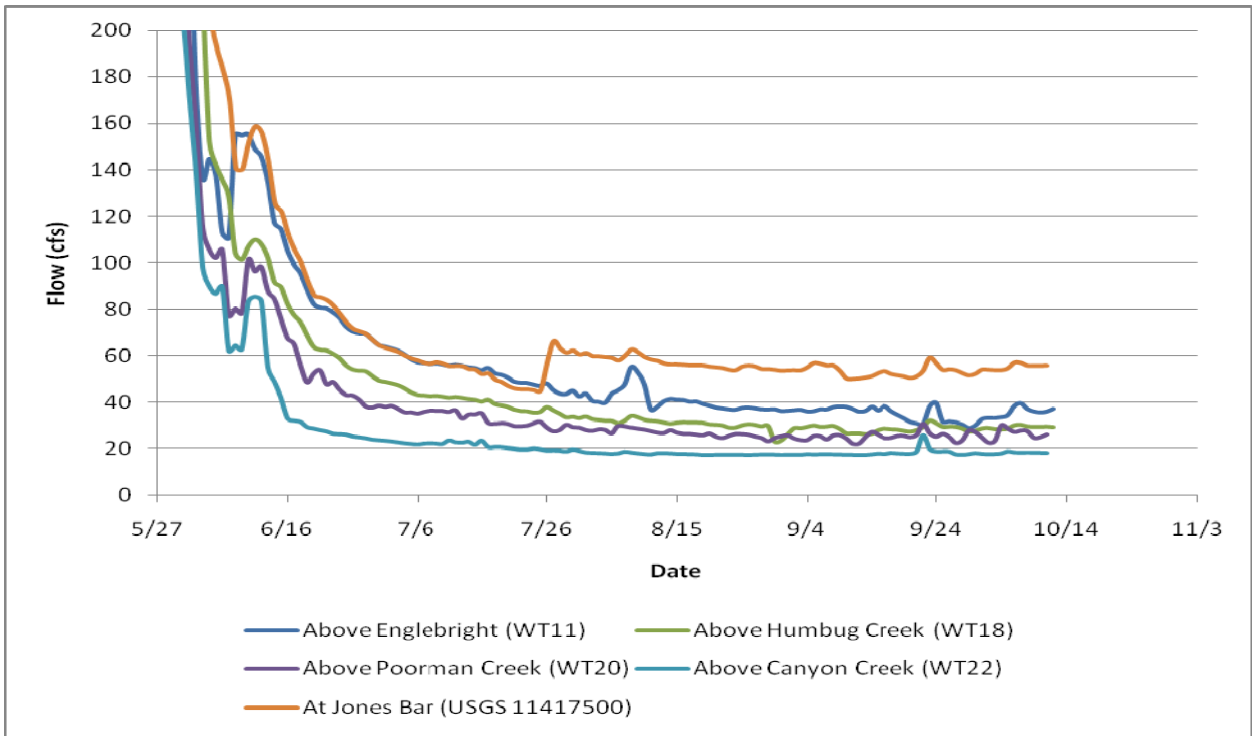

Figure 3.3-6. Mean daily flow hydrographs at sites on the South Yuba River, 2009.

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3.4 Reservoir Water Temperature Profiles and Dissolved Oxygen

Reservoir water temperature and DO 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. At each reservoir location, water temperature profiles are shown for a representative month and include historic data as well as Licensees-collected data in 2008 and 2009. Water temperature profile results for 2008 and 2009 are described below, and detailed plots for the 2008 and 2009 monitoring period can be found in Attachment 2-2C.

DO concentrations for each reservoir are described below; tables comparing 2008 and 2009 minimum and maximum values by month are also provided. Attachment 2-2C provides complete DO concentrations recorded by month at each reservoir for 2008 and 2009.

3.4.1 Yuba-Bear Hydroelectric Project

3.4.1.1 Jackson Meadows Reservoir

Reservoir profiles were taken monthly from July through October 2009 at one location near the dam in the thalweg of the reservoir.

In July, August and September 2009, a thermocline was present between 25 and 45 ft below the water surface. The October profile shows a decline in temperatures from top to bottom, with a less definitive thermocline. Water temperatures at the surface ranged from 12.5°C in October to 20.21°C in July and at the bottom from 4.76°C in July to 5.44°C in October.

Figure 3.4-1 provides a direct comparison of August water temperatures in 2004, 2007 and 2009. Profile data for 2004 were estimated using data collected by the Upper Yuba River Studies Program (UYRSP). Profile data for 2007 and 2009 were collected by Licensees.

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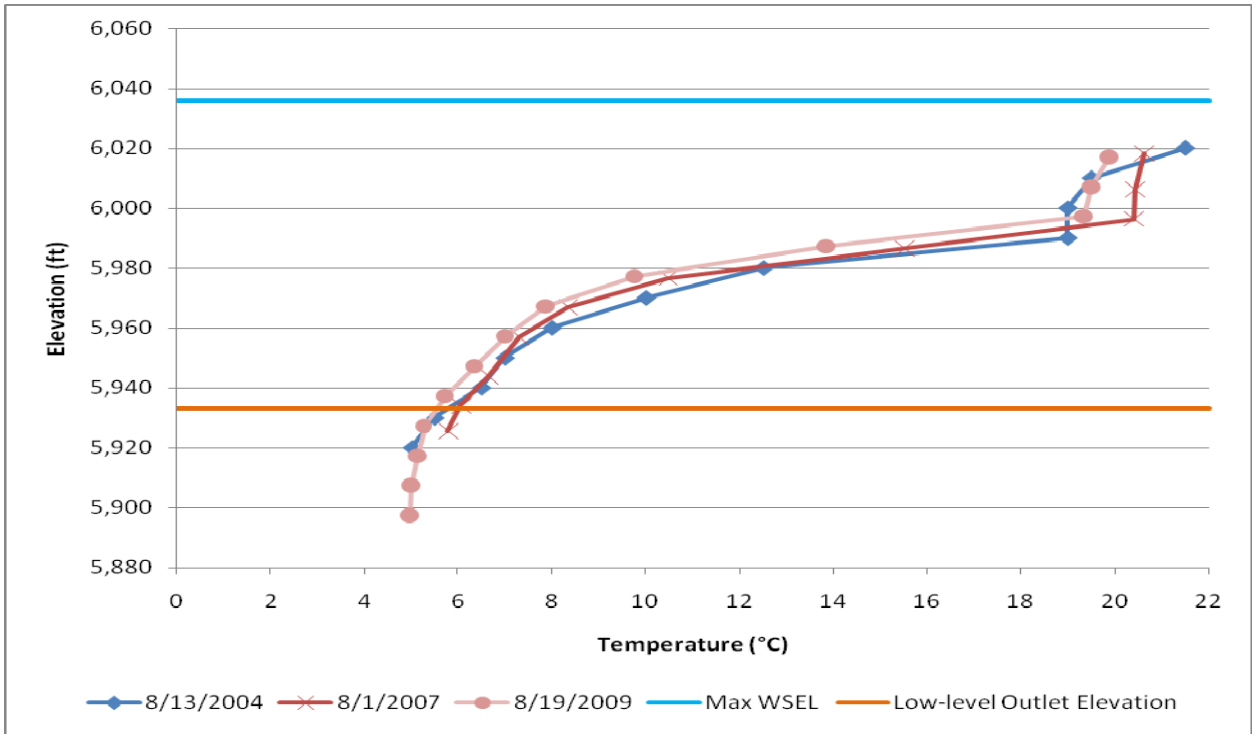

Figure 3.4-1. Jackson Meadows Reservoirs water temperature profiles, August 2004, 2007 and 2009.

In 2009, DO levels ranged from a minimum of 1.2 mg/L near the bottom in August to a maximum of 9.79 mg/L in July, about 30 feet below the surface.

3.4.1.2 Sawmill Lake

One temperature profile was taken in Sawmill Lake approximately two weeks after the reservoir stopped spilling in late July 2008 and 2009. A weak thermocline was present 30 ft below the water surface in 2008 and 20 ft below the water surface in 2009. Water temperatures declined from 21.2°C at the surface to 17.2°C at the bottom in 2008 and from 21.7°C at the surface to 13°C at the bottom in 2009. Figure 3.4-2 provides a direct comparison of water temperatures in 2008 and 2009.

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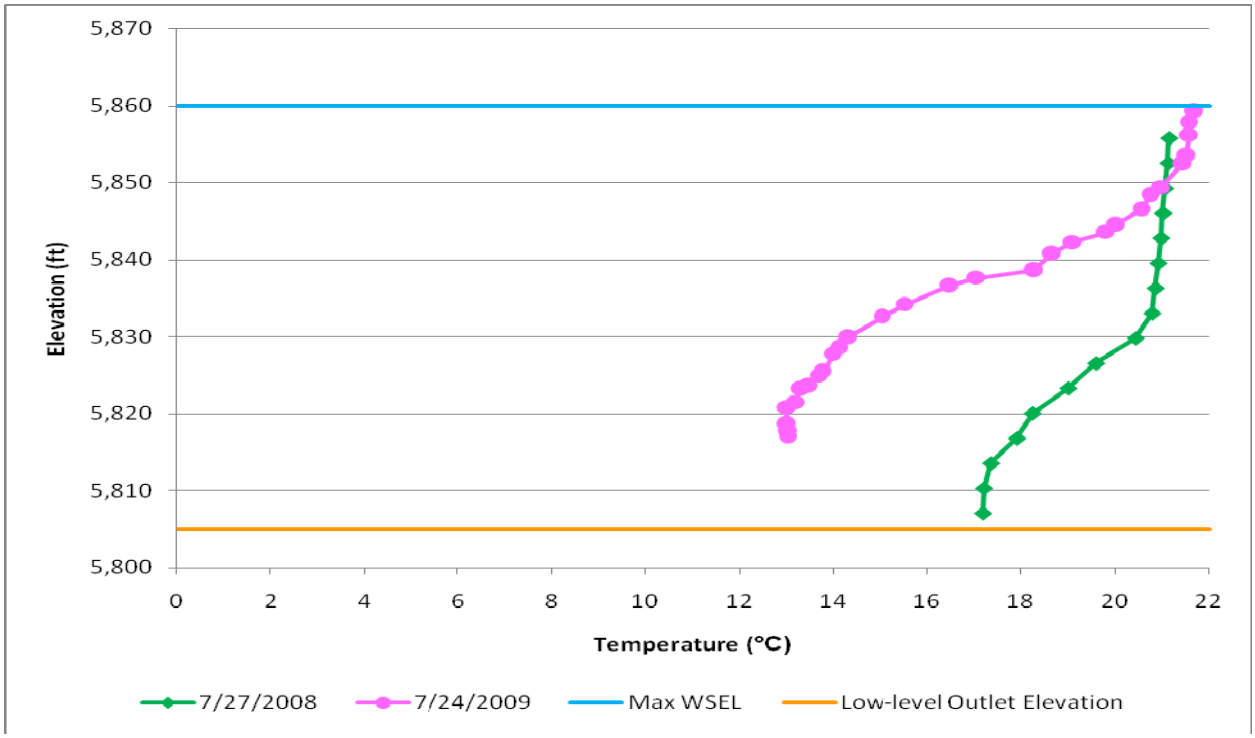

Figure 3.4-2. Sawmill Lake water temperature profiles, July 2008 and 2009.

In 2008, DO declined from 7.4 mg/L at the surface to 5.9 mg/L at the bottom. In 2009, DO was approximately 7.5 mg/L at the surface and at the bottom and increased to 8.9 mg/L 20–22 ft below the surface. Table 3.4-1 shows a direct comparison of DO concentration ranges in 2008 and 2009.

Table 3.4-1. Sawmill Lake DO concentrations, July 2008 and 2009.

2008		2009	
Min DO (mg/L)	Max DO (mg/L)	Min DO (mg/L)	Max DO (mg/L)
5.9	7.4	7.5	8.9

3.4.1.3 Bowman Lake

Reservoir profiles were taken monthly from July through October 2008 and 2009 at one location near the dam, in the thalweg of the reservoir.

In July and August 2008, a thermocline was present at approximately 45 ft and 60 ft below the water surface, respectively. The September and October profiles show the reservoir fully mixed. 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.

In July and August 2009, a thermocline was present at approximately 35 and 55 ft below the water surface, respectively. The September profile shows a slight decline in temperatures from

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top to bottom, with no definitive thermocline, while the October profile indicates complete mixing. Water temperatures at the surface ranged from 13.0°C in October to 19.7°C in July and at the bottom from 7.2°C in June to 15.5°C in September.

Figure 3.4-3 provides a direct comparison of August water temperatures in 2004 and 2007 through 2009. Profile data for 2004 were estimated using data collected by the Upper Yuba River Studies Program (UYRSP). Profile data for 2007 through 2009 were collected by Licensees.

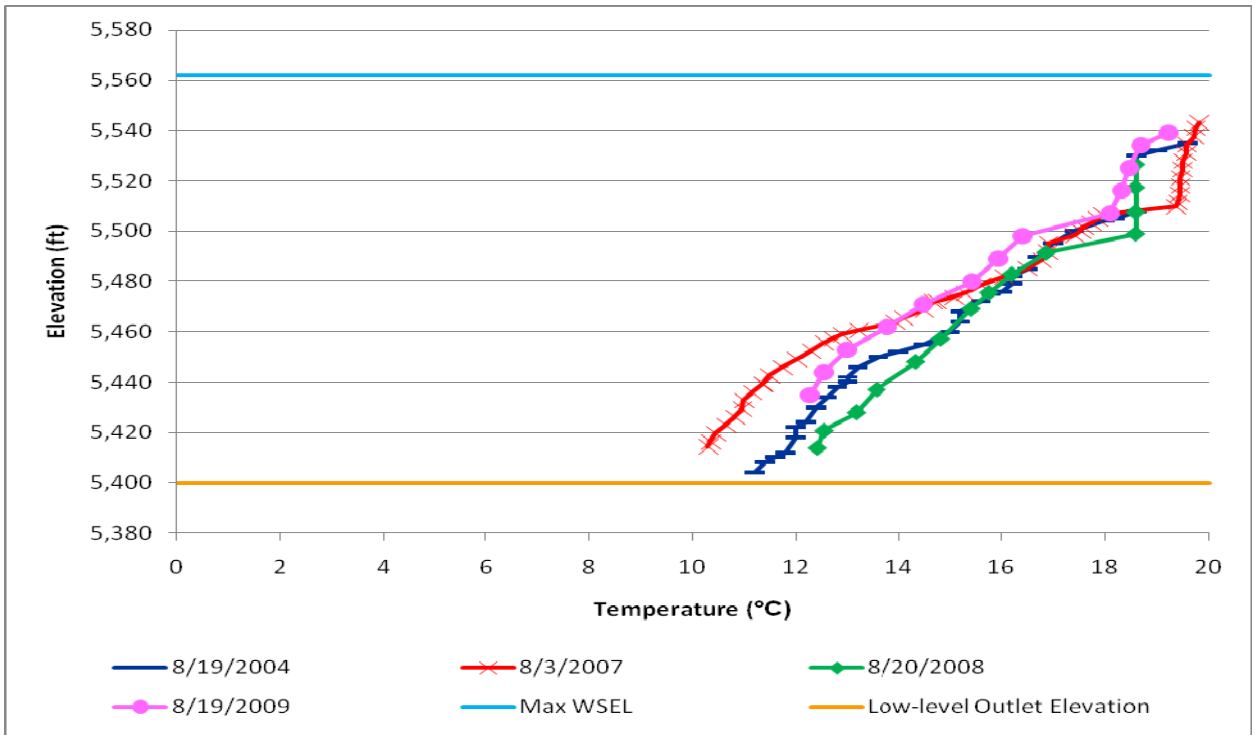

Figure 3.4-3. Bowman Lake water temperature profiles near dam, August 2004, 2007, 2008 and 2009.

In 2008, DO levels were similar from July through 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 varied only by 0.1 mg/L (Table 3.4-2).

In 2009, DO levels were similar from July through August and October and decreased in September. The minimum concentration recorded was 6.2 mg/L in September and the maximum was 8.3 mg/L in July.

Table 3.4-2 shows a direct comparison of DO concentration ranges in 2008 and 2009.

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Table 3.4-2. Bowman Lake DO concentrations, 2008 and 2009.

Month	2008		2009	
	Min DO (mg/L)	Max DO (mg/L)	Min DO (mg/L)	Max DO (mg/L)
July	7.1	8.9	7.1	8.3
August	6.7	8.0	6.7	8.1
September	7.0	7.6	6.2	7.7
October	9.1	9.2	7.3	8.0

3.4.1.4 Rollins Reservoir

Water temperature and DO data were collected at one location near Rollins Reservoir Dam from May through October 2008 and 2009.

In 2008, 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 ft, 20 ft, 30 ft, and 150 ft, respectively. Surface water temperatures ranged from 16.3°C in October to 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; temperatures at this elevation varied from 8.5°C in May to 18.3°C in September.

In 2009, a thermocline was also present in each of the sampling months but was again most definite during June, July, August, and September at depths of approximately 0 ft, 10 ft, 20 ft, and 150 ft, respectively. Surface water temperatures ranged from a minimum of 13.5°C in May to a high of 24.8°C in July. Water temperatures near the bottom ranged from 7.6°C in June to 17.6°C in October.

Figure 3.4-4 provides a direct comparison of July water temperatures from 2007 through 2009. Data were collected in 2007 by Licensees in advance of study plan development.

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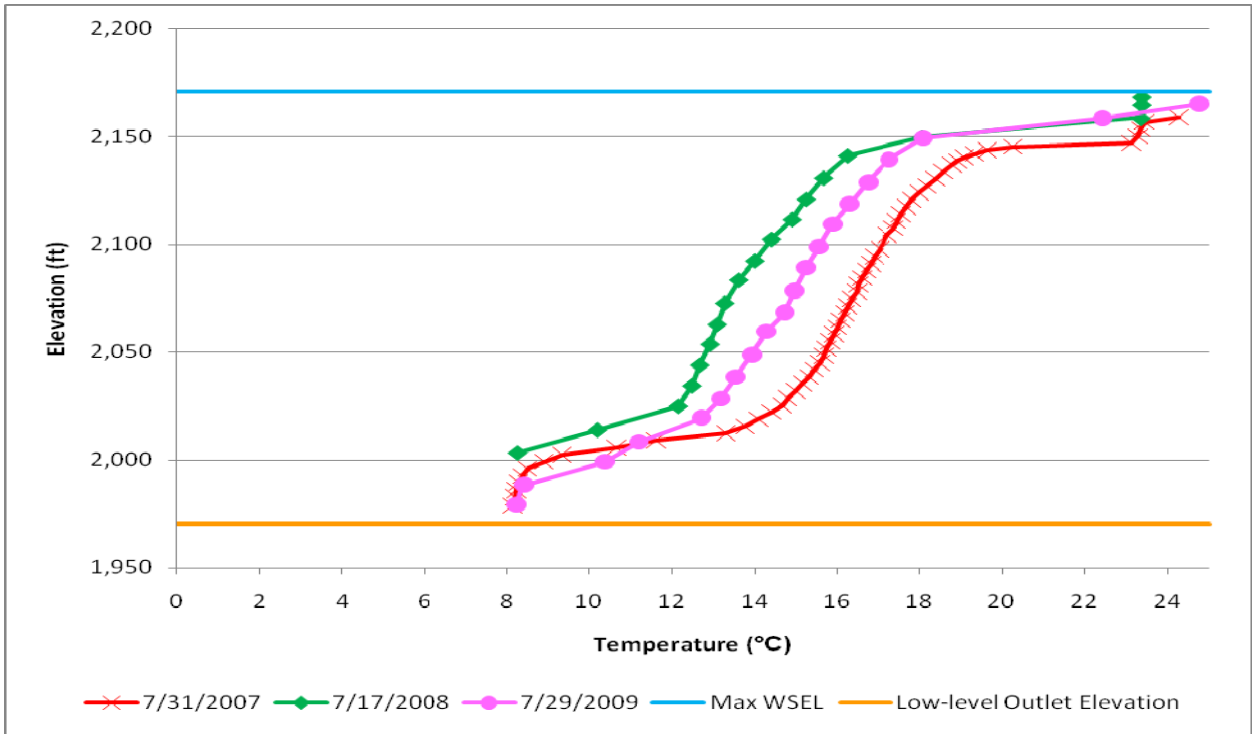

Figure 3.4-4. Rollins Reservoir water temperature profiles, July 2007, 2008 and 2009.

DO concentrations were collected in May, July, August, September, and October 2008. 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.

In 2009, DO concentrations were collected from May through October. The minimum DO concentration recorded was 0.5 mg/L in September, and the maximum was 10.6 mg/L in May and June. DO concentrations below 1.0 mg/L occurred at the bottom of the reservoir.

Table 3.4-3 shows a direct comparison of DO concentration ranges in 2008 and 2009.

Table 3.4-3. Rollins Reservoir DO concentrations, 2008 and 2009.

Month	2008		2009	
	Min DO (mg/L)	Max DO (mg/L)	Min DO (mg/L)	Max DO (mg/L)
May	7.1	8.6	7.2	11.9
June	No data	No data	6.7	10.9
July	6.7	7.4	1.8	10.4
August	3.6	6.9	2.5	8.7
September	5.2	8.6	0.5	8.2
October	1.1	8.5	0.9	7.8

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3.4.2 Drum-Spaulding Project

3.4.2.1 Meadow Lake

One water temperature profile was collected in early September 2008 and 2009 near Meadow Lake Dam. At the times of the samples, there were no thermoclines present and temperatures ranged from 17.3°C at the surface to 15.9°C at the bottom in 2008 and from 17.1°C at the surface to 16.7°C at the bottom in 2009. Figure 3.4-5 provides a direct comparison of September water temperatures in 2008 and 2009.

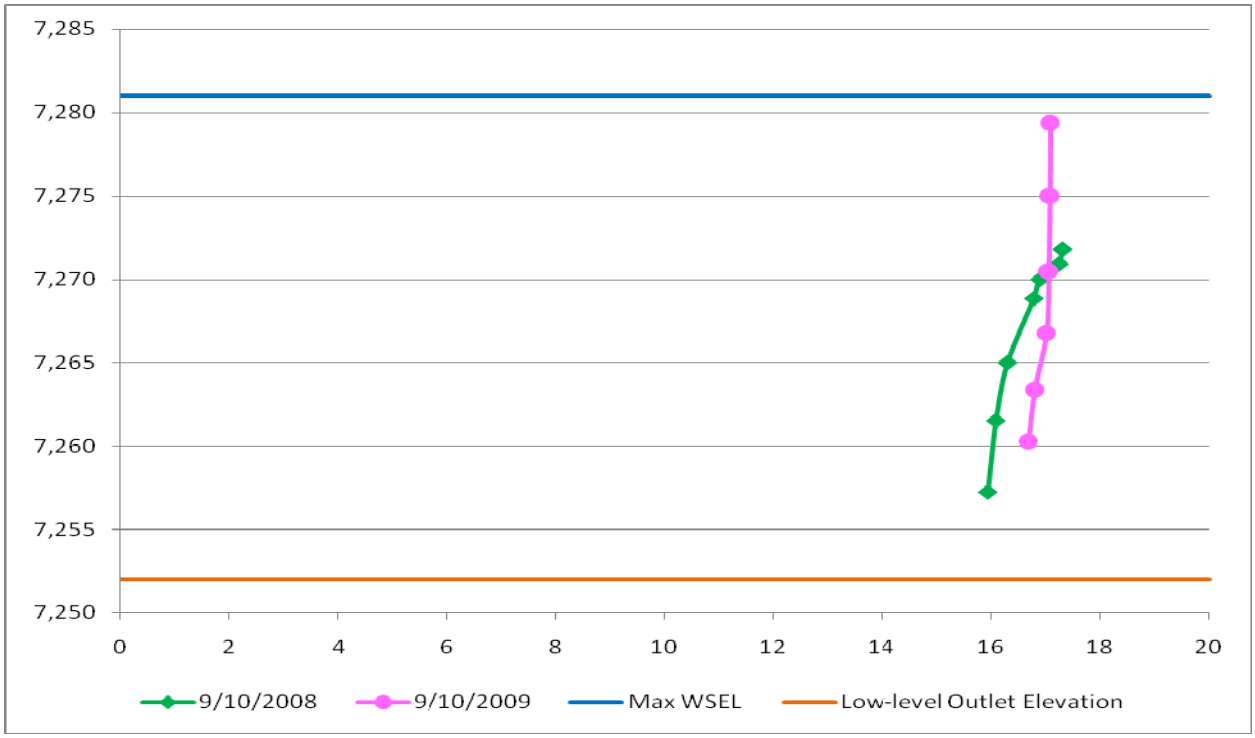

Figure 3.4-5. Meadow Lake water temperature profiles, September 2008 and 2009.

No dissolved oxygen readings were taken in 2008 due to an equipment malfunction. In 2009, all the DO readings were within 0.2 mg/L of each other, ranging from 7.1 to 7.3 mg/L.

3.4.2.2 Fordyce Lake

Water temperature profiles were taken in July, September, and October 2008 and July through October 2009. No sample was taken in August 2008 due to an equipment malfunction.

A thermocline was present in each of the three samples in 2008, occurring at approximately 25 ft in July, 50 ft in September, and 60 ft 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.

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In 2009, a thermocline was present in each of the four samples but was most definite in July, August, and September, starting at approximately 35 ft, 65 ft, and 95 ft below the water surface, respectively. Water temperatures at the surface ranged from 9.1°C in October to 20.2°C in July and at the bottom from 7.5°C in July to 11.2°C in August.

Figure 3.4-6 provides a direct comparison of water temperatures in August 2004, 2007, and 2009 and September 2008. No data were available in August 2008; therefore September 2008 data were used for the purpose of the provided comparison. Profile data for 2004 were collected as part of the UYRSP. Profile data for 2007 were collected by Licensees in advance of study plan development.

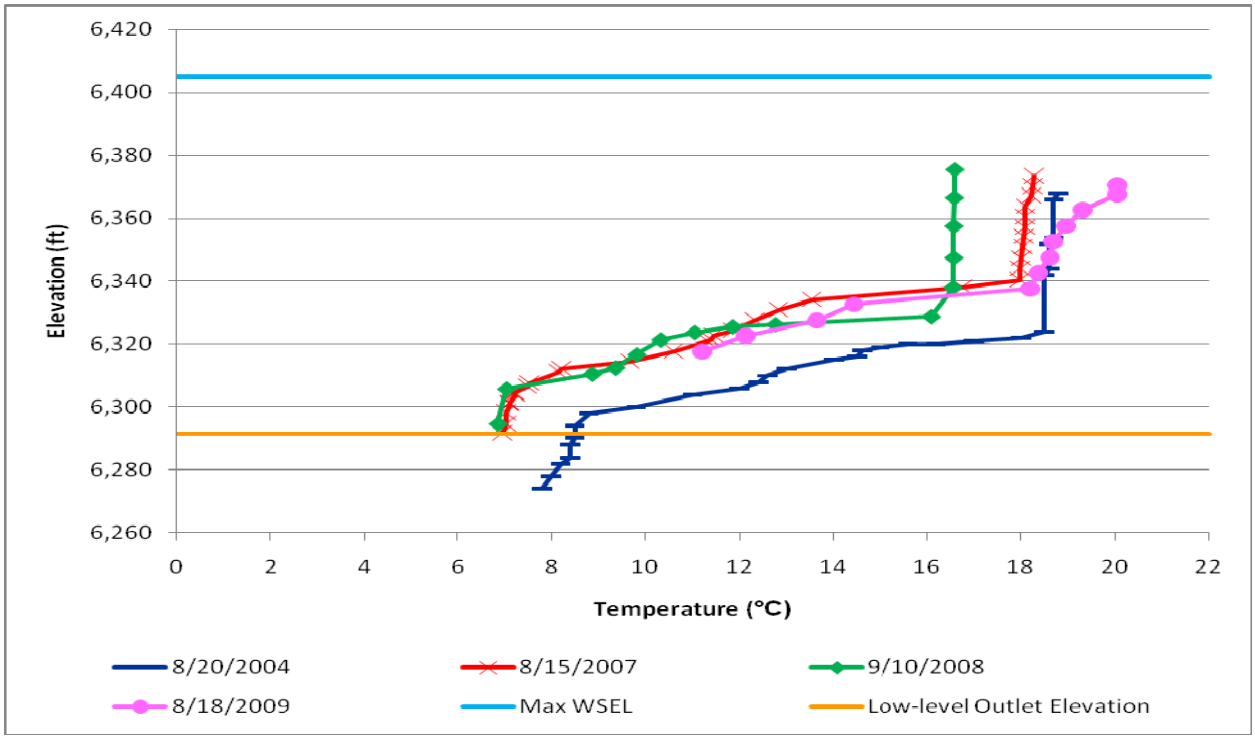

Figure 3.4-6. Fordyce Lake water temperature profiles, August 2004, 2007, and 2009, September 2008.

The minimum and maximum DO concentrations recorded in 2008 were 4.5 mg/L and 9.8 mg/L, respectively, both recorded in October. The minimum DO concentration recorded in 2009 was 5.2 mg/L in September and the maximum DO concentration was 10.0 mg/L in August and September.

Table 3.4-4 shows a direct comparison of DO concentration ranges in 2008 and 2009.

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Table 3.4-4. Fordyce Lake DO concentrations, 2008 and 2009.

Month	2008		2009	
	Min DO (mg/L)	Max DO (mg/L)	Min DO (mg/L)	Max DO (mg/L)
July	7.7	9.0	7.4	9.6
August	No data	No data	7.4	10.0
September	6.8	9.2	5.2	10.0
October	4.5	9.8	9.1	9.7

3.4.2.3 Lake Spaulding

Water temperature profiles were taken in Lake Spaulding at two locations between July and October 2008 and 2009. 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 2008 or at either location in October 2008 due to inclement weather and unsafe boating conditions.

In 2008, a thermocline was present near the dam each month occurring between 20 ft (July) and 90 ft (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 ft, indicating the sample was not taken within the thalweg (placement of the sonde within the thalweg can be challenging, especially when wind speeds are significant and the channel is narrow).

In 2009, a thermocline was present near the dam each month as well, occurring between 30 ft (July) and 185 ft (September and October) below the water surface. Water temperatures at the surface ranged from 14.5°C in October to 20.4°C in July. Near the bottom, temperatures ranged from 6.6°C in July to 6.9°C in August and September.

Figure 3.4-7 provides a direct comparison of August water temperatures in 2004 and 2007 through 2009. Profile data for 2004 were collected as part of the UYRSP. Profile data were collected in 2007 by Licensees in advance of study plan development.

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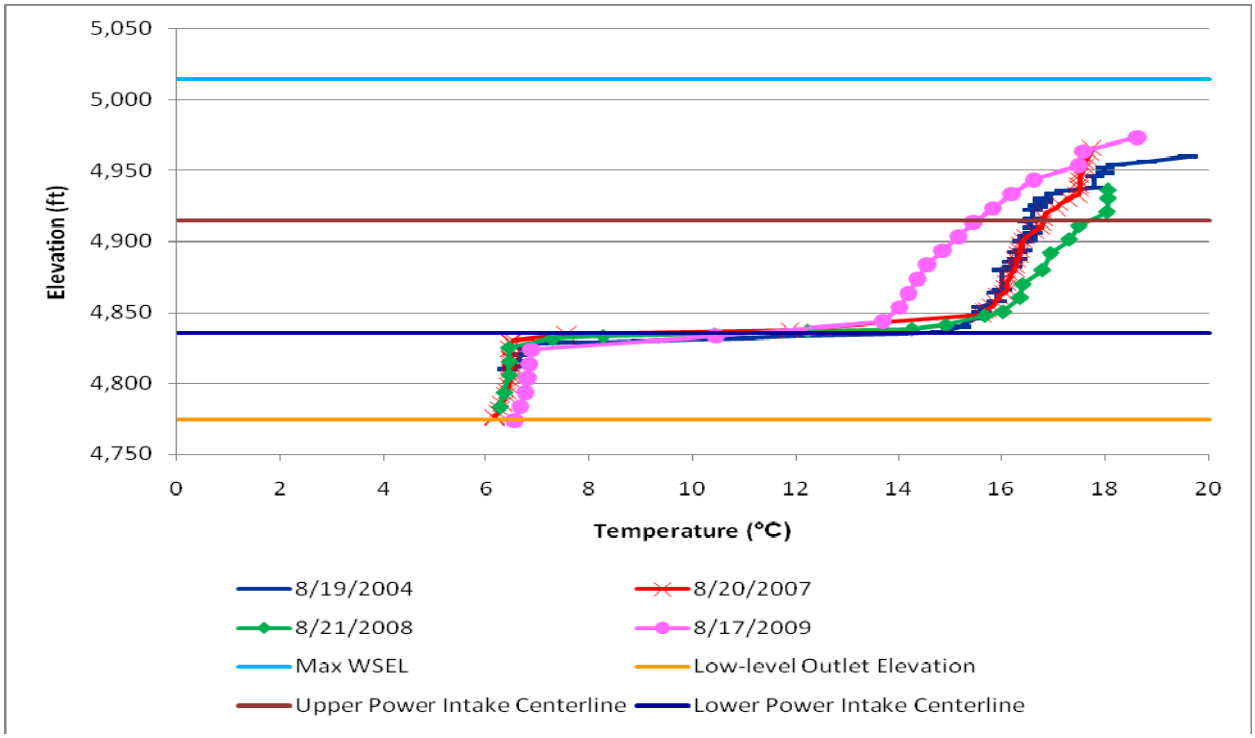

Figure 3.4-7. Lake Spaulding near dam water temperature profiles, August 2004, 2007, 2008 and 2009.

The minimum DO concentration recorded in 2008 was 0.8 mg/L in September, and the maximum was 8.4 mg/L in July. The minimum DO concentration recorded in 2009 was 0.3 mg/L in October, and the maximum was 9.2 mg/L in July. DO concentrations below 1.0 mg/L occurred at the bottom of the reservoir.

Table 3.4-5 shows a direct comparison of DO concentration ranges in 2008 and 2009.

Table 3.4-5. Lake Spaulding near dam DO concentrations, 2008 and 2009.

Month	2008		2009	
	Min DO (mg/L)	Max DO (mg/L)	Min DO (mg/L)	Max DO (mg/L)
July	7.7	8.4	5.4	9.2
August	4.5	8.0	3.3	8.5
September	0.8	7.2	1.3	8.4
October	No data	No data	0.3	8.2

In 2008, a weak thermocline was present at the mid-point in the reservoir in July and August. The maximum depths measured were 75 ft in July and 60 ft in August. Surface water temperatures ranged from 18.4°C in August to 19.3°C in July; temperatures near the bottom were 13.4°C in July to 16.5°C in August.

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The thermoclines at the mid-point in the reservoir are present for all four months in 2009 and much more definite than they were in 2008, starting between 30 ft (July) and 170 ft (October) below the water surface. Surface water temperatures ranged from 14.6°C in October to 20.8°C in July; temperatures near the bottom ranged from 6.6°C in July to 8.3°C in October.

Figure 3.4-8 provides a direct comparison of August water temperatures from 2007 through 2009. Data were collected in 2007 by the Licensees in advance of study plan development.

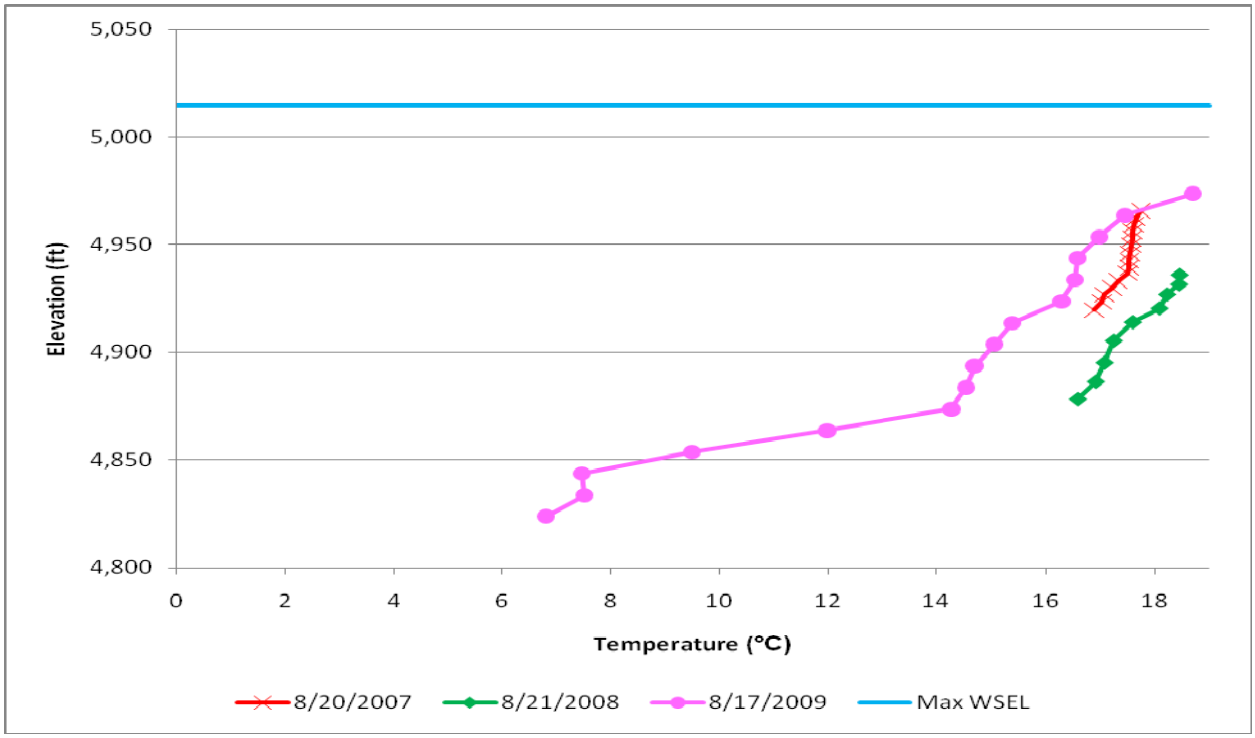

Figure 3.4-8. Lake Spaulding at mid-reservoir water temperature profiles, August 2007, 2008 and 2009.

The minimum DO concentration recorded in 2008 was 7.7 mg/L in August, and the maximum was 8.2 mg/L in July. The minimum DO concentration recorded in 2009 was 2.0 mg/L in September and the maximum was 11.5 mg/L in August.

Table 3.4-6 shows a direct comparison of DO concentration ranges in 2008 and 2009.

Table 3.4-6. Lake Spaulding at mid-reservoir DO concentrations, 2008 and 2009.

Month	2008		2009	
	Min DO (mg/L)	Max DO (mg/L)	Min DO (mg/L)	Max DO (mg/L)
July	7.9	8.2	6.8	9.0
August	7.7	8.1	4.5	11.5
September	No data	No data	2.0	7.8
October	No data	No data	4.5	8.4

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3.2.4.4 Lake Valley Reservoir

Two profiles were taken in Lake Valley Reservoir at a location near the dam in 2008 and 2009. In June 2008, a maximum temperature of 15.8°C at the surface and a minimum of 10.7°C at the bottom were observed. The August 2008 sample had a more definite thermocline occurring approximately 35 ft below the water surface. Temperatures in 2008 ranged from 21.5°C to 12.8°C.

In 2009, thermoclines were present in both June and August, starting at approximately 15 ft and 30 ft below the water surface, respectively. Surface water temperature was 15.4°C in June and 21.1°C in August; water temperature at the bottom was 8.4°C in June and 10.9°C in August.

Figure 3.4-9 provides a direct comparison of August water temperatures in 2008 and 2009.

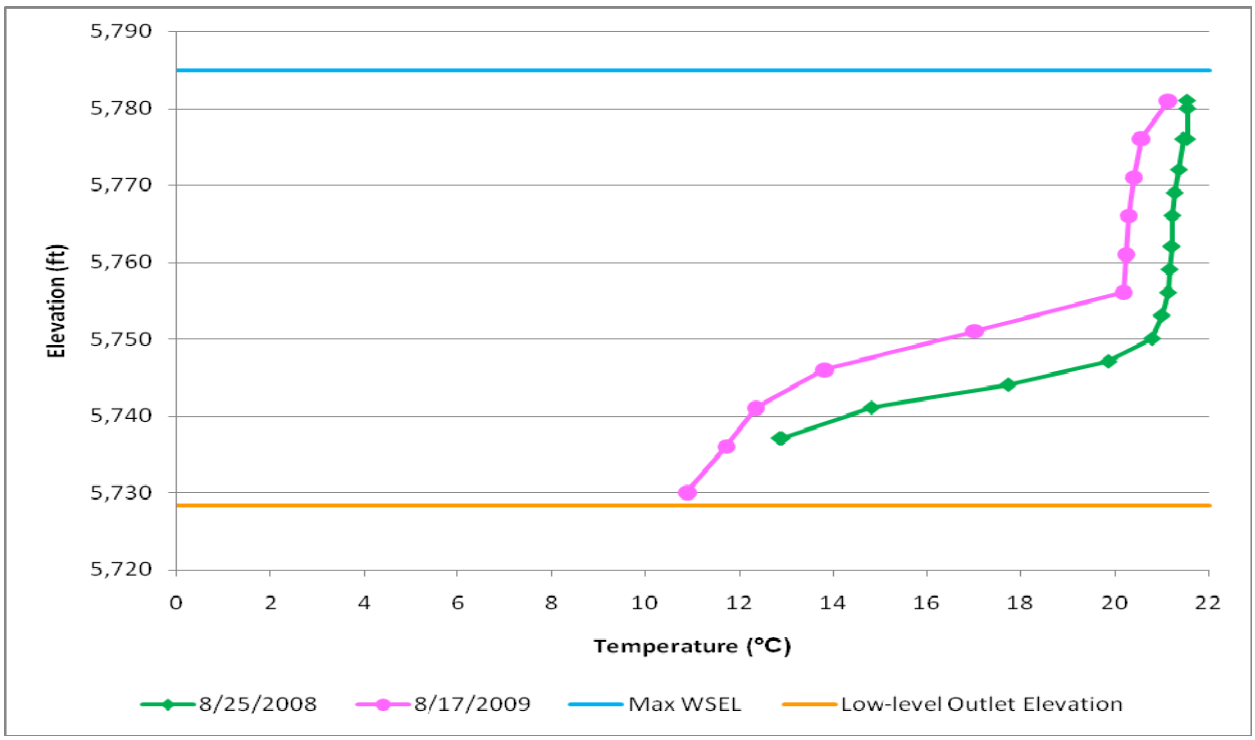

Figure 3.4-9. Lake Valley Reservoir water temperature profiles, August 2008 and 2009.

DO levels were not collected in June 2008 due to an equipment malfunction. The minimum and maximum DO concentrations recorded in August 2008 were 1.2 mg/L and 6.0 mg/L, respectively.

In 2009, the minimum DO concentration was 2.6 mg/L, recorded in August, and the maximum DO concentration was 11.3 mg/L, recorded in June.

Table 3.4-7 shows a direct comparison of DO concentration ranges in 2008 and 2009.

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Table 3.4-7. Lake Valley Reservoir DO concentrations, 2008 and 2009.

Month	2008		2009	
	Min DO (mg/L)	Max DO (mg/L)	Min DO (mg/L)	Max DO (mg/L)
June	No data	No data	8.8	11.3
August	1.2	6.0	2.9	9.2

3.5 Lake Spaulding Thermal Underflow/Stratification Analysis

[Relicensing Participants – This section will be completed when all data have been QA/QC'ed and analyzed. We have included profiles below for your information. Licensees]

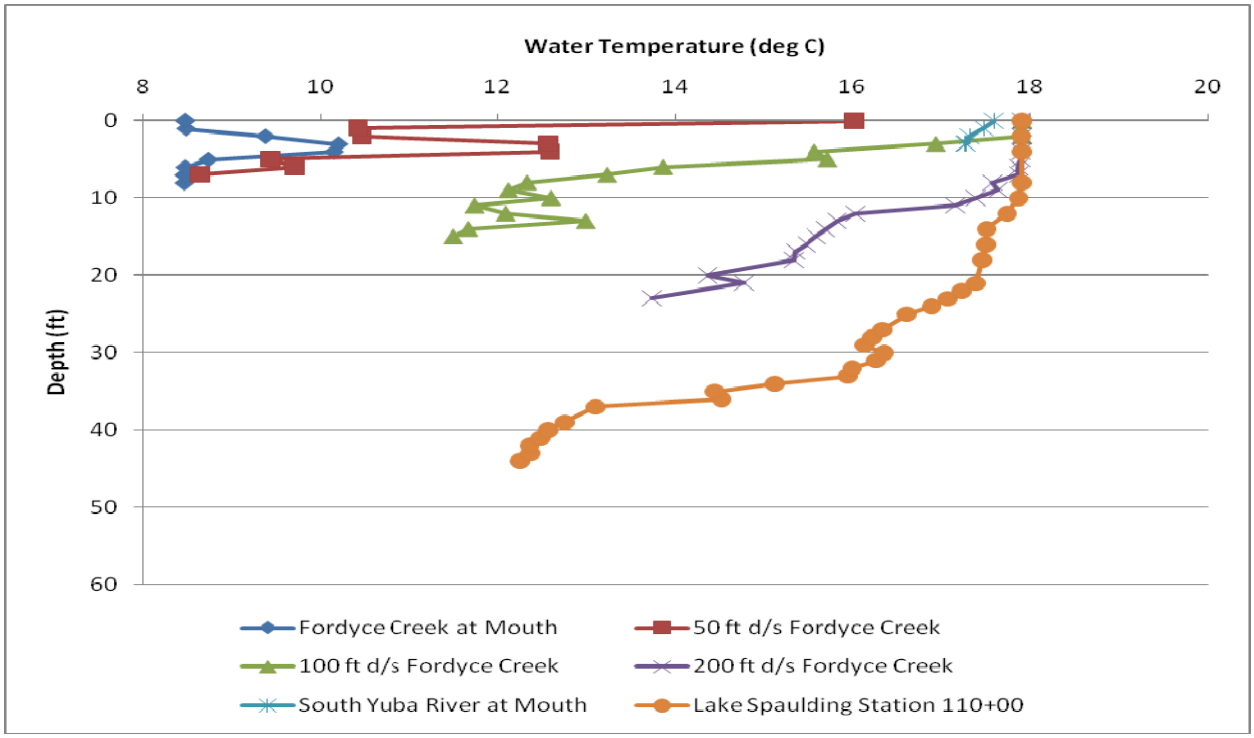

Figure 3.5-1. Water temperature profiles near mouths of Fordyce Creek and South Yuba River, August 2008.

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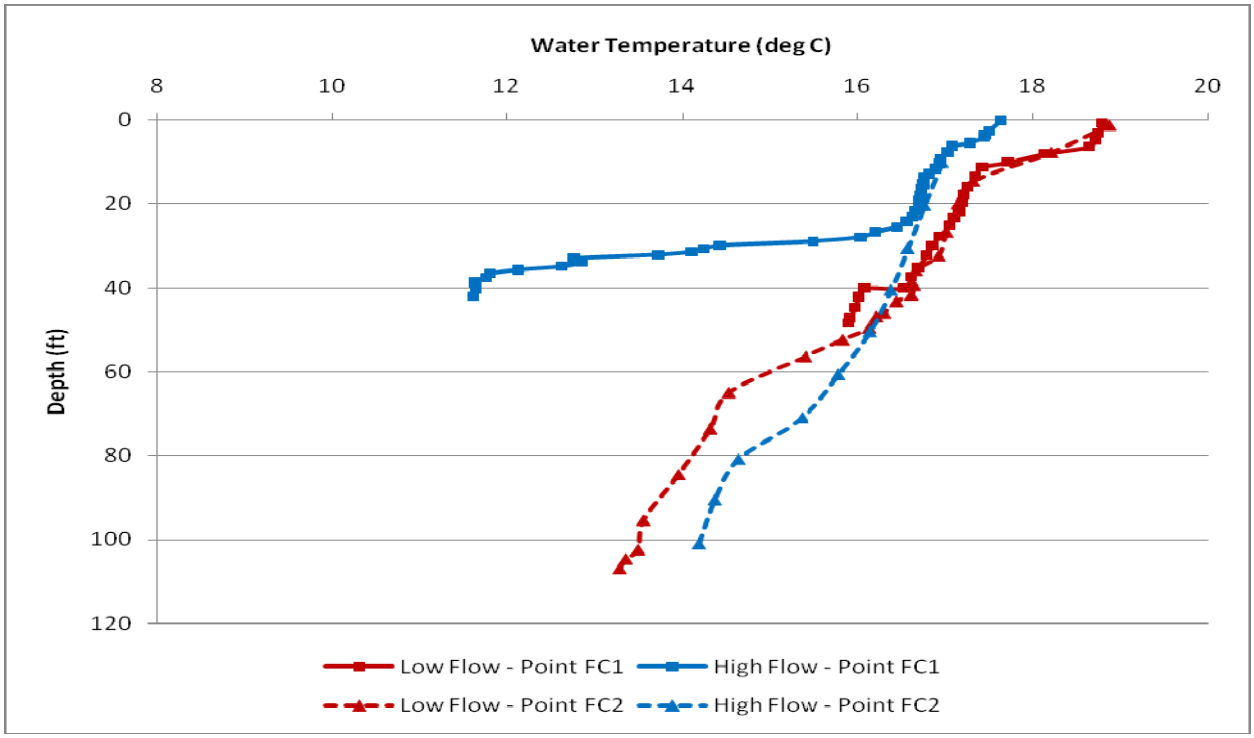

Figure 3.5-2. Water temperature profiles near mouth of Fordyce Creek, August 2009

4.0 Discussion

This section presents discussion of the results of the 2008 and 2009 monitoring, comparing it to historical data where available or providing explanations for any anomalous data points.

4.1 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, before declining in late September and October. This temperature trend is consistent with the Mediterranean climate patterns of inland northern California. On a daily scale, monitoring locations showed a widely varying amount of diurnal influence. Diurnal variance was increasingly 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 daily mean air temperatures observed regionally; this trend was also stronger at those locations with lower flows or increased distance from reservoir outlets as water temperatures began to approach equilibrium with the surrounding environment.

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

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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 Yuba River, South Yuba River, Canyon Creek, and Bear River.

4.1.1 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 and showed seasonal variations consistent with a high-elevation river.

Figure 4.1-1 compares mean daily water temperatures in the Middle Yuba River below Milton Diversion Dam (RM44.4.) and above Our House Dam (RM12.8) using the 2008 and 2009 Licensees-collected data, as well as data from the UYRSP collected in 2003 to 2007. In general, there was a 5°C to 10°C difference in mean daily temperatures between the upstream and downstream locations, with the largest temperature changes occurring during the summer months.

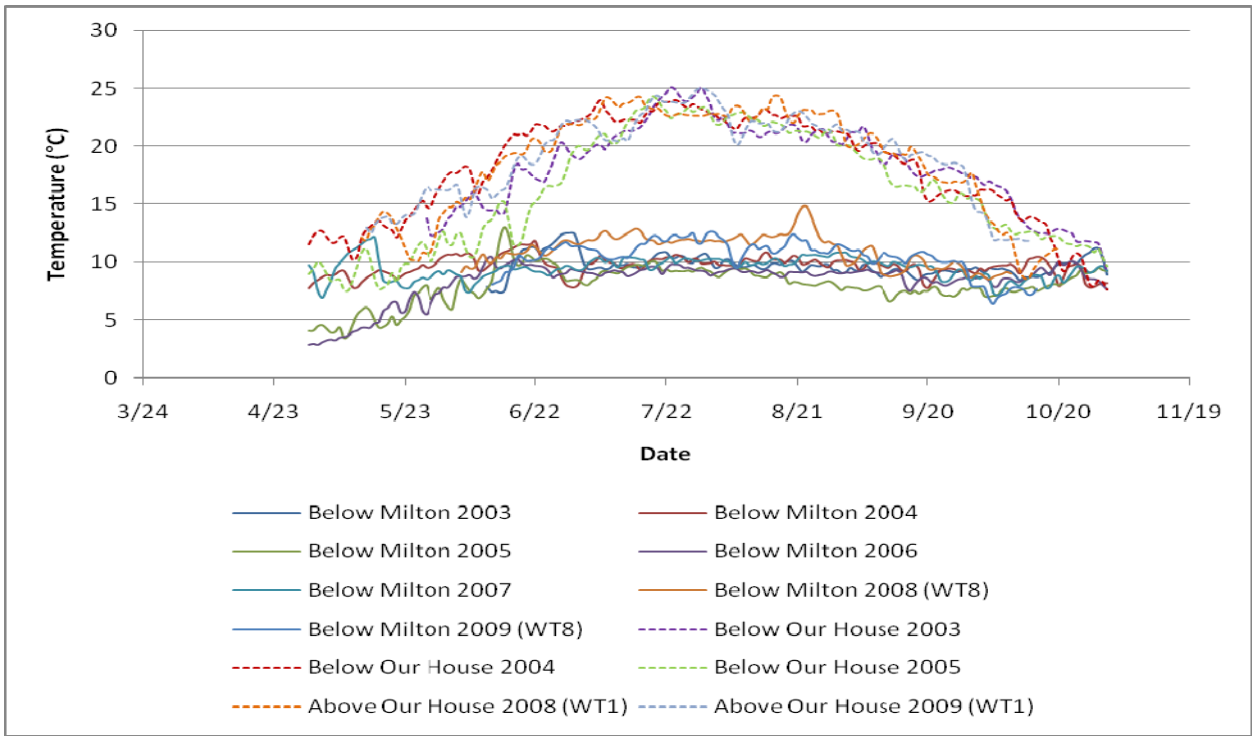

Figure 4.1-1. Mean daily water temperatures at the Middle Yuba River Below Milton Diversion Dam (RM44.4) during 2003 to 2009, below Our House Dam (RM12.8) in 2003 to 2005, and above Our House Dam (RM12.8) in 2008 to 2009.

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4.1.2 South Yuba River

The South Yuba River monitoring locations 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 4.1-2 compares mean daily water temperatures in the South Yuba River below Spaulding Dam (RM40.8) and above Englebright Reservoir (RM0.1) using the 2008 and 2009 Licensees-collected data, as well as data from the UYRSP collected in 2003–2007. In general, there was an 8°C to 15°C difference in mean daily temperatures between the upstream and downstream locations, with the largest temperature changes occurring during the summer months.

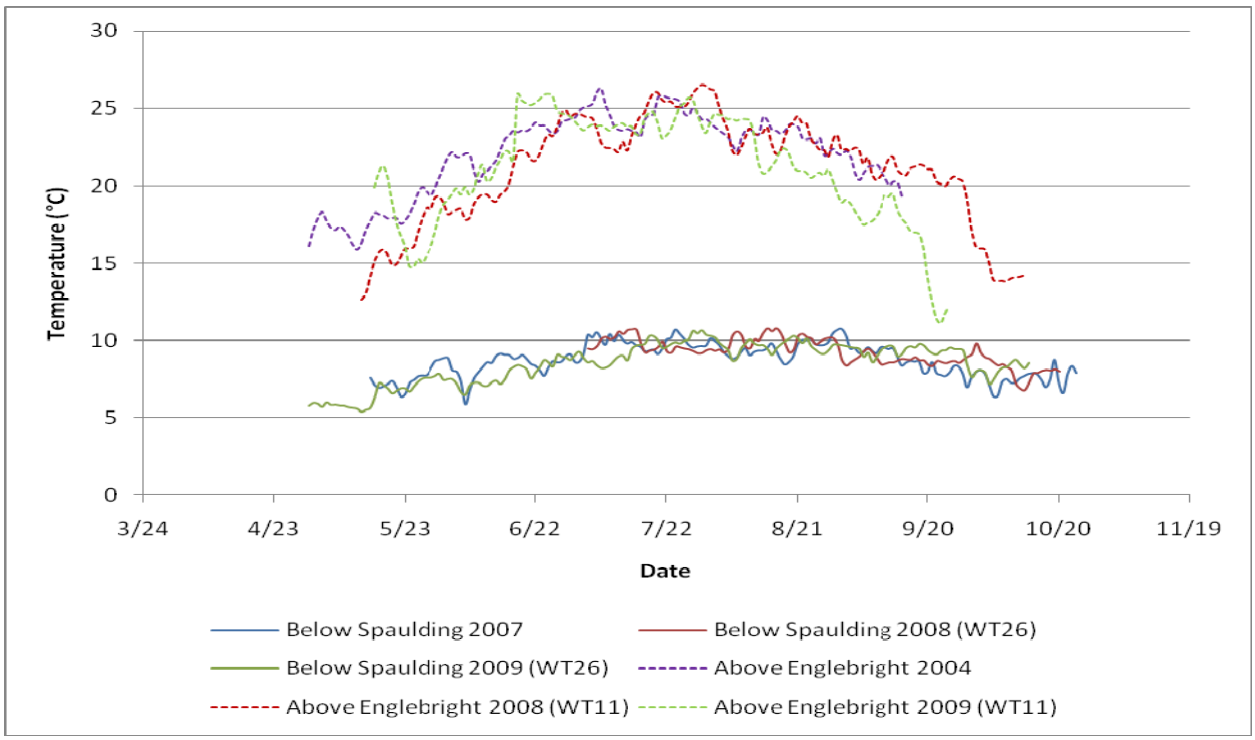

Figure 4.1-2. Mean daily water temperatures at the South Yuba River below Spaulding Dam (RM40.8) during 2007–2009, and above Englebright Reservoir (RM0.1), 2004 and 2008 through 2009.

In addition, a more focused temperature phenomenon derived from Licensees-collected data in 2008–2009 and supported by UYRSP data is the large increase in summer mean daily water temperatures on a 12-mile stretch of the South Yuba River between the confluences of Jordan Creek (RM 40.2) and Poorman Creek (RM 28.1). Temperatures consistently increased by approximately 10°C between these two monitoring stations during the months of June through September, with the increase peaking in mid-July (Figure 4.1-3).

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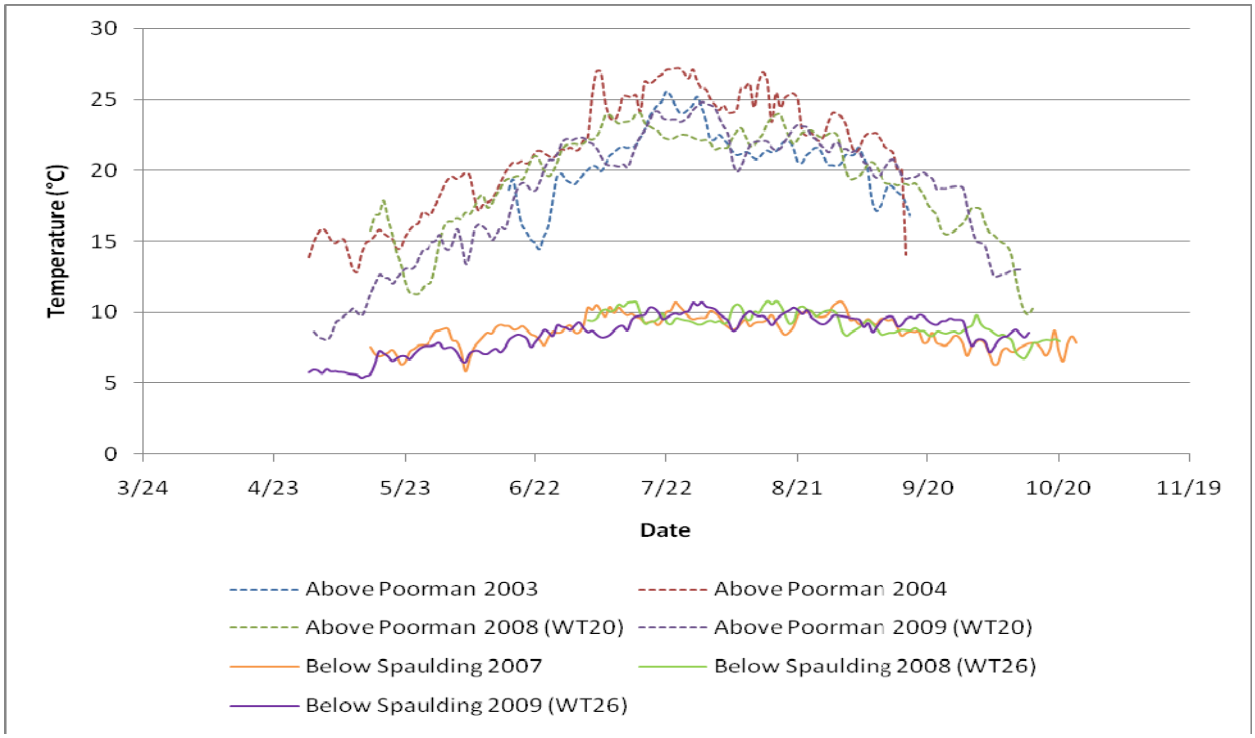

Figure 4.1-3. Mean daily water temperatures at the South Yuba River below Spaulding Dam (RM40.8), 2007–2009 and above Poorman Creek (RM28.1), 2003–2004 and 2008-2009.

4.1.3 Canyon Creek

The Canyon Creek monitoring locations were located from below the Yuba-Bear Hydroelectric Project's French Lake to above the confluence with the South Yuba River. Water temperatures are influenced by regulation of water at Faucherie, Sawmill, and Bowman lakes. In general, mean daily temperatures between Canyon Creek below Bowman Lake (RM 9.7) and above the confluence with the South Yuba River (RM 0.5) increased from the upstream to the downstream locations; however, mean daily temperatures became more uniform later in the season. During the summer months, a 4°C to 8°C difference in mean daily temperatures was observed (Figure 4.1-4).

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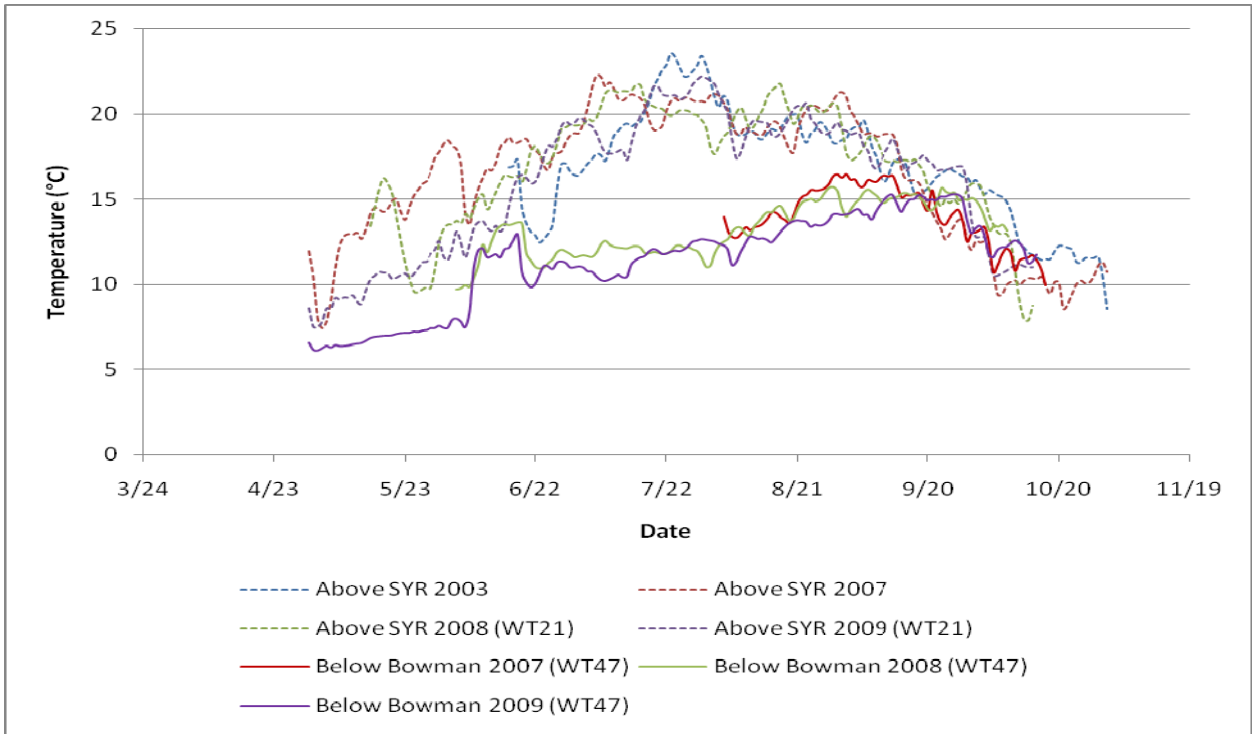

Figure 4.1-4. Mean daily water temperatures at Canyon Creek below Bowman (RM9.7), 2008 through 2009 and above confluence with South Yuba River (RM0.1), 2003 and 2007 through 2009.

4.1.4 Bear River

Bear River monitoring occurred from the headwaters near Highway 20 to just above the inflow to the non-project Lake Combie. Water temperatures are influenced in the upper portion of the Bear River by regulation of flow at Drum Afterbay and Dutch Flat Afterbay. Further downstream, Rollins Reservoir has a deep seasonal stratification and releases from Rollins Reservoir and diversions into the Bear River Canal dominate water temperature effects in the lower portion of the Bear River between Rollins Reservoir (RM 10.0) and above Lake Combie (RM 0.5).

Figure 4.1-5 compares mean daily water temperatures in the Bear River below Rollins Reservoir (RM10.0) and above Lake Combie (RM0.5) using the 2008 and 2009 Licensees-collected data. In general, temperatures were warmer at the downstream end of the Bear River and showed more seasonal variation. Temperatures in the Bear River near Rollins Reservoir increased consistently through the monitoring period.

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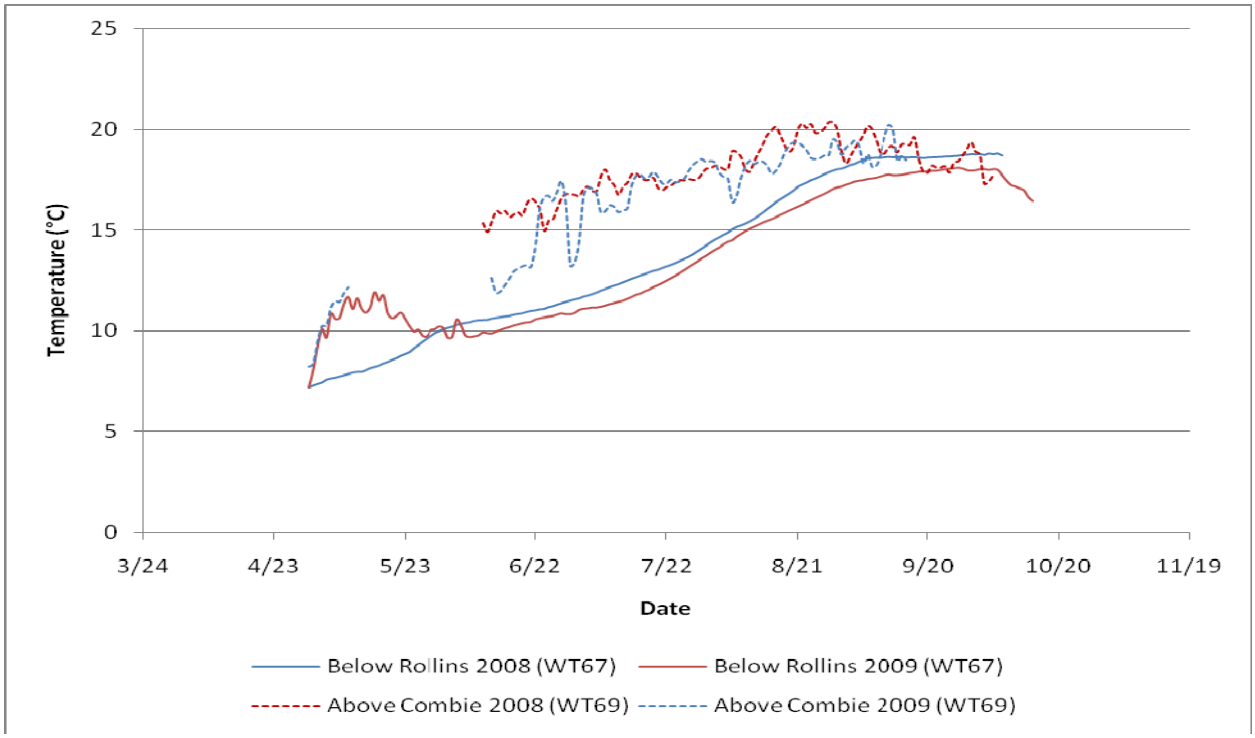

Figure 4.1-5. Mean daily water temperatures at the Bear River below Rollins Reservoir (RM10.0), 2008 to 2009 and above Lake Combie (RM0.5), 2008 to 2009.

4.2 Stream Flow Monitoring

During the 2009 monitoring period, the measured stream flow at the monitoring sites decreased from the time of logger installation in April or June through October. These flow regimes are consistent with typical seasonal flows observed in northern California, with the exception of stream reaches that are used for conveyance of regulated upstream waters. Most of the sites showed a diurnal pattern with daily variability decreasing as daily flow reached baseflow levels. Sites directly below reservoirs showed less daily and monthly variability. The unit baseflow discharge ranged from 0.01 cfs/mi^2 at Rush Creek above the South Yuba River (WT13) to 0.7 cfs/mi^2 at Jordan Creek above the South Yuba River[3] (Table 2.2-1). Sites directly below project facilities overall have lower unit baseflow discharge values. Site-specific hydrographs can be found in Attachment 2-2B, plotted with the corresponding average water and air temperature.

For data collected in 2008, stream stage was monitored at 11 sites and stream discharge was measured at 14 sites. The lack of discharge and manual stage measurements greatly limits the accuracy of the 2008 stream flow records. The stage records are accurate, but without more flow measurements, stage discharge rating curves were not developed. To help develop "synthetic" rating curves for the 2008 data, discharge measurements from 2009 were used and shifted to match the channel geometry of the 2008 sites as much as possible. The stream flow records have

[3] Unit baseflow measurements in this reach may be influenced by leakage flows from lateral dams on tributaries to Jordan Creek, which seasonally impound PG&E's Lake Spaulding.

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a 30 percent margin of error. 2008 site-specific hydrographs can be found in Attachment 2-2B, plotted with the corresponding average water and air temperature.

Additional discussion is provided below for the Middle Yuba River and South Yuba River sub-basins.

4.2.1 Middle Yuba River

The monitoring sites in the Middle Yuba River were all located downstream of Milton Diversion Dam, the last Yuba-Bear Hydroelectric Project facility on the river. The amount of baseflow increased in a downstream direction as drainage area increased. Stage and flow tended to increase coincidently between sites in response to rainfall and reduced summer flows. Generally, the daily average flow increased sequentially between sites. Once baseflow was reached, the unit discharge was at about 0.2 to 0.3 cfs/mi^2 and the downstream stream flow difference was less for a given day. By late August 2009, there was little measurable difference between WY7, WT5, and WT3 along the main stem of the Middle Yuba River.

For unknown reasons, in early July 2009 the flow at WT1 decreased about 5 cfs for a few days, reading lower than upstream sites WT3 and WT5 (Figure 2). Also, visible in Figure 15 in mid-September 2009, the flow increased at WT1 about 5 cfs while the other sites showed no increase. The data for these time periods appear to be accurate. Further, the WT1 site produced one of the most accurate and reliable flow records in 2009. The average daily flow at WT1 was compared to the Middle Yuba River average daily flow measured below YCWA's Our House Diversion Dam combined with inflows to YCWA's Lohman Ridge Tunnel intake.

4.2.2 South Yuba River

The South Yuba River stream flow monitoring sites were all located downstream of Lake Spaulding, the last Drum-Spaulding Project facility on the river. The confluence with Canyon Creek (i.e., WT21) provides the last inflow of Yuba-Bear Hydroelectric Project-affected water to the South Yuba River. The amount of flow increased in a downstream direction. The unit baseflow discharge did not decrease sequentially downstream and is less than 0.15 cfs/mi^2 at all the sites except Jordan Creek (WT24) and Poorman Creek (WT19). At WT24, the unit discharge is high as a result of overflow and leakage from Spaulding Dam into Jordan Creek. Poorman Creek is unregulated and has a unit baseflow discharge similar to those measured in the Middle Yuba River (i.e., 0.15 cfs/mi^2). Small tributaries in the lower South Yuba River had unit baseflow discharge values of less than 0.10 cfs/mi^2. This is likely a function of elevation rather than flow regulation or diversion.

Stage and flow tended to increase coincidently between sites in response to rainfall and reduced summer flows. Generally, the daily average flow increased sequentially between sites. Once baseflow was reached, the unit discharge was between 0.10 and 0.15 cfs/mi^2 and the downstream stream flow difference was less for a given day. By late September 2009, there was little to no measurable difference between WY22, WT18, WT14, and WT11 along the main stem of the South Yuba River (Figure 3.3-2).

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Upstream on the South Yuba River, between Lake Spaulding and the confluence with Canyon Creek, the unit baseflow discharge of the mainstem South Yuba River proper nearly doubles (Figure 18). Neither Canyon Creek nor Poorman Creek, both relatively large tributaries, increase the unit discharge of the South Yuba River during the lowest flows of the year. There appears to be a substantial source of inflow between South Yuba River above Jordan Creek (WT25) and South Yuba River above Canyon Creek (WT22). Monthly, the discharge at the mouth of all tributaries between these sites was measured. Accounting for tributary inflow, almost half of the flow measured at WT22 was unaccounted for. This trend is consistent and occurred from June through September 2009. For example, in August 2009, the instantaneous flow measured at WT24 was 7 cfs while the flow at WT22 was 18 cfs. The measured tributary inflow between WT25 and WT22 was 2 cfs. For the August 2009 synoptic sampling event, there is basically 9 cfs gained between these two sites that were not measured. The unit discharge increases from 0.6 to 1.1 cfs/mi^2. It is plausible that leakage/seepage flows from the Bowman-Spaulding Conduit and Lake Spaulding, as well as substantial springs, may account for some or all of the observed increase in flow.

4.3 Estimated Storage in Selected Project Reservoirs at 5°C, 10°C, and 15°C Isotherms

In general, water temperature profiles collected during the 2008 and 2009 monitoring period were consistent with historical profiles taken in the same reservoirs and general trends expected in larger reservoirs. Profiles taken in Jackson Meadows Reservoir, 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 reservoirs, as well as Rollins Reservoir, in 2007.

Licensees-collected water temperature profiles in 2008 and 2009 were used to calculate an estimate of the useable storage below the 5°C, 10°C, and 15°C isotherms for Jackson Meadows, Bowman Lake, Rollins Reservoir, Fordyce Lake, Lake Spaulding, and Lake Valley Reservoir. Tables 4.3-1 through 4.3-6 describe the estimated storage below the 5°C, 10°C, and 15°C isotherms by month for 2008 and 2009.

Table 4.3-1. Estimated storage in Jackson Meadows Reservoir at the 5°C, 10°C, and 15°C isotherms relative to the low-level outlet.

Month	Date of Sampling	Reservoir Elevation (ft)	Total Useable Storage (acre-feet [ac-ft])	Estimated Storage below 15°C Isotherm (ac-ft)	Estimated Storage below 10°C Isotherm (ac-ft)	Estimated Storage below 5°C Isotherm (ac-ft)
July	7/24/2009	6,024	55,777	36,552	29,628	2,095
August	8/19/2009	6,017	49,342	26,801	19,529	761
September	9/25/2009	6,007	40,659	13,416	10,327	0
October	10/15/2009	6,004	38,176	38,176	4,855	0

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Table 4.3-2. Estimated storage in Bowman Lake at the 5°C, 10°C, and 15°C isotherms relative to the low-level outlet.

Month	Date of Sampling	Reservoir Elevation (ft)	Total Useable Storage (acre-feet [ac-ft])	Estimated Storage below 15°C Isotherm (ac-ft)	Estimated Storage below 10°C Isotherm (ac-ft)	Estimated Storage below 5°C Isotherm (ac-ft)
July	7/18/2008	5,542	53,653	28,000	8,300	0
	7/24/2009	5,549	57,974	30,900	7,600	0
August	8/20/2008	5,527	41,899	9,700	0	0
	8/19/2009	5,539	50,430	13,200	0	0
September	9/24/2008	5,516	34,658	0	0	0
	9/25/2009	5,531	44,674	0	0	0
October	10/24/2008	5510	30,954	30,954	0	0
	10/17/2009	5,526	41,217	41,217	0	0

Table 4.3-3. Estimated storage in Rollins Reservoir at the 5°C, 10°C, and 15°C isotherms relative to the low-level outlet.

Month	Date of Sampling	Reservoir Elevation (ft)	Total Useable Storage (ac-ft)	Estimated Storage below 15°C Isotherm (ac-ft)	Estimated Storage below 10°C Isotherm (ac-ft)	Estimated Storage below 5°C Isotherm (ac-ft)
May	5/23/2008	2,169	57,122	53,400	19,600	0
	5/29/09	2,171	58,682	58,682	33,900	0
June	6/13/2008	2,168	56,353	46,600	2,500	0
	6/23/2009	2,169	57,122	50,600	2,900	0
July	7/17/2008	2,163	52,663	23,000	1,500	0
	7/29/2009	2,169	57,122	14,436	800	0
August	8/25/2008	2,160	50,577	2,100	1,200	0
	8/19/2009	2,165	54,103	2,000	600	0
September	9/11/2008	2,165	54,103	1,900	1,200	0
	9/24/2009	2,159	49,897	1,200	400	0
October	10/24/2008	2,135	35,912	1,300	800	0
	10/14/2009	2,147	42,382	0	0	0

Table 4.3-4. Estimated storage in Lake Spaulding at the 5°C, 10°C, and 15°C isotherms relative to the low-level outlet.

Month	Date of Sampling	Reservoir Elevation (ft)	Total Useable Storage (ac-ft)	Estimated Storage below 15°C Isotherm (ac-ft)	Estimated Storage below 10°C Isotherm (ac-ft)	Estimated Storage below 5°C Isotherm (ac-ft)
July	7/16/2008	4,973	49,818	19,800	0[1]	0
	7/28/2009	4,982	55,000	29,400	3,300	0
August	8/21/2008	4,937	31,569	2,200	1,300	0
	8/17/2009	4,973	49,800	17,000	2,700	0
September	9/24/2008	4,926	26,789	6,300	1,200	0
	9/15/2009	4,965	45,400	3,300	1,500	0
October[2]	N/A	N/A	N/A	N/A	N/A	N/A
	10/12/2009	4,975	50,952	50,952	500	0

[1] Profile was not taken in thalweg; therefore no storage at 10°C is shown by the data.
[2] No data collected in October 2008 due to access issues.

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Table 4.3-5. Estimated storage in Fordyce Lake at the 5°C, 10°C, and 15°C isotherms relative to the low-level outlet.

Month	Date of Sampling	Reservoir Elevation (feet)	Total Useable Storage (ac-ft)	Estimated Storage below 15°C Isotherm (ac-ft)	Estimated Storage below 10°C Isotherm (ac-ft)	Estimated Storage below 5°C Isotherm (ac-ft)
July	7/21/2008	6,394	41,802	27,600	20,600	0
	7/27/2009	6,384	35,312	18,600	12,300	0
August[1]	N/A	N/A	N/A	N/A	N/A	N/A
	8/18/2009	6,370	27,011	10,400	0	0
September	9/10/2008	6,376	30,462	8,100	5,800	0
	9/16/2009	6,340	12,307	3,000	1,600	0
October	10/9/2008	6,360	21,621	21,621	1,400	0
	10/12/2009	6,312	3,709	3,709	3,709	0

[1] No data collected in August 2008 due to equipment malfunction.

Table 4.3-6. Estimated storage in Lake Valley Reservoir at the 5°C, 10°C and 15°C isotherms.

Month	Date of Sampling	Reservoir Elevation (ft)	Total Useable Storage (ac-ft)	Estimated Storage below 15°C Isotherm (ac-ft)	Estimated Storage below 10°C Isotherm (ac-ft)	Estimated Storage below 5°C Isotherm (ac-ft)
June	6/13/2008	5,779	6,152	5,600	0	0
	6/10/2009	5,783	7,600	4,800	1,500	0
August	8/25/2008	5,776	5,337	30	0	0
	8/17/2009	5,781	7,009	600	0	0

5.0 Study-Specific Collaboration and Consultation

The FERC-approved study plan included one study-specific collaboration addressed below.

5.1 Field Visits

The FERC-approved study states:

> *"Invite interested Relicensing Participants into the field to comment on specific sampling stream continuous water temperature monitoring sites.*
>
> *Invite interested Relicensing Participants into the field to comment on specific reservoir water temperature profiling sites."*

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 FERC-Approved Study

This study was conducted following the methods in Study 2.2.2 that was included in Licensees' Revised Study Plans filed with FERC on January 23, 2009, and approved by FERC in its Study

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Determination on February 23, 2009. The following items were variances from the FERC-approved study; however the variances were minor and did not affect the objectives of the study.

6.1 Stream Temperature Monitoring

In general, some high-elevation monitoring locations were not installed until early July 2008 due to remnant snow and limited road access. In October 2008, Licensees installed some loggers for overwintering in order to capture the spring 2009 runoff period, even if access to the sites was delayed in 2009. In general, water temperature recorders were installed earlier in 2009 throughout the sampling area.

No temperature logger was installed in Wilson Creek below the Wilson Creek Diversion Dam. When Licensees arrived at this location in June 2008 and 2009, the streambed was dry. Water temperatures above the Wilson Creek Diversion were recorded for the entire monitoring period.

Spot discharge measurements were not taken at each required location every month in 2008 and 2009 due to difficulty in accurately measuring discharge with the equipment used for smaller tributaries (propeller-type velocimeter on rod) or due to high flows, which created dangerous wading conditions. Discharge and stage measurements that were taken during 2008 and 2009 provided Licensees enough data to develop stage-discharge tables for select locations. In addition, stages and discharges in the Middle Yuba River were measured in 2008 and in the South Yuba River in 2009 as part of the Instream Flow Study.

6.2 Reservoir Water Temperature Profiling

Water temperature profiles were not recorded at Lake Spaulding at either the near-dam and mid-reservoir location in October or the mid-reservoir location in September due to unsafe boating conditions and access. While the data in 2008 and 2009 did not include the fall turnover in Lake Spaulding, mean water column temperatures from profiles taken in October from 2004 through 2009 range from 12°C – 14°C. Based on these data, releases made from Lake Spaulding post-turnover (likely to occur in November or December) would continue to support cold water resources in the downstream reach. This variance is therefore considered to be insignificant in the context of overall study results. DO was not measured at the above locations where access was an issue. In addition, DO was not collected in Lake Valley (June 2008) or Meadow Lake (July 2008) due to a malfunction of the DO sensor.

6.3 Lake Spaulding Thermal Underflow/Stratification Analysis

ADCP data collection did not take place in 2009 due to inconclusive results from 2008 data collection efforts, as compared to coincident water temperature profiles. In lieu of ADCP measurements, additional water temperature profiles were taken in 2009 at the mouth of Fordyce Creek, where the combination of higher flows and lower inflow temperatures provided the highest potential for thermal underflow and stratification.

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7.0 Attachments to this Technical Memorandum

This technical memorandum includes five attachments:

- Attachment 2-2A Stream Temperature and Reservoir Profile Location Map [1 Adobe PDF file: 9 MB; 1 page formatted to print on 36 by 52 paper]
- Attachment 2-2B Stream Temperature Plots [1 Adobe PDF file: 16 MB; 164 pages formatted to print double sided on 8 ½ by 11 paper]
- Attachment 2-2C Reservoir Water Temperature and Dissolved Oxygen Data [1 Microsoft Word file: 1.5 MB; 22 pages formatted to print double sided on 8 ½ by 11 paper]
- Attachment 2-2D Stream Temperature DSS Data [1 Adobe PDF file: 22 kB; 2 pages formatted to print single sided on 8 ½ by 11 paper and 1 dss file: 1.5 MB]
- Attachment 2-2E Stream Temperature and Reservoir Profile Raw Data [1 Adobe PDF file: 7 kB; 1 page formatted to print on 8 ½ by 11 paper, and 1 CD available upon request]

8.0 References Cited

California Data Exchange Center, 2009. Selected Meteorological Data. Available online: <cdec.water.ca.gov>. Accessed December 2008 and November 2009.

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