6.5 Water Quality

6.5 Water Quality

This section describes the relevant aspects of water quality in the vicinity of the Upper North Fork Feather River Hydroelectric Project (UNFFR Project), Federal Energy Regulatory Commission (FERC) Project No. 2105. This section also analyzes the potential impacts of the operation of the UNFFR Project, under a new FERC license, on water quality conditions in Lake Almanor, Butt Valley reservoir, Butt Creek, and the North Fork Feather River. The alternatives described in Chapter 4 – Project Alternatives (e.g., thermal curtains, modified releases) have no effect on the overall storage or lake levels in Lake Almanor.

The following topics are not discussed in this section for the reasons noted:

- **Groundwater Quality:** Neither the Proposed UNFFR Project nor the alternatives would affect groundwater quality in the area.

- **Shoreline Erosion and Suspended Sediment:** These topics are addressed in section 6.3, Geology, Geomorphology, and Soils.

- **Water Visibility:** The Lake Almanor Water Quality Report – 2010 prepared for the Plumas County Flood Control and Water Conservation District and Almanor Basin Watershed Advisory Committee reported that Secchi depth visibility during 2009 and 2010 were in agreement with historic values in the database maintained by the California Department of Water Resources (Johnston and McMurtry 2010). This is consistent with the information provided by PG&E in its 2002 License Application for the UNFFR Project (Pacific Gas and Electric 2002). Neither the Proposed UNFFR Project nor the alternatives would change the visibility of the water in Lake Almanor relative to baseline conditions.

- **Global Climate Change:** Neither the Proposed UNFFR Project or the alternatives would be likely to affect the potential trends in water temperatures of Lake Almanor that may be related to climate change (i.e., global warming) because overall seasonal reservoir storage volumes would not be affected.

- **Nutrients:** Neither the Proposed UNFFR Project of the alternatives would cause a detrimental change in the overall concentrations of nutrients that would stimulate algal productivity in Lake Almanor, primarily because seasonal reservoir storage volumes would not be affected. A slight reduction in total phosphorus loading in Lake Almanor could occur through hypolimnetic[1] releases of phosphorus solubilized from the lake bed sediments by anoxic conditions in the hypolimnion in the late summer (Cooke et al. 1993). This would not increase algal productivity or otherwise decrease water quality in the reservoir because phosphorus is already considered the limiting nutrient for algal growth in Lake Almanor (Earthworks Restoration and CH2M Hill 2007). An associated slight increase in phosphate concentration could occur immediately below Canyon dam during hypolimnetic releases late in the summer but would rapidly decline to baseline as phosphorus binds to riverbed sediments as the water reoxygenates below Canyon dam.

- **Coliform Bacteria:** Neither the Proposed UNFFR Project nor the alternatives would cause a change in the occurrence of coliform bacteria in Lake Almanor, Butt Valley

[1] The layer of water in a thermally stratified lake that lies below the thermocline, is noncirculating, and remains perpetually cold

> reservoir, or the North Fork Feather River because seasonal reservoir storage and discharge volumes would not be affected. Sporadic, localized high concentrations of coliform bacteria have been reported at Lake Almanor (Pacific Gas and Electric Company 2002). Coliform bacteria concentrations above the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan) water quality objective of a geometric mean concentration of 200 coliform bacteria per 100 milliliters have been reported in the southern extent of Lake Almanor near Canyon dam during May, August, and October (Federal Energy Regulatory Commission 2005). The source of these relatively high coliform concentrations is uncertain, but may be connected to discharges from the Chester wastewater treatment plant or inadvertent pollution from leaking septic systems around Lake Almanor (CH2M Hill 2006).

The potential impacts of the Proposed UNFFR Project operations have been evaluated in the Final Environmental Impact Statement for the Upper North Fork Feather River Project EIS issued by the FERC. As allowed under section 15150 of the California Environmental Quality Act (CEQA) Guidelines, the State Water Resources Control Board (State Water Board) incorporates, by reference, certain sections of Chapter 3.3.1 of the Final FERC EIS, which analyzes the impacts of UNFFR Project operations on water quality. These specific sections are identified later in this chapter.

The potential impacts of the alternatives on water quality that supports coldwater habitat and the recreational fishery of Lake Almanor and Butt Valley reservoir were raised as primary concerns during the public scoping process for this Environmental Impact Report (EIR) (Appendix B). Accordingly, water temperature and dissolved oxygen (DO), the key water quality parameters associated with the cold freshwater habitat beneficial use in the UNFFR Project water bodies and which may be affected by implementation of Proposed UNFFR Project and either alternative, are the focus of the water quality analysis presented in this section of the EIR.

6.5.1 Environmental Setting

The North Fork Feather River lies within the Sacramento River basin (see Figure 1-1). The river and its tributaries are therefore subject to the water quality objectives set forth in the Basin Plan.

The beneficial uses identified in the Basin Plan are shown in Table 2-1 in Chapter 2, State Water Board's Regulatory Responsibilities. The numerical and narrative objectives applicable to the beneficial uses of Lake Almanor and the North Fork Feather River are listed in Table 2-2 in Chapter 2.

Over the past 100 years, the hydrology of the North Fork Feather River watershed has been modified by numerous hydroelectric projects on the river and its tributaries (See Figure 3-3). Other land uses, including the construction and operation of railroads and highways, timber harvest and management, mining, livestock grazing, recreation, and residential development have also affected the watershed. These projects and activities have influenced the water quality of the North Fork Feather River and its tributaries. Extensive hydroelectric development on the North Fork Feather River has greatly altered the river's physical character and flow regime. The North Fork Feather River contains three FERC-licensed hydroelectric projects consisting of five diversion dams located on the mainstem of the North Fork Feather River: the UNFFR Project; Rock Creek–Cresta Hydroelectric Project (FERC Project No. 1962); and the Poe Hydroelectric Project (FERC Project No. 2107). The Hamilton Branch Project is also located on the North Fork Feather River. In addition, PG&E operates the Hamilton Branch Project under an exemption from FERC. As a result of these hydroelectric facilities, much of the river's flow from Lake Almanor to Lake Oroville is diverted through tunnels and penstocks (See Figure 3-2). The current operations, project features, and relationships among the projects result in a limited ability to control dam releases for water temperature management in the North Fork Feather River (Pacific Gas and Electric Company 1979, 2000, 2005; Woodward-Clyde Consultants 1987; California Department of Fish and Game 1988; Federal Energy Regulatory Commission 2005).

As described in Chapter 2, the Basin Plan identifies two hydrologic units (i.e., water bodies) within the UNFFR Project boundary: Lake Almanor (Hydrologic Unit No. 518.41) and the North Fork Feather River downstream of Canyon dam (Hydrologic Unit No. 518.4). The entire Butt Creek watershed, including Butt Valley reservoir, is a tributary to the North Fork Feather River and is included in Hydrologic Unit No. 518.4.

Beneficial uses designated for Lake Almanor are: hydropower generation; water contact recreation; warm and cold freshwater habitat; warm spawning habitat; and wildlife habitat. Beneficial uses designated for the North Fork Feather River below Canyon dam are: municipal and domestic supply; hydropower generation; water contact recreation; non-water contact recreation; cold freshwater habitat; cold spawning habitat; and wildlife habitat. The State Water Board is required by law to establish water quality objectives that ensure the reasonable protection of designated beneficial uses, and it must consider and balance all competing uses of a body of water in its decision-making. In instances where both warm and cold water beneficial use designations occur within a single water body, such as Lake Almanor, the coldwater uses usually are the most limiting, and water quality objectives to protect coldwater habitat receive special consideration.

In 2006, a 49-mile segment of the North Fork Feather River below Lake Almanor, from Belden dam downstream to Lake Oroville, was listed by the United States Environmental Protection Agency (USEPA) under Section 303(d) of the Clean Water Act for non-compliance with the Basin Plan's water quality objectives for the river. The listing was based on water quality limitations caused by occurrences of high summertime water temperatures and elevated mercury concentrations. The elevated mercury concentrations are attributable to historic mining activities, not the UNFFR Project. The primary causes of water temperature impairment in the North Fork Feather River are attributed to hydromodification and flow regulation/modification (State Water Board Resolution No. 2006-0079).

Water Quality Conditions

This EIR focuses on potential modifications to the existing UNFFR Project that may be implemented to better protect the overall beneficial uses of the North Fork Feather River, while limiting water quality impacts to the beneficial uses of Lake Almanor. The following sections describe aspects of key water quality conditions and the relevant water quality objectives as they pertain to the specific beneficial uses (see Table 2-1) that occur within the general vicinity of the North Fork Feather River and that are subject to the influence of controllable factors[2] associated with the UNFFR Project.

[2] Protection and attainment of beneficial uses designated in the Basin Plan requires the State Water Board and Regional Water Quality Control Boards (collectively, Water Boards) to apply the water quality objectives to reasonably controllable water quality factors in issuing Clean Water Act Section 401 water quality certifications. "Controllable water quality factors" are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the State that are subject to the authority of the Water Boards and may be reasonably controlled.

During the FERC relicensing process for the UNFFR Project, PG&E performed numerous technical studies to improve the understanding of the current resource conditions and beneficial uses of Lake Almanor and the North Fork Feather River, including its tributaries. The Draft and Final FERC EIS provided additional information on this topic, much of which is incorporated by reference in this EIR. Since the Final FERC EIS was prepared in 2005, PG&E and the Plumas County Flood Control and Water Conservation District have contributed to a body of information on various water quality conditions, including water temperature and DO, through ongoing monitoring efforts and watershed planning documents (CH2M Hill 2006, Earthworks Restoration and CH2M Hill 2007). In 2006, PG&E conducted a series of special tests to provide data for the analysis presented in this EIR (as part of the ongoing CEQA planning effort (Stetson Engineers and Pacific Gas and Electric Company 2007a).

The following section, organized by water body, briefly describes the relevant water quality conditions of concern, with respect to the Basin Plan's water quality objectives and beneficial uses.

Reservoirs

Lake Almanor

Lake Almanor is one of the largest reservoirs in California, with a normal storage capacity of 1.13 million AF. The reservoir receives inflow from the upper North Fork Feather River, the Hamilton Branch Project, and a number of smaller streams and springs (see Figure 3-1). Lake Almanor has an average hydraulic residence time, or flow-through rate, of between 0.75 to 1 year (Federal Energy Regulatory Commission 2005, Earthworks Resources and CH2M Hill 2007). Water quality information provided in PG&E's FERC license application (Pacific Gas and Electric Company 2002) and other available sources, including historic limnology and fisheries studies (California Department of Water Resources and California Department of Fish and Game 1974), watershed condition and water quality assessments of the Lake Almanor basin (CH2M Hill 2006, Earthworks Resources and CH2M Hill 2007), the Final FERC EIS (Federal Energy Regulatory Commission 2005), and recent water quality monitoring by Plumas County Flood Control and Water Conservation District (Johnston and McMurtry 2010), indicate that Lake Almanor generally meets water quality objectives supportive of currently designated beneficial uses[3], as defined in the Basin Plan, and shows predictable seasonal patterns. Lake Almanor shows little or no evidence of long-term trends, except for a recent finding by Schneider et al. (2009) that the nighttime lake surface temperature appears to be warming at about 0.15 ± 0.03°C per year since 1992.

Data on Secchi disk transparency, nutrient concentrations, and algal biomass for Lake Almanor reflect a moderate level of productivity, a lake characteristic known as being "mesotrophic" (Cooke et al. 1993, as cited by Earthworks Restoration and CH2M Hill 2007; Johnston and McMurtry 2010). As would be expected in a mesotrophic lake, current conditions include some seasonal oxygen depletion in the deepest areas of the lake below the thermocline, as described in more detail below. However, this seasonal occurrence does not appear to indicate a water quality impairment of the designated cold freshwater habitat beneficial use because the temporal and spatial extent of the seasonal oxygen depletion is limited (CH2M Hill 2006).

[3] Historical water temperature and DO data indicate that the suitable cold freshwater habitat volume (i.e., volume of water that equals or is less than 20°C and has DO of 5 mg/L or greater) in Lake Almanor is severely limited in the summer during critically dry water years. However, the absence of observed historical fish kills, even in critically dry water years, suggests that the water quality in Lake Almanor generally supports its currently designated beneficial uses.

The overall water quality of Lake Almanor may be variously influenced by such factors as water depth, season, climatic conditions, and the timing and volume of stream and spring inflows, overland runoff, erosion and sediment influx, and septic system leachate and treated wastewater effluent discharges to the lake (California Department of Water Resources and California Department of Fish and Game 1974, Earthworks Restoration and CH2M Hill 2007). The size and depth of the lake, coupled with the seasonal climatic variability, causes the lake to thermally stratify during the late-spring/early-summer period. Thermal stratification refers to the physical process in a water body when warming of surface water creates a sufficient gradient in the relative densities between the surface and deeper waters because of the differences in temperature, which ultimately limits the depth to which wind can mix the warm surface with the deeper colder water. This stratification process results in the formation of a distinctive warm upper layer (known as the epilimnion) and cooler bottom layer (known as the hypolimnion). The transitional zone between the two layers that exhibits the greatest rate of temperature change is referred to as the thermocline or metalimnion. A thermocline typically develops in Lake Almanor around late May and begins to dissipate by late September (Pacific Gas and Electric Company 2002, 2008, 2009, 2010, 2011; Johnston and McMurtry 2009, 2010). The depth of the thermocline varies over the season and is primarily affected by variations in annual climatic conditions, solar radiation, day length, and the prevailing wind direction and its strength.

Figures 6.5-1a and 6.5-1b illustrate the seasonal pattern of thermal stratification that occurred in Lake Almanor in the general vicinity of Canyon dam from 2000 through 2010 under a variety of hydrologic conditions. The seasonal development and dissipation of the thermocline can be seen for each year in these illustrations. Variation in thermocline elevations and the related change in depth range (or thickness) of the epilimnion can also be seen in these illustrations. The timing and degree of thermal stratification in Lake Almanor varies annually as does the maximum surface water temperature (Pacific Gas and Electric Company 2008, 2009; Johnston and McMurtry 2009, 2010). As air temperatures fall and days shorten in September, the epiliminion cools and consequently the difference in water densities of the epilimnion and hypolimnion becomes smaller and the layers ultimately mix, which dissipates the thermocline. By October, the thermocline is gone and Lake Almanor becomes well-mixed in terms of temperature throughout its depths.

At the height of the summer, the epilimnion of Lake Almanor typically occurs from the surface down to a depth of 30 to 40 feet, with average daily water temperatures ranging from 20°C to 24°C. The corresponding hypolimnion occurs below depths of approximately 50 feet, with water temperatures ranging from 7°C to 14°C (Pacific Gas and Electric Company 2002, 2005b, 2008, 2009, 2010, 2011; Johnston and McMurtry 2010).

DO concentrations have been periodically monitored in Lake Almanor for more than 35 years. DO concentrations were initially monitored by the California Department of Water Resources in the 1970s and 1980s (California Department of Water Resources and California Department of Fish and Game 1974). Since 2000, PG&E has monitored DO concentrations to support the UNFFR Project relicensing process and to comply with the Rock Creek–Cresta Settlement Agreement and FERC license conditions (Pacific Gas and Electric Company 2002, 2005, 2008, 2009, 2010, 2011). More recently, DO monitoring has been done by the Plumas County Flood Control and Water Conservation District (Johnston and McMurtry 2009, 2010). DO concentrations in Lake Almanor follow typical seasonal and spatial patterns generally associated with large thermally stratified reservoirs (Federal Energy Regulatory Commission 2005). Within the epilimnion, atmospheric conditions (e.g., wind mixing, air temperature, water temperature) and algal blooms, through oxygen production by photosynthesis, primarily affect DO concentrations and maintain relatively high DO levels. Below the thermocline, oxygen consumption by fish, invertebrates, and bacterial decomposition of organic material is the dominant process affecting DO concentrations, with little mixing of surface waters to maintain DO levels. As a result of this oxygen consumption in the hypolimnion, DO concentrations generally decline rapidly with depth below the thermocline. DO levels can vary widely throughout the Lake Almanor, both with respect to depth and geographic location as a result of localized conditions, such as proximity to spring and stream inflows, algal blooms, and surface exposure to prevailing winds. Prevailing winds on Lake Almanor can generate large wind waves that may increase surface mixing and DO concentrations, even down to the depth of the thermocline and into the upper hypolimnion, under certain conditions (Federal Energy Regulatory Commission 2005).

Figures 6.5-2a and 6.5-2b illustrate the seasonal depth patterns of DO concentrations near Canyon dam during the summer for a variety of water year types (2000 – above normal; 2009 – dry; 2010 – below normal; and 2011 – wet). These figures show the strong association of DO concentrations with the thermal stratification at the deepest portion of the reservoir near Canyon dam during the heat of the summer and the subsequent equalization of DO throughout depths that occurs with mixing of the water column when the thermocline dissipates with cooling of the surface water during the shorter days and cooler nights in the early fall.

PG&E sampled for 12 trace metals (arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, silver, and zinc) in 2000 during the months of April, June, July, August, September, and November. Unfortunately, method detection limits for cadmium, lead, mercury, and silver were too high to ensure compliance with applicable standards. PG&E could only estimate dissolved fractions for arsenic, cadmium, copper, lead, mercury, silver, and zinc using USEPA-acceptable protocols.

Between July and November 2001, PG&E modified its monitoring program to focus on obtaining information appropriate for further evaluation of selected trace metals (iron, manganese, and silver) with lower detection limits. In 2002 and 2003, PG&E developed a supplemental monitoring program using trace metal clean methodology which could test for lower detection limits of cadmium, lead, mercury, and silver.

Trace metal concentrations for Lake Almanor generally fell within applicable criteria with the exception of dissolved cadmium and iron concentrations. A July 2003 surface sample had a cadmium concentration of 0.15 micrograms per liter (µg/l). Applicable USEPA criterion dictated that cadmium concentrations may not exceed a national four-day average of 0.13 µg/l[4]. While the July 2003 surface sample may be noteworthy, it is impossible to determine if USEPA criteria were exceeded based on a single sample rather than a four-day average.

From September to mid-October 2001, dissolved iron concentrations of more than the allowable instantaneous maximum of 1.0 milligram per liter (mg/l) were reported near the bottom of the Canyon dam outlet[5] tower in Lake Almanor. During the same sampling period, a mineral spring located adjacent to the Canyon dam outlet structure also exceeded the allowable instantaneous maximum concentration, suggesting a possible natural source.

Butt Valley Reservoir

On average, more than 90 percent of the inflow to Butt Valley reservoir comes from Lake Almanor via the Prattville intake. Therefore, the water quality of Butt Valley reservoir is highly

[4] This is a hardness-dependent criterion. The listed criterion is for a hardness of 50 mg/l.
[5] Canyon dam “intake” and Canyon dam “outlet” are synonymous.

influenced by conditions in Lake Almanor (see Figure 3-2). Some inflow from upper Butt Creek, an unregulated tributary, also influences water quality in Butt Valley reservoir, though to a lesser degree. Summer water temperature at Butt Valley reservoir is predominantly influenced by the operation of the Prattville intake, discharges from the Butt Valley powerhouse, and operation of the Caribou powerhouses. The operation of UNFFR Project facilities affects water temperatures throughout Butt Valley reservoir, and results in a moderate thermal gradient along the reservoir from the Butt Valley powerhouse (cooler water) to the Caribou intakes (warmer water) during late spring and early summer, with a less-defined gradient during the rest of the year. Due to its size, reservoir geometry, and relatively short hydraulic residence time during the summer, a well-developed thermocline does not occur at Butt Valley reservoir (Stetson Engineers 2009).

Average daily water temperatures during July and August below the Butt Valley powerhouse ranged from 15.7°C to 21.3°C between 2000 and 2007, averaging 18.9°C (Pacific Gas and Electric Company 2002, 2008). At the Caribou intakes near Butt Valley dam, water temperatures averaged 21.6°C near the surface and 16.5°C near the bottom over the course of an 8-year monitoring period (Pacific Gas and Electric Company 2002, 2008). Because of the relatively short retention time of water in the reservoir during the summer and relatively shallow depth, the water in Butt Valley reservoir tends to remain fairly well mixed and develops only weak thermal stratification, if any.

Use of the Caribou No. 1 powerhouse draws water through the Caribou No. 1 intake from a lower elevation in the reservoir than does the Caribou No. 2 intake and thus can rapidly deplete the reservoir of any coldwater storage (Stetson Engineers 2009). Figures 6.5-3a and 6.5-3b illustrate the seasonal pattern of water temperatures in Butt Valley reservoir. The observed temperatures indicate that (1) the temperature of Caribou No. 2 powerhouse discharge water was generally close to the temperature of the Butt Valley reservoir epilimnion, indicating that the Caribou No. 2 intake mainly withdrew epilimnion water; (2) the temperature of Caribou No.1 powerhouse discharge water was generally close to the Butt Valley powerhouse discharge water, and both Caribou No. 1 powerhouse and Butt Valley powerhouse discharge waters had an increasing trend in temperature during the summer; and (3) the temperature of Caribou No. 1 powerhouse discharge water was lower than Caribou No. 2 powerhouse discharge by about 3°C to 4°C in July, with the difference reduced to less than 2°C in August. In late August and September, there was little difference. The data suggest that replenishment of the relatively cold water from the Butt Valley powerhouse, the coldwater plunge into the reservoir hypolimnion, and the coldwater movement along the hypolimnion of Butt Valley reservoir are important factors affecting the reservoir thermal stratification and Caribou No. 1 powerhouse discharge temperatures.

DO concentrations measured during the June–August timeframes at the Butt Valley powerhouse in 2000 and 2002 ranged from 6.3 to 10.2 mg/l. These levels are similar to those measured in Lake Almanor in the epilimnion near the Prattville intake during the same sampling periods (Pacific Gas and Electric Company 2002). DO measurements taken near the Caribou intakes in Butt Valley reservoir in 2000 ranged from 0.4 to 10.6 mg/l. DO levels at the surface ranged from 6.0 to 10.6 mg/l and near the bottom of Butt Valley reservoir ranged from 0.4 to 10.3 mg/l. Hypoxic conditions (DO<2.0 mg/l) occurred in June and July of 2000 near the bottom and anoxic conditions (DO = 0 mg/L) occurred in August 2000 (Pacific Gas and Electric Company 2002).

Trace metal concentrations in Butt Valley reservoir generally fall within acceptable criteria. Similar to Lake Almanor, a July 2003 sample taken from the Butt Valley powerhouse tailrace had a dissolved cadmium concentration of 0.8 µg/l.

In addition to the 2000 through 2003 trace metals monitoring programs, PG&E evaluated the bioaccumulation of mercury, silver, and polychlorinated biphenyls (PCBs) in fish and crayfish during 2001, 2002, and 2003. PG&E modified this program in 2002 to analyze fillets of fish species that would represent fish caught by sport fishermen in Butt Valley reservoir. These samples were tested only for total mercury concentrations on the assumption that the majority of the accumulated mercury would be in the methylated form.

Total mercury concentrations from these fish fillets ranged from 60 to 200 micrograms per kilogram (µg/kg), with larger fish tending to accumulate the most mercury. Allowable mercury concentrations vary widely between agencies; the United States Food and Drug Administration (FDA) developed an action level of 1,000 µg/kg whereas the California Office of Environmental Health Hazard Assessment (OEHHA) established a fish contaminant goal of 220 µg/kg. In either case, mercury accumulation in fish caught within Butt Valley reservoir fall below these limits.

Belden Forebay

The water quality of Belden forebay is affected by inflow from the Seneca reach, lower Butt Creek, and Butt Valley reservoir diversions through the Caribou intakes (see Figure 3-2). Water quality is generally good in the forebay, though exceedances of Basin Plan objectives have occurred for water temperature, DO, specific conductance, mercury, and PCB concentrations in fish tissues (Pacific Gas and Electric Company 2002, State Water Resources Control Board 2010). In the Belden forebay, some trace metals, minerals, and total dissolved solids have exhibited elevated levels relative to USEPA's California Toxics Rule (40 CFR Part 131.36) criteria (Federal Energy Regulatory Commission 2005). Concentrations of PCBs in fish tissues collected from the Belden forebay have also chronically exceeded the OEHHA's fish contaminant goal of 3.6 grams per nanogram of fish flesh, which was established to protect human health (see State Water Resources Control Board 2010). In 1984, a rockslide damaged the Caribou No. 2 powerhouse, resulting in a discharge of PCBs that contaminated soil, slide debris, and sediments stored in the Belden forebay. While PG&E has taken measures to remediate the materials contaminated with PCB by dredging Belden forebay and placing material downstream near Oak Flat at a contained upland location, ongoing monitoring has detected that some residual contamination remains in the aquatic food chain (Federal Energy Regulatory Commission 2005, State Water Resources Control Board 2010).

Water temperatures in Belden forebay are similar to those in Butt Valley reservoir, with little thermal stratification (Federal Energy Regulatory Commission 2005, Stetson Engineers 2007b, 2009). During the summer, inflow to the Belden forebay comes predominantly from the Caribou powerhouses, with less influence from the Seneca reach and lower Butt Creek. On average, the Seneca reach contributes less than five percent (5%) of the flow through the forebay during the July–September period (Stetson Engineers 2007b, 2009). The average daily water temperature of discharges from the Caribou powerhouses ranged from 13.3°C to 21.9°C for Caribou No. 1 and 17.4°C to 23.4°C for Caribou No. 2 during the summer months (June through September) of a variety of water years from 2000 to 2004 (Pacific Gas and Electric Company 2002; Stetson Engineers 2007b, 2009). Due to the differences in the elevation and operation of the Caribou intakes, the water temperature can vary substantially, depending on which intake is used. The Caribou No. 1 intake draws water from a lower elevation (deeper) in Butt Valley reservoir, which likely explains the lower temperature of its discharges. Daily summer water temperatures in the Belden forebay near its dam ranged from 15.8°C to 22.8°C, with no more than a 3°C vertical temperature stratification, during 2000 to 2004 (Pacific Gas and Electric Company 2002; Stetson Engineers 2007b, 2009). PG&E monitoring during the months of June through September reported that average daily water temperatures exceeded 20°C for 35 percent of days monitored at the Caribou No. 1 powerhouse discharge (mostly during August) and 65 percent of days monitored at the Caribou No. 2 powerhouse discharge (mostly during July–September).

The relatively uniform temperatures along the length and throughout the depths of the Belden forebay are likely a result of the forebay's small size, inflow dominated by the discharges of the Caribou powerhouses, short retention time (less than one day), instream flow releases to the Belden reach, diversions to the Belden powerhouse, and wide daily stage fluctuations in the forebay related to PG&E operation and maintenance activities (Stetson Engineers and Pacific Gas and Electric Company 2007; Stetson Engineers 2007b, 2009).

DO concentrations tend to fall below 7.0 mg/l near the bottom of the Belden forebay in June and July and near the discharge points of the Caribou powerhouses in September (Pacific Gas and Electric Company 2002).

PG&E's 2000 through 2003 trace metals monitoring program identified dissolved copper and total recoverable manganese as exceeding, or having the potential to exceed, acceptable criteria. In July 2000, the dissolved copper concentration at the Caribou No. 1 powerhouse tailrace was estimated to be 0.00605 mg/l. This exceeds the California Toxic Rule, Freshwater Aquatic Life Protection hardness-dependent four-day criterion of 0.0049 mg/l. However, a four-day average cannot be determined by a single sample and all other samples fell well below the hardness-dependent criteria.

During the 2000 monitoring program, manganese concentrations at the Caribou No. 1 and No.2 powerhouse tailraces exceeded the Title 22 secondary maximum contaminate level (MCL) of 0.05 mg/l. During the 2001 modified monitoring program, dissolved manganese concentrations remained within acceptable limits.

Bioaccumulation of silver in samples taken from the Belden forebay ranged from 2 µg/kg in smallmouth bass to 23 µg/kg in a composite crayfish sample. Bioaccumulation of mercury was also considered low, with a range of 33.3 µg/kg in the composite crayfish sample and 114.0 µg/kg in smallmouth bass. There is no FDA action level for silver. The FDA action level for mercury in fish is 1 mg/kg, or 1,000 µg/kg.

Between 2001 and 2002, levels of PCBs ranged from 0.80 µg/kg in a composite crayfish sample to 14.90 µg/kg in a smallmouth bass sample. Screening values for total PCBs levels vary widely between state and federal agencies. FDA tolerance levels for PCBs prohibit interstate commerce of fish flesh containing 2,000 parts per billion (ppb) while the USEPA uses a screening value of 10 ppb. Several of the samples collected from the Belden forebay exceeded the USEPA PCB screening value (Pacific Gas and Electric Company 2002).

North Fork Feather River

Seneca Reach

The majority of inflow to the 10.8-mile-long Seneca reach is from Lake Almanor via discharges from the Canyon dam outlet structure (see Figure 3-1). As a result, the water quality in the Seneca reach is similar to the water quality in Lake Almanor near the Canyon dam outlet structure. The lower gates of the outlet structure have typically been used by PG&E to release flows to the Seneca reach. The lower gates, with an invert elevation of 4,422 feet above mean sea level, draw water from the hypolimnion during the summer, which is colder than the surface of the lake and contains lower amounts of DO. DO concentrations in the water released into the Seneca reach rapidly increases due to reaeration of the water upon discharge from the lake (Pacific Gas and Electric Company 2002). Seasonal measurements for DO concentrations along the Seneca reach, including lower Butt Creek, have been consistently greater than 7.0 mg/l (Pacific Gas and Electric Company 2002).

Average daily water temperatures in the Seneca reach during the summer months (June–September) from 1999 to 2004 ranged from 9.8°C to 14.1°C near Canyon dam and 11.8°C to 16.8°C upstream of the Caribou powerhouses with the exception of 2004, which had observed average daily water temperatures up to 22.5°C near Canyon dam and up to 18.1°C upstream of the Caribou powerhouses. The warmer temperatures observed in 2004 occurred during a test of the upper-level gates of the Canyon dam outlet structure (Pacific Gas and Electric Company 2002, 2005a; Federal Energy Regulatory Commission 2005; Stetson Engineers 2007b, 2009). Under the existing baseline condition and typical operations, average daily water temperatures in the Seneca reach during the summer months rarely exceed 13.5°C near Canyon dam and 17.5°C upstream of the Caribou powerhouses (Pacific Gas and Electric Company 2005b; Stetson Engineers 2007b, 2009). Water temperatures along the Seneca reach tend to increase between Canyon dam and the Butt Creek confluence (9.6 miles downstream), then decrease somewhat below the confluence. This is due to the cool inflow from lower Butt Creek, which had average daily temperatures between 10.2°C and 13.1°C during 2000 to 2004 (Pacific Gas and Electric Company 2002; Stetson Engineers 2007b, 2009). The accretion flows from lower Butt Creek to the Seneca reach mainly originate from springs and surface runoff emanating downstream of Butt Valley dam because all of the upper Butt Creek flow is impounded in Butt Valley reservoir behind the dam and diverted through the Caribou intakes and there is little seepage through the Butt Valley dam (approximately 0.07 cfs).

Detectable levels of dissolved iron, manganese, and sulfide in the Seneca reach near Canyon dam were documented by PG&E during water quality monitoring of a 35 cfs test release through the lower gate of the Canyon dam outlet structure in 2001. The salt solubility of these metals and minerals is greater in the low-oxygen environment of the hypolimnion of lakes, which occurs in Lake Almanor during the late summer and early fall at depths near the level of the lower gate on the Canyon dam outlet structure. The concentrations of dissolved iron, manganese, and sulfide in the Canyon dam discharge decreased when the upper-level gates were used during the 2001 tests (Federal Energy Regulatory Commission 2005). Dissolved iron, manganese, and sulfide, along with specific conductance and DO in the lower-level releases from Canyon dam, varied throughout the 2001 monitoring period and occasionally exceeded water quality objectives established in the Basin Plan, especially from late August to October; however, concentrations of these water quality constituents substantially decreased below exceedance thresholds within a short distance downstream of Canyon dam, where the water rapidly reoxygenates (Pacific Gas and Electric Company 2002). Odors, specifically due to hydrogen sulfide, have also been reported to occasionally exceed drinking water standard thresholds, mostly during fall months in the Seneca reach immediately downstream of Canyon dam; however, this condition rapidly dissipates within 0.6 mile of Canyon dam (Pacific Gas and Electric Company 2002).

Belden Reach

Inflow to the 8.8-mile-long Belden reach is from Belden forebay via discharge at the Oak Flat powerhouse and subsequent additions from smaller tributaries downstream of Belden dam and from the East Branch of the North Fork Feather River (see Figure 3-1). The water quality of the

Belden reach near Belden dam is similar to the water quality in Belden forebay. About 7.2 miles downstream of Belden dam, the contribution of the East Branch of the North Fork Feather River influences the Belden reach in terms of total discharge and water chemistry. As with Belden forebay, the Belden reach has exceeded Basin Plan objectives for water temperature, DO, specific conductance, mercury, and PCB concentrations in fish tissues (Pacific Gas and Electric Company 2002, State Water Resources Control Board 2010).

The water temperature of the Belden reach is primarily driven by the water temperature in Belden forebay, which in turn is controlled by the Lake Almanor and Butt Valley reservoir outflow temperatures (Pacific Gas and Electric Company 2005b, Stetson Engineers 2009). Reservoir outflow temperatures for Lake Almanor and Butt Valley reservoir are affected by many factors, including meteorology, inflow hydrology, regulated outflows, reservoir water levels, and the timing of these factors. However, there is no straightforward relationship between hydrological year type or meteorology and reservoir outflow temperature. For example, a dry hydrological year and warm meteorological year would not necessarily result in reservoir outflow temperatures that are warmer than a normal hydrological year and a normal meteorological year (Stetson Engineers 2009).

In addition to UNFFR Project operations, there are a number of influences on water temperature in the Belden reach. The most notable are the contributions of the East Branch of the North Fork Feather River and Yellow Creek; the confluence of the East Branch with the North Fork Feather River is about 1.6 miles upstream of the Belden powerhouse, and the confluence of Yellow Creek with the North Fork Feather River is at the lower end of the Belden reach. The East Branch is considerably warmer than the North Fork Feather River during the summer while Yellow Creek tends to be cooler than the North Fork Feather River. The North Fork Feather River's physical characteristics, such as vegetative cover and topographic shading, and meteorological conditions associated with lower elevations in the watershed also influence water temperature throughout the Belden reach (Pacific Gas and Electric Company 2002).

For a given water temperature of Belden forebay discharge, temperatures in the North Fork Feather River downstream have a relatively straightforward relationship with meteorological (i.e., climate) and hydrological (i.e., flow) conditions. For example, the water temperatures in the Belden reach are warmer when air temperatures are warm and flows are reduced (Stetson Engineers 2009). Average daily water temperatures in the Belden reach during the summer months during the 1999–2004 period ranged from 13.9°C to 22.9°C from Belden dam to immediately upstream of the Belden powerhouse. Water temperatures tend to be coolest near the reach's confluence with Mosquito Creek and increase downstream of the East Branch of the North Fork Feather River confluence, partially as a result of the warm inflows from the East Branch. Average daily water temperatures in the Belden reach upstream of the East Branch exceeded 20°C for 20 to 29 percent of the days in July and August during 1999–2004 compared to downstream of the East Branch, where 51 percent of the days in June through September during 1999–2004 exceeded 20°C (Pacific Gas and Electric Company 2002, 2005b; Federal Energy Regulatory Commission 2005). A maximum instantaneous diel temperature of 24°C and average fluctuation ranges between the daily minimum and maximum temperatures of 4.8°C for June and July and 4.1°C for August and September were reported for the Belden reach above the East Branch during 2002–2004 (Stetson Engineers 2009).

All DO concentrations reported for the Belden reach by PG&E (2002) were greater than 7 mg/L and generally exceeded 80 percent of air saturation.

The 1984 rockslide that occurred upslope of the Belden forebay resulted in deposition of contaminated sediment in the Belden forebay. Subsequent remediation efforts by PG&E resulted in placement of material dredged from the forebay onto the floodplain of the North Fork Feather River downstream of Belden dam. PG&E relicensing studies included efforts to sample nine specimens of various aquatic organisms for PCBs downstream of this dredge disposal pile: four Sacramento sucker, four rainbow trout, and one crayfish. All nine samples had PCB levels lower than the USEPA screening level of 10 ppb and well below the FDA action level of 2,000 ppb (Pacific Gas and Electric Company 2002).

Downstream of Belden Powerhouse

Water quality in the North Fork Feather River downstream of the UNFFR Project, specifically water temperature in the Rock Creek and Cresta reaches (downstream of Belden powerhouse to Cresta powerhouse), is influenced by streamflow releases and powerhouse discharges from the UNFFR Project, inflow from the unregulated East Branch of the North Fork Feather River and other tributaries, and the Bucks Creek Project, which discharges into the Rock Creek reach. Warm inflow, mainly from the Belden powerhouse to the Rock Creek reservoir, along with high ambient air temperatures and solar radiation during the summer months (June through September) lead to warm water temperatures in the North Fork Feather River downstream of the UNFFR Project boundary all the way to Lake Oroville (Pacific Gas and Electric Company 2005b, Stetson Engineers 2009). Average daily temperatures are often generally higher than 20.0ºC in all downstream reaches and powerhouse discharges associated with the Rock Creek, Cresta, and Poe projects during June to September (Federal Energy Regulatory Commission 2005). Average daily temperatures up to 22.9°C in the Rock Creek reach and up to 22.7°C in the Cresta reach have been recorded during some water years (Pacific Gas and Electric Company 2005b, Stetson Engineers 2007b). A maximum instantaneous diel temperature of 24°C was reported during the 2002–2004 monitoring of the Rock Creek reach above Bucks Creek and the Cresta reach above Cresta powerhouse (Stetson Engineers 2009). The average water temperature fluctuation ranged between a daily minimum and maximum temperature for the Rock Creek and Cresta reaches of 3.6°C and 2.9°C, respectively, in June; 3.1°C and 2.8°C, respectively, in July; 2.7°C and 2.5°C, respectively, in August; and 2.5°C and 2.0°C, respectively, in September (Stetson Engineers 2009).

Water temperature patterns for the Poe reach (downstream of Cresta powerhouse to Poe powerhouse) are similar to those of the upstream reaches, though the Poe reach tends to be the warmest when compared to the rest of the North Fork Feather River, with a recorded average daily temperature up to 24.7ºC during the summer months (Stetson Engineers 2007b). A maximum instantaneous diel temperature of 26.6°C was reported for the Poe reach during 2002–2004, with average fluctuation ranges between the daily minimum and maximum temperatures of 3.2°C in June, 3.1°C in July, 2.7°C in August, and 2.4°C in September (Stetson Engineers 2009).

DO concentrations are reported to remain at or near air saturation in the Rock Creek, Cresta, and Poe reaches, though these reaches exhibit periodic increases in turbidity, iron, aluminum, and specific conductance during high precipitation and runoff events (Federal Energy Regulatory Commission 2006).

6.5.2 Environmental Impacts and Mitigation Measures

Methodology

A combination of recent and historic water quality monitoring data and various modeling tools were used to evaluate the potential impacts of the Proposed UNFFR Project and each alternative on the water quality and beneficial uses of the North Fork Feather River, including Lake Almanor. Anticipated construction practices and materials, locations, and duration of construction for features that may be required to implement the Proposed UNFFR Project and each alternative were also evaluated for potential impacts on water quality and beneficial uses. The spatial limits of the analysis encompass the activity areas and immediate vicinity with respect to construction impacts and the North Fork Feather River system from Lake Almanor to the Poe reach with respect to operational impacts.

Studies prepared for PG&E in support of its UNFFR Project relicensing application were used to establish the baseline conditions for the discussion of the environmental setting and to characterize the water quality of the UNFFR Project waters and the water quality conditions in reaches of the North Fork Feather River that are downstream of and affected by the UNFFR Project. Additional literature and studies were used to supplement the information from the PG&E license application and various annual water quality monitoring reports.

The analysis of environmental impacts is largely based on the *Level 3 Report: Analysis of Temperature Control Alternatives Advanced from Level 2 Designed to Meet Water Quality Requirements and Protect Cold Freshwater Habitat Along the North Fork Feather River* (Level 3 Report) (Stetson Engineers 2009) and a supplemental analysis—*Evaluation of the Biological Performance of Water Quality Measures to Improve Compliance with Temperature Objectives of the Water Quality Control Plan for the Sacramento and San Joaquin River Basins*—that evaluates the potential changes in water temperatures and DO of UNFFR Project reservoirs and the North Fork Feather River resulting from various alternatives (Appendices E and E1). The reader is referred to Appendices E and E1 for additional detail on the methodology and assumptions used in modeling of water temperature and DO for this analysis of impacts on water quality. In summary, the Level 3 and supplemental analysis examined how water temperatures and DO would change with implementation of the various alternatives and what the resulting effects would be on water quality for coldwater habitat uses within and downstream of the UNFFR Project. The focus of these analyses was on changes in the frequency and duration of temperature exceedances relative to the requirements of rainbow trout (an important, obligate coldwater habitat species) during the period of maximum summer water temperatures. Water temperature and DO conditions in the North Fork Feather River and in UNFFR Project reservoirs resulting from various alternatives were compared to current operating conditions (CEQA baseline condition).

A 19-year period of record for hydrological and meteorological data (1984–2002), representing wet, normal, dry, and critically dry water year reservoir discharge temperatures, river flows, and nominally associated weather conditions, was used for modeling purposes in the Level 3 Report analysis. The 50 percent exceedance[6] (normal), 25 percent exceedance (warm and dry), 10 percent exceedance (warm and critically dry), and worst-case maximum highest water

[6] The term “exceedance” refers to the percent of time during a given period that a parameter value (in this case, hydrologic and meteorological conditions) is equaled or exceeded. For example, a 25 percent exceedance mean daily temperature for July means that 25 percent of the July days in the 19-year period of record had a mean daily temperature equal to or greater than the 25 percent exceedance temperature value.

temperature conditions during the summer for each alternative were compared to those for the operations proposed under the 2004 Settlement Agreement and the CEQA Baseline condition (existing UNFFR Project operations at the time the Notice of Preparation was issued).

This EIR uses two critical temperature criteria for screening and analysis of the levels of protection to riverine coldwater habitat uses and potential impacts provided by the alternatives. These screening criteria are based on a review of relevant information concerning thermal requirements and tolerances of coldwater aquatic species representative of the North Fork Feather River (see Appendix E1 for details):

1. *Average daily water temperature of 20°C* – defined as the average of water temperatures over the course of a 24-hour day. The average daily temperature is the limit of resolution of the temperature model used to estimate river temperatures (see Appendix D). This statistic allows evaluation of relatively short-term extreme thermal exposures and is consistent with the Rock Creek–Cresta Project Relicensing Settlement Agreement's adoption of a mean daily water temperature criterion of 20ºC to protect cold freshwater habitat (Federal Energy Regulatory Commission 2005). The daily range in fluctuation of water temperatures around the daily mean (referred to as the diel temperature range) for various locations along the North Fork Feather River were also taken into consideration in selecting this criterion. The diel temperature range statistic can be used along with the daily mean temperature statistic to estimate the magnitude of daily maximum and minimum temperatures.

2. *Maximum weekly average water temperature (MWAT) of 20°C* – defined as the maximum value of seven-day running averages of average daily water temperatures. The MWAT can be computed on annual and monthly bases. The Level 3 Report provides MWAT on a monthly basis for the summer period for each alternative analyzed. MWAT provides one measure of chronic, or cumulative, temperature exposure when keyed to thermal requirements (temperature limits) for specific life stages of representative coldwater species (Environmental Protection Agency 1977, Coutant 1999). Selection of a 20°C MWAT criterion for this impact analysis was based on a review of annual and seasonal water temperature patterns at monitoring locations along the North Fork Feather River and the thermal requirements and tolerances of the rainbow trout (see Appendices E and F). Use of the MWAT statistic for this analysis does not convey or imply imposition of a particular water temperature standard for the North Fork Feather River; its use is strictly as an index to compare modeled water temperature conditions for the alternatives to relevant data on thermal requirements of representative coldwater species.

Additionally, this EIR evaluates the evidence provided in the PG&E license application along with the information compiled on biological temperature performance provided in Appendix F. For the purposes of this impact analysis, the primary criterion for defining a summer coldwater habitat index for UNFFR Project reservoirs was water with a temperature of less than 20ºC and DO levels greater than 5 mg/L[7]. Additionally, 21ºC and 22ºC were selected as secondary

[7] Use of 5 mg/L DO concentration for the purpose of defining a lower criterion for the thermal refuge habitat index at Lake Almanor is not to be construed as a departure from the Basin Plan DO objective of 7 mg/L for cold, freshwater habitat because the natural process of thermal stratification in lakes results in a declining relationship of DO saturation levels with depth in thermally stratified lakes during the summer. This results in DO levels below 7 mg/L at depths with the colder temperatures that are preferred by coldwater fish. DO may be near air saturation levels in shallower, warmer water above the thermocline (see Appendix F for a detailed rationale). In addition, as shown in Figure 6.5-2b, the entire lake had a DO level below 7 mg/L in September and November of 2011. Applying the

temperature criteria for the evaluation of the thermal refuge habitat for coldwater fish in Lake Almanor because suitable habitat meeting the 20°C primary criterion and containing sufficient DO can be absent at times even under existing conditions (Jones and Stokes 2004).

The Level 3 Report presents a broad range of modeled river and reservoir conditions resulting from various feasible alternatives for the UNFFR Project (see Appendix E). The two alternatives evaluated by this EIR represent a subset of the range of reasonable measures analyzed in the Level 3 Report and are specifically modeled and compared in the supplemental analysis provided in Appendix E1.

The significance thresholds used for assessing potential impacts on water quality were developed based on guidance provided by the CEQA Guidelines. These threshold criteria were applied to the qualitative assessment and quantitative modeling results and used to determine the significance of impacts on water quality and associated beneficial uses of the affected water bodies. The analysis of water quality impacts and benefits focuses on temperature, DO, taste and odors, turbidity, and the potential for discharge of hazardous materials due to the nature of the two alternatives described in Chapter 4.

Thresholds of Significance

Impacts on water quality would be significant if the Proposed UNFFR Project or either alternative would:

- Violate existing water quality standards or otherwise substantially degrade water quality
- Result in substantial water quality changes that would adversely affect beneficial uses
- Result in substantive undesirable impacts on public health or environmental receptors

Impacts and Mitigation Measures

This section provides a discussion of the anticipated impacts related to water quality associated with the Proposed UNFFR Project as well as each alternative and identifies mitigation measures for significant impacts. A comparison of the final level of significance for each impact (with incorporation of mitigation measures, if appropriate) is provided in Table 6.5-1.

Basin Plan DO objective of 7 mg/L as the lower criterion for the thermal refuge habitat index would indicate an absence of suitable cold freshwater habitat in the Lake Almanor, which is not the case since there have been no observed fish kills.

Table 6.5-1. Summary of Water Quality (WQ) Impacts

IMPACT	PROPOSED UNFFR PROJECT	ALTERNATIVE 1	ALTERNATIVE 2
Impact WQ-1: Implementation of the UNFFR Project could affect water temperature in Lake Almanor.	Less than significant	Less than significant with mitigation	Less than significant with mitigation
Impact WQ-2: Implementation of the UNFFR Project could affect water temperature in Butt Valley reservoir.	Less than significant	Less than significant	Less than significant
Impact WQ-3: Implementation of the UNFFR Project could affect water temperatures in the North Fork Feather River below Canyon dam and Belden dam.	No impact	No impact (Beneficial)	No impact (Beneficial)
Impact WQ-4: Implementation of the UNFFR Project could affect DO levels in water discharged from Canyon dam and Butt Valley powerhouse.	Less than significant	Less than significant	Less than significant
Impact WQ-5: Implementation of the UNFFR Project could cause water released from Canyon dam to have an undesirable taste or odor.	Less than significant	Less than significant	Less than significant
Impact WQ-6: Implementation of the UNFFR Project could cause a change in the character or quantity of dissolved metal concentrations or other contaminants in Lake Almanor or the North Fork Feather River.	Less than significant	Less than significant	Less than significant
Impact WQ-7: Construction activities associated with the UNFFR Project could result in temporary increases in turbidity and total suspended solids in Lake Almanor, Butt Valley reservoir, and the North Fork Feather River.	Less than significant with mitigation	Less than significant with mitigation	Less than significant with mitigation
Impact WQ-8: Hazardous materials spills during construction activities associated with the UNFFR Project could cause contamination of Lake Almanor, Butt Valley reservoir, and the North Fork Feather River.	Less than significant with mitigation	Less than significant with mitigation	Less than significant with mitigation

Impact WQ-1: Implementation of the UNFFR Project could affect water temperature in Lake Almanor.

Proposed UNFFR Project

Implementation of the Proposed UNFFR Project would result in increased releases from Canyon dam, with equivalent decreases from the Prattville intake diversion, as outlined in the 2004 Settlement Agreement. This could affect the distribution of water temperatures in Lake Almanor during the period of summer thermal stratification. The effects on thermal stratification as a result of the increased withdrawal of hypolimnetic water from the Canyon dam lower gate outlet structure were described by Stetson Engineers (2009, 2012) (Appendix E). Increased withdrawal of hypolimnetic water could reduce the volume of cold water in the hypolimnion and induce a small amount of movement of the hypolimnetic water. As a result, some mixing is expected at the interface of the hypolimnion and the metalimnion water layers.

Lake Almanor's thermal structure and DO profiles during the summer months are determined in large part by the thermocline. The depth of the thermocline delineates the relative amounts of coldwater and warmwater habitat that are available during the summer. Increased withdrawals of cold, hypolimnetic water through use of the lower elevation gates on Canyon dam would cause the depth of the thermocline to increase by up to three feet during one to two weeks in late September and early October in normal and drier water years, compared with current conditions (see Appendix E1– Tables 7 and 8 and Figures 9 and 10). During other times of the year and in wet water years, the depth of the thermocline is not affected. An increase in the depth of the thermocline would result in an increase in the relative thickness of the warm epilimnion and a corresponding increase in the volume and area of the lake with temperatures preferred by warmwater species and a decrease in the volume and area of the lake with suitable cooler temperatures and sufficient DO concentrations (5 mg/L and greater) for coldwater species. However, since water temperatures of the entire lake are normally below 20°C by late September, the increase in the depth of thermocline would have little effect on coldwater species.

Under all water year types, the suitable coldwater habitat volumes in Lake Almanor (i.e., water equal to or less than 20ºC with DO of 5 mg/L or greater) would be similar to current conditions. In general, Lake Almanor has the least suitable coldwater habitat volume in August under both current and Proposed UNFFR Project conditions.

In a **normal water year**, implementation of the Proposed UNFFR Project may reduce the suitable coldwater habitat volume in August by up to about 3,490 AF (7.9 percent), from about 44,400 AF to 40,910 AF (see Appendix E1 – Table 9 and Figure 11). This change in suitable coldwater habitat in Lake Almanor would have a minor seasonal impact because of the availability of suitable coldwater habitat and because of the relatively small change in the volume of suitable coldwater habitat and the short duration of the change.

In a **critically dry water year**, the lake appears to be absent of suitable coldwater habitat volume (i.e., water equal to or less than 20ºC with DO of 5 mg/L or higher) in August under both current and Proposed UNNFR Project conditions (see Appendix E1 – Table 12 and Figure 14). The coolest refugial habitat that would be available at such times would be restricted to water strata of 21ºC and 22ºC with DO concentrations of 5 mg/L and higher. Accordingly, the impact assessment was conducted using the marginal water temperature criterion of 21ºC. With this marginal temperature criterion of 21ºC, implementation of the Proposed UNFFR Project could reduce the marginal coldwater habitat volume in August of a critically dry year by up to about 3,010 AF (12.9 percent), from about 23,260 AF to 20,250 AF (see Appendix E1 – Table 13 and Figure 15). This change in marginal coldwater habitat volume would be considered to have a minor seasonal impact because of the availability of marginal coldwater habitat and because of the relatively small change in marginal coldwater habitat volume and the short duration of the change.

Under all water year types, the Proposed UNFFR Project could increase the suitable coldwater habitat volume in September and early October, although this increase may not be seen as an important benefit because a large volume of suitable coldwater habitat is already available at this time. On a lake wide basis, the Proposed UNFFR Project could result in a reduction of less than one percent (<1%) of suitable habitat volume in some summer months.

Based on the above analysis, the impact of the Proposed UNFFR Project on water temperature in Lake Almanor would be **less than significant**.

Alternative 1

Operation of a thermal curtain at the Prattville intake and increased water releases of up to 250 cfs from mid-June to mid-September through the Canyon dam low-level outlet structure, with a parallel decrease in the Prattville intake diversion, would affect the distribution of water temperatures in Lake Almanor during the period of summer thermal stratification. The effects on thermal stratification as a result of the withdrawal of hypolimnetic water, both from the Prattville intake with use of a thermal curtain and from the Canyon dam outlet structure once it is modified to allow releases up to 250 cfs, were described by Stetson Engineers (2009) (Appendix E). Increased withdrawal of hypolimnetic water would reduce the volume of cold water in the hypolimnion. It would also simultaneously induce a small amount of movement of the hypolimnetic water, resulting in some mixing at the interface of the hypolimnion and thermocline water layers. This, in turn, would increase the depth of the thermocline and increase DO concentrations in upper portions of the hypolimnion. The consequent reduction in surface releases, as compared to current operations, could occasionally result in a slight increase (0–0.5°C) in surface water temperature because of increased residence time of water in the epilimnion (Jones and Stokes 2004, Stetson Engineers 2009); however, this change by itself would not be sufficient to affect water quality and the beneficial uses of Lake Almanor.

Lake Almanor's thermal structure and DO profiles during the summer months are determined in large part by the thermocline. The depth of the thermocline delineates the relative amounts of coldwater and warmwater habitat that is available during the summer. Increased withdrawals of cold, hypolimnetic water through use of a thermal curtain and the lower elevation gates on Canyon dam would cause the depth of the thermocline to increase by up to three feet during two to four weeks from July through August in normal and drier water years, compared with current conditions (see Appendix E1– Tables 7 and 8 and Figures 9 and 10). An increase in the depth of the thermocline during this time window in July and August would result in an increase in the relative thickness of the warm epilimnion and a corresponding increase in the volume and area of the lake with temperatures preferred by warmwater species and a decrease in the volume and area of the lake with suitable cooler temperatures and sufficient DO concentrations (5 mg/L and greater) for coldwater species.

In **a normal water year**, suitable coldwater habitat volumes (i.e., water equal to or less than 20ºC with DO of 5 mg/L or higher) would be similar to current conditions, except for about a two-week period in mid-August when Alternative 1 may reduce the suitable coldwater habitat volume by up to about 10,420 AF (23.5 percent), from about 44,400 AF to 33,980 AF (see Appendix E1 – Table 9 and Figure 11). On a lakewide basis, the percentage of the lake's total volume suitable for coldwater habitat would be reduced by one percent, from 5 percent to 4 percent, in the worst case. This change in suitable coldwater habitat in Lake Almanor would have a minor seasonal impact during a normal water year because of the availability of suitable coldwater habitat and because of the relatively small change in the volume of suitable coldwater habitat and the short duration of the change (Appendix E1–Table 9 and Figure 11; Appendix F). Therefore, the impact would be **less than significant**.

In a **critically dry water year**, like under current conditions, the volume of the most suitable coldwater habitat (i.e., water equal to or less than 20ºC with DO of 5 mg/L or more) would become severely limited by mid-July and decline to zero during much of August under Alternative 1 (Appendix E1–Table 12 and Figure 14). The coolest habitat that would be available at such times would be restricted to water strata with temperatures ranging from just above 20ºC up to 22ºC with DO concentrations of 5 mg/L and higher. The volume of the remaining cool water habitat under Alternative 1 would be similar to the current condition except in late August, when water with temperatures lower than 21°C would be reduced by 11,530 AF (49.6 percent) from 23,260 AF to 11,730 AF (Appendix E1–Table 13 and Figure 15). On a lakewide basis, the percentage of the lake's volume with suitable (<20°C) coldwater habitat would be reduced from 6 percent to 5 percent during mid-July and the percentage of the coolest available habitat (<21°C) would be reduced from 4 percent to 2 percent in mid-August under the worst case; however, this effect would be short-lived because surface waters begin to cool into the suitable range during September. Because of the reduction in the volume of marginally suitable coldwater habitat during August, the effects on Lake Almanor's cold freshwater habitat would be **significant without mitigation**.

Without thermal curtains, the effect of increased Canyon dam releases of up to 250 cfs on Lake Almanor water temperature would be similar to that of the Proposed UNFFR Project. This conclusion is based on the Level 3 Report, which analyzed the effect of increased Canyon dam releases up to 600 cfs on Lake Almanor water temperature and found an effect similar to the Proposed UNFFR Project.

Alternative 2

Under Alternative 2, use of the thermal curtain at the Prattville intake would have effects on warmwater and coldwater habitat in Lake Almanor similar to those of Alternative 1, with a small difference in suitable or marginal coldwater habitat volume. Even without increased withdrawals through Canyon dam during the summer months, the total hypolimnetic discharge would be the same. The small difference in suitable or marginal coldwater habitat volume between Alternative 1 and Alternative 2 is the result of different hydrodynamics within the lake under the two alternatives[8].

Compared to the current or baseline conditions, Alternative 2 would result in:

- an increased depth of the thermocline by up to three feet in late July to early August of a normal water year and in July of a critically dry water year (Appendix E1–Tables 7 and 8 and Figures 9 and 10);
- a decrease in the lakewide percentage of suitable coldwater habitat by a small amount, from 5 percent to 4 percent of the total lake volume from the current condition during mid-August in normal water years (Appendix E1–Table 9 and Figure 11);
- a decrease in the volume of suitable (<20°C) coldwater habitat by up to about 9,370 AF (21.1 percent) in mid-August of normal water years, from about 44,400 AF to 35,030 AF (Appendix E1–Table 9 and Figure 11).
- a decrease in the volume of marginal (<21°C) coldwater refugia by up to about 8,530 AF (36.7 percent), from about 23,260 AF to 14,730AF, during mid-August of critically dry water years after the disappearance of the most suitable <20°C thermal habitat (Appendix E1–Table 13 and Figure 15).

[8] Although the total hypolimnetic withdrawal would be the same, lake hydrodynamics would be different because the relative amounts of withdrawal from Prattville intake vs Canyon dam would be different, which, in turn, would change lake hydrodynamics and, therefore, the distribution of oxygen and temperature.

Because of the significant reduction in the limited volume of the remaining available marginal (<21°C) thermal refugial habitat in **critically dry water years**, the effects on the cold freshwater habitat use of Lake Almanor would be **significant without mitigation**.

Mitigation Measure

Mitigation Measure WQ-1 (Alternatives 1 and 2): Implement Temperature Monitoring and Operations Coordination and Augment Stocking of Coldwater Fishery following Critically Dry Water Years

Under this mitigation measure, PG&E would be required to implement a limnological monitoring program during critically dry water years to monitor water temperature and DO depth profiles throughout Lake Almanor and the resulting effects on coldwater fish in Lake Almanor. If monitoring reveals a reduction in coldwater refugial habitat to less than 4 percent of the total lake volume and increased thermally related mortality of coldwater fish during the summer, PG&E will coordinate with and provide funding to CDFW and others as appropriate to supplement the existing fish stocking program following critically dry water years to maintain the current trout fishery in Lake Almanor.

Significance after Mitigation

Mitigation Measure WQ-1 would: (1) reduce the uncertainty associated with summer coldwater habitat estimates for Lake Almanor by increasing the base of monitoring information to improve the understanding of coldwater habitat conditions; and (2) improve the ability of the coldwater fishery to recover after critically dry water years. Implementation of this mitigation measure would reduce the impact to a **less than significant** level.

Impact WQ-2: Implementation of the UNFFR Project could affect water temperature in Butt Valley Reservoir.

Proposed UNFFR Project

Under the Proposed UNFFR Project, the water temperature in Butt Valley reservoir would be very similar to that experienced under current, baseline conditions. The Proposed UNFFR Project contains operational changes, as outlined in the 2004 Settlement Agreement (i.e., decreased inflow from Prattville intakes as a result of increased flows from Canyon dam), which may reduce the inflows and outflows of Butt Valley reservoir by a small amount. The inflow temperatures of the Butt Valley powerhouse and the outflow temperatures of the Caribou No.1 and Caribou No. 2 powerhouses would be similar to that experienced under baseline conditions. The hydrodynamics within the reservoir would also be similar to those experienced under baseline conditions because the change in inflows and outflows is small (about 3 percent on average) compared to baseline operations. Therefore, the impact of the Proposed UNFFR Project on the water temperature conditions of Butt Valley reservoir would be less than significant.

Alternative 1

With the Prattville thermal curtain in place, water discharged through the Butt Valley powerhouse into Butt Valley reservoir would be cooler and contain lower DO levels[9] during the

[9] However, reaeration that occurs at the Butt Valley powerhouse discharges would increase the DO levels. Reaeration under current conditions would not be expected to be high because the Prattville intake mainly

summer. A thermal curtain at the Caribou intakes would not have a substantial effect on the volume of coldwater habitat in Butt Valley reservoir because of the existing hydrodynamics of the Butt Valley powerhouse discharge flows, minimal thermal stratification that occurs in the reservoir, small storage volume, and relatively short hydraulic residence time (about 2 weeks) (see Appendix E for details on Butt Valley reservoir hydrodynamics). Withdrawals through the Caribou intakes would not increase with the thermal curtain in place, but more hypolimnetic water would be withdrawn and released downstream into Belden forebay. The withdrawal of hypolimnetic water would not affect the development of a thermocline because the hypolimnetic water would be replenished by the coldwater inflow from the Butt Valley powerhouse; changes in the volume of suitable coldwater habitat in the reservoir would be influenced more by the Prattville intake thermal curtain.

In general, Alternative 1 would increase the volume of suitable coldwater habitat (i.e., water equal to or less than 20ºC with DO of 5 mg/L or higher) in Butt Valley reservoir in all water year types (Appendix E1–Tables 17 and 20 and Figures 19 and 22). The increase would be due to the low temperature produced by the Prattville intake thermal curtain in the Butt Valley powerhouse discharge, which, overall, would cool the reservoir and increase the volume of water cooler than 20°C. Therefore, the impact of Alternative 1 on water temperature in Butt Valley reservoir would be less than significant and would, in fact, be beneficial overall for cold freshwater habitat of the reservoir.

Alternative 2

Alternative 2 would also increase the volume of suitable cold freshwater habitat in Butt Valley reservoir in all water year types, and the increased amount would be greater than under Alternative 1. Under Alternative 1, the added releases from Canyon dam would require an equivalent reduction in the discharge through the Prattville intake to maintain lake levels in Lake Almanor, which, in turn, would have less coldwater discharge from the Butt Valley powerhouse to Butt Valley reservoir. Similar to the impact under Alternative 1, the impact of Alternative 2 on water temperature in Butt Valley reservoir would be **less than significant** and would, in fact, be beneficial overall for the cold freshwater habitat of the reservoir.

Without thermal curtains, the effect of increased Canyon dam releases up to 250 cfs on Butt Valley reservoir water temperature would be similar to that of the Proposed UNFFR Project.

Impact WQ-3: Implementation of the UNFFR Project could affect water temperatures in the North Fork Feather River below Canyon dam and Belden dam.

Proposed UNFFR Project

The proposed minimum flow schedule for the Seneca and Belden reaches, as outlined in the 2004 Settlement Agreement, would only have a minimal effect on water temperatures in the North Fork Feather River. Decreases in water temperature would occur in parts of the Belden and Rock Creek reaches during June of certain water year types (Appendix E1). However, in all

withdraws epilimnion water, which already has relatively high concentrations of DO and is warmer. However, if a thermal curtain near the Prattville intake is used to withdraw cold hypolimnion water (with low DO), reaeration under this condition would be greater. This was evidenced during the 2006 summertime special test (Stetson Engineers and PG&E 2007a). Due to the complicated mechanisms of reaeration, reaeration was not modeled or analyzed in the Level 3 Report (Stetson Engineers 2009). Therefore, the impact assessment on the suitable coldwater habitat in Butt Valley reservoir represents a “worst case” condition; it is anticipated that DO levels would be higher.

other summer months of all water year types, the temperature regime of each reach is similar to that found under baseline conditions. Water temperatures would continue to exceed the optimal temperatures for rainbow trout in summer months, a condition that led the USEPA to list the North Fork Feather River upstream of Lake Oroville under Section 303(d) of the Clean Water Act (CWA) as water quality limited for temperature. The Proposed UNFFR Project is considered to have no impact.

Alternative 1

The State Water Board's alternative minimum flow schedule for the Seneca and Belden reaches would, by itself, have only a minimal effect on water temperatures in these reaches. The combined effects of the changes in minimum flow, increased summer releases from Canyon dam, and use of the two thermal curtains are discussed below.

A release of up to 250 cfs from mid-June to mid-September from the low-level Canyon dam outlet structure into the Seneca reach would decrease water temperatures while increasing streamflow compared to the existing (baseline) condition. Mean daily temperatures and MWAT in the middle of the Seneca reach, which already remain well below 20°C under the baseline condition, would be reduced by up to 2.5ºC in the Seneca reach, when flows of 250 cfs are released (Appendix E1–Figures 1 to 4). The lower temperatures during the summer would remain within a suitable temperature range in the Seneca reach to protect the cold freshwater habitat use and is, therefore, considered to be beneficial and to have **no impact**.

Mean daily temperatures in the Belden reach upstream of the East Branch of the North Fork Feather River would be maintained at or below 20°C in July and August of all but critically dry water years compared to the current exceedances of 20°C along the entire Belden reach during these months in most years (Appendix E1–Figures 1 to 4, Tables 3 to 6). More importantly, MWATs along the Belden reach that currently range from 21.5°C to 23°C in most years during July and August would be reduced by as much as 3ºC below current conditions, reflecting a much reduced frequency of daily temperatures exceeding 20°C (Appendix E1–Figures 5 to 8). These temperature reductions would result from the combination of the increased Canyon dam discharges and the operation of thermal curtains in Lake Almanor and Butt Valley reservoir. A 0.7-mile segment of the North Fork Feather River between the confluence of the East Branch of the North Fork Feather River and the Belden powerhouse would continue to experience warmer temperatures than the rest of the reach because of the warmer temperatures of the East Branch discharges. Below Belden powerhouse in the Rock Creek and Cresta reaches, MWATs would be similarly reduced from the 21.5°C to 23°C range to below 20ºC in normal to dry water years. MWATs would continue to exceed 20ºC along portions of these reaches in critically dry water years when the weather is warm, but only by up to 0.5°C to 1°C. The reduction in MWAT with increased Canyon dam releases would be about 2°C to 2.5ºC in the Rock Creek and Cresta reaches. Water temperatures in the Poe reach would be reduced from MWATs ranging from 21°C to 25°C by about 1°C to 2ºC, but more than half of the reach would remain above 20ºC during warmer summer months of dry and critically dry water years.

Historically, a maximum instantaneous diel temperature of 24°C, 24°C, 24°C, and 26.7°C was reported for the Belden, Rock Creek, Cresta, and Poe reaches, respectively. Alternative 1 would not be sufficient to eliminate the occurrence of exceedances of 25°C diel fluctuations for the Poe reach during warm summer months of dry and critically dry water years, but would reduce the frequency of diel fluctuations from reaching and exceeding 25ºC, the ultimate upper incipient lethal temperature[10] for rainbow trout. The overall effect of the increased discharges through Canyon dam would be to reduce water temperatures to better attain protection of cold freshwater habitat throughout much of the North Fork Feather River downstream through the Cresta reach. As a result, the combined effects of the increased Canyon dam releases and the thermal curtains would have **no** (adverse) **impact** on the water temperature regime of the North Fork Feather River and would, in fact, be beneficial in some reaches overall for aquatic species dependent on cold freshwater habitat during some water year types.

Without thermal curtains, the effect of increased Canyon dam releases up to 250 cfs on North Fork Feather River water temperature in the Seneca reach would be similar to the temperature reductions predicted for the Seneca reach under Alternative 1. For the Belden reach and reaches downstream of the Belden reach, the effect can be estimated by the difference between Alternative 1 and Alternative 2. Specifically, by applying this difference, mean daily temperatures and MWAT in the Seneca reach, which already remain well below 20°C under baseline condition, would be reduced by up to 2.5ºC. Mean daily temperatures in July and August in the Belden, Rock Creek, Cresta, and Poe reaches would be reduced by about 0.6ºC, 0.4ºC, 0.4ºC, and 0.3ºC, respectively. MWAT in July and August in the Belden, Rock Creek, Cresta, and Poe reaches would be reduced by up to 1.0ºC, 0.8ºC, 0.7ºC, and 0.5ºC, respectively. Water temperatures would continue to exceed the 20ºC threshold in summer months.

Alternative 2

Alternative 2 would provide a benefit for cold freshwater habitat in the North Fork Feather River, but at a somewhat lower level than Alternative 1. Beneficial thermal effects from the Prattville and Caribou intakes thermal curtains alone (without the increased Canyon dam release) under this alternative would result in less temperature reduction than Alternative 1, with daily mean water temperatures expected to remain between 12°C and 16ºC in the Seneca reach without the 250 cfs Canyon dam release (Appendix E1–Figures 1 to 4).

In the Belden reach, the thermal curtains would result in MWATs remaining below 20ºC in July and August of normal water years, with reductions in temperatures between 1.5°C and 3ºC below current conditions (21.5° to 23°C) (Appendix E1–Figures 5 to 8). Similar changes would be expected farther downstream in the Rock Creek and Cresta reaches, with MWATs remaining near or below 20ºC in normal water years. MWATs would exceed 20ºC along most of these reaches in dry and critically dry water years during warm weather, but by no more than 0.5°C to 1°C. The MWATs would be 1°C to 2ºC cooler than current conditions (21°C to 23°C) in these reaches. In the Poe reach, MWATs would be 0.6°C to 2ºC cooler than current conditions (21°C to 25°C); however, more than half of the reach would remain above 20ºC during July and August in normal years, and the entire reach would exceed 20ºC in dry and critically dry water years. In most water years, only the upper half of the Poe reach would see a reduction in the frequency of diel fluctuations reaching and exceeding 25ºC.

The reduction in water temperatures during July and August would protect the coldwater beneficial use throughout much of the North Fork Feather River downstream through the Cresta reach in normal years. In dry and critically dry water years during warm weather, the water temperatures could result in diel fluctuations that reach or exceed lethal levels for coldwater species in the Poe reach. Protection of cold freshwater habitat would be expected to be

[10] 25°C is the ultimate upper incipient lethal temperature for rainbow trout. The ultimate upper incipient lethal temperature is the highest temperature to which the species can be acclimated; above this temperature, all temperatures are lethal regardless of previous thermal exposure (Jobling 1981).

improved under Alternative 2 compared to current conditions, but not as much as under Alternative 1. As a result, the thermal curtains would have **no** (adverse) **impact** on the water temperature regime of the North Fork Feather River and would, in fact, be beneficial during some months under certain water year types.

Impact WQ-4: Implementation of the UNFFR Project could affect DO concentration in water discharged from Canyon dam and Butt Valley powerhouse.

Proposed UNFFR Project

Under the Proposed UNFFR Project, discharges from Canyon dam and the Butt Valley powerhouse would have DO levels similar to baseline conditions. The increased Canyon dam releases from the low-elevation outlet as specified in the 2004 Settlement Agreement, with an equivalent reduction in the discharge through the Prattville intake to maintain lake levels in Lake Almanor, would release more hypolimnetic water with low DO to the Seneca reach during the summer than under the current operation. Although the increased flows are between two and four times greater than the current minimum flow release of 35 cfs from Canyon dam, it is expected that the DO concentration would be 6 mg/L at the point of discharge and would increase to greater than 7 mg/L within a distance of less than 0.3 mile from the dam[11].

The Proposed UNFFR Project does not call for the implementation of any measures that would modify the Prattville intake. Therefore, discharges from the Butt Valley powerhouse would contain DO levels similar to baseline conditions. The impact of the Proposed UNFFR Project on DO concentration in water discharged from Canyon dam and Butt Valley powerhouse would be **less than significant.**

Alternatives 1 and 2

With the Prattville thermal curtain in place under both alternatives, discharge through the Butt Valley powerhouse into Butt Valley reservoir would contain lower DO levels during certain periods of the summer. It is estimated that the hypolimnetic water coming from Lake Almanor will have reduced DO levels of 2 to 4 mg/L compared to existing conditions of 6 to 7 mg/L. However, oxygen reaeration that occurs at the Butt Valley powerhouse discharges would increase the DO levels. Oxygen reaeration under existing conditions would not be expected to be high because the Prattville intake mainly withdraws epilimnion water that has relatively high concentrations of DO. However, if a thermal curtain near the Prattville intake is used to cause hypolimnion cold water withdrawal (with low DO), oxygen reaeration under this condition would be greater. This was evidenced during the 2006 summertime special test (Stetson Engineers and Pacific Gas and Electric Company 2007a). During the 2006 summertime special test, the Butt Valley powerhouse discharge was reduced to about 500 cfs to cause selective withdrawal of hypolimnion cold water at the Prattville intake (i.e., water was taken from a lower level). Measurements of water temperature and DO in the discharge channel about 180 feet

[11] Seasonal measurements for DO concentrations below the dam under current conditions have been consistently greater than 7.0 mg/L (PG&E 2002). Stetson Engineers estimated the aeration efficiency at the Canyon dam discharge outlet to be about 63 percent. Theoretically, the aeration efficiency is related to both the Froude number and the Reynolds number (i.e., indices of turbulence) of the flow jet at the discharge outlet. Analysis by Stetson Engineers showed that the aeration efficiency could be reduced from the current 63 percent to about 55 percent when the release rate is increased from 35 cfs to 90 cfs. At the estimated aeration efficiency of 55 percent, the DO concentration would be greater than 6 mg/L at the discharge outlet. Using the Streeter–Phelps DO model (H.W. Streeter and E. B. Phelps 1925), Stetson Engineers estimated that the DO concentration would increase to greater than 7 mg/L within a distance of less than 0.3 mile from the discharge outlet.

downstream from the Butt Valley powerhouse (Table 6.5-2) demonstrate that oxygen reaeration at the powerhouse discharge outlet would increase the DO to near air saturation. Therefore, the impact of Alternatives 1 and 2 on DO concentration in water discharged from Butt Valley powerhouse would be **less than significant**.

Table 6.5-2. Measured Water Temperature and DO in the Discharge Channel about 180 Feet from the Butt Valley Powerhouse during the 2006 Summertime Special Test

Measurement Time	Estimated DO at Prattville Intake[a] (mg/L)	Measured Water Temperature in the Discharge Channel (°C)	Measured DO in the Discharge Channel (mg/L)
8/1/2006, 7:00am	4.5	14.0	8.7
8/2/2006, 7:45am	4.5	12.2	8.4
8/3/2006, 7:45am	4.5	12.4	8.4
8/4/2006, 8:31am	4.5	13.2	8.2
8/5/2006, 8:00am	4.5	12.3	8.8

[a] The DO concentration at the Prattville intake was estimated based on the measured discharge water temperature and the measured vertical profiles of water temperature and DO at the Prattville intake.

Under Alternative 1, the increased Canyon dam release of up to 250 cfs from June 15 through September 15 from the low-elevation outlet with an equivalent reduction in the discharge through the Prattville intake to maintain lake levels in Lake Almanor, more water with low DO concentrations would be released to the Seneca reach during the summer than occurs under the current operation. Although a Canyon dam release of 250 cfs would be seven times greater than the current minimum flow release of 35 cfs, it is expected that the DO concentration would be greater than 5.5 mg/L at the point of discharge and would increase to greater than 7 mg/L within a distance of less than 1.0 mile from the dam[12]. Under Alternative 2, the releases from Canyon dam would be similar to those required by the Proposed UNFFR Project. The effects on DO would be the same. Therefore, the effects of both alternatives on the DO concentration in the water discharged from Canyon dam would be **less than significant.**

The effect of increased Canyon dam releases of up to 250 cfs on the DO concentration in the water discharged from Canyon dam, without thermal curtains, is discussed above. The effect of increased Canyon dam releases of up to 250 cfs on the DO concentration in the water discharged from the Butt Valley powerhouse would be similar to that of the Proposed UNFFR Project. The effect of increased Canyon dam releases of up to 250 cfs, without thermal curtains, on the DO concentration in water discharged from Canyon dam and Butt Valley powerhouse would be similar to Alternative 1 and would be **less than significant**.

[12] Seasonal measurements for DO concentrations below Canyon dam under current conditions have been consistently greater than 7.0 mg/L (PG&E 2002). Stetson Engineers estimated the aeration efficiency at the Canyon dam discharge point to be about 63 percent. Theoretically, the aeration efficiency is related to both the Froude number and the Reynolds number (i.e., indices of turbulence) of the flow jet at the discharge point. Analysis by Stetson Engineers showed that the aeration efficiency could be reduced from the current 63 percent to about 45 percent when the release rate is increased from 35 cfs to 250 cfs. At the estimated aeration efficiency of 45 percent, the DO concentration would be greater than 5.5 mg/L at the discharge outlet. Using the Streeter–Phelps DO model (H.W. Streeter and E.B. Phelps 1925), Stetson Engineers estimates that the DO concentration would increase to greater than 7 mg/L within a distance of less than 1.0 mile from the discharge outlet.

Impact WQ-5: Implementation of the UNFFR Project could cause water released from Canyon dam to have an undesirable taste or odor.

Proposed UNFFR Project

The increased releases from the Canyon dam low-level outlet, as outlined in the 2004 Settlement Agreement could cause an increase in noticeable hydrogen sulfide odors in the immediate vicinity of the dam discharge to the Seneca reach of the North Fork Feather River during certain times in late summer, depending on annual hydrologic conditions and Lake Almanor water storage levels. While a sulfide odor may be noticeable during the increased late-summer releases of 60 cfs, it is unlikely that the degree of change in its duration relative to the current (baseline) condition (35 cfs) would be noticeable. This impact would be **less than significant**.

Alternative 1

The modification of the Canyon dam low-elevation outlet and its operation to release up to 250 cfs from mid-June to mid-September could cause an increase in noticeable hydrogen sulfide odors in the immediate vicinity of the dam discharge to the Seneca reach of the North Fork Feather River during certain times in late summer, depending on annual hydrologic conditions and Lake Almanor water storage levels. The increased Canyon dam releases of up to 250 cfs would occur when Lake Almanor is thermally stratified and during a portion of the period when hydrogen sulfide is produced in the hypolimnion, which is usually during the late summer to early fall season and with high lake surface elevations (Pacific Gas and Electric Company 2002, Federal Energy regulatory Commission 2005). However, the highest hydrogen sulfide, iron, and manganese concentrations, which are all soluble under the anoxic chemical-reducing conditions at the interface of the lake bed and the hypolimnion, are reported by PG&E to occur from mid-September to October (Federal Energy Regulatory Commission 2005). The temperature control discharges of up to 250 cfs from the Canyon dam low-elevation outlet would not be required after mid-September, when the occurrence of hydrogen sulfide odors typically has been most noticeable.

The 250 cfs release would draw more water from the deep hypolimnion compared to the current 35 cfs release under the Proposed UNFFR Project. It is anticipated that the withdrawal zone of the outlet gate for a 250 cfs release will be larger than the current nine-foot-depth band surrounding the gate currently used for the 35 cfs Canyon dam release (Pacific Gas and Electric 2002). The increased withdrawal zone above and below the outlet gate would result in considerable mixing and dilution of the sulfide-containing deep hypolimnetic water with water from higher in the water column and containing little to no hydrogen sulfide. In addition, water quality monitoring downstream of Canyon dam suggests that rapid reaeration of water as it passes through the Canyon dam discharge tunnel and is released to the Seneca reach returns sulfide concentrations to near non-detectable levels within a short distance (1,250 feet) below the dam (Federal Energy Regulatory Commission 2005). While a sulfide odor may be noticeable during late-summer releases of up to 250 cfs at Canyon dam, it is unlikely that it would be more noticeable than under current conditions. This impact would be **less than significant**.

Alternative 2

Under Alternative 2, Canyon dam releases would occur according to the alternative minimum instream flow conditions for the Seneca reach shown in Table 4-1. These releases would be greater than the current 35 cfs, but less than the releases under Alternative 1 (250 cfs) from mid-June through mid-September. Therefore, for the reasons explained above, this impact would be **less than significant**.

Impact WQ-6: Implementation of the UNFFR Project could cause a change in the character or quantity of dissolved metal concentrations or other contaminants in Lake Almanor or the North Fork Feather River.

Proposed UNFFR Project

As stated above, releases from the Canyon dam low-elevation outlet structure could contain lower DO concentrations. Low DO concentrations at the water-sediment interface allow reductive chemical processes to occur. Iron and manganese are converted into soluble forms and released from sediments under anoxic conditions with pH levels of 7.5 units or less (Wetzel 1975).

Iron and manganese were found to have exceeded water quality objectives in the Seneca reach only during dry water years; however, concentrations of these water quality constituents substantially decreased to below exceedance thresholds within a short distance downstream of Canyon dam, where the water rapidly re-oxygenates (Pacific Gas and Electric Company 2002). All other water quality objectives were satisfied at the Canyon dam outlet near the bottom of Lake Almanor, and are not expected to adversely affect conditions within the Seneca reach.

Increased withdrawal of hypolimnetic water under the Proposed UNFFR Project relative to withdrawal under the baseline condition could reduce the volume of cold water in the hypolimnion of Lake Almanor. In addition, increasing the cold water withdrawal also would induce a small amount of movement of the hypolimnetic water, resulting in some mixing at the interface of the hypolimnion and the metalimnion water layers. This mixing could result in either no increase or a small increase in the DO concentration in the upper hypolimnion. The DO concentration in the lower hypolimnion at the water-sediment interface would be expected to remain unchanged. Therefore, dissolved metal concentrations within Lake Almanor would be expected to remain unchanged relative to baseline conditions. Because dissolved metal concentrations within Lake Almanor will remain unchanged, releases to water bodies via the Prattville intake or Canyon dam would have no adverse effects related to dissolved metal concentrations in Lake Almanor, the Seneca reach, and Butt Valley reservoir. No operational changes would occur that would influence metal concentrations in Belden forebay. Although flows will increase in the Belden reach, the PCB levels would be expected to remain stable or potentially decrease over time. Impacts under the Proposed UNFFR Project would be **less than significant.**

Alternative 1

The 250 cfs release from Canyon dam would draw more water from the hypolimnion than occurs under the current 35 cfs release. It would be expected that the withdrawal zone of the intake gate for a 250 cfs release would be larger than the nine-foot-depth band surrounding the outlet gate associated with the current 35 cfs release (Pacific Gas and Electric Company 2002). The increased withdrawal zone above and below the outlet gate would cause considerable mixing and dilution of the hypolimnetic water at or near the lake bottom containing metals with water higher in the water column containing a smaller amount of metals. This could result in lower metal concentrations in the release water compared to the baseline condition. In addition, concentrations of these metals would be substantially decreased to below exceedance thresholds within a short distance downstream of Canyon dam, where the water would rapidly re-oxygenate, causing the metals to precipitate to the channel bed.

Thermal curtains installed at the Prattville intake together with the increased Canyon dam release of up to 250 cfs would reduce the volume of cold water in the hypolimnion of Lake Almanor and induce movement of the hypolimnetic water, resulting in mixing at the interface of the hypolimnion and the metalimnion water layers. This mixing would result in an increase in the DO concentration in the upper hypolimnion and, possibly, in the lower hypolimnion at the water-sediment interface. Increased DO at the water-sediment interface would reduce the release of metals from the lakebed sediments and, thereby, decrease dissolved metal concentrations in Lake Almanor. Decreased concentrations of dissolved metals in Lake Almanor would result in decreased concentrations in Butt Valley reservoir.

In summary, no adverse effects on dissolved metal concentrations in Lake Almanor or other water bodies within the boundary of the UNFFR Project are expected. Impacts under Alternative 1 would be **less than significant**.

Alternative 2

Under Alternative 2, releases from the Canyon dam outlet structure will increase from the current minimum of 35 cfs (year round) to between 60 and 150 cfs, depending on month and water year type. Increases in minimum flow releases will likely encourage some degree of mixing and dilution of the hypolimnion of Lake Almanor and promote downstream aeration within the Seneca reach. These factors are expected to contribute to a decrease in dissolved metal concentrations that have historically exceeded water quality objectives (e.g., iron and manganese). Similar to Alternative 1, no adverse effects on dissolved metal concentrations in Lake Almanor or other water bodies within the boundary of the UNFFR Project are expected. Impacts under Alternative 2 would be **less than significant**.

Impact WQ-7: Construction activities associated with the UNFFR Project could result in temporary increases in turbidity and total suspended solids in Lake Almanor, Butt Valley reservoir, and the North Fork Feather River.

Proposed UNFFR Project

Pages 3-222 to 3-239 of Section 3.3.5 of the Final FERC EIS contain descriptions of the 30 recreational facilities and improvements to be implemented under the Proposed UNFFR Project. These descriptions, without FERC's environmental effects analysis, are hereby incorporated into this EIR by reference. The 30 recreational facilities and improvements make up the majority of the construction activities associated with the Proposed UNFFR Project. The construction activities associated with these recreational facilities and improvements will be located near Lake Almanor, Butt Valley reservoir, and various reaches of the North Fork Feather River. The amount of detail provided for each of these proposed recreational facilities or improvements is insufficient to allow for the accurate assessment of environmental impacts. In reviewing these proposals, the State Water Board must be conservative in making its determination in order to ensure the continued protection of designated beneficial uses and compliance with water quality objectives.

In addition to the 30 recreational facilities and improvements, PG&E has also proposed the removal of the Gansner Bar fish barrier and potentially the NF-9 gage weir as part of the

Proposed UNFFR Project. The Gansner Bar fish barrier is located in the Belden reach of the North Fork Feather River approximately 0.2 mile upstream of the confluence with the East Branch of the North Fork Feather River. The NF-9 gage weir is located in lower Butt Creek between Butt Valley dam and its confluence with the North Fork Feather River. PG&E proposes the removal of the Gansner Bar fish barrier as a condition of its new license. A monitoring plan will be developed, in consultation with the California Department of Fish and Wildlife, the State Water Board, the United States Forest Service, and the United States Fish and Wildlife Service, to determine if the NF-9 gage weir is an obstacle to upstream fish passage. If monitoring data confirms that the NF-9 gage weir is preventing or limiting upstream fish passage, PG&E has agreed to remove or modify it to provide upstream passage for fish. The amount of detail provided for each of these proposed construction activities is insufficient to allow for the site-specific assessment of environmental impacts, but the general nature of instream construction projects is included as a potential impact to water quality. As previously stated, the State Water Board must be conservative when reviewing these proposed projects in order to ensure the continued protection of designated beneficial uses and compliance with water quality objectives.

Due to the proximity of the various facility development and improvement projects to Lake Almanor and the other water bodies within the boundary of the UNFFR Project and the potential for surface-disturbing activities, the construction impacts on turbidity and total suspended solids within these water bodies is considered **significant without mitigation**.

Alternative 1

Construction activities under Alternative 1 would involve installation of a thermal curtain around both the Prattville and Caribou intakes and modifications to the Canyon dam low-level outlet gates. Ground disturbance and placement of fill along the lake bed and shore at both Lake Almanor and Butt Valley reservoir would temporarily increase turbidity and total suspended solids in these water bodies. Use of geotechnical fabrics under the foundations of bin walls and use of divers during installation of the thermal curtains and modifications to the Canyon dam outlet structure would minimize disturbance of the sediments along the bottom of the water bodies, but installation of the bin walls for the thermal curtain would require discharge of backfill material into the water bodies and along the shore. Vehicle access and launching of the barges could disturb soil along the shore of the water bodies and discharge sediment into them.

Fine sediments, such as silts and clays, from the fill material or shore disturbance could become suspended in the water bodies around the activity areas, increasing turbidity and total suspended solids for short periods of time. Larger-sized sediments, such as coarse sand and gravel, would fall to the bottom. Some sediment may be dispersed around the water bodies or be discharged from one of the release structures (Prattville intake, Caribou intakes, Canyon dam outlet) into the water body immediately downstream. These sediments could affect turbidity and total suspended solids beyond the activity area, but the effects would be reduced farther away from the disturbance. The temporary increase in turbidity and total suspended solids could affect beneficial uses of the receiving or downstream water bodies, including freshwater and spawning habitat and recreational uses.

As described in Chapter 4, PG&E would be required to comply with water quality standards and implement appropriate water pollution control measures to minimize construction-related impacts on water quality. With implementation of these measures and compliance with the water quality certification, construction impacts associated with installation of the thermal curtains and modifications to the Canyon dam outlet structure on turbidity and total suspended solids in Lake Almanor, Butt Valley reservoir, and downstream water bodies would be **less than significant** and would not adversely affect beneficial uses.

However, Alternative 1 includes the construction of facilities outlined in the Proposed UNFFR Project. With consideration for the entire Alternative 1 (i.e., Canyon dam outlet structure modifications, thermal curtains, Proposed UNFFR Project), potential impacts on turbidity and total suspended solids in Lake Almanor and the other water bodies within the UNFFR Project boundary is considered **significant without mitigation**.

Alternative 2

Construction activities under Alternative 2 would be the same as described for Alternative 1, except that Alternative 2 does not include modifications to the Canyon dam outlet structure. Implementation of water pollution control measures during construction would reduce adverse effects on water quality; therefore, as stated above, construction impacts associated with the thermal curtain would be **less than significant**.

However, the impact of Alternative 2 in conjunction with the impacts described for the Proposed UNFFR Project related to turbidity and total suspended solids in Lake Almanor and the other water bodies within the UNFFR Project boundary is considered **significant without mitigation**.

Mitigation Measure

Mitigation Measure Geology, Geomorphology, and Soils (GGS)-1: Approval of Construction Activities by the State Water Board (Turbidity and Total Suspended Solids)

See Section 6.3.2. for mitigation measures associated with construction activities for the Proposed UNFFR Project and alternatives.

Significance after Mitigation

Implementation of Mitigation Measure GGS-1 would reduce the impact to a **less than significant** level.

Impact WQ-8: Hazardous materials spills during construction activities associated with the UNFFR Project could cause contamination of Lake Almanor, Butt Valley reservoir, and the North Fork Feather River.

Proposed UNFFR Project

As previously stated, the Proposed UNFFR Project includes various construction activities (including the facility development and improvement projects) in the vicinity of Lake Almanor, Butt Valley reservoir, and the North Fork Feather River. Due to the proximity of the Proposed UNFFR Project sites to UNFFR Project waters (Lake Almanor, Butt Valley reservoir, and the North Fork Feather River), the potential for a spill of hazardous materials (e.g., oil, grease, gasoline, or solvents) during construction activities to cause contamination in the water bodies is considered **significant without mitigation**. A spill could degrade water quality and have adverse effects on fish and other aquatic organisms near the construction areas, resulting in adverse effects on beneficial uses. (See Section 6.6, Fisheries, for more information on fishery impacts.)

Alternatives 1 and 2

Construction activities under either alternative would require the use of barges in the water and vehicles and equipment along the shores of Lake Almanor and Butt Valley reservoir. Activities in the water or along the shore could result in a spill of hazardous materials (e.g., oil, grease, gasoline, or solvents) into the lake or reservoir, which could be transported downstream into the North Fork Feather River. Such spills could degrade water quality and have adverse effects on fish and other aquatic organisms near the activity areas, resulting in adverse effects on beneficial uses (see Section 6.6 Fisheries for more information on fishery impacts). As described in Chapter 4, PG&E would be required to implement appropriate water pollution control measures to minimize construction-related impacts on water quality. With implementation of these measures and compliance with the water quality certification, construction impacts on water quality from hazardous materials associated with either water quality measure would be **less than significant**.

However, both alternatives would also include the construction of the recreational facilities and improvements outlined in the Proposed UNFFR Project for which potential impacts on water quality from hazardous materials is considered **significant without mitigation.**

Mitigation Measure

Mitigation Measure WQ-8: Approval of Construction Activities by the State Water Board (Hazardous Materials)

Prior to construction, PG&E will submit detailed plans outlining all construction activities associated with the work to be completed to the State Water Board for review and written approval. Each plan will contain a detailed description of the proposed activities, activity boundaries, potential environmental impacts, pollutants of concern, and appropriate best management practices (BMPs) that will be implemented. The following measures or the equivalent will be included in the water quality certification and incorporated into each construction plan:

- Construction material, debris, spoils, soil, silt, sand, bark, slash, sawdust, rubbish, steel, other organic or earthen material, or any other substances that could be hazardous to aquatic life resulting from UNFFR Project–related activities shall be prevented from entering surface waters.

- All wash water shall be contained and disposed of in compliance with state and local laws, ordinances, and regulations.

- No unset cement, concrete, grout, damaged concrete, concrete spoils, or wash water used to clean concrete surfaces shall contact or enter surface waters.

- All equipment must be washed prior to transport to the UNFFR Project site and must be free of sediment, debris, and foreign matter.

- Any maintenance or refueling of vehicles or equipment occurring on site will be done in a designated area with secondary containment, located away from drainage courses to prevent the runoff of stormwater and spills. All equipment using gas, oil, hydraulic fluid, or other petroleum products shall be inspected for leaks prior to use and shall be monitored for leakage. Stationary equipment (motors, pumps, generators, etc.) and vehicles not in use shall be positioned over drip pans or other types of containment.

Spill and containment equipment (oil spill booms, sorbent pads, etc.) shall be maintained onsite at all locations where such equipment is used or staged.

- All imported riprap, rocks, and gravels used for construction shall be pre-washed.

- No leachate from truck or grout mixer cleaning stations shall percolate into UNFFR Project area soils. Cleaning of concrete trucks or grout mixers shall be performed in designated washout areas of sufficient size to completely contain all liquid and waste concrete or grout generated during washout procedures. Hardened concrete or grout shall be disposed of at an authorized landfill, in compliance with state and local laws, ordinances, and regulations.

- All construction debris and trash shall be contained and regularly removed from the work area to the staging area during construction activities. Upon completion, all UNFFR Project–generated debris, building materials, excess material, waste, and trash shall be removed from all the UNFFR Project sites for disposal at an authorized landfill or other disposal site in compliance with state and local laws, ordinances, and regulations.

- Onsite containment for storage of chemicals classified as hazardous shall include secondary containment and appropriate management as specified in California Code of Regulations, title 27, section 20320.

- If at any time an unauthorized discharge to surface waters (including rivers or streams) occurs or monitoring indicates that the UNFFR Project has or could soon be in violation with water quality objectives, the associated UNFFR Project activities shall cease immediately and the Deputy Director for Water Rights (Deputy Director) and the Central Valley Regional Water Quality Control Board Executive Officer shall be notified. Associated activities may not resume without approval from the Deputy Director.

The State Water Board will modify the UNFFR Project or require additional mitigation measures, as necessary, in order to prevent impacts to water quality objectives or designated beneficial uses.

Significance after Mitigation

Implementation of Mitigation Measure WQ-8 would reduce the impact to a **less than significant** level.

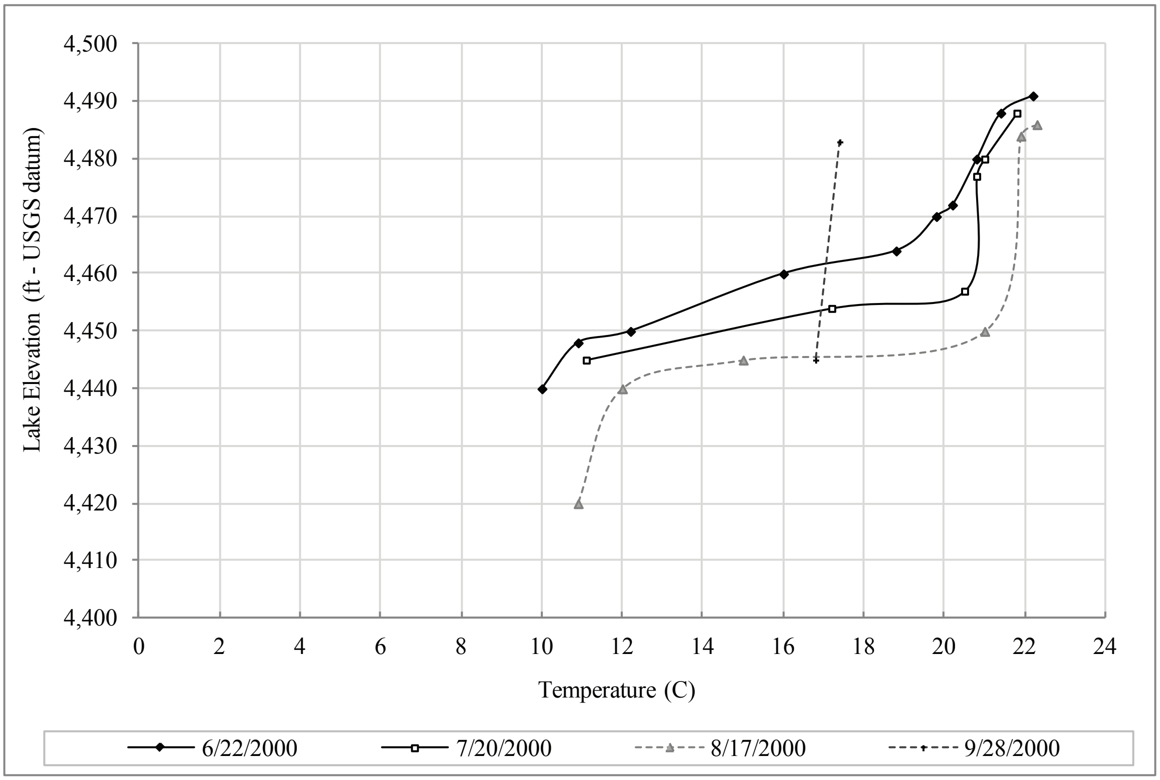

Figure 6.5-1a. Year 2000 (Normal Water Year). Source: Stetson Engineers Inc. (2009).

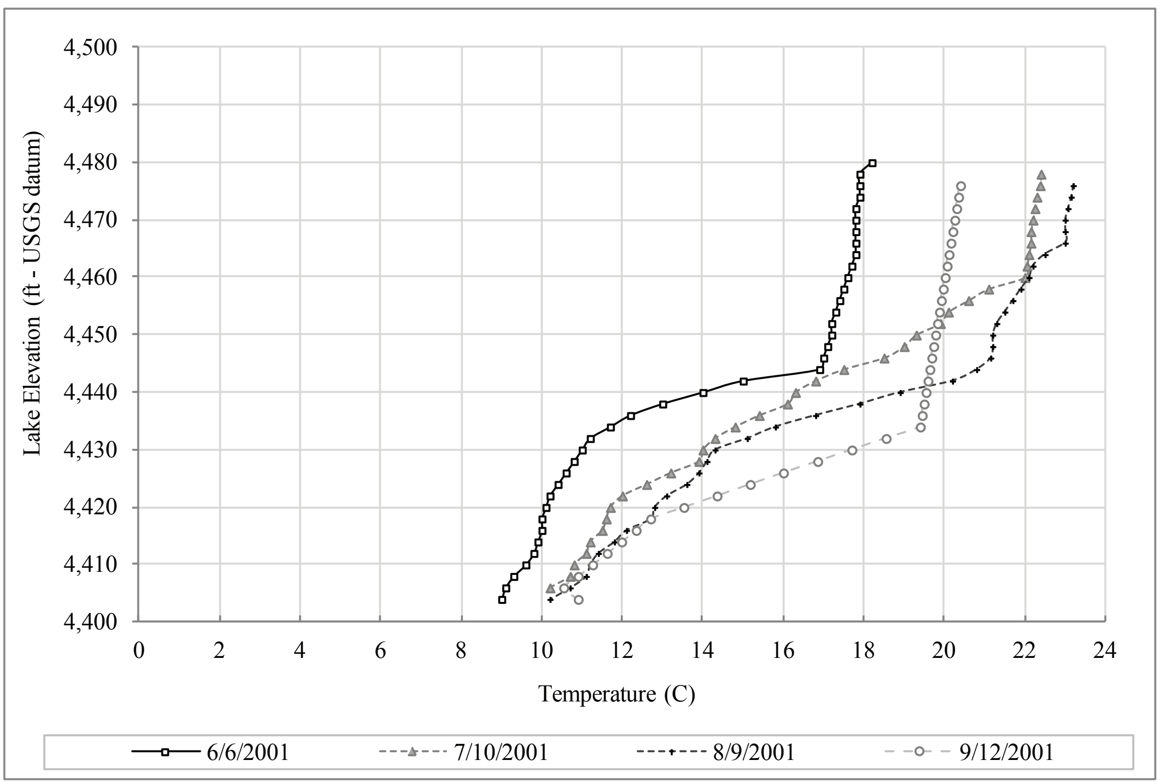

Figure 6.5-1b. Year 2001 (Critically Dry Water Year). Source: Stetson Engineers Inc. (2009).

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Figure 6.5-1a and b
Seasonal temperature profiles in Lake Almanor at station LA1 near Canyon Dam

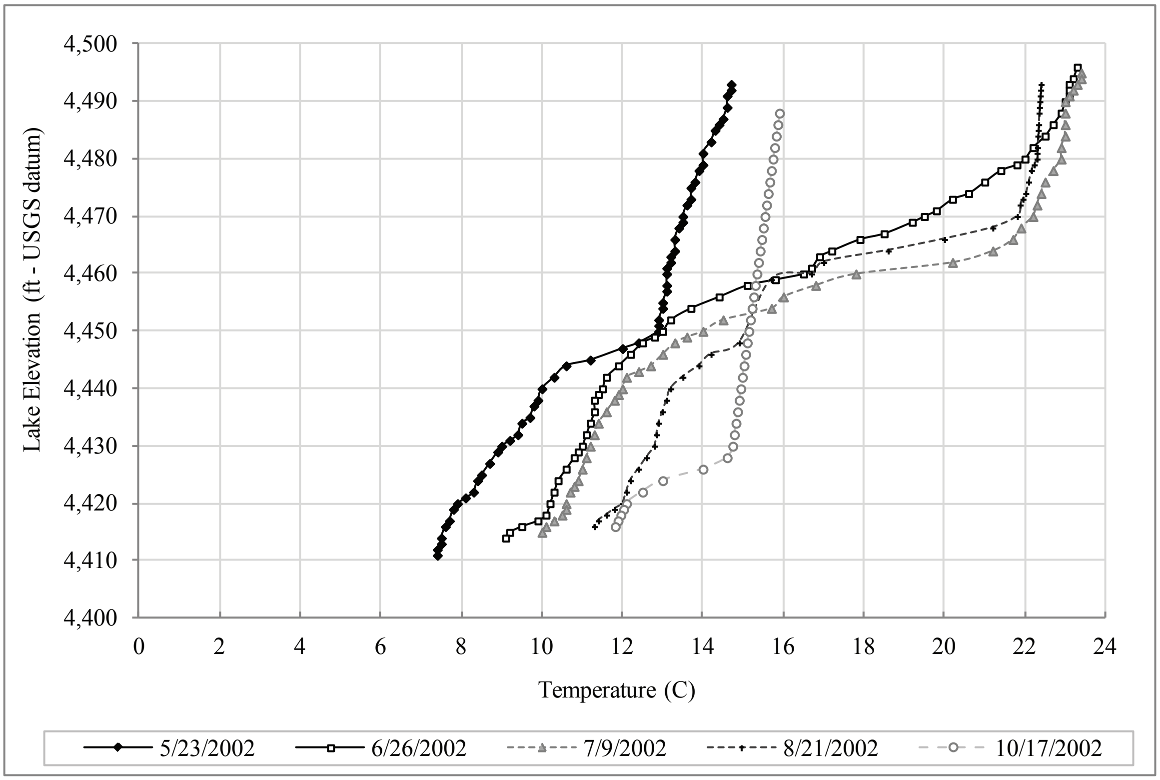

Figure 6.5-1c. Year 2002 (Dry Water Year). Source: PG&E (2003).

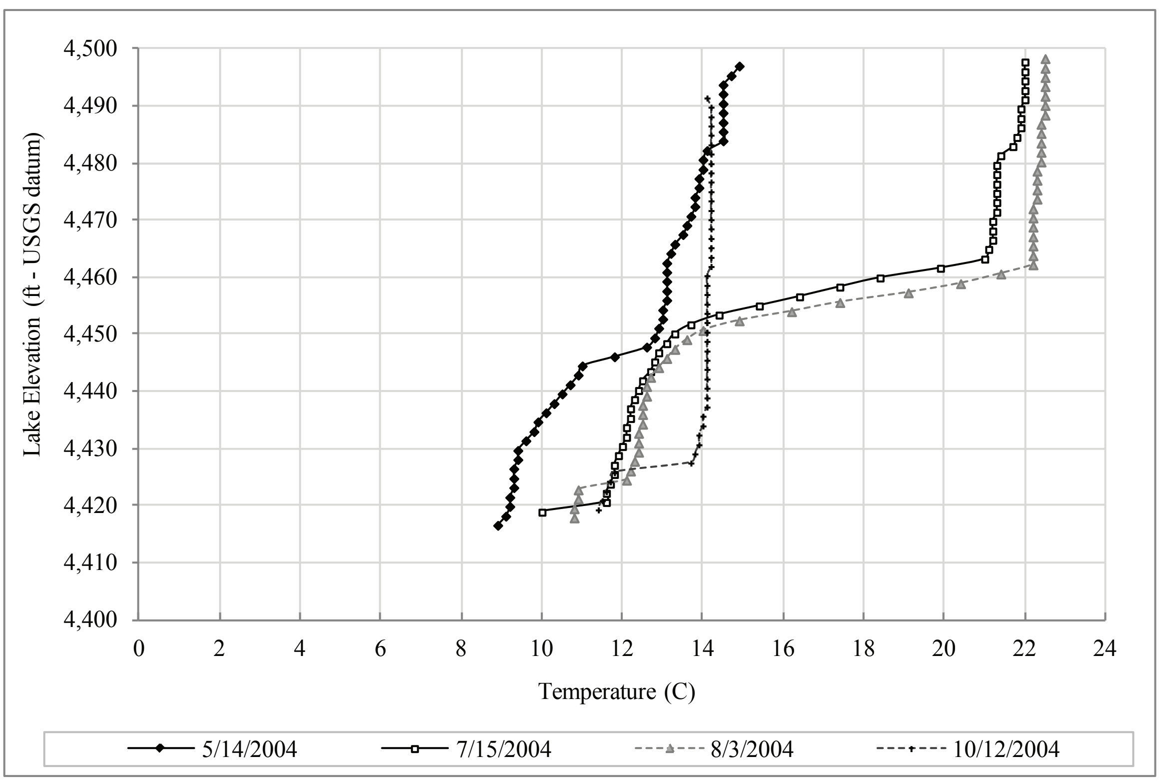

Figure 6.5-1d. Year 2004 (Below Normal Water Year). Source: PG&E (2005).

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Figure 6.5-1c and d
Seasonal temperature profiles in Lake Almanor at station LA1 near Canyon Dam

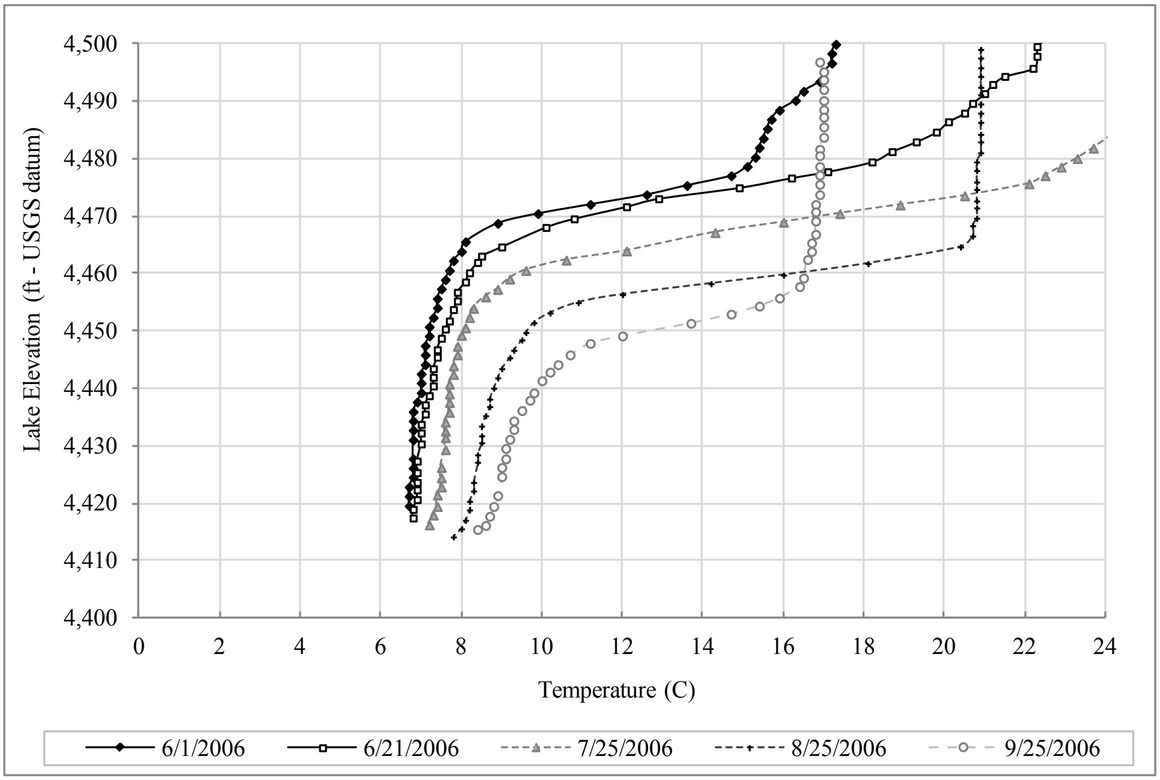

Figure 6.5-1e. Year 2006 (Wet Water Year). Source: PG&E (2007).

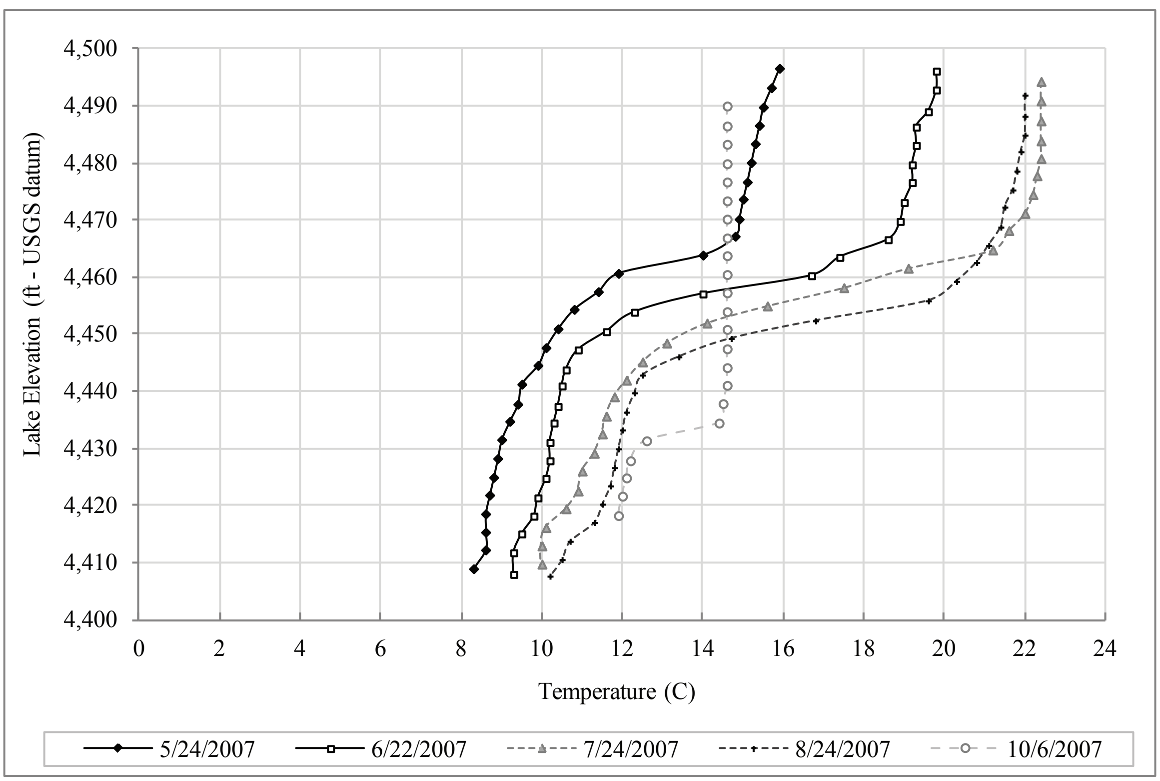

Figure 6.5-1f. Year 2007 (Dry Water Year). Source: PG&E (2008).

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Figure 6.5-1e and f
Seasonal temperature profiles in Lake Almanor at station LA1 near Canyon Dam

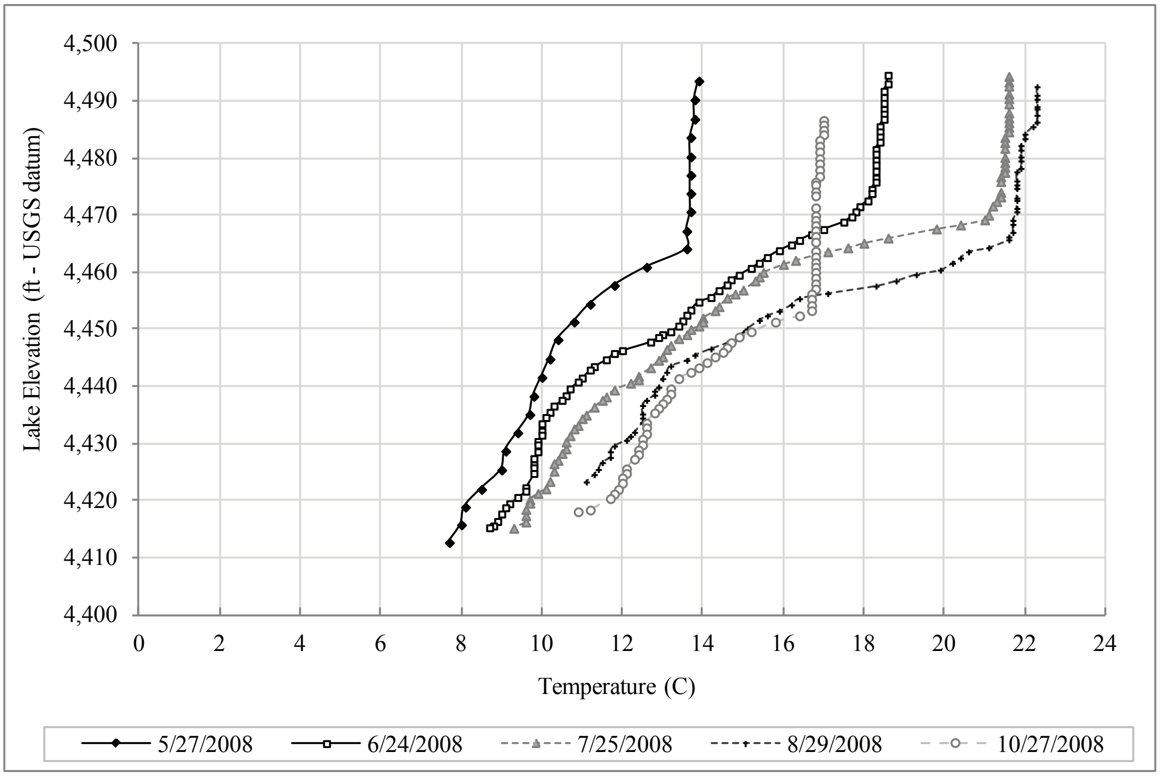

Figure 6.5-1g. Year 2008 (Critically Dry Water Year). Source: PG&E (2009).

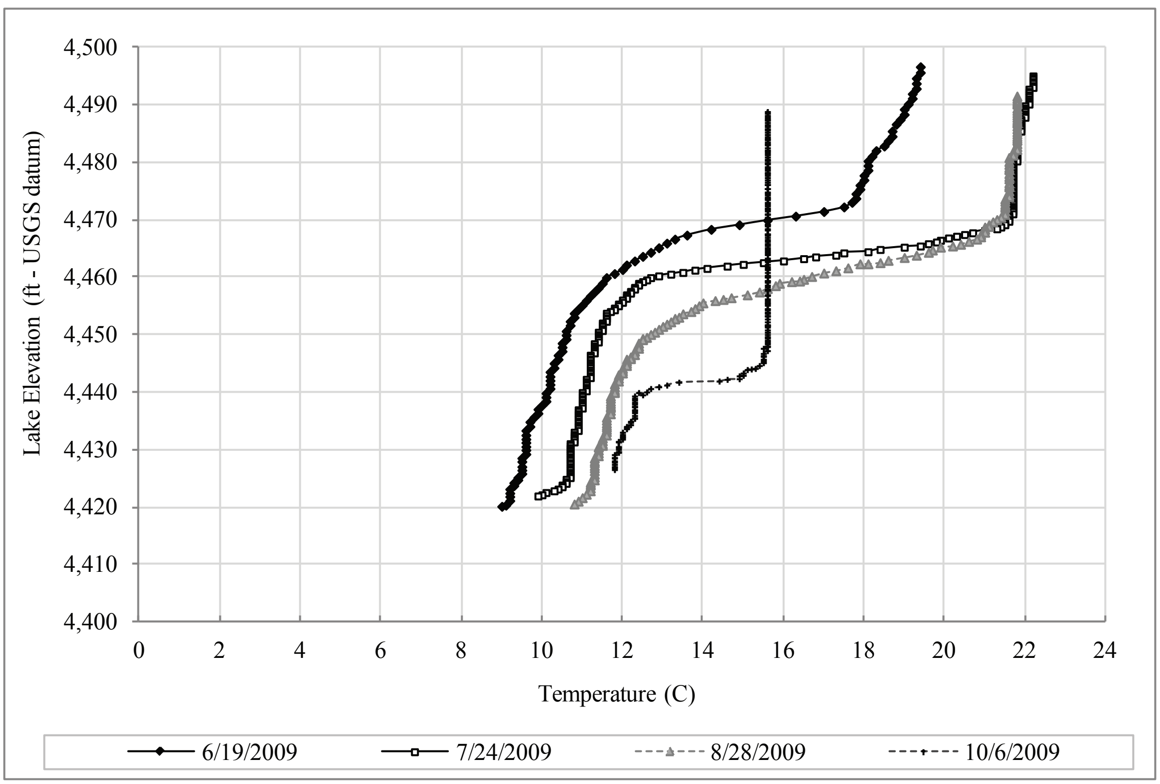

Figure 6.5-1h. Year 2009 (Dry Water Year). Source: PG&E (2010).

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North State Resources, Inc.

Figure 6.5-1g and h
Seasonal temperature profiles in Lake Almanor at station LA1 near Canyon Dam

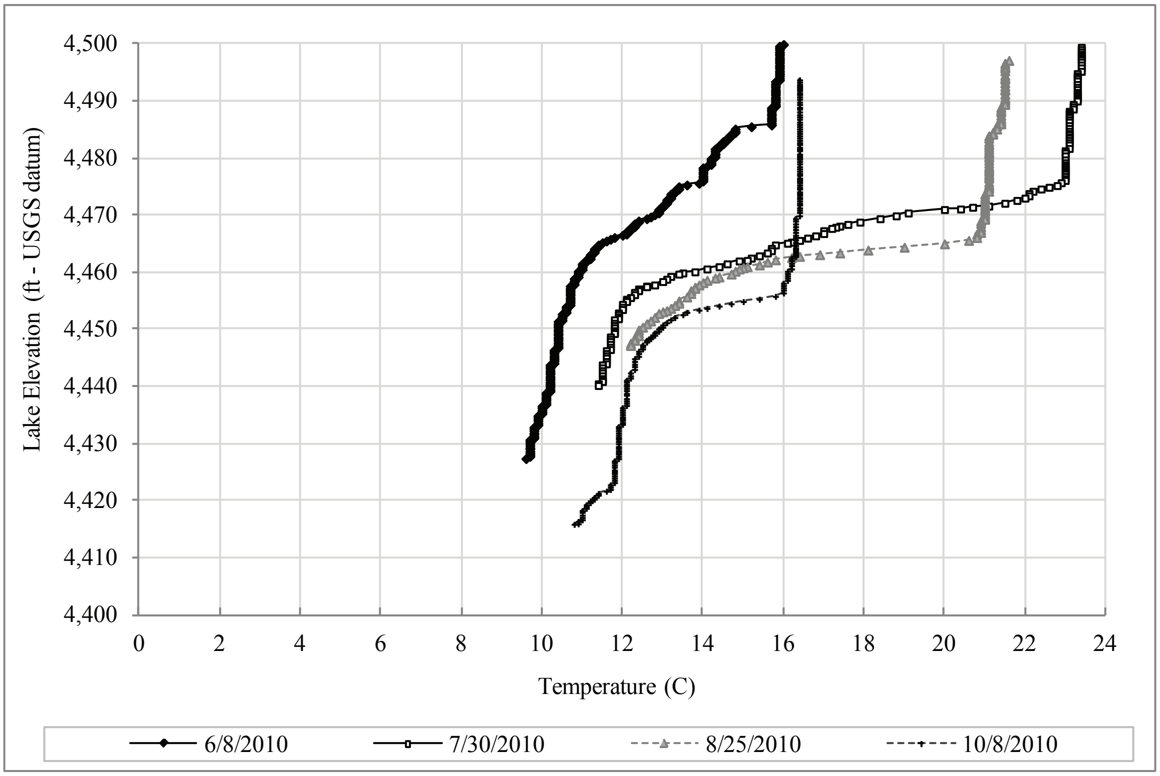

Figure 6.5-1i. Year 2010 (Below Normal Water Year). Source: PG&E (2011).

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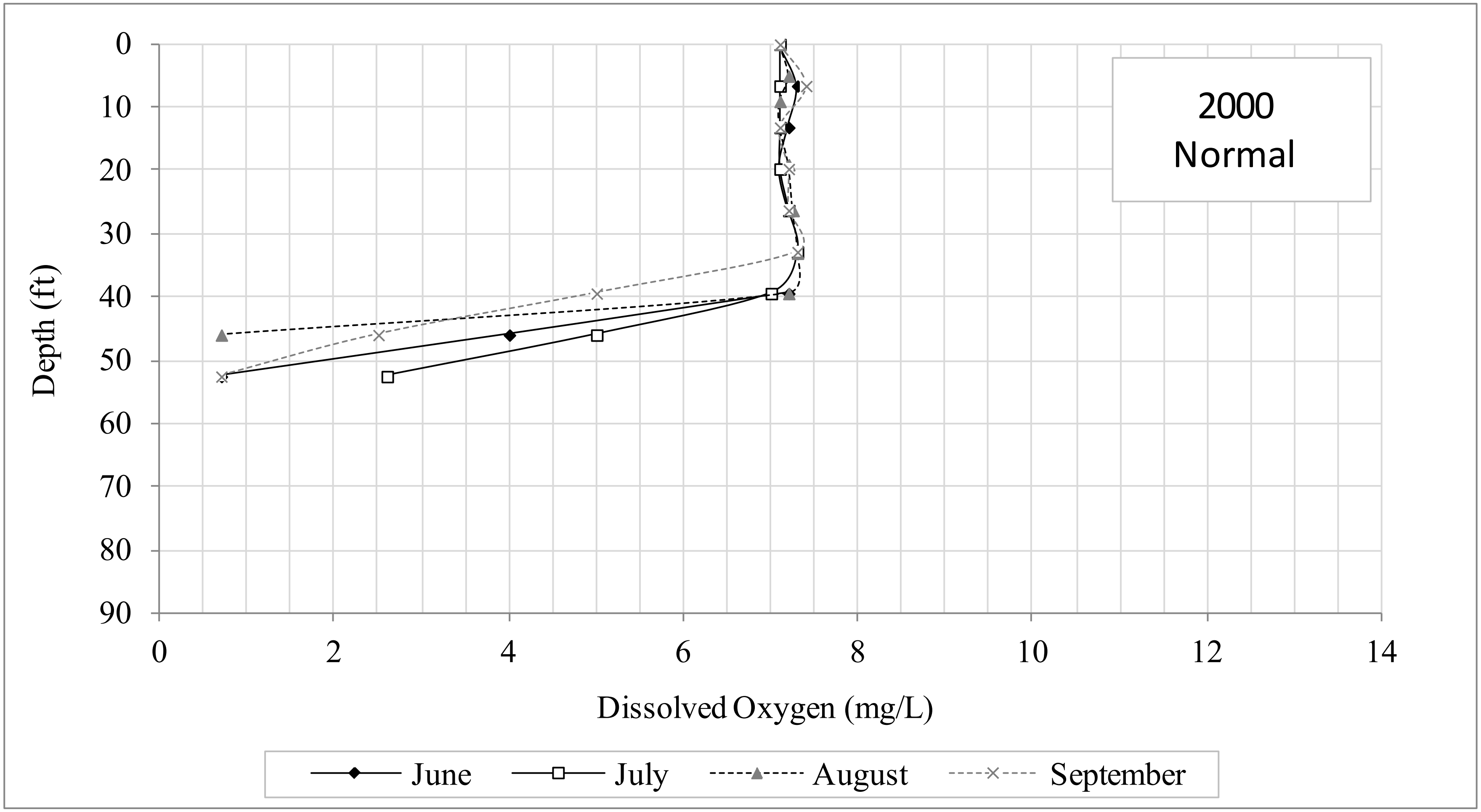
Figure 6.5-1i
Seasonal temperature profiles in Lake Almanor at station LA1 near Canyon Dam



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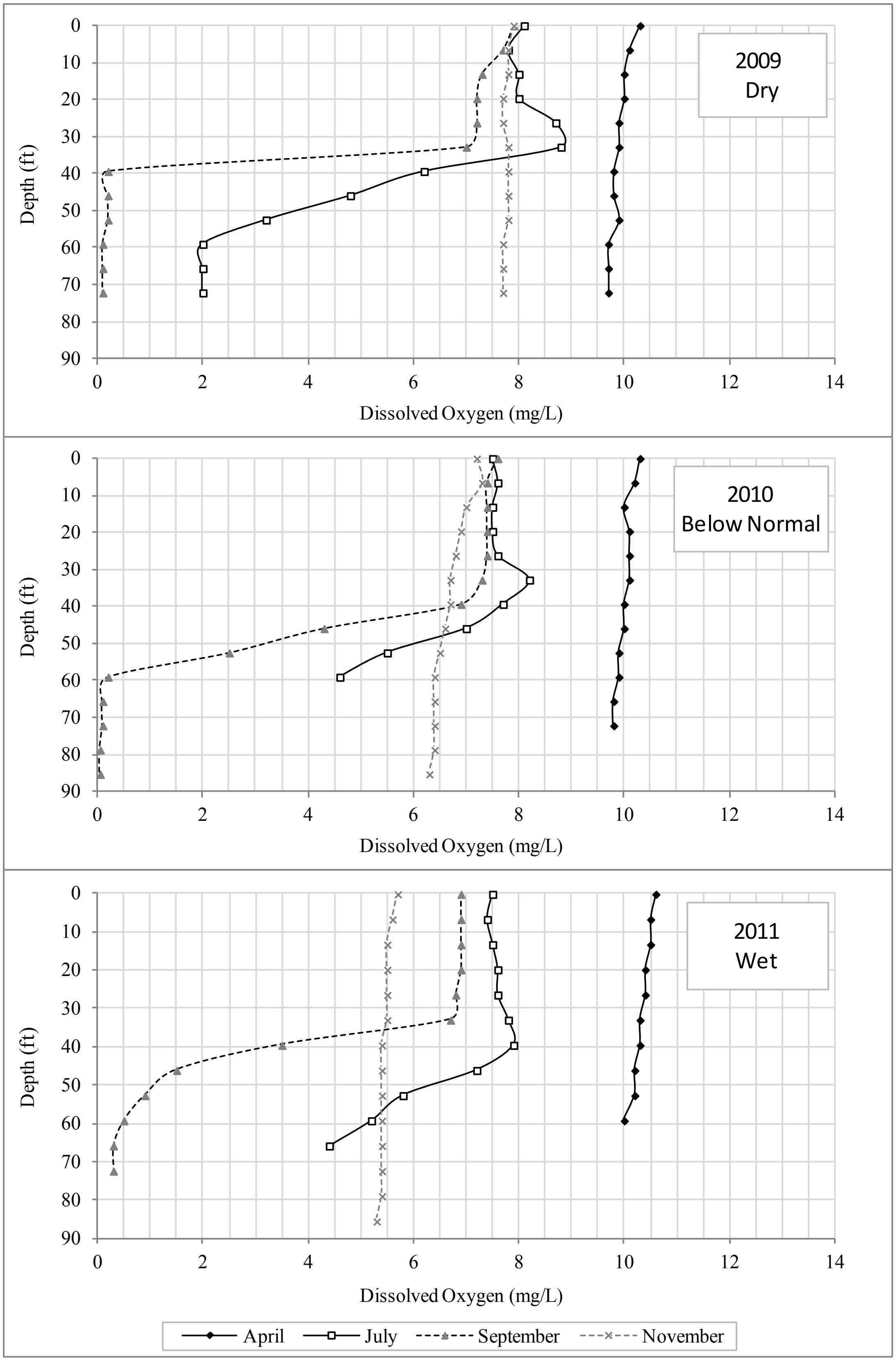
Source: Stetson Engineers Inc.

Figure 6.5-2a
Seasonal dissolved oxygen profiles in Lake Almanor at station LA-01 Near Canyon Dam during 2000 (Normal Water Year)



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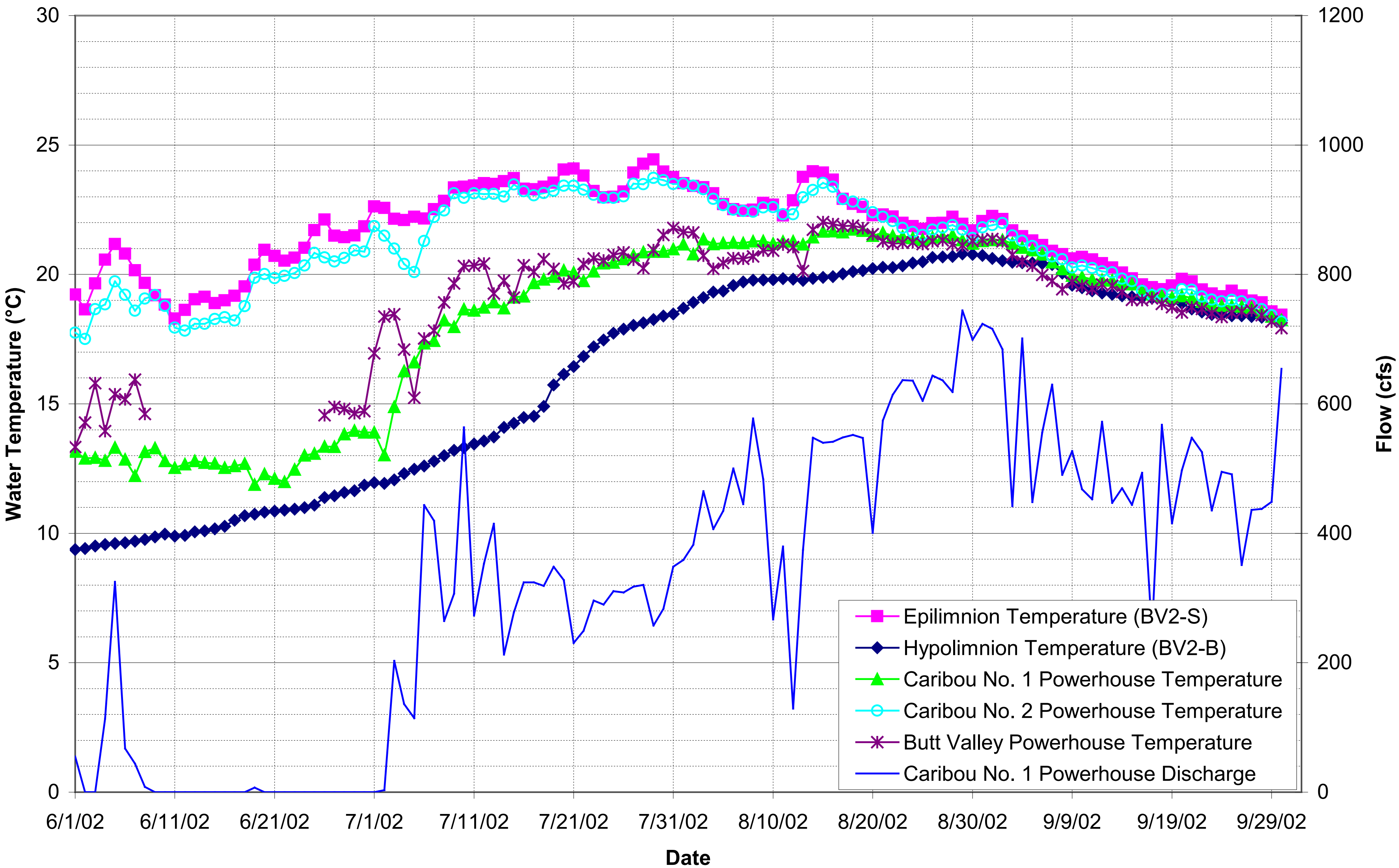
Source: Johnston and McMurtry

Figure 6.5-2b
Seasonal Dissolved Oxygen Profiles in Lake Almanor at Station LA-01 Near Canyon Dam by Year (2009-2011)



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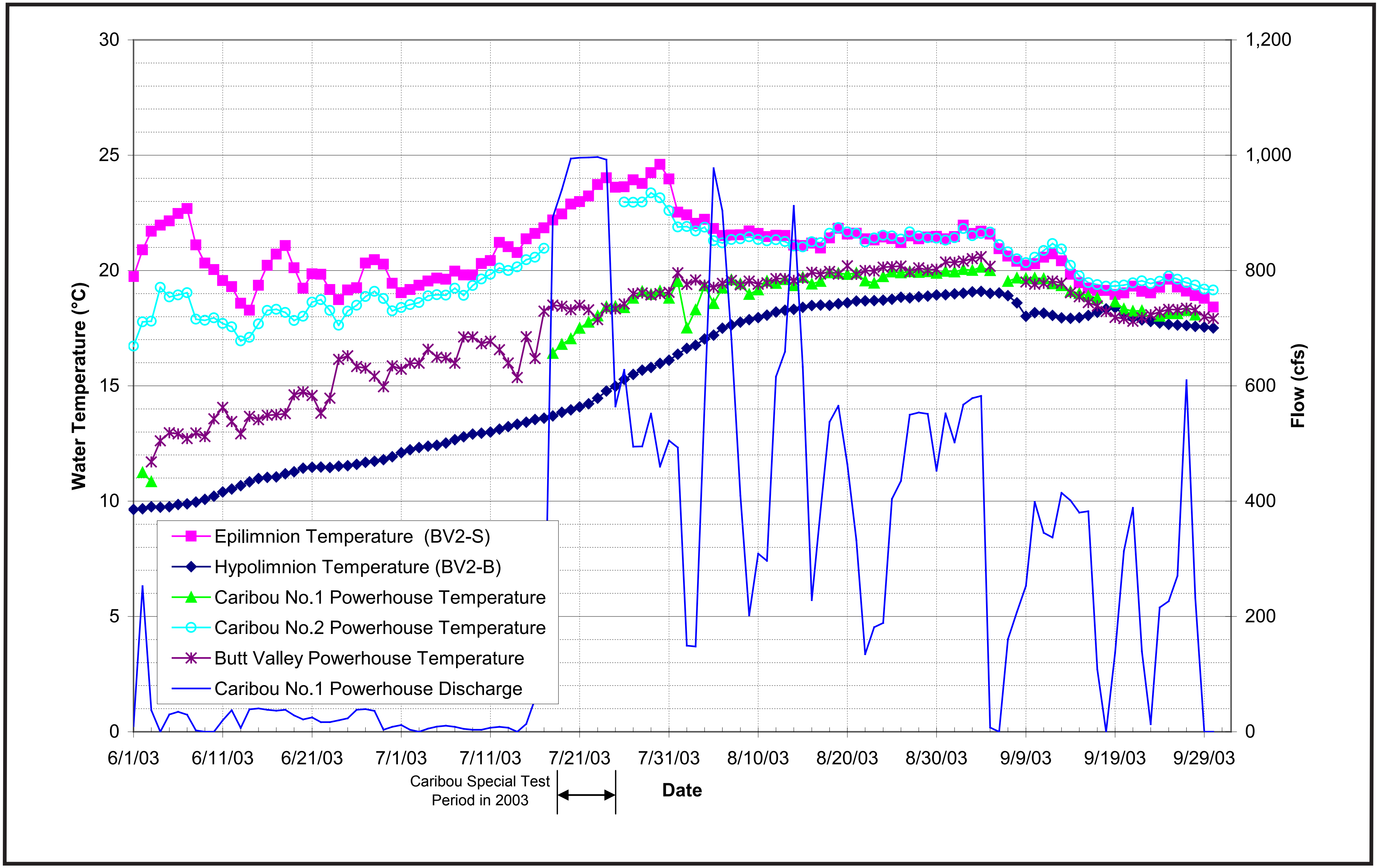
North State Resources, Inc.

Upper North Fork Feather River Hydroelectric Project

Figure 6.5-3a
Measured Mean Daily Water Temperatures in Butt Valley Reservoir in 2002 (Dry)



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North State Resources, Inc.

Upper North Fork Feather River Hydroelectric Project

Figure 6.5-3b

Measured Mean Daily Water Temperatures in Butt Valley Reservoir in 2003 (Normal)