5.3 Proposed Action and Alternatives

This section discusses the effects of the SMUD Proposed Action and alternatives on environmental resources except for cumulative effects, which are discussed in Section 7.3. In general, for each major resource area, this section discusses: 1) pertinent technical reports prepared by SMUD, or SMUD and PG&E together for Overlapping Studies; 2) a description of the affected environment; 3) a discussion of anticipated environmental consequences should the Proposed Action or an alternative be implemented; and 4) description of unavoidable adverse effects should the Proposed Action or an alternative be implemented. As required in 40 CFR § 1502.15, the description of each affected environment is no longer than necessary and commensurate with the importance of potential effects.

5.3.1 Water Resources

The water resources that would potentially be affected by the Proposed Action include eleven reservoirs and 12 reaches of river (81 river miles excluding reservoirs). This section first describes the affected environment, detailing the existing water quality and water quantity of the reservoirs and reaches, which forms the baseline for the discussion of the effects of the Proposed Action. Next, this section analyzes the environmental effects of the Proposed Action.

It first looks at the effect of the Proposed Action on water quantity, and finds that the Proposed Action will not change the quantities of water in the reservoirs and, depending on the reach and the water year, will either not change or will increase the quantity of water in the reaches. Finally, this section examines the effect of the Proposed Action on water quality in the eleven reservoirs and the 12 reaches of river by determining how the Proposed Action will effect compliance with Basin Plan objectives for bacteria, chemical constituents, dissolved oxygen, pH, taste and odor, toxicity, temperature, and for the reaches only, sediment. It concludes that the Proposed Action will not have any significant adverse effect on water quality.

As part of the discussion on environmental effects, this section also examines the potential effects of several of SMUD's Proposed Action environmental measures. These measures are intended to improve the existing environment, and do not have any negative effects.

5.3.1.1 Pertinent Technical Reports

For the purpose of the UARP Relicensing, most of these reports were prepared jointly by SMUD and PG&E because they dealt with overlapping issues. Six technical reports and one white paper were prepared that are pertinent to water resources. They are:

- *Hydrology Technical Report* (DTA and Hannaford 2005a) – This report includes: 1) an extensive compilation of all historic stream flow and reservoir storage information, which includes mean daily flows, where available, from over 40 flow gages that have been operated by the United States Geological Survey (USGS) and others; 2) a synthesis of mean daily flows that might have occurred in the UARP area if the UARP and Chili Bar Project had not been in place from Water Year 1975 through 2001, the UARP

Relicensing Hydrology Period of Record. (Note: the synthesized flow condition assumes the CDFG-operated reservoirs on the upper Rubicon River are in place and operating as they historically operated, and that EID's El Dorado Project operated as it is planned to operate in the future based on EID's Operations Model output.); 3) a synthesis of mean daily accretion flows at various locations within the project reaches which were requested by the UARP Relicensing Plenary Group; 4) a synthesis of hourly flow data in the Ice House and Slab Creek dam reaches from 1990 through 2001; 5) a summary of annual peak flow data including a flood-peak frequency analysis; and 6) an Indicators of Hydrologic Alteration (IHA) analysis. Data are provided in both raw form and graphically.

- *Water Quality Technical Report* (DTA 2005d) – This report provides: 1) a summary of historic water quality sampling information in the vicinity of the UARP, PG&E's Chili Bar Reservoir and the Reach Downstream of Chili Bar, and includes 1959-1961 SWRCB's sampling downstream of Ice House and Union Valley dams and SMUD's 1992 sampling in Slab Creek Reservoir; 2) a summary of UARP-related historic spill/waste discharge events; and 3) the results of SMUD's and PG&E's 2002, 2003 and 2004 relicensing water quality sampling in UARP reservoirs, Chili Bar Reservoir, project reaches and the Reach Downstream of Chili Bar. Sampling was conducted during the fall reservoir turnover, after the first major rain event in the late fall, during high spring flow and during summer low flow. Samples were taken at a variety of depths in reservoirs. Over 125 samples were collected in the river and over 140 samples in reservoirs throughout the eight-season sampling period. The water quality samples were tested for a full suite of parameters including general limnology parameters (temperature, DO, pH, nitrates, nitrites, phosphates, etc.), turbidity, solids (both total and suspended), organics (oil/grease, methyl-t-butyl ether or MTBE, and TPH), metals (total and dissolved), and coliform bacteria. In addition, the tissue of four fish species in six reservoirs was tested for presence of metals. The technical report includes a comparison of results to various standards and guidelines including the water quality objectives in the Basin Plan. All raw data are included in report appendices.

- *Water Temperature Technical Report* (DTA 2005e) – The *Water Temperature Technical Report* includes the results of SMUD's and PG&E's: 1) 1999/2000 and 2002/2003/2004 water temperature profiling in the UARP reservoirs and PG&E's Chili Bar Reservoir. Profiling was also performed for dissolved oxygen (DO), pH, and specific conductance; 2) continuous water temperature monitoring at 46 stream locations in the project reaches and Reach Downstream of Chili Bar, with many of the data recorders in place for more than 3 years; 3) water temperature modeling using USFWS' SNTEMP water temperature model in Ice House, Camino and Slab Creek dam reaches; and 4) instantaneous water temperature data from tributaries not affected by the UARP that flow into the major UARP reservoirs. The technical report also includes all raw data as well as summary plots.

- *Iowa Hill Water Temperature Report* (DTA and EES 2005a) – This report provides the results of water temperature modeling of the existing Slab Creek Reservoir and proposed

Iowa Hill Reservoir under typical operations of the proposed Iowa Hill Development. Modeling was performed using the USACOE's CE-QUAL-W2 (version 3.2), and included an assessment of downstream temperature effects. The technical report includes the model and all raw data including calibration/verification data.

- *Aquatic Bioassessment Technical Report* (DTA and Stillwater 2005b) – This report provides the results of SMUD's and PG&E's CSBP in 2002 to 2004 at 36 sites in project reaches and in the Reach Downstream of Chili Bar. As stated in the Plenary Group-approved Aquatic Bioassessment Study Plan, CSBP is a water quality assessment tool "…that utilizes measures of stream benthic macroinvertebrate community and physical/habitat characteristics to evaluate the biological integrity of stream ecosystems." The report includes benthic macroinvertebrate: 1) site-and transect-scale habitat quality and point measurements of water quality; 2) biological metrics suggested by the CDFG; and 3) composite metric scores for 10 of the metrics considered reliable responders to habitat and/or water quality changes. Analyses, by ecological sub-regions and reference sites, were performed and including cluster analyses. Habitat characterizations, taxonomic lists and benthic macroinvertebrate abundance data are also provided in the report.

- *PG&E's Chili Bar Reservoir Carbon Cycle Disruption White Paper* (DTA 2004f) – This white paper provides a generic and brief summary of the recent scientific literature with regard to terrestrial and aquatic carbon cycling, effects of creating a reservoir on carbon storage and transport as it relates to the River Continuum Concept, Flood Pulse Theory and Serial Discontinuity. In addition, the white paper examines carbon cycling disruptions within the riverine, transition and lacustrine zones of a reservoir, as well as the influence of water level fluctuation on dissolved carbon transport.

- *PG&E's Chili Bar Reservoir Incremental Storage* (DTA 2005b) – This technical report presents the results of an analysis that used the UARP/Chili Bar Project (CHEOPS™) Water Balance Model to evaluate the potential benefits to water management of increasing the usable storage in PG&E's Chili Bar Reservoir by either: 1) adding a seasonally-operated crest-gate to PG&E's Chili Bar Dam; or 2) removing accumulated sediment in PG&E's Chili Bar Reservoir.

Each of these reports and the white paper are appended to this PDEA on CD. Key findings from the reports are summarized below.

5.3.1.2 Affected Environment

Water Quantity

Storage in and Diversions from Reservoirs

The UARP includes 11 reservoirs with a total usable storage of 381,119 ac-ft of water. Table 5.3.1-1 provides, for each UARP reservoir, information regarding drainage area, water surface elevation, storage, retention time, typical daily and annual changes in water surface elevation, and diversions from the reservoirs.

Table 5.3.1-1. Information regarding the UARP's reservoirs.

Reservoir	Drainage Area (sq mi)	Normal Maximum Water Surface Elevation (ft)	Usable Storage (ac-ft)	Average Retention Time (days)	Typical Daily Elevation Changes/Typical Annual Elevation Changes (ft)	Diversion Tunnel/ Powerhouses
Rubicon	26.5	6,545	1,010	4.6	<0.5/11.8	Rockbound Tunnel
Buck Island	6.0	6,436	648[a]	2.5	<0.5/11.5	Buck-Loon Tunnel
Loon Lake	8.0	6,410	68,988	142.5	<0.5/36	Loon Lake Powerhouse
Gerle Creek	28.7	5,231	483	NA	1.5/9	Gerle Creek Canal
Robbs Peak	15.2	5,231	30b	NA	<0.5/5	Robbs Peak Powerhouse
Ice House	27.2	5,450	35,065[a]	162.3	<0.5/42	Jones Fork Powerhouse
Union Valley	83.7	4,870	266,303[a]	261.6	<0.5/60	Union Valley Powerhouse
Junction	147	4,450	2,104	1.5	20/32	Jaybird Powerhouse
Camino	160	2,915	489[a]	0.3	20/30	Camino Powerhouse
Brush Creek	8.0	2,915	374	NA	20[b]/<1	Camino Powerhouse
Slab Creek	493	1,850	5,580	2.2	6/30	White Rock Powerhouse

[a] Top of spillway or bulkhead gates, or stop logs when in place.
[b] Brush Creek is rarely used in super peaking mode, but when it is, the typical daily change in surface elevation is about 20 feet.

Table 5.3.1-2 provides flow statistics for diversions from each of the reservoirs. Information regarding releases into the downstream rivers is presented later in this PDEA.

Table 5.3.1-2. Summary of hydrologic data from U. S. Geological Survey (USGS) and SMUD stream, canal, tunnel and powerhouse flow gages in the vicinity of the UARP since 1961 when the UARP began commercial operation. All data are in cubic feet per second.

USGS Gage		Mean Annual				Mean Monthly		Daily		Instantaneous		Period of Record
(number)	(name)	Mean	Median	Highest	Lowest	Highest	Lowest	Highest	Lowest	Highest	Lowest	
Diversion Tunnels												
11427940	Rockbound Tunnel	103	112	197 (1982)	31 (1977)	334 (May)	13 (Sep)	1,180 (1/1/77)	0 (periodic)	N/A	0 (periodic)	1976-1999
11428300	Buck-Loon Tunnel	131	140	245 (1982)	39 (1977)	425 (May)	16 (Sep)	1,190 (1/13/80)	0 (periodic)	N/A	0 (periodic)	1976-1999
Powerhouses												
11429300	Robbs Peak Powerhouse	255	251	490 (1995)	50 (1977)	438 (Apr)	84 (Oct)	1,220 (3/10/95)	0 (periodic)	N/A	0 (periodic)	1976-1999
11429340	Loon Lake Powerhouse	149	141	307 (1982)	12 (1999)	278 (June)	80 (Oct)	1,030 (5/19/95)	0 (periodic)	N/A	0 (periodic)	1976-1999
11440900	Jones Fork Powerhouse	65	53	141 (1995)	20 (1985)	93 (June)	31 (Nov)	285 (6/95)	0 (periodic)	N/A	0 (periodic)	1985-1999
11441002	Union Valley Powerhouse	509	420	841 (1995)	70 (1977)	704 (July)	259 (Oct)	1,610 (1/21/97)	0 (periodic)	N/A	0 (periodic)	1976-1999
11441780	Jaybird Powerhouse	683	769	913 (1998)	322 (1992)	901 (Mar)	328 (Nov)	1,490 (7/12/95)	0 (periodic)	N/A	0 (periodic)	1992-1999
11441895	Camino Powerhouse	623	542	1,045 (1983)	100 (1977)	782 (Mar)	337 (Nov)	1,560 (3/6/97)	0 (periodic)	N/A	0 (periodic)	1976-1999
11443460	White Rock Powerhouse	1,137	1,066	2,165 (1983)	186 (1977)	1,910 (May)	451 (Oct)	3,950 (3/25/98)	0 (periodic)	N/A	0 (periodic)	1976-1999

Typical current operation of each UARP reservoir is described below.

Rubicon Reservoir

The primary purpose of the Rubicon Reservoir is diversion of high spring flow from the main stem of the Rubicon River to Buck Island Reservoir via the Rockbound Tunnel, which diverts into Rockbound Lake. Rubicon Reservoir is not used for long-term storage; however, SMUD has water rights for storage of up to 450 ac-ft at this reservoir. Water is released downstream from Rubicon Dam by either passing over the spillway or through one or both 10-inch-diameter globe valve controlled low-level outlets, which have a combined capacity of about 18 cfs at full reservoir pool.

Because Rubicon Reservoir is operated primarily as a diversion facility, the water level in the reservoir fluctuates with changing volumes of inflow, ranging between the minimum operating pool level of 6,533.2 feet and the normal full pool level of 6,545.0 feet. During the summer recreation season of roughly May 1 through September 10, the minimum operating pool level is increased by 6.0 feet to an elevation of 6,539.2 feet by manually lowering two gates at the Rockbound Tunnel entrance, effectively narrowing the range of water elevation fluctuation from 11.8 to 5.8 feet. This stabilizes the water level fluctuation during the recreation season. As the recreation season extends into the dry late summer months, water levels in the reservoir typically stabilize once natural inflow drops below 6 cfs.

Buck Island Reservoir

Like Rubicon Reservoir, the primary purpose of the Buck Island Reservoir is diversion of high spring flow from the Rubicon River via the Buck-Loon Tunnel to Loon Lake Reservoir. Buck Island Reservoir is not used for long-term storage; however, SMUD has water rights for storage up to 440 ac-ft in this reservoir. Water is released downstream from Buck Island Dam by either passing over the spillway or through one 12-inch diameter, globe valve, low-level outlet, which has a capacity of about 11 cfs at full reservoir pool.

As with Rubicon Reservoir, the water level in Buck Island Reservoir fluctuates with changing volumes of inflow, ranging between the minimum operating pool level of 6,424.5 feet and the normal full pool level of 6,436.0 feet. Also, as with Rubicon Reservoir, during the summer recreation season of May 1 through September 10, SMUD increases the minimum operating pool level by 6.5 feet to 6,431.0 feet, effectively narrowing the range of maximum water elevation fluctuation from 11.5 to 5.0 feet.

Loon Lake Reservoir

Loon Lake Reservoir is the highest elevation storage reservoir in the UARP. Water is released from the reservoir though the Loon Lake Penstock to the Loon Lake Powerhouse and then into Gerle Creek Reservoir. Water is released downstream from Loon Lake Dam by either passing over the spillway or through one or more of two 10-inch-diameter, globe valves (maximum capacity of 41 cfs) or one 42-inch-diameter, Howell-Bunger valve (maximum capacity of 600 cfs).

Loon Lake Reservoir storage volume typically follows an annual cycle, with reservoir elevations reaching their highest levels during early summer months. The reservoir levels gradually lower throughout the summer months. This gradual lowering of the reservoir continues into the fall and winter months. The water elevation slowly rises during the spring and early summer as the rain and snowmelt runoff refill the reservoir.

Gerle Creek Reservoir

As with Rubicon and Buck Island, the primary purpose of the Gerle Creek Reservoir is diversion of high spring flow and water re-diverted from upstream UARP facilities via the Gerle Canal to Robbs Peak Reservoir and then to Robbs Peak Powerhouse on Union Valley Reservoir. There are no storage rights at Gerle Creek Reservoir. Water is released downstream from Gerle Creek Dam by either passing over the spillway or through one 10-inch-diameter, globe valve, low-level outlet, which has a capacity of about 13 cfs at full pool.

Robbs Peak Reservoir

Robbs Peak Reservoir's primary purposes are to divert water from the SFRR and the Gerle Canal into the Robbs Peak Tunnel and to regulate inflow to the Robbs Peak Powerhouse located on the northeast shore of Union Valley Reservoir. Water is released downstream from Robbs Peak

Dam by either passing over the spillway or through one 6-inch-diameter, diaphragm valve, low-level outlet, which has a capacity of about 4 cfs at full pool.

The California Department of Water Resources (CDWR), Division of Safety of Dams (DSOD) Certificate of Approval specifies that the Robbs Peak Dam bulkhead gates be held in a full open position from October 1 through May 31, except that Gate 2 may be closed for the full year.

Ice House Reservoir

The primary purpose of Ice House Reservoir is storage. Water is released from the reservoir though the Jones Fork Tunnel to the Jones Fork Powerhouse located on Union Valley Reservoir. Water is released downstream from Ice House Dam by either passing over the spillway or through one or both of two 10-inch-diameter globe valve low-level outlets and one 42-inch-diameter Howell-Bunger valve low-level outlet, which have a combined capacity of about 740 cfs at reservoir full pool.

The DSOD Certificate of Approval specifies that the spillway gates be held in the full open position from November 1 through April 1. Between April 1 and April 15, water may be impounded to the top of the spillway gates (El. 5,445.0 feet, which is considered full pool). After April 15, water level may be increased to elevation 5,447.0 feet. During October, the water level must be lowered gradually to elevation 5,436.5 feet, the spillway crest.

Union Valley Reservoir

The primary purpose of Union Valley Reservoir is storage. Water is released from the reservoir though the Union Valley Tunnel to the Union Valley Powerhouse located on Junction Reservoir, which is an afterbay for Union Valley Powerhouse. Union Valley Dam does not have a low-level outlet.

The DSOD Certificate of Approval specifies that the spillway gates be held in the full open position from November 1 through April 1. Between April 1 and April 15, water may be impounded to elevation 4,865 feet. After April 15, water level may be increased to elevation 4,867.0 feet. During October, water level must be lowered gradually to elevation 4,855.0 feet, the spillway crest.

Junction Reservoir

The primary purpose of Junction Reservoir is to act as a regulating afterbay for Union Valley Powerhouse and a regulating forebay for the Jaybird Powerhouse, which releases into the Camino Reservoir. Water is released into the Jaybird Tunnel. Water is released downstream from Junction Dam by either passing over the spillway or through one 18-inch-diameter hollow cone valve low-level outlet, which has a maximum capacity of about 138 cfs at reservoir full pool.

Camino Reservoir

Camino Reservoir is a regulating afterbay for the Jaybird Powerhouse and one of two regulating forebays for the Camino Powerhouse. Brush Creek Dam, which is discussed below, forms the other regulating forebay for the Camino Powerhouse. Water is released from Camino Reservoir into the Camino Tunnel, which joins the Brush Creek Tunnel. Water is released downstream from Camino Dam by either passing over the spillway or through one 18-inch-diameter hollow cone valve low-level outlets, which has a capacity of about 112 cfs at full pool.

Brush Creek Reservoir

Unlike the Camino Reservoir and other reservoirs within the UARP, Brush Creek Reservoir is often operated to provide spinning reserves for reliability purposes. It is also used to generate maximum peak power during emergency and other limited situations, such as when all available generating units are expected to operate at full load for short periods of time. Under this super-peaking operating mode, the daily water level may fluctuate up to 20 feet, ranging between the operating pool levels of 2,895.0 feet and 2,915.0 feet. Over the appropriate nighttime periods of the next two to three days following this operating mode, SMUD typically shuts down the operation of the Camino Powerhouse while operating the Jaybird Powerhouse. Concurrently, the water exiting the Jaybird Powerhouse is transported via the Camino and Brush Creek tunnels to refill Brush Creek Reservoir. Water is released downstream from Brush Creek Dam by either passing over the spillway or through a low level outlet, which has a capacity of about 145 cfs at full pool.

Slab Creek Reservoir

Slab Creek Reservoir purposes include: 1) a regulating afterbay for the Camino Powerhouse; and 2) a regulating forebay for the White Rock Powerhouse, which releases into PG&E's Chili Bar Reservoir. In addition, under the Proposed Action, Slab Creek Reservoir would function as the lower reservoir for the Iowa Hill Development. Water is released from the reservoir through the White Rock Tunnel. Water is released downstream from Slab Creek Dam by either passing over the spillway or through one 24-inch-diameter Howell-Bunger valve low-level outlet, which leads either to the Slab Creek Powerhouse or a bypass facility if the powerhouse is not operating. The low-level outlet valve has a capacity of about 270 cfs at full pool.

<u>Flow in Project Reaches</u>

Twelve sections of river (about 81 river miles, excluding reservoirs) are affected by the UARP through either a transfer of water around the section of river via a project tunnel or canal, or storage at and release of water from a UARP dam directly into the reach (Table 5.3.1-3). For the purpose of this PDEA, these sections of river are called "project reaches," most named after the UARP facility from which the water is diverted or stored. The downstream end of each project reach is established by a UARP facility (typically the normal high water line of the next downstream reservoir), a non-UARP reservoir, or the confluence with a major tributary. Table 5.3.1-3 describes the general features of each project reach, Table 5.3.1-2 provides flow statistics for each reach, and Table 5.3.1-4 describes the minimum release requirements in each UARP project reach as specified in the UARP initial license, as amended.

Table 5.3.1-3. Information regarding the 12 project reaches associated with SMUD's UARP.

River	Section	Reach Name	Upstream & Downstream Termini	Length (mi)	Elevation Range (ft, from base of dam)	Ave. Gradient (%)
Rubicon River	Main Stem	Rubicon Dam	Rubicon Dam - Miller Creek	4.2	6,509 – 6,046	1.9
	Little Rubicon	Rockbound Dam	Rockbound Dam – Buck Island Reservoir	0.3	6,529 – 6,436	7.2
		Buck Island Dam	Buck Island Dam – Rubicon River	2.5	6,413 – 5,945	2.9
	Gerle Creek	Loon Lake Dam	Loon Lake Dam – Gerle Reservoir	8.5	6,320 –5,231	2.3
		Gerle Creek Dam	Gerle Creek Dam – South Fork Rubicon River	1.2	5,170 – 4,980	3.5
	South Fork Rubicon	Robbs Peak Dam	Robbs Peak Dam – Rubicon River	5.9	5,817 – 3,540	5.5
Silver Creek	South Fork Silver Creek	Ice House Dam	Ice House Dam – Junction Reservoir	11.5	5,300 – 4,450	1.4
	Main Stem	Junction Dam	Junction Dam – Camino Reservoir	8.3	4,290 –2,915	3.2
		Camino Dam	Camino Dam – South Fork American River	6.2	2,810 – 2,055	2.3
South Fork American River	Brush Creek	Brush Creek Dam	Brush Creek Dam – Slab Creek Reservoir	2.2	2,710 –1,850	9.0
	Main Stem	South Fork American River	Silver Creek – Slab Creek Reservoir	2.8	2,055 – 1,850	1.2
	Main Stem	Slab Creek Dam	Slab Creek Dam – Chili Bar Reservoir	8.0	1,650 – 995	1.5

The volume of water flowing in the different project reaches is a function of three factors: 1) minimum releases at project reservoirs; 2) accretion provided by various tributaries within the reaches; 3) and spill from the reservoirs. The remainder of this section provides information concerning the contribution of each of these three sources to the existing flow regime in the different project reaches.

With respect to the contribution of minimum releases from project reservoirs, there are ten project reservoirs from which SMUD is currently required to release minimum water quantities for the protection of aquatic resources in downstream reaches (Table 5.3.1-4). The minimum releases required by the current license generally vary by month and water year type. There are four water year types specified in the current license, with each water year type defined by the total annual volume of water inflow to Folsom Lake, which is located downstream of the UARP on the mainstem of the American River:

- Type 1 - Inflow less than 1.0 million ac-ft
- Type 2 - Inflow between 1.0 to 1.499 million ac-ft
- Type 3 - Inflow between 1.5 to 1.999 million ac-ft
- Type 4 - Inflow greater and equal to 2.0 million ac-ft

For the purposes of this PDEA, a set of five water year types will also be discussed (see Section 5.3.1.3). These five water year types have been identified in the UARP relicensing process as potential replacements for the existing four water year types. They also are a component of the Proposed Action. For this reason, many of the hydrologic analyses performed for the relicensing have been displayed across these five water year types, and this breakdown is used in this section to display representative flow information. The five water year types, which are also based on total annual volume of inflow to Lake Folsom, are defined as:

- Critical Dry - Inflow less than 900,000 ac-ft
- Dry - Inflow between 900,001 and 1,700,000 ac-ft
- Below Normal - Inflow between 1,700,001 and 2,600,000 ac-ft
- Above Normal - Inflow between 2,600,000 and 3,500,000 ac-ft
- Wet - Inflow greater than 3,500,000 ac-ft

Because flow information provided in this section of the PDEA is displayed across the five water year types, it is necessary to incorporate the current four-water-year-type minimum releases into the five-water-year-type information displays. This is accomplished by applying each of the four water year types to the most appropriate water year of the five types. For example, Type 1 minimum release values are applied to Critical Dry years and Type 2 values are applied to Dry years.

Table 5.3.1-4 provides the minimum release requirements in each UARP project reach as specified in the current UARP license.

Accretion is an important factor in determining flows in the project reaches. A characteristic feature of the UARP area is the high level of seasonal variability in runoff pattern. This highly variable runoff in the watershed dictates the distribution and volume of accretion that flows into the UARP reaches. The majority of the runoff in the different watersheds occurs during the snowmelt period, roughly between April and June, when melting snow runs off the dominant metamorphic and granitic rock surfaces. Little water is retained in the watersheds beyond the runoff period due to the shallow soil deposits overlaying the rock surfaces. Thus, the difference in volume of water flowing in project reaches between spring and summer is substantial, ranging from many hundreds of cubic feet per second to less than 1 cfs, or in some cases no flow (Table 5.3.1-5). The typical spring snowmelt runoff pattern of the upper reaches is replaced in the lower reaches by a winter runoff pattern. In the Junction, Camino and Slab Creek reaches, for example, the accretion attains its highest point in February and March.

This phenomenon of flashy hydrology is most pronounced in the upper basin watersheds, and it affects both the seasonal volume of water flowing into project reaches in the form of accretion, and the volume of water entering project reservoirs. Information gathered by SMUD during a 3-year summer field study of streamflow reveal how low flow levels become in many of the streams in the upper portion of the Rubicon River and Silver Creek watersheds (Table 5.3.1-6). These data demonstrate that, just like accretion, natural flows entering the UARP upper reservoirs and project reaches fall to very low values in the late summer or early fall of each year.

Table 5.3.1-4. Summary of minimum streamflow requirements included in the current FERC license for the UARP.

USGS Gaging Station	Years when less than 1 million acre-ft annual inflow is forecasted for Folsom Reservoir	FERC Article 29 Ref.	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Comments
11427960	Rubicon River Below Rubicon Dam	(a)	6	6	6	6	6	6	6	6	6	6	6	6	See Note 1
11428400	Little Rubicon River Below Buck Island Dam	(b)	1	1	1	1	1	1	1	1	1	1	1	1	See Note 2
11429500	Gerle Creek below Loon Lake Dam	(c)	8	8	8	8	8	8	8	8	8	8	8	8	
11430000	South Fork Rubicon River below Robbs Peak Dam	(d) (g)	1	1	1	1	1	1	1	1	1	1	1	1	See Notes 3,8
11430000	Gerle Creek below Gerle Creek Dam	(d) (g)	4	4	4	4	4	4	4	4	4	4	4	4	See Notes 3,8
11441500	South Fork Silver Creek below Ice House Dam	(e) (g)	5	5	5	5	5	5	5	5	5	5	5	5	See Note 4
11441800	Silver Creek below Junction Dam	(f) (g)	5	5	5	5	5	5	5	5	5	5	5	5	See Note 3
11441900	Silver Creek below Camino Dam	(g)	5	5	5	5	5	5	5	5	5	5	5	5	See Note 3
11442700	Brush Creek below Brush Creek Dam	(I)	2	4	4	4	4	4	4	4	2	2	2	2	See Notes 5, 6
1143500	South Fork American River below Slab Creek Dam	(h)	36	36/10	10	10	10	10	10	10	36	36	36	36	See Notes 6, 7
USGS Gaging Station	**Years when 1.0-1.499 million acre-ft annual inflow is forecasted for Folsom Reservoir**	**FERC Article 29 Ref.**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**Comments**
11427960	Rubicon River Below Rubicon Dam	(a)	6	6	6	6	6	6	6	6	6	6	6	6	See Note 1
11428400	Little Rubicon River Below Buck Island Dam	(b)	1	1	1	1	1	1	1	1	1	1	1	1	See Note 2
11429500	Gerle Creek below Loon Lake Dam	(c)	8	8	8	8	8	8	8	8	8	8	8	8	
11430000	South Fork Rubicon River below Robbs Peak Dam	(d) (g)	1	1	1	1	1	1	1	1	1	1	1	1	See Notes 3,8
11430000	Gerle Creek below Gerle Creek Dam	(d) (g)	4	4	4	4	4	4	4	4	4	4	4	4	See Notes 3,8
11441500	South Fork Silver Creek below Ice House Dam	(e) (g)	5	5	5	5	5	5	5	5	5	5	5	5	See Note 4
11441800	Silver Creek below Junction Dam	(f) (g)	10	6	6	6	6	6	6	10	10	10	10	10	See Note 3
11441900	Silver Creek below Camino Dam	(g)	10	6	6	6	6	6	6	10	10	10	10	10	See Note 3
11442700	Brush Creek below Brush Creek Dam	(i)	2	4	4	4	4	4	4	4	2	2	2	2	See Notes 5, 6
11443500	South Fork American River below Slab Creek Dam	(h)	36	36/10	10	10	10	10	10	10	36	36	36	36	See Notes 6,7
USGS Gaging Station	**Years when 1.5-1.999 million acre-ft annual inflow is forecasted for Folsom Reservoir**	**FERC Article 29 Ref.**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**Comments**
11427960	Rubicon River Below Rubicon Dam	(a)	6	6	6	6	6	6	6	6	6	6	6	6	See Note 1
11428400	Little Rubicon River Below Buck Island Dam	(b)	1	1	1	1	1	1	1	1	1	1	1	1	See Note 2
11429500	Gerle Creek below Loon Lake Dam	(c)	8	8	8	8	8	8	8	8	8	8	8	8	
11430000	South Fork Rubicon River below Robbs Peak Dam	(d) (g)	3	1	1	1	1	1	1	3	3	3	3	3	See Notes 3, 8
11430000	Gerle Creek below Gerle Creek Dam	(d) (g)	7	4	4	4	4	4	4	7	7	7	7	7	See Notes 3, 8
11441500	South Fork Silver Creek below Ice House Dam	(e) (g)	12	10/4	4	3	3	3	3	8	8	15	15	15	See Notes 4,7
11441800	Silver Creek below Junction Dam	(f) (g)	15	8	8	8	8	8	8	15	15	15	15	15	See Note 3
11441900	Silver Creek below Camino Dam	(g)	15	8	8	8	8	8	8	15	15	15	15	15	See Note 3
11442700	Brush Creek below Brush Creek Dam	(I)	3	6	6	6	6	6	6	6	3	3	3	3	See Notes 5, 6
11443500	South Fork American River below Slab Creek Dam	(h)	36	36	36	36	36	36	36	36	36	36	36	36	See Note 6

Table 5.3.1-4. Summary of minimum streamflow requirements included in the current FERC license for the UARP.

USGS Gaging Station	Years when less than 1 million acre-ft annual inflow is forecasted for Folsom Reservoir	FERC Article 29 Ref.	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Comments
USGS Gaging Station	**Years when more than 2 million acre-ft annual inflow is forecasted for Folsom Reservoir**	**FERC Article 29 Ref.**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**Comments**
11427960	Rubicon River Below Rubicon Dam	(a)	6	6	6	6	6	6	6	6	6	6	6	6	See Note 1
11428400	Little Rubicon River Below Buck Island Dam	(b)	1	1	1	1	1	1	1	1	1	1	1	1	See Note 2
11429500	Gerle Creek below Loon Lake Dam	(c)	8	8	8	8	8	8	8	8	8	8	8	8	
11430000	South Fork Rubicon River below Robbs Peak Dam	(d) (g)	3	1	1	1	1	1	1	3	3	3	3	3	See Notes 3, 8
11430000	Gerle Creek below Gerle Creek Dam	(d) (g)	7	4	4	4	4	4	4	7	7	7	7	7	See Notes 3, 8
11441500	South Fork Silver Creek below Ice House Dam	(e) (g)	12	10/4	4	3	3	3	3	8	8	15	15	15	See Notes 4,7
11441800	Silver Creek below Junction Dam	(f) (g)	20	10	10	10	10	10	10	20	20	20	20	20	See Note 3
11441900	Silver Creek below Camino Dam	(g)	20	10	10	10	10	10	10	20	20	20	20	20	See Note 3
11442700	Brush Creek below Brush Creek Dam	(I)	3	6	6	6	6	6	6	6	3	3	3	3	See Notes 5, 6
11443500	South Fork American River below Slab Creek Dam	(h)	36	36	36	36	36	36	36	36	36	36	36	36	See Note 6

Notes:
1. 6 cfs or the natural flow, whichever is less, plus storage provided by stream flow maintenance dams of the CDFG in Lakes Clyde, Schmidell, Lois, and Middle Velma.
2. 1 cfs at all times in addition to the storage releases from stream flow maintenance dams of the CDFG in Rockbound and Highland Lakes as determined by that dept.
3. Requirements are based on the 4/1 CDWR Bulletin 120 forecasted "Water Year Unimpaired Runoff" for the Folsom Reservoir (which is deemed to be the same as American River at Fair Oaks).
4. Requirements are based on the CDWR Bulletin 120 forecasted "Water Year Unimpaired Runoff" to Folsom Reservoir, beginning with the 4/1 bulletin and applying in turn the 5/1 bulletin as it is issued. The 5/1 bulletin shall apply until 4/1 bulletin of the succeeding year is issued.
5. Requirements are as specified or natural flow, whichever is less.
6. Based on the CDWR Bulletin 120 forecasted "Water Year Unimpaired Runoff" to Folsom Reservoir, beginning with the 3/1 bulletin and applying in turn the 4/1 & 5/1 bulletins as they are issued. The 5/1 bulletin shall apply until 3/1 bulletin of the succeeding year is issued.
7. From November 1 - November 15, releases are 10 cfs. From November 16- November 30, releases are 4 cfs.
8. Combined releases should be either 10 cfs or 5 cfs (distributed as noted in this chart), measured on the South Fork Rubicon River below the mouth of Gerle Creek.

Table 5.3.1-5. Computed median monthly accretion flows (cfs) at bottom of project reaches[1] for below normal (BN) and above normal (AN) water years.

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep
Rubicon Dam	AN	1	6	7	7	18	41	77	251	210	59	7	2
	BN	3	18	13	23	21	21	96	222	120	26	1	0
Buck Island Dam	AN	0	2	2	3	7	14	25	98	60	12	1	1
	BN	1	7	5	8	9	10	35	82	31	8	0	0
Loon Lake Dam	AN	1	4	4	12	41	109	114	158	57	8	2	1
	BN	1	6	10	49	50	43	109	94	21	4	1	1
Robbs Peak Dam	AN	5	7	7	8	61	97	58	35	18	10	9	7
	BN	5	7	8	31	51	36	36	27	15	5	4	4
Ice House Dam	AN	9	12	13	14	104	164	98	59	31	17	15	11
	BN	8	11	13	52	86	61	61	45	26	8	7	7
Junction Dam	AN	12	13	14	16	116	157	87	66	41	26	25	18
	BN	12	12	14	58	96	59	54	50	34	13	11	11
Camino Dam	AN	5	6	6	7	49	35	26	20	12	7	5	4
	BN	2	5	4	20	37	29	21	18	5	3	3	2
Brush Creek Dam	AN	2	3	3	3	20	16	12	9	5	3	2	2
	BN	1	2	2	9	17	12	9	8	2	1	1	1
Slab Creek Dam	AN	32	39	40	46	302	239	180	134	72	42	32	29
	BN	15	33	23	127	254	176	128	115	32	18	17	14

[1] Accretion data are not available for Rockbound Dam, Gerle Dam, and South Fork American River reaches.

Table 5.3.1-6. Measured natural flows (cfs) during summer and fall of 2002-2004 in streams and rivers entering project reservoirs or project reaches in the upper segments of the UARP[1].

	2002		2003		2004	
	Date	**Flow (cfs)**	**Date**	**Flow (cfs)**	**Date**	**Flow (cfs)**
Rubicon River entering Rubicon Reservoir	July 30	6.0	--	--	--	--
	August 14	1.5	August 13	4.5	August 23	1.3
	September 17	0.0	September 12	0.01e	September 21	0.3
Jerrett Creek entering Loon Lake Dam Reach	July 10	0.2	July 24	0.1	June 10	3.1
	August 8	0.0	August 11	0.0	--	--
	--	--	--	--	September 8	0.0
Barts Creek entering Loon Lake Dam Reach	July 10	1.1	July 24	0.8	July 14	0.7
	August 8	0.4	August 11	0.4	August 10	0.2
	October 17	0.1	September 30	0.1	September 30	0.1
Dellar Creek entering Loon Lake Dam Reach	July 10	0.8	July 10	0.5	July 14	0.0
	August 8	0.0	August 11	0.0	--	--
	--	--	--	--	--	--
South Fork Rubicon River entering Robbs Reservoir	July 10	2.9	July 10	3.8	July 14	1.4
	August 6	0.2	August 11	0.4	August 10	0.07
	September 18	<0.05e	September 30	<0.05e	September 7	<0.05e
Tells Creek entering Union Valley Reservoir	July 10	1.1	July 9	2.9	July 14	0.8
	August 8	0.4	August 11	0.6	August 10	0.2
	October 17	0.1	September 30	0.1	September 7	0.15

Table 5.3.1-6. Measured natural flows (cfs) during summer and fall of 2002-2004 in streams and rivers entering project reservoirs or project reaches in the upper segments of the UARP[1].

	2002		2003		2004	
	Date	**Flow (cfs)**	**Date**	**Flow (cfs)**	**Date**	**Flow (cfs)**
Big Silver Creek entering Union Valley Reservoir	July 10	6.9	July 9	16.8	July 14	3.0
	August 8	1.5	August 11	1.7	August 10	0.6
	October 17	0.8	September 30	0.7	September 7	0.5
Jones Fork Creek entering Union Valley Reservoir	July 10	4.5	July 9	9.4	July 14	1.7
	August 8	1.0	August 11	1.9	August 10	0.8
	October 17	0.9	September 30	1.2	September 7	1.0
South Fork Silver Creek entering Ice House Reservoir	July 11	16.0	July 25	10.3	July 15	12.0
	September 18	0.5	August 28	1.8	August 13	0.8
	October 17	0.4	September 30	0.6	September 7	0.5

[1] Water years 2002 and 2003 were classified as below normal water years and 2004 was classified as a dry water year.

Spill from UARP reservoirs into the project reaches occurs with varying levels of frequency and magnitude throughout the project. In general, spills are less frequent at the three large storage reservoirs of the UARP: Loon Lake Reservoir, Union Valley Reservoir, and Ice House Reservoir. These reservoirs often have sufficient storage capacity to capture the snowmelt flows without spilling, except in wetter water years. The afterbay/forebay reservoirs such as Junction, Camino, Gerle Creek, and Robbs Peak spill more frequently due to their limited size compared to the volume of accretion flows that originate within their watersheds. The contribution of spill to the flow regime is discussed in detail in the following sections for each of the project reaches. For each reach, a plot of daily flows in each of the five water year types is presented that illustrates the timing, magnitude and dynamics of the flow regime.

Rubicon Dam Reach

The existing flow regime in the Rubicon Dam Reach is highly variable, due primarily to accretion flows associated with snowmelt runoff. The existing release schedule for Rubicon Dam requires a minimum release of 6 cfs or natural inflow from the Rubicon River. During the late summer/early fall period, when inflow falls below 1 cfs or to zero (see Table 5.3.1-6), SMUD usually releases 1 cfs from the dam. Generally, accretion in the project reach is also zero during this low flow period, which results in the 1 cfs release extending throughout the entire reach, even past Miller Creek, which typically dries up in summer. The sole augmentation of flow in the project reach during this period occurs at the confluence with the Little Rubicon River, where the 1 cfs released by SMUD from Buck Island Reservoir enters the Rubicon River.

During the snowmelt runoff, flows in the reach are substantially higher than the minimum release value of 6 cfs because of the substantial accretion runoff. Monthly median values for accretion throughout the reach during the snowmelt period climb to values of approximately 200-250 cfs in Above and Below Normal water years (see Table 5.3.1-5).

A more thorough understanding of the flow regime in the Rubicon Dam Reach is revealed by review of a plot of daily flows. Figure 5.3.1-1 provides a plot of daily flows in the reach for the five water year types described above. The values provided in the plot are daily reservoir release plus accretion flows for the each of five representative water year types that occur over the period 1975-2001 (DTA and Hannaford 2005a).

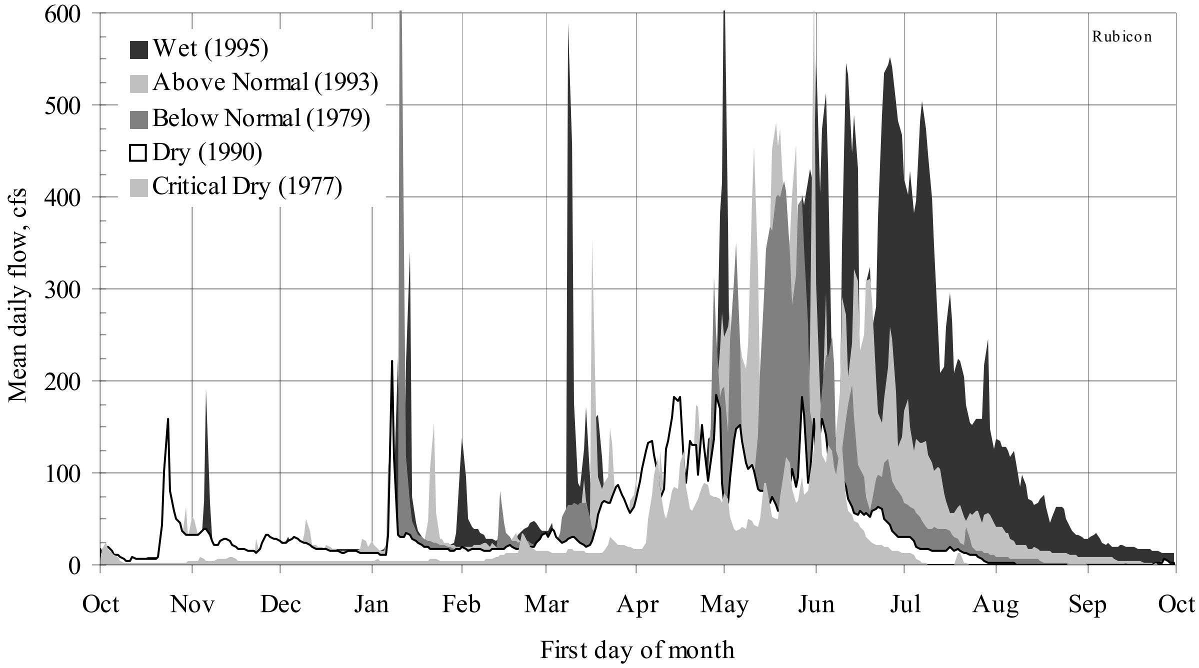

Figure 5.3.1-1. Daily flows in Rubicon Dam Reach at point of confluence with Miller Creek (spill flows not included).

The plot shows the substantial increase in flow during the May and June time period at the point of confluence with Miller Creek. The plot also illustrates the substantial volume of winter accretion that enters the reach over short periods of time. These periodic high flow events are generally caused by rain-on-snow events or rapid snowmelt resulting from unseasonably warm air temperatures. Winter base flows are generally low, however, due to the fact that much of the precipitation that falls on the project reach watershed is in the form of snow that remains frozen during winter. In a Below Normal water year, the magnitude of the winter high-flow event exceeds that of the spring runoff flows.

Spill at Rubicon Reservoir occurs during the spring snowmelt period, generally in above normal and wet water years. Spill additions to project reach flows, while not depicted in Figure 5.3.1-1, augment the high flow events in winter and spring.

Rockbound Dam Reach

The Rockbound Dam Reach is a 0.3-mile segment of stream that lies between Rockbound Lake, a non-UARP facility, and Buck Island Reservoir. Rockbound Lake is a natural lake with a small non-UARP masonry dam located at its outlet. Dam maintenance and operation are the responsibility of the CDFG. Because the dam outlet facilities are currently inoperable, flows out of Rockbound Lake are the result of water passing over the dam into the stream reach. The existing flow regime in the stream reach is a combination of water diverted from the Rubicon River at Rubicon Reservoir (and passed through the Rockbound Tunnel into Rockbound Lake) and natural flows in Highland Creek, which also enter Rockbound Lake.

Both sources of water are volatile because of the exposed bedrock nature of the watershed. During the spring snowmelt, flows in the tunnel contribute hundreds of cfs to Rockbound Lake (median monthly May/June tunnel flow between 250-300 cfs), while Highland Creek, which is not gaged, likely contributes peak flows of approximately 100 cfs. These combined flows pass through the lake and flow through the short project reach. As the snowmelt abates, flows from the tunnel and Highland Creek drop substantially, eventually falling to zero in the summer/fall period. During this time, however, flows out of Rockbound Lake into the reach are at constant levels of less than 1 cfs due to leakage at the outlet facilities of the masonry dam.

Buck Island Dam Reach

The existing flow regime in the Buck Island Dam Reach is very similar to that of the Rubicon Dam Reach. The watershed of the Buck Island Dam Reach is almost entirely composed of exposed bedrock sheets and boulder, thereby lacking the capacity to retain water. Once the snowmelt runoff has ceased, generally by July, flows in the entire watershed quickly fall to zero. This is true of Highland Creek, the feeder stream that provides the majority of natural inflow to Buck Island Reservoir, and of the watershed downstream of the reservoir. There are no tributaries of significance along the 2.5-mile reach of the Little Rubicon River.

The minimum release schedule for Buck Island Reservoir is 1 cfs across all months and water year types. This reservoir release is augmented by snowmelt accretion in April and May, although it is of a reduced volume compared to the Rubicon River. Spill at Buck Island Dam into the reach generally coincides with the spill events at Rubicon Reservoir and occurs primarily in wet water years.

Loon Lake Dam Reach

The existing flow regime in the Loon Lake Dam Reach is similar in nature to that of the other high elevation project reaches. The existing license requires a minimum release of 8 cfs from Loon Lake into Gerle Creek during all months and all water year types. Unlike Rubicon Reservoir, which has a limited storage capacity, releases at Loon Lake during the summer/fall period are not contingent upon the natural inflow from Ellis Creek, which typically dries up during summer. Instead, because there is greater storage capacity, releases from Loon Lake Reservoir remain fixed at 8 cfs all summer and fall. Generally, during this low flow period, accretion is insignificant (see Table 5.3.1-6), which results in the 8 cfs flow extending throughout the course of the 8.5-mile-long reach.

During the snowmelt runoff, flows in the reach are substantially higher than the minimum release value of 8 cfs due to accretion runoff. As described previously, a number of tributaries enter Gerle Creek within the Loon Lake Dam Reach. These include Jerrett, Barts, Dellar, and Rocky Basin creeks. Monthly median values for total-reach accretion during the snowmelt period reach approximately 100-150 cfs in above and below normal water years (see Table 5.3.1-5).

Daily flows from reservoir releases and accretion through the reach (Figure 5.3.1-2) show that winter and spring are quite variable, with short duration peaks in winter reaching highs up to 1,000 cfs in some years. Winter base flows are generally low, however, due to the fact that much of the precipitation that falls on the reach watershed is in the form of snow and remains frozen during winter. Once the snow melts, it results in a sustained April/May runoff of between 50 and 200 cfs in the project reach watershed, depending on water year type. Due to the substantial storage capacity of Loon Lake Reservoir, and its location at the uppermost end of the local watershed, spill events are very infrequent.

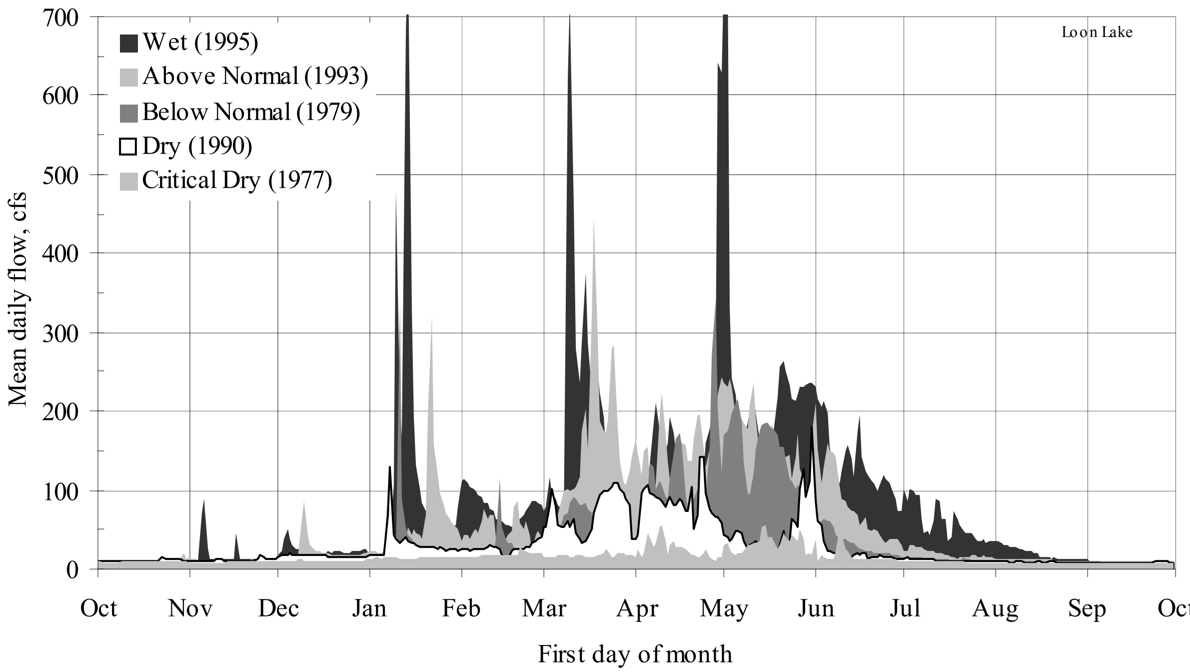

Figure 5.3.1-2. Daily flows in Loon Lake Dam Reach at point of inflow to Gerle Creek Reservoir (spill flows not included).

Robbs Peak Dam Reach

The existing flow regime in the Robbs Peak Dam Reach is a function of releases from Robbs Peak and Gerle Creek dams, spill events at both dams, and accretion along the 5.9-mile-long reach of the SFRR down to its confluence with the main stem Rubicon River. The release from Gerle Creek Dam enters the Robbs Peak Reach 1.1 miles downstream of Robbs Peak Dam. The current license requires a combined release from the two dams ranging from 5 cfs to 11 cfs depending on month and water year type (see Table 5.3.1-4). These releases constitute the primary sources of flow at the confluence of the SFRR and Gerle Creek as each segment of the reach extends about 1 mile, with little contribution from accretion.

Downstream of the confluence of SFRR and Gerle Creek, the reach drops precipitously through a deeply incised canyon with no major tributaries. Accretion within the reach is low in volume given the lack of tributaries. During the spring runoff period, median monthly accretion throughout the reach amounts to between 40 and 100 cfs in below and above normal water years (see Table 5.3.1-5). Accretion in summer/fall is approximately 5 to 10 cfs, a more substantial volume of water than the upper SFRR, where summer/fall flows often drop below 1 cfs (see Table 5.3.1-6).

A plot of the daily flow regime from minimum releases and accretion (Figure 5.3.1-3) shows low summer flows of approximately 10-20 cfs with spring summer flows in the range of 50-100 cfs. These high spring flows are augmented by frequent spills from Robbs Peak Reservoir and Gerle Creek Reservoir. Spill events are common, occurring in most water years, and reach peak values between 1,000 and 7,000 cfs.

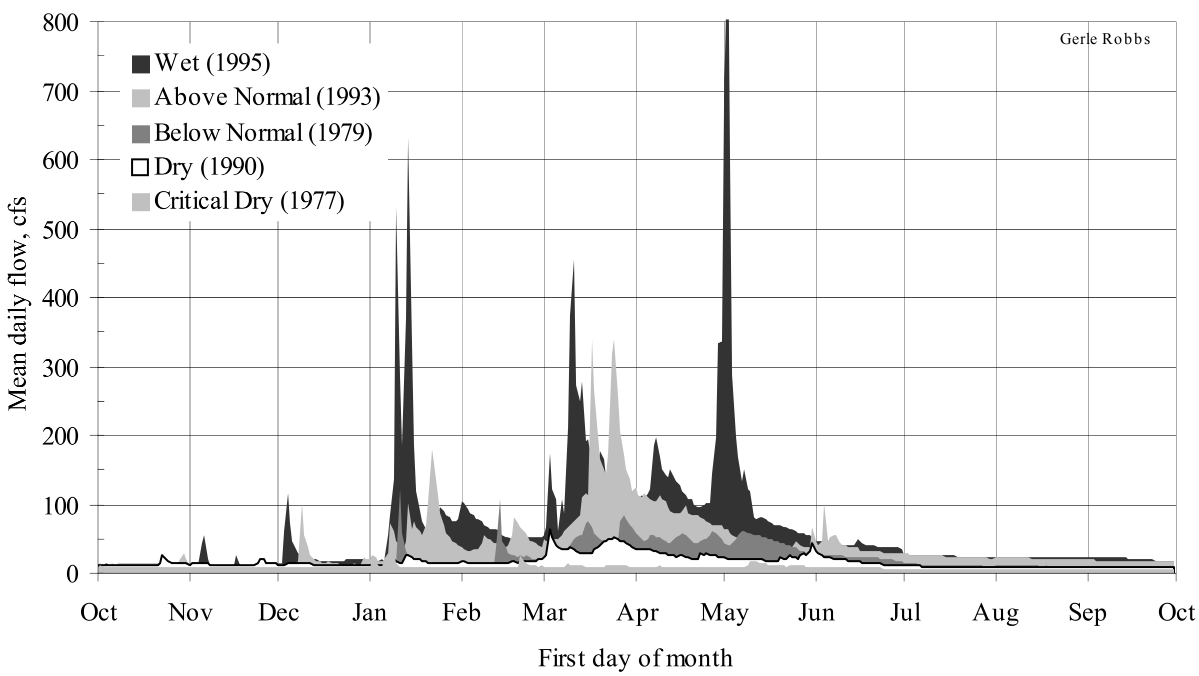

Figure 5.3.1-3. Daily flows in Robbs Dam Reach at confluence with Rubicon River (spill flows not included).

Ice House Dam Reach

The existing flow regime in the Ice House Dam Reach is similar in nature to that of the other high elevation project reaches, although the elevation of the reach is approximately 1,000 feet lower than the others. The existing release schedule at Ice House Dam is highly variable, ranging from winter lows of 3 cfs to summer highs of 15 cfs in wet years, but less variable in other water year types. Despite the fact that SFSC inflow to Ice House Reservoir typically falls to very low values in late summer and early fall (see Table 5.3.1-6), releases from Ice House Dam during this low flow period are between 5 and 15 cfs because of the storage capacity of the reservoir. Generally, during this low flow period accretion is near zero (see Table 5.3.1-5), which results in the 5 to 15 cfs releases extending throughout the course of the 11.5-mile-long reach.

During the snowmelt runoff, flows in the reach are substantially higher than the minimum release values because of the substantial accretion runoff. As described previously, a number of tributaries enter SFSC within the Ice House Dam Reach. These include Peavine Ridge, Windmiller Ridge, and Big Hill creeks. Monthly median values for accretion throughout the reach during the snowmelt period approximate 80-160 cfs in above and below normal water years (see Table 5.3.1-5).

The daily flows in the reach during winter and spring are quite variable, with short duration peaks in winter reaching highs of over 1,000 cfs (Figure 5.3.1-4). Like the other high elevation reaches, winter base flows are generally low due to much of the precipitation that falls on the watershed in the form of snow and remains frozen during winter. Once snow melts, it results in a sustained April/May runoff of between 50 to 150 cfs in the reach, depending on water year type. Ice House Reservoir does not spill on a regular basis. Thus, the flows depicted in Figure 5.3.1-4 would not be substantially supplemented in the spring by spill flows at Ice House Dam.

Junction Dam Reach

In contrast to the upstream project reaches, the flow regime in the Junction Dam Reach is influenced by different timing of minimum releases, accretion, and spill events. The minimum release schedule of Junction Dam ranges from 5 to 20 cfs, depending upon month and water year type (see Table 5.3.1-4). These flows are augmented by accretion contributed by Grey Horse, Onion and Sugar Pine creeks that enter Silver Creek over the 8.3-mile project reach. However, because of the lower elevation of the project reach watershed, the timing of accretion flow is shifted with respect to that of the higher elevation project reaches. Most of the precipitation that falls into the reach watershed does so as rain during winter storms. Hence, the pattern of accretion runoff peaks in February and March, when median monthly flows range between 100 and 150 cfs in below and above normal water years (see Table 5.3.1-5).

Another feature of the accretion pattern evident in the Junction Dam Reach is the higher volume of inflow entering Silver Creek in the summer/fall. In contrast to the upper reaches of the UARP, the watersheds in the lower reaches have deeper soil layers overlaying the bedrock, resulting in more moisture retention into the summer/fall, and thus, more accretion during that time. Median monthly accretion levels in the Junction Dam Reach during these periods are substantially higher than those of the upper reaches (see Table 5.3.1-5).

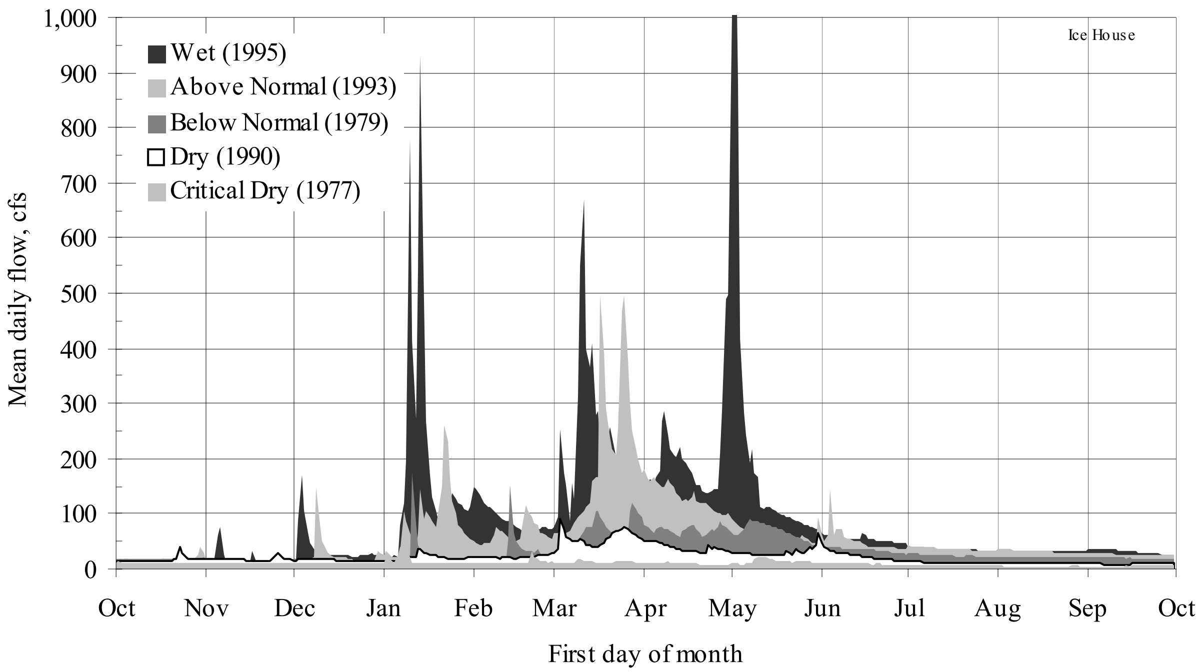

Figure 5.3.1-4. Daily flows in Ice House Dam Reach at point of inflow to Junction Reservoir (spill flows not included).

The resulting daily flows in Silver Creek range from summer/fall lows of 20-40 cfs to winter highs of 100-200 cfs. In the spring months (April and May) when the accretion flows are near their peak in the upper reaches, flows in the Junction Dam Reach are in the range of 50 to 100 cfs. The resulting pattern of flow in the reach is more volatile because the high flow events are dominated by winter storms rather than by a sustained snowmelt (Figure 5.3.1-5). Spill events occur in above normal and wet water years, typically during winter storms, due in part to the inflow from SFSC and Little Silver Creek, a tributary to Junction Reservoir. February and March spill volumes range from approximately 500 cfs to 2,000 cfs.

Camino Dam Reach

The existing flow regime in the Camino Dam Reach is very similar to that of the Junction Dam Reach. The timing of flows in the reach is driven by the same influences as those in the reach above. The minimum release schedule of Camino Dam is the same as Junction Dam, ranging from 5 to 20 cfs, depending upon month and water year type (see Table 5.3.1-4). However, the volume and timing of accretion entering the Camino Dam Reach differs from the Junction Dam Reach for two reasons: watershed size and elevation. The Camino Dam Reach has a smaller watershed than the Junction Reach, with fewer tributary streams entering into the 6.2-mile segment of Silver Creek. Also, the elevation of the watershed is lower, so nearly all the precipitation falling into the limited watershed occurs as rain. The result is median monthly accretion flows of about half the volume of those upstream in the Junction Dam Reach, approximately 50 to 100 cfs (Table 5.3.1-5).

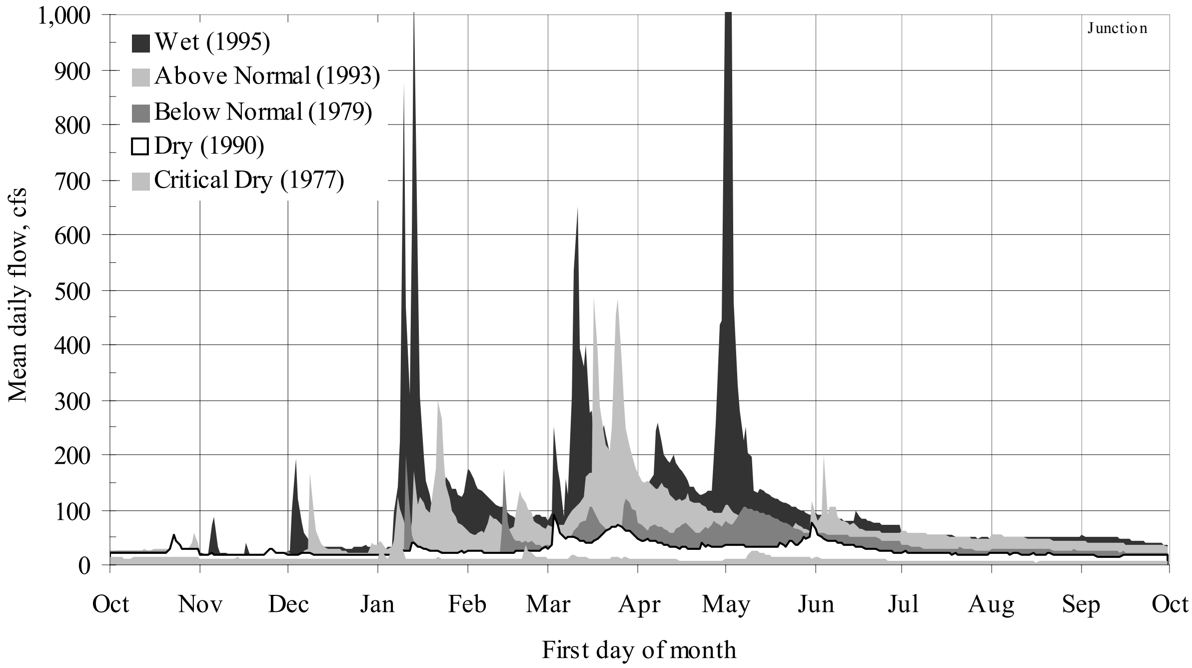

Figure 5.3.1-5. Daily flows in Junction Dam Reach at point of inflow to Camino Reservoir (spill flows not included).

The accretion pattern in summer and fall in the Camino Dam Reach is similar to that described in the Junction Dam Reach, only lower in volume. Median monthly accretion levels in the Camino Dam Reach are generally less than 10 cfs, but still reflect a higher runoff volume than the upper project reaches which experience near zero runoff.

The resulting daily flows in the Camino Dam Reach range from summer lows of approximately 10 to 20 cfs to winter highs of between 50 and 100 cfs. In the spring months (April and May) when the accretion flows are near their peak in the upper reaches, flows in the Camino Dam Reach are comparatively low, near 40 cfs. The pattern of flow in the reach reflects the typical volatile pattern of a system driven by winter storms rather than by a sustained snowmelt (Figure 5.3.1-6), with frequent winter spikes that result from winter rainstorms. Typically, spills into the Camino Dam Reach occur in wet and above normal years and occur mostly in the winter months of February and March. Spills range in volume from approximately 500 cfs to 2,000 cfs.

Brush Creek Dam Reach

The existing flow regime at Brush Creek Dam is primarily the result of the releases from Brush Creek Dam and accretion over the 2.2-mile project reach. Minimum releases from the dam range between 2 and 6 cfs, depending on month and water year type. No major tributaries enter

Brush Creek along its short and steep descent to Slab Creek Reservoir. Hence, the only flow augmentations to the dam releases are the accretion flows that accumulate within the immediate watershed of the stream segment. Median monthly accretion during the winter runoff period range between 10-20 cfs (see Table 5.3.1-5) and drop to 1-2 cfs in summer and fall. Daily flows peak in late February and March and drop by June (Figure 5.3.1-7).

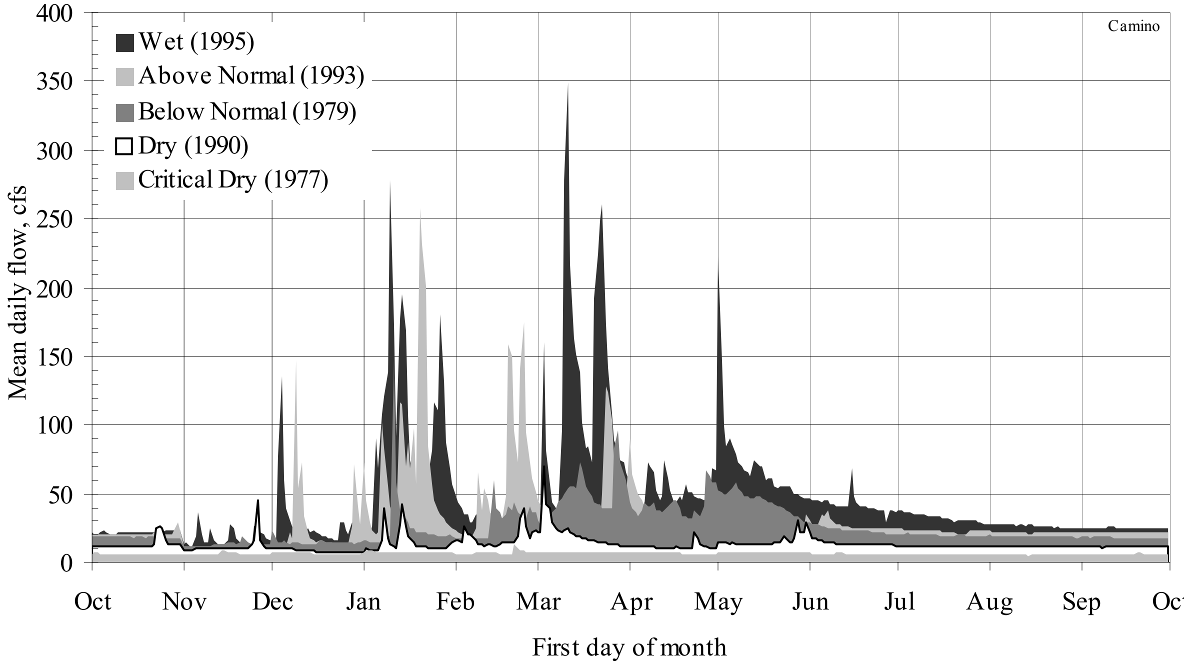

Figure 5.3.1-6. Daily flows in Camino Dam Reach at confluence with SFARr (spill flows not included)

Slab Creek Dam Reach

The existing flow regime in the Slab Creek Dam Reach is unique within the 12 project reaches. Because Slab Creek Dam lies on the SFAR, flows in the project reach are governed by more factors than the upstream Junction Dam and Camino Dam reaches. Spill from Slab Creek Dam during the spring snowmelt period is one of the primary determinates of the flow regime in the reach. Nevertheless, for most of the year, flows in the reach are largely a function of the minimum releases made at the dam and accretion from tributary streams.

The existing minimum release schedule at Slab Creek Dam ranges from 10 to 36 cfs, depending on month and water year type (see Table 5.3.1-4). These flows are augmented by several tributaries that flow into the SFAR along the 8.0-mile reach, including Iowa Canyon, Mosquito, and Rock Basin. Rock Creek, which is located approximately five miles downstream of Slab Creek Dam, is by far the largest of the tributaries, draining a watershed of 74.5 square miles. During winter, these tributaries contribute significant volumes of accretion to the project reach. Median monthly accretion throughout the reach during February and March ranges from 200 to 300 cfs in below and above normal water years (see Table 5.3.1-5). By contrast, accretion to the reach during the summer/fall low flow period ranges from 15 to 30 cfs. Plots of daily flows in the reach clearly demonstrate a volatile nature characteristic of rain driven runoff systems (Figure 5.3.1-8). Numerous spikes in flow are present, reaching levels between 200 and 1,000 cfs. Summer/fall flows are more stable, reflecting the constant 36 cfs dam release plus stable tributary input.

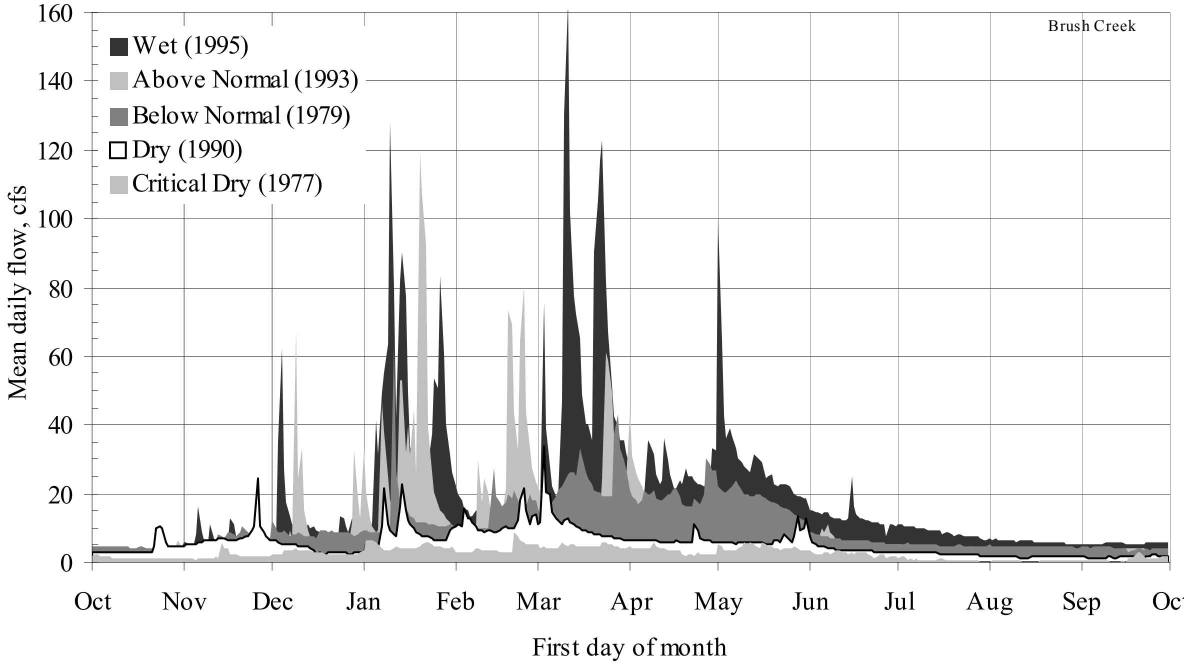

Figure 5.3.1-7. Daily flows in Brush Creek Dam Reach at point of inflow to Slab Creek Reservoir (spill flows not included).

Spill at Slab Creek Dam primarily occurs during winter and spring. Winter storms, such as rain on snow events in the upper SFAR basin can result in large, short-duration flows entering Slab Creek Reservoir and spill events at the dam. Also, in Wet and Above Normal water years, the SFAR spring snowmelt often leads to flows that exceed the capacity of Slab Creek Reservoir (16,600 ac-ft) and the White Rock Tunnel (3,950 cfs), leading to spill at the dam. The winter spill events add to the volatile nature of flows in the project reach during this time of year, with spill events adding flows up to the tens of thousand of cfs to the reach over a short period of time. The above normal and wet year spring spill events are generally longer in duration (lasting for weeks and months) and lower in magnitude, generally augmenting flow in the reach by less than 10,000 cfs.

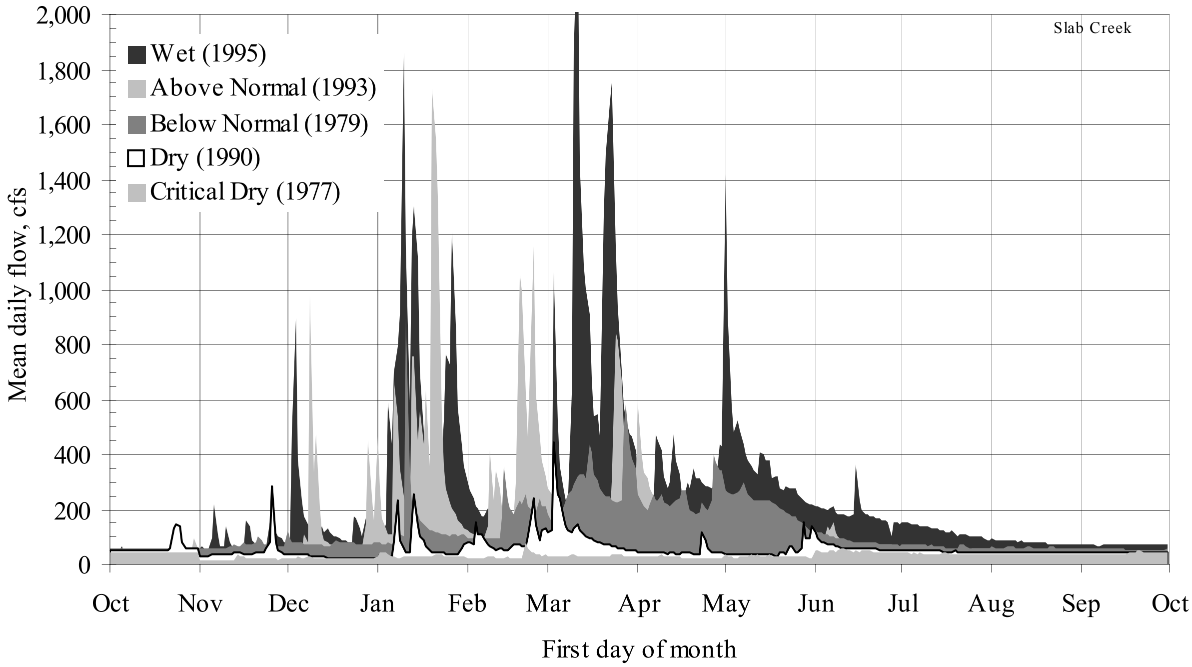

Figure 5.3.1-8. Daily flows in Slab Creek Dam Reach at point of inflow to Chili Bar Reservoir (spill flows not included).

UARP Water Rights

The FERC license for Project No. 2101 was approved on August 28, 1957, authorizing SMUD to construct and operate the UARP. All UARP project works, including all water diversion facilities, were "constructed in substantial conformity with the approved exhibits" adopted by FERC, including specifications for water diversion facilities and power generation capacity.[9] The FERC license does not restrict the rate or volume of water that may be diverted by the UARP,[10] though it does impose minimum instream flow requirements.[11]

In conjunction with the FERC license, SMUD holds five licenses and one permit issued by the State Water Resources Control Board (SWRCB) providing water rights for use in the UARP (Table 5.3.1-7). These licenses and permit authorize SMUD to directly divert and store water to generate hydroelectric power in UARP facilities. Under SWRCB orders, the licenses and permit incorporate the minimum instream flow releases mandated in the FERC license. SMUD's proposed action would increase the instream flow releases mandated in both the FERC license and the SWRCB water rights in order to improve water quality and benefit aquatic resources (see Table 3.1.3-1).

9 Federal Power Commission Terms and Conditions of License at 1 (made applicable to the UARP by Federal Power Commission Order Issuing License (Major) and Dismissing Application for Preliminary Permit (August 28, 1957)).
10 *See id.* at 1–36.
11 *Id.* at 13–18.

Since its construction, the UARP has been run under a consistent operational scheme for maximizing power generation under the terms of the FERC license, as described in Section 3.1.2, while releasing water downstream to meet minimum instream flow requirements. The actual volume of water diverted into UARP water conveyance and power generation facilities under historic operations has varied depending on the volume of water available in UARP streams on a given day. Given consistent operational criteria, this variation results principally from natural changes in climatic conditions, snowpack, runoff, and precipitation.

Under the Proposed Action, SMUD would continue operating the UARP in accordance with this past practice. However, in conducting a hydrological review of UARP streams and facilities as part of the FERC relicensing process, SMUD has discovered that in some stream reaches its state law water rights are insufficient to generate power to the full extent allowed under the FERC license. Because the FERC license gives SMUD the flexibility to divert as much available water as is necessary to operate the UARP to maximum generation capacity, SMUD will seek to modify its water rights as necessary to enable the UARP to continue operating as it has historically and to generate power limited only by FERC-approved project specifications, required instream releases, and other associated limits. Furthermore, it is foreseeable that runoff may increase in parts of the Upper American River basin over the period of the new FERC license (2007–2057). Accordingly, SMUD will seek water rights to accommodate anticipated increases in stream flow rates and annual volume with the intent of using these additional flows to maximize generation under the terms of the FERC license.

Table 5.3.1-7. Summary of water rights held by SMUD for operation of the UARP.

Priority (date)	SWRCB Designation (permit|application)		Purpose (use)	Source (name)	Diversion and Storage (amount, place)[1]	Rediversion (dam)	Beneficial Use (powerhouse)
License 10495							
8/12/52	10705	14963	Power	Silver Creek	400 cfs @ Union Valley, Junction, and Camino Dams	Junction	Union Valley
				SFAR	800 cfs @ Slab Creek and Chili Bar Dams	Camino	Jaybird
						Brush Creek	Camino
						Slab Creek	Slab Creek
						Chili Bar	White Rock
							Chili Bar
PG&E is a co-owner to the extent of use of water through Chili Bar Powerhouse. (Figure A1.0-1)							
License 10496							
12/12/61	13746	20522	Power	Brush Creek and SFAR	1,900 cfs @ Brush Creek, Slab Creek, and Chili Bar Dams combined	Slab Creek	Camino
				SFAR		Chili Bar	Slab Creek
							White Rock
							Chili Bar
PG&E is a co-owner to the extent of use of water through Chili Bar Powerhouse. (Figure A1.0-1)							
License 10513							
4/23/65	15088	22110	Power	SFAR	800 cfs @ Slab Creek Dam	Chili Bar	White Rock
							Slab Creek
							Chili Bar
PG&E is a co-owner to the extent of use of water through Chili Bar Powerhouse. (Figure A1.0-1)							

Table 5.3.1-7. Summary of water rights held by SMUD for operation of the UARP.

Priority (date)	SWRCB Designation (permit|application)		Purpose (use)	Source (name)	Diversion and Storage (amount, place)[1]	Rediversion (dam)	Beneficial Use (powerhouse)
License 11073							
2/13/48	10703	12323	Power	Silver Creek and SF Silver Creek	400 cfs @ Union Valley, Junction, and Camino Dams	Brush Creek	Union Valley
			Recreation	SF Silver Creek	238,900 ac-ft @ Union Valley and	Slab Creek	Jaybird
					Ice House Reservoirs combined	Chili Bar	Camino
							Slab Creek
							White Rock
							Jones Fork
							Chili Bar
PG&E is a co-owner to the extent of use of water through Chili Bar Powerhouse. (Figure A1.0-1)							
License 11074							
7/29/48	10704	12624	Power	Rubicon River	500 cfs @ Rubicon Dam	Union Valley	Loon Lake
			Recreation	Rockbound Creek	200 cfs @ Buck Island Dam	Junction	Robbs Peak
			Fish and Wildlife	Gerle Creek	325 cfs @ Loon Lake & Gerle Creek Dams combined	Camino	Union Valley
			Mitigation and Enhance-ment	SF Rubicon River	175 cfs @ Robbs Peak Dam	Brush Creek	Jaybird
					226,010 ac-ft @ Loon Lake and	Slab Creek	Camino
					Union Valley Reservoirs	Chili Bar	White Rock
License 11074							
					440 ac-ft @ Buck Island Reservoir		Slab Creek
					450 ac-ft @ Rubicon Reservoir		Chili Bar

Table 5.3.1-7. Summary of water rights held by SMUD for operation of the UARP.

Priority (date)	SWRCB Designation (permit|application)		Purpose (use)	Source (name)	Diversion and Storage (amount, place)[1]	Rediversion (dam)	Beneficial Use (powerhouse)
Permit 19025							
3/30/81	19025	26768	Power	SF Silver Creek	270 cfs @ Ice House Dam	Union Valley	Jones Fork
					60,000 ac-ft @ Ice House and Union Valley Reservoirs		Union Valley

[1] Water may be directly diverted and rediverted at any time during the year. Direct diversions are calculated based on a 14-day running average. Water may be diverted to storage from October 1 through July 31.

Water Quality

In accordance with the Clean Water Act (CWA) and the State of California's Porter-Cologne Water Quality Act, the Central Valley Regional Water Quality Control Board developed a water quality control plan for the Sacramento and San Joaquin river basins. The State Water Resources Control Board (SWRCB) reviewed and approved the Basin Plan (RWQCB 2004). The Basin Plan establishes water quality standards, which *"…consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses."* (33 U.S.C. § 1313(C)(2)(A). Table 5.3.1-8 lists the designated beneficial uses of water in the vicinity of the project, as set forth in the Basin Plan. Table 5.3.1-9 lists the Basin Plan water quality objectives to protect these beneficial uses.

Table 5.3.1-8. Beneficial uses of the Middle Fork American River (Hydro Unit Number 514.4), South Forks American River (514.32) and Desolation Valley Lakes (514.4) in the vicinity of the UARP as designated by the Central Valley Regional Water Quality Control Board in the Sacramento River and San Joaquin Basin Plan. (Basin Plan, RWQCB 2004)

Designated Beneficial Use	Description	Middle Fork	South Fork	Desolation Valley Lakes
Municipal and Domestic Supply (MUN)	Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.	Existing	Existing	-----
Agriculture (AGR)	Use of water for farming, horticulture, or ranching including but not limited to irrigation, stock watering or support of vegetation for range grazing.	Existing	-----	-----
Hydropower Generation (POW)	Use of water for hydropower generation.	Existing	Existing	-----
Water Contact Recreation (REC-1)	Use of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.	Existing	Existing	Existing

Table 5.3.1-8. Beneficial uses of the Middle Fork American River (Hydro Unit Number 514.4), South Forks American River (514.32) and Desolation Valley Lakes (514.4) in the vicinity of the UARP as designated by the Central Valley Regional Water Quality Control Board in the Sacramento River and San Joaquin Basin Plan. (Basin Plan, RWQCB 2004)

Designated Beneficial Use	Description	Middle Fork	South Fork	Desolation Valley Lakes
Non-Contact Water Recreation (REC-2)	Use of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beach-combing, camping, boating, tide-pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.	Existing	Existing	Existing
Warm Freshwater Habitat[1] (WARM)	Uses of water that support warmwater ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	Potential	Potential	-----
Cold Freshwater Habitat (COLD)	Uses of water that support coldwater ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	Existing	Existing	Existing
Cold Freshwater Spawning (SPWN)	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.	Existing	Existing	Existing
Wildlife Habitat (WILD)	Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation or enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.	Existing	Existing	Existing

[1] Table II-1, footnote 2 in the Basin Plan states: "Any stream segment with both COLD and WARM beneficial use designations will be considered COLD water bodies for the application of the water quality objectives."

Table 5.3.1-9. Water quality objectives to support designated beneficial uses of SFAR and MFAR waters in the UARP area, as identified in the Basin Plan. (Basin Plan, RWQCB 2004)

Water Quality Objective	Description
Bacteria for Water Contact Recreation	In terms of fecal coliform: less than a geometric mean of 200/100 ml on five samples collected in any 30-day period and less than 400/100 ml on 10 percent of all samples taken in a 30-day period.
Biostimulatory Substances	Water shall not contain biostimulatory substances that promote aquatic growth in concentrations that cause nuisance or adversely affect beneficial uses.
Chemical Constituents	Waters shall not contain chemical constituents in concentrations that exceed maximum contaminant levels (MCLs) specified in various provisions of Title 22 of the California Code of Regulations. This includes inorganic chemicals, fluoride, organic chemicals, and others. Waters shall not contain lead in excess of 0.015 mg/l.
Color	Water shall be free of discoloration that causes nuisance or adversely affects beneficial uses.

Table 5.3.1-9. Water quality objectives to support designated beneficial uses of SFAR and MFAR waters in the UARP area, as identified in the Basin Plan. (Basin Plan, RWQCB 2004)

Water Quality Objective	Description
Dissolved Oxygen	Monthly median of the mean daily dissolved oxygen concentration shall not fall below 85 percent of saturation in the main water mass, and the 95 percent concentration shall not fall below 75 percent of saturation. Minimum level of 7 mg/l.
Floating Material	Water shall not contain floating material in amounts that cause nuisance or adversely affect beneficial uses.
Oil & Grease	Water shall not contain oils, greases, waxes or other material in concentrations that cause nuisance, result in visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.
pH	From 6.5 to 8.5, and changes of less than 0.5.
Pesticides	Waters shall not contain pesticides or combination of pesticides in concentrations that adversely affect beneficial uses. Other limits established as well.
Radioactivity	Radionuclides shall not be present in concentrations that are harmful to human, plant, animal, or aquatic life nor that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life.
Salinity	Total dissolved solids shall not exceed 125 mg/l (90 percentile). No objectives are identified for electrical conductivity.
Sediment	The suspended sediment load and suspended-sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
Settleable Material	Waters shall not contain substances in concentrations that result in the deposition of material that causes nuisance or adversely affect beneficial uses.
Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Tastes and Odor	Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes and odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses.
Temperature	An increase of less than 5º F (or 3.1º C) above natural receiving-water temperature.
Toxicity	All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by analysis indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests, as specified by the RWQCB.
Turbidity	Where natural turbidity is 0 to 5 NTUs, increases shall not exceed 1 NTU; where 5 to 50 NTUs, increases shall not exceed 20 percent; where 50 to 100 NTUs, increases shall not exceed 10 NTUs; and where natural turbidity is greater than 100 NTUs, increase shall not exceed 10 percent.

Section 303 of the CWA requires each state to submit to the USEPA biannually a list of rivers, lakes, and reservoirs in the state for which pollution control or requirements have failed to provide water quality. No river reaches or project waters are included on the Revised 1998 California 303(d) List and TMDL Priority Schedule, as shown at the SWRCB's Web page on May 12, 2005.

<u>*Project Reservoirs*</u>

General Water Quality

In general, the 11 UARP reservoirs and non-UARP Rockbound Lake are cold, with summertime surface water temperatures less than 20 degrees Celsius (°C) and bottom temperatures as cold as 7°C to 8°C in the deeper reservoirs. Rubicon, Buck Island and Loon Lake reservoirs and Rockbound Lake are dimitic: they generally have winter ice cover and fully mix twice a year - in fall before ice cover and in spring after ice out. Since they are relatively shallow, Rubicon and Buck Island reservoirs do not thermally stratify, but Loon Lake Reservoir and Rockbound Lake each thermally stratify in summer with cold hypolimnia in the deepest portion or the reservoir. Ice House, Union Valley, Junction, Brush Creek, and Slab Creek reservoirs are monomitic: that is, they are never completely ice-covered, circulate freely in the winter, and stratify directly in the summer. Gerle Creek, Robbs Peak, and Camino reservoirs are polymictic: they normally do not have ice cover, do not stratify, and mix freely.

Specific conductance showed an increasing trend from upstream reservoirs (readings ranging from about 6 to 13 μS/cm) to the downstream reservoirs (20 to 37 μS/cm), indicating increasing ion concentration from the upper to lower elevation reservoirs. Water in the reservoirs is relatively clear, with Secchi depth readings ranging from about 10 to 30 feet. The waters are soft with hardness readings ranging from less than 1 to about 15 mg/l, and total alkalinity levels ranging from about 4 to 14 mg/l indicating a low buffer capacity to changes in pH. The water is low in total suspended and dissolved solids (TSS/TDS) (less than 10 mg/l). Mineral levels are low. All organic compounds (oil and grease, methyl-t-butyl ether [MTBE], total petroleum hydrocarbons [TPH], and gasoline range organics) are below detection limits. Based on Secchi depth and total nitrogen and phosphorus readings, the reservoirs range in trophic status from mesotrophic (represented best by Slab Creek Reservoir) to oligotrophic, (represented best by Junction Reservoir). The maximum nitrate concentration in each reservoir is well below the 1.0-mg/l nitrate standard typically used to characterize source waters that can stimulate algae growth. SMUD is unaware of any reports of floating material that would affect designated beneficial uses.

Based on the relicensing studies, project reservoirs are within the range of the established Water Quality Objectives in the Basin Plan with the exceptions discussed below.

Bacteria Water Quality Objective

The Basin Plan (RWQCB 1998) establishes fecal coliform bacteria concentration limits for all surface waters where Water Contact Recreation is a designated Beneficial Use. The specific objective is "…*based on a minimum of not less than five samples for any 30-day period shall not exceed a geometric mean of 200/100 ml, nor shall more than ten percent of the total number of samples taken during the 30-day period exceed 400 organisms/100 ml*)." In addition, the SWRCB staff has proposed an *Escherichia coli* (*E. coli*) Bacteria Water Quality Objective that would replace the existing fecal coliform objective in the Basin Plan, but to date staff's proposed objective has not been adopted.

SMUD collected five fecal coliform samples within a 30-day period at 15 different locations in 2003 for a total of 75 samples. All of the 2003 samples were taken from June 23 through July 22, 2003, except at four sites: Buck Island Reservoir (1 site); Loon Lake Reservoir (2 sites); and Loon Lake Dam Reach below the dam (1 site). Samples at these sites were collected from August 19 through September 23, 2003.

Of the 15 sites sampled, 14 of the sites had a 5-day geometric mean less than the Basin Plan criterion of less than 200 organisms/100ml. The only site where the geometric mean was greater than the Basin Plan was upstream of the UARP. On the Jones Fork of Silver Creek upstream from Union Valley Reservoir near Ice House Road, a geometric mean of 468 organisms/100ml was reported.

Of the 75 fecal coliform samples, nine samples contained fecal coliform concentrations greater than 400 organisms/100 ml, the Basin Plan criterion for 10 percent of the total number of samples taken during a 30-day period. Five of these samples were in Union Valley Reservoir and four collected upstream of the UARP. On June 23, 2003 the fecal coliform concentrations in Union Valley Reservoir at the Camino Cove, Fashoda Beach and Jones Fork campgrounds were 600, 550, and 3,180 organisms/100 ml, respectively, and on July 1, 2003 the concentrations at Camino Cove and Jones Fork campgrounds were 1,200 and 2,900 organisms/100 ml, respectively. Fecal coliform concentrations in the other samples collected at these three sites were generally low (<1 to 172 organisms/100 ml).

Upstream of Union Valley Reservoir, fecal concentrations in the Jones Fork of Silver Creek at Ice House Road were 730, 400 and 1,500 organisms/100 ml on June 23, July 15 and July 22, 2003, respectively. In Big Silver Creek at Bike Bridge, fecal coliform concentration was 1,160 organisms/100 ml on July 22, 2003.

SMUD also collected *E. coli* samples as part of the seasonal water quality sampling. None of the 145 *E. coli* samples collected had concentrations greater than the SWRCB staff's proposed *E. coli* maximum concentration of 235 organisms/100ml.

Chemical Constituents Water Quality Objective

Pursuant to the California Safe Drinking Water Act, the California Department of Health Services (DHS) has established Primary and Secondary Maximum Contaminant Levels (MCLs) for drinking water; the SWRCB incorporated these standards into the Basin Plan under Chemical Constituent Water Quality Objectives. DHS derived Primary MCLs from health-based criteria from Public Health Goals, or from a one-in-a-million incremental cancer risk estimate for carcinogens and threshold toxicity levels for non-carcinogens. DHS developed Secondary MCLs from human welfare considerations (taste, odor, etc.).

SMUD analyzed water quality samples for metals on seven occasions: 1) 2002 fall turnover; 2) 2002 first major rain; 3) 2003 spring runoff; 4) 2003 summer low flow; 5) 2004 spring runoff; 6) 2004 summer low flow: 7) 2004 first major rain/fall turnover. Metals analyzed included aluminum, arsenic, barium, cadmium, copper, iron, lead, manganese, mercury, nickel, selenium, silver and zinc.

Of the 4,486 metal samples, 47 samples had concentrations greater than the numerical limits established by the DHS for Primary MCLs: 41 for lead and 6 for mercury. Two aluminum samples and 16 iron samples had concentrations greater than the DHS numerical limits for Secondary MCLs.

- *Lead* - Forty-six of the 406 lead samples were greater than the Primary MCL for lead (15 µg/l). All 46 occurred in reservoirs during the 2004 sampling events:
  - On May 3, 2004 (during the Spring Runoff sampling event) in the Slab Creek Reservoir (65 and 86 µg/l).
  - On May 5, 2004 (Spring Runoff) in the Union Valley Reservoir (15, 25 and 47 µg/l) and in the Junction Reservoir (15 µg/l).
  - On May 6, 2004 (Spring Runoff) at Loon Lake Reservoir (47, 48 and 91 µg/l).
  - On May 11, 2004 (Spring Runoff) at Ice House Reservoir (18 and 54 µg/l).
  - On May 12, 2004 (Spring Runoff) at Rockbound Reservoir (19 µg/l) and Buck Island Reservoir (97 µg/l).
  - On September 13, 2004 (Summer Low Flow) in Slab Creek Reservoir (66, 110 and 110 µg/l).
  - On September 14, 2004 (Summer Low Flow) in Union Valley Reservoir (24, 47 and 28 µg/l) and Junction Reservoir (68 µg/l).
  - On September 15, 2004 (Summer Low Flow) in Gerle Creek Reservoir (59 µg/l).
  - On September 20, 2004 (Summer Low Flow) in Brush Creek Reservoir (48 and 85 µg/l) and Ice House Reservoir (47, 33, 47, 36 and 120 µg/l).
  - On September 21, 2004 (Summer Low Flow) in Rockbound Reservoir (39 and 54 µg/l) and Buck Island Reservoir (49 µg/l).
  - On September 22, 2004 (Summer Low Flow) in Loon Lake Reservoir (51, 100, 140 and 190 µg/l).
  - On October 25, 2004 (First Major Rain/Fall Turnover) in Slab Creek Reservoir (31 µg/l).
  - On November 1, 2004 (First Major Rain/Fall Turnover) in Brush Creek Reservoir (53 µg/l) and Ice House Reservoir (47µg/l).
  - On November 2, 2004 (First Major Rain/Fall Turnover) in Rockbound Reservoir (43 µg/l).
  - On November 8, 2004 (First Major Rain/Fall Turnover) in Union Valley Reservoir (150 µg/l).
  - On November 10, 2004 (First Major Rain/Fall Turnover) in Loon Lake Reservoir (41 µg/l).
- *Mercury* - Six of the 215 mercury samples were equal to or exceeded the Primary MCL (2.0 µg/l). All eight occurred in reservoirs during the 2003 summer low flow sampling:
  - On September 15, 2003 in Slab Creek Reservoir (2.4 and 5.6 µg/l).
  - On September 16, 2003 in Loon Lake Reservoir (5.7 and 2.2 µg/l).
  - On September 18, 2003 in Union Valley Reservoir (2.1 µg/l) and Ice House Reservoir (3.4µg/l).

- *Aluminum* - Two of the 398 aluminum samples were greater than the Secondary MCL for aluminum (200 µg/l). Both occurred in stream reaches:
  - On October 7, 2002 (Fall Turnover) in the Rubicon Dam Reach downstream from the dam (230 µg/l).
  - On May 11, 2003 (Spring Runoff) in the Slab Creek Dam Reach downstream from the Rock Creek confluence (230 µg/l).
- *Iron* - Sixteen of the 382 iron samples were equal to or greater than Secondary MCL for iron (300 µg/l). Ten of these occurred in river-reach samples and seven in reservoir samples:
  - On September 17, 2003 (Summer Low Flow) in the Rubicon Reservoir and in the Rubicon Dam Reach downstream of the dam (390 and 340 µg/l, respectively).
  - On September 18, 2003 (Summer Low Flow) in the South Fork Silver Creek reach downstream from Ice House Dam (300 µg/l).
  - On May 4, 2004 (Spring Runoff) in the SFAR upstream of the Camino Powerhouse and downstream of the Camino Powerhouse (500 and 460 µg/l, respectively).
  - On May 5, 2004 (Spring Runoff) in the South Fork Silver Creek reach downstream from Junction Dam (440 µg/l).
  - On May 5, 2004 (Spring Runoff) at a non-project affected reach; in the SFAR at Highway 50 and Ice House Road (310 µg/l).
  - On September 14, 2004 (Summer Low Flow) in the South Fork Silver Creek outflow from Junction Dam (440 µg/l).
  - On September 15 2004 (Summer Low Flow) in the South Fork Silver Creek outflow from Ice House Reservoir (380 µg/l).
  - On September 20, 2004 (Summer Low Flow) in Ice House Reservoir (340 µg/l).
  - On September 21, 2004 (Summer Low Flow) in Rockbound Reservoir (330 µg/l), Rubicon Reservoir (540 µg/l) and in the Rubicon River outflow from Rubicon Reservoir (340 µg/l).
  - On October 27, 2004 (First Major Rain) in the South Fork Silver Creek outflow from Ice House Reservoir (990 µg/l).
  - On November 1, 2004 (First Major Rain) in Ice House Reservoir (980 and 570 µg/l).

The elevated reservoir mercury concentrations in 2003 and elevated reservoir lead concentrations in 2004 are unreliable due to contamination related to the reservoir sampling equipment. During 2002 sampling events, reservoir samples were collected using a rented Van Dorn sampler and none of 2002 reservoir samples exceeded MCLs. In 2003, SMUD purchased, rather than rented, a Van Dorn sampler. Laboratory analysis of the 2003 samples resulted in a substantial increase in mercury concentrations in reservoir samples compared to 2002. SMUD evaluated the potential sources of increased mercury levels in reservoir samples from 2002 to 2003, and contacted the supplier of the Van Dorn sampler to inquire about the sampler as a possible source of mercury. The supplier confirmed that the sampling cups sold for use with the Van Dorn sampler at that time were a source of mercury.

To avoid further equipment-related contamination of reservoir samples, SMUD purchased a new Kemmerer sampler for use in collecting reservoir samples during 2004 sampling events.

Laboratory analysis of 2004 reservoir samples collected with the new sampler show that mercury concentrations decreased to levels similar to that found in area streams, however, lead concentrations increased significantly in reservoir samples, exceeding the MCL for lead for the first time. A quality-assurance sample collected in the field (i.e., de-ionized-water rinse of the new Kemmerer sampler) during the 2004 spring sampling event yielded a lead concentration of 7.7 µg/l, which suggests the source of elevated lead concentrations in 2004 reservoir samples is the new Kemmerer sampler. The Kemmerer sampler has since undergone laboratory testing and analysis to confirm this; the laboratory report is available in Appendix D of the *Water Quality Technical Report* (DTA 2005d). Additional evidence to support this conclusion is that all riverine samples collected below reservoirs have lead concentrations that range from non-detect to 0.3 µg/l, well below MCL limits. Collection of riverine sampling entails filling sample bottles directly from the stream and therefore does not require the use of a Kemmerer or Van Dorn depth sampler. If lead concentrations were truly elevated in the reservoirs as suggested by the 2004 analytical data, then 2004 riverine samples collected just below the dams should have similar lead concentrations as found in the reservoirs, but this is not the case (i.e., lead results for riverine samples are about four orders of magnitude less than the reservoir samples, and well below MCL limits).

The iron and aluminum levels are greater than the Secondary MCL numerical limits. Secondary MCLs have no human health considerations, but are established with regards to taste, odor, etc. The instances where the concentrations are over numerical limits are relatively rare: 2 out of 398 samples or 0.5 percent for lead, and 16 out of 382 samples or 4.2 percent for iron. The two higher aluminum concentrations occurred in the river and during higher flow events (fall turnover and spring runoff). The 16 higher iron concentrations were ubiquitous occurring within the entire watershed and in both reservoirs and streams.

Dissolved Oxygen Water Quality Objective

The Basin Plan's Dissolved Oxygen (DO) Water Quality Objective states: "Monthly median of the mean daily dissolved oxygen concentration shall not fall below 85 percent of saturation in the main water mass, and the 95 percent concentration shall not fall below 75 percent of saturation. Minimum level of 7 mg/l." All of the UARP reservoirs are normally above the 85 percent and 7 milligrams per liter (mg/l) objectives: DO concentrations in the upper portions of the reservoirs in summer are typically greater than 85 percent saturation and 8.0 mg/l. None of the reservoirs showed bottom anoxic conditions, although lower DO concentrations (as low as 3 mg/l and 30% saturation) were found at the bottom of Ice House, Union Valley and Brush Creek reservoirs, as well as at the bottom of the natural Rockbound Lake.

pH Water Quality Objective

The Basin Plan states that the pH of surface waters should be between 6.5 and 8.5. The water in the reservoirs is basic to slightly alkaline with pH readings ranging from about 6.0 to 8.0. Values for pH were occasionally measured below 6.5 in six reservoirs (Rockbound, Loon Lake, Union Valley, Ice House, Junction, and Brush Creek reservoirs), and pH values were greater than 8.5 in one reservoir (Junction Reservoir).

At the natural Rockbound Lake, pH values dropped below 6.5 on October 7, 2002 and May 12, 2004, with minimum pH values of 6.1 and 6.3, respectively. The pH trend at Rockbound Lake is values greater than 6.5 at the lake surface and generally decreasing pH with increasing depth.

At Loon Lake Reservoir, pH values dropped below 6.5 on September 16, 2003, at two locations: the west end of Loon Lake Reservoir and near the boat ramp with a pH of 6.45 at the surface of the reservoir and decreasing to 5.8 at the bottom five meters of the reservoir (total depth 21 meters); and in the northeast portion of Loon Lake Reservoir with pH decreasing from 6.5 to 6.0 at a depth interval from 16.5 meters to total depth of 18.2 meters. On May 6, 2003, pH dropped below 6.5 at three locations: near the dam with pH of approximately 6.2 throughout the water column to a total depth of 19.5 meters; at the west end near the boat ramp, with a pH range of 6.3 at the surface and decreasing to approximately 6.0 at total depth of 24 meters; and at the northeast water body with pH decreasing from 6.5 to 6.2 at a depth interval of 4.0 meters to a total depth of 27 meters.

At Union Valley Reservoir, pH values dropped below 6.5 during October 2002, September 2003, and May 2004, with a minimum pH value of 6.0. The trend at Union Valley Reservoir is pH values greater than 6.5 at the reservoir surface and generally decreasing pH with increasing depth.

At Ice House Reservoir, pH values dropped below 6.5 during October 2002, November 2002, September 2003, and May 2004, with a minimum pH value of 6.0. The trend at Ice House Reservoir is pH values greater than 6.5 at the reservoir surface and generally decreasing pH with increasing depth.

At Junction Reservoir, pH values dropped below 6.5 on September 16, 2003, and May 5, 2004, with a minimum pH value of 6.2. The trend at Junction Reservoir is pH values greater than 6.5 at the reservoir surface and generally decreasing pH with increasing depth. On May 13, 2003, Junction Reservoir pH values were greater than 8.5 at a depth interval of one to five meters, with a maximum pH value of 9.3.

At Brush Creek Reservoir, pH values dropped below 6.5 on September 16, 2003 at a depth interval of 15 to 29.6 meters (total depth), with a minimum pH value of 6.1. The trend at Brush Creek Reservoir is pH values greater than 6.5 at the reservoir surface and generally decreasing pH with increasing depth.

Taste and Odor Water Quality Objective

The Basin Plan states: "Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes and odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses." As described above, one iron concentration (390 μg/l of total iron) in Rubicon Reservoir in September 2003 exceeded the Secondary MCL level of 300 μg/l of total iron, which is established for taste and odor. SMUD is unaware of any reports regarding the taste or odor of Rubicon Reservoir water.

Toxicity Water Quality Objective

Metal Concentrations in Fish Tissue

Unlike MCLs, there is no definitive standard, for levels of metals concentrations in fish tissue that would pose a human health risk. However, the USEPA and the SWRCB have developed guidelines. The USEPA guidelines are in the form of screening values (SVs) related to recreational fishing (the form of fishing that occurs throughout the UARP area). One SV is for Target Analytes and one for Defining Green Areas (USEPA 2000a). Both are measured as total concentration of metal in fish tissue (filet). The SV for Target Analytes is the *"…concentration of target analytes (in fish or shellfish tissue) that are of potential public health concern and that are used as threshold values against which levels of contamination in similar tissue collected from the ambient environment can be compared. Exceedance of these SVs should be taken as an indication that more intensive site specific monitoring and /or evaluation of human health risk should be conducted"* (USEPA 2000). The SV for Green Areas denotes areas for unrestricted fish consumption (USEPA 2000). The SWRCB's guideline, called Maximum Tissue Residue Levels (MTRL), is similar to the USEPA's Target Analyst SV.

The SWRCB uses MTRL as *"…alert levels or guidelines indicating water bodies with potential human health concerns, and are an assessment tool and not compliance or enforcement criteria."* (TSMP 1995). Like SVs, MTRLs are used for comparison to filet (edible tissue) samples only. In addition, the National Recommended Water Quality Criteria (USEPA 2002) provides a recommended human health-based criterion for mercury in fish tissue.

At least a moderate level of recreational fishing occurs at five UARP reservoirs: Loon Lake, Gerle Creek, Union Valley, Ice House, and Slab Creek. SMUD collected fish from these reservoirs and analyzed filets for metals covered by the USEPA SVs (arsenic, cadmium, mercury and selenium) and/or by the SWRCB MTRLs (arsenic, cadmium, mercury, nickel, and selenium). Of the 30 filets examined, none had metal concentrations greater than the SWRCB MTRL guidelines, and two had concentrations greater than the USEPA's Screening Values (SV) guidelines. Two samples exceeded the USEPA SV of 0.026 ppm for arsenic: at Union Valley Reservoir (0.06 ppm) and Ice House Reservoir (0.16 ppm). Two samples exceeded the USEPA SVs for both the Target Analytes and Green Areas of 0.4 ppm for mercury, and three samples exceeded the National Recommended Water Quality Criteria (USEPA 2002) of 0.3 ppm for mercury: at Gerle Creek Reservoir (brown trout, 0.32 ppm), Union Valley Reservoir (smallmouth bass, 0.42 ppm) and Slab Creek Reservoir (brown trout, 0.59 ppm). Findings greater than this guideline do not necessarily indicate a human health risk, but only that "…*more intensive site specific monitoring and/or evaluation of human health risk should be conducted."* (USEPA 2000). As far as SMUD is aware, UARP operations and maintenance activities do not contribute to these occasional elevated metal levels, and over the 40 years of fishing in UARP reservoirs, no reports of illnesses have been documented from ingesting fish caught in Union Valley or Slab Creek reservoirs.

Toxicity to Aquatic Life

Metals in surface waters can be toxic to aquatic life. The USEPA, under 40 CFR § 131.38, has established Criterion Maximum Concentrations (CMC) and Criterion Continuous Concentrations (CCC) for freshwater aquatic life for 23 priority toxic pollutants for the State of California. While these criteria are not included into the Basin Plan directly, they might be inferred under the Toxicity Water Quality Objective. The USEPA (40 CFR § 131.38) defines CMC as the highest concentration to which aquatic life can be exposed for a short period of time without deleterious effects. In comparison, CCC is defined as the highest concentration to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. Both CMCs and CCCs are reported in micrograms per liter (µg/l) of dissolved metal concentrations. Ten of the 14 metals for which SMUD performed analyses have CMC and/or CCC values established under 40 CFR § 131.38. The criteria for six of the metals (cadmium, copper, lead, nickel, silver and zinc) are calculated values based on hardness of the water when the sample was collected since the level at which each of these metals is reportedly toxic to aquatic life is lower at lower hardness levels. CMC and CCC levels for these metals in 5 mg/l increments of hardness are presented in Table 5.3.1-10.

Table 5.3.1-10. CCC and CMC values at 5, 10 and 15 mg/l of hardness. (DTA 2005d)

Metal	Hardness (mg/l)	Dissolved (µg/l)	
		CCC	CMC
Cadmium	5	0.21	0.15
	10	0.37	0.32
	15	0.50	0.50
Copper	5	0.69	0.80
	10	1.25	1.54
	15	1.77	2.25
Lead	5	0.06	1.43
	10	0.13	3.44
	15	0.22	5.77
Nickel	5	4.12	37.14
	10	7.41	66.75
	15	10.45	94.07
Silver[1]	5	NA	0.02
	10	NA	0.07
	15	NA	0.13
Zinc	5	9.33	9.26
	10	16.79	16.66
	15	23.68	23.48

1 Criterion for silver is based on the instantaneous maximum, not the CMC.

40 CFR § 131.38 provides absolute criteria (not calculated as a function of hardness) for arsenic, selenium and cyanide. 40 CFR § 131.38 CCC and CMC values for mercury as well as CMC values for selenium are "reserved" (not established by 40 CFR § 131.38 at this time). These criteria are shown in Table 5.3.1-11.

Table 5.3.1-11. USEPA CCC and CMC freshwater criteria for metals and cyanide where toxicity is not a function of hardness (40 CFR § 131.38 of the California Toxics Rule).

	Dissolved (µg/l)	
Parameter	**CCC**	**CMC**
Arsenic	150	340
Mercury	Reserved	Reserved
Selenium	5.0	Reserved
Cyanide	5.2	22.0

During the 2004 spring, summer and fall sampling events, SMUD collected 56, 64, and 65 water samples, respectively, and analyzed them for dissolved metals for comparison to CCC and CMC criteria. Hardness in UARP reservoirs ranged from approximately 1-9 mg/l. The percent of reservoir samples that exceeded the CCC and/or CMC ranged from 21.7 percent of copper samples, 2.9 percent of cadmium and silver (CMC only) samples to zero percent of nickel or zinc samples exceeding either criteria, as shown in Table 5.3.1-12. One freshly fallen snow sample was taken in 2004 and it exceeded the CCC and CMC for cadmium, copper, and lead. Table 5.3.1-13 lists the 2004 reservoir samples that exceed the CCC and CMC. The snow sample is included in this list of exceedances since snowmelt is a major source of water to the reservoirs. Lead results are not included in Table 5.3.1-13 because the Kemmerer water sampler used for reservoir sampling in 2004 was confirmed to be a source of lead contamination as described above in Chemical Constituents Water Quality Objective.

Table 5.3.1-12. Total number of 2004 samples (measured as dissolved concentrations) of cadmium, copper, lead, nickel, silver, and zinc from project reservoirs that exceed CCC or CMC criteria (DTA 2005d).

Metal	Number of Samples Exceeding CCC	Number of Samples Exceeding CMC	Total Samples	Percent of Samples Exceeding CCC/CMC
Cadmium	2	2	69	2.9/2.9
Copper	15	15	69	21.7/21.7
Lead	*	*	69	
Nickel	0	0	69	0/0
Silver	NA	2	69	NA/2.9
Zinc	0	0	49	0/0

* Reservoir samples were contaminated with lead from the Kemmerer sampler, therefore lead results are not included in this table.

Table 5.3.1-13. UARP 2004 reservoir samples with dissolved metal concentrations exceeding CCC and CMC criteria. (DTA 2005d).

Site Number	Site Name	Date	Hardness (mg/L)	Cadmium (ug/L)			Copper (ug/L)			Lead[2] (ug/L)			Silver (ug/L)			Zinc (ug/L)		
				Lab[1]	CCC	CMC	Lab[1]	CCC	CMC	Lab[1]	CCC	CMC	Lab[1]	CCC	CMC	Lab[1]	CCC	CMC
R-2	Rockbound Reservoir	5/12/04	1.99				0.50	0.32	0.34									
R-2H	Rockbound Reservoir	9/21/04	1.50										0.012J	NA	0.004			
R-3a	Buck Island	5/12/04	1.89				0.62	0.30	0.32									
R-4a	Loon Lake near Dam	9/22/04	1.00				0.30J	0.18	0.18									
R-4a	Loon Lake near Dam	11/10/04	ND				0.19	0.18	0.18									
R-4b	Loon Lake West End	9/22/04	ND				0.52	0.18	0.18									
R-4b	Loon Lake West End	11/10/04	ND				0.18	0.18	0.18									
R-4c	Loon Lake NE Waterbody	9/22/04	1.50				0.29	0.25	0.26									
R-4c	Loon Lake NE Waterbody	11/10/04	ND	0.06	0.06	0.02												
R-4c	Loon Lake NE Waterbody	11/10/04	ND				0.31	0.18	0.18									
R-5	Gerle Creek Reservoir	11/10/04	ND	0.07	0.06	0.02												
R-5	Gerle Creek Reservoir	11/10/04	ND				0.21	0.18	0.18									
R-6d	Union Valley Res - Jones Fork Arm	11/8/04	3.00				56.00	0.45	0.49									
R-7a	Ice House Reservoir	5/11/04	2.65				0.49	0.40	0.44									
R-7aH	Ice House Res. Nr. Dam	9/20/04	2.80										0.016J	NA	0.004			
R-9a	Camino Reservoir	9/12/04	ND				0.22	0.18	0.18									
R-11a	Slab Creek Middle Site	9/13/04	ND				0.28	0.18	0.18									
R-11aH	Slab Creek Middle Site	9/13/04	ND				0.36	0.18	0.18									
R-11b	Slab Creek UpperSite	9/13/04	ND				0.39	0.18	0.18									
Snow Sample[3]																		
	Snow Sample-1	5/12/04	ND	0.19	0.06	0.02	1.9	0.18	0.18	0.13	0.01	0.18						

[1] Laboratory reported dissolved concentration.
[2] Lead results are not included in this table since the 2004 reservoir samples were contanimated with lead from the Kemmerer sampler.
[3] The snow sample was not analyzed for zinc.
NA not applicable.
ND non detectable concentration.
Note: the laboratory reporting limit for hardness analysis was 1.0 mg/l, therefore, for samples with a non-detectable hardness concentration, the CCC and CMC calculations were based on an assumed hardness of 1.0 mg/l.

During the 2002 Fall, 2003 Spring, and 2003 Summer sampling events, SMUD collected 64, 62, and 66 water samples, respectively, and analyzed them for hardness and for total recoverable concentrations of cadmium, copper, lead, nickel, silver, and zinc. The resulting total recoverable metal concentrations for 2002 and 2003 are compared below to the CCC and CMC criteria, which are based on dissolved concentration criteria. Concentrations reported as total recoverable include both the dissolved and particulate fractions of a given metal analyte, therefore, this comparison of total recoverable metal concentrations versus dissolved metal criteria may present an overestimate of exceedances but is provided here as a conservative indicator of potential CCC and CMC exceedances. Hardness in UARP reservoirs during the 2002 and 2003 sampling events ranged from approximately 1-15 mg/l. The percent of reservoir samples that exceeded the CCC and/or CMC ranged from 35 percent of lead samples to 22.6 percent of silver (CMC only), 11 percent of copper samples to zero percent of nickel or zinc samples exceeding either criteria (Table 5.3.1-14). There were no snow samples collected during 2002 and 2003.

Table 5.3.1-14. Total number of 2002-2003 samples (reported as total recoverable concentrations) of cadmium, copper, lead, nickel, silver, and zinc from project reservoirs that exceed CCC or CMC criteria. (DTA 2005d).

Metal	Number of Samples Exceeding CCC	Number of Samples Exceeding CMC	Total Samples	Percent of Samples Exceeding CCC/CMC
Cadmium	0	0	72	0/0
Copper	8	7	72	11.1/9.7
Lead	29	2	83	35/2.4
Nickel	0	0	72	0/0
Silver	NA	18	84	NA/21.4
Zinc	0	0	47	0/0

UARP Project Reaches

General Water Quality

Alkalinity in waters in the UARP project reaches is low, with most readings less than 10 mg/l, indicating a low buffer capacity to changes in pH. Turbidity and total suspended solids are also low, with mean values of less than 1 NTU and 1 mg/l, respectively. The greatest total suspended solid concentration was 18 mg/l, and the highest turbidity reading was 6.4 NTUs (both on May 11, 2003), in the Slab Creek Dam Reach downstream of the confluence with Rock Creek. Total dissolved constituents, measured as total dissolved solids or individually as calcium, magnesium, potassium, sodium, chloride, and sulfate are also low. Values are generally below reporting limits, with minimal site or seasonal differences. All organic compounds (oil and grease, MTBE, TPH, and gasoline range organics) are below detection limits. The water is very soft with hardness readings ranging from less than 1 mg/l to 27 mg/l. Nutrients are also low. Total phosphorus and ortho-phosphorus each ranged from a low of less than 0.01 mg/l to a high of 0.22 mg/l for total phosphorus and 0.03 mg/l for orthophosphorus. Total Kjeldahl nitrogen ranged from less than 0.023 mg/l to 0.55 mg/l. Nitrate-nitrite ranged from less than 0.023 mg/l to 0.29 mg/l. The maximum nitrate concentration in each reach is well below the 1.0-mg/l nitrate standard used to characterize source waters that can stimulate algae growth. Like the reservoirs, pH ranges from about 6.5 to 8.0, and mineral levels are low. Three pH values were measured below 6.0, all of which occurred in non-project affected reaches: 5.0 on September 17, 2003 at SFRR inflow to Robbs Peak Reservoir, and Highland Creek inflow to Rockbound Lake on June 11, 2003 and May 12, 2004 (5.75 and 5.83, respectively).

Based on the relicensing studies, the water quality parameters of all the project reaches are within the range of established Water Quality Objectives in the Basin Plan with the exceptions discussed below.

Bacteria Water Quality Objective

All bacteria samples collected in river reaches during the relicensing studies were below the Basin Plan Water Quality Objective for fecal coliform geometric mean and single sample criteria, as well as the SWRCB staff's proposed water quality objective for *E. coli*. However, as discussed under project reservoirs, fecal coliform concentrations in tributaries to the UARP's Union Valley Reservoir were greater than the single sample fecal coliform criteria at times of increased dispersed recreational use.

Chemical Constituents Water Quality Objective

With the exceptions of selenium (and cyanide), metals are found in reportable quantities in most UARP project reaches. Table 5.3.1-15 summarizes the range of total recoverable metal concentrations in the upper elevation (Rubicon, Rockbound, Buck Island, Loon Lake and Gerle Creek reaches), mid elevation (Ice House, Union Valley, Junction, SFAR, and Camino reaches) and lower elevation (Brush Creek and Slab Creek) reaches.

Table 5.3.1-15. Reportable quantities of metals in upper elevation (Rubicon, Rockbound, Buck Island, Loon Lake and Gerle Creek reaches), mid elevation (Ice House, Union Valley, Junction, SFAR, and Camino reaches) and lower elevation (Brush Creek and Slab Creek) reaches. (DTA 2005d).

Metal	Upper Elevation (Total mg/l)	Middle Elevation (Total mg/l)	Lower Elevation (Total mg/l)
Aluminum	<50 - 230	<50 – 140	<50 - 230
Arsenic	<0.2 – 6.0	<0.02 - <1.0	<1.0
Barium	<20	<20 – 28	<20 - 20
Cadmium	<0.05 – 0.2	<0.04 - <0.1	<0.05 - <0.2
Copper	0.2 – 2.3	<0.1 – 2.5	0.11 – 1.3
Cyanide	<5	<5	<5
Iron	32 - 340	30 – 300	40 - 120
Lead	<0.051 – 0.082	<0.03 – 0.83	058 – 0.29
Manganese	<10 - 11	<10 – 37	<10 - 30
Mercury	<0.005 – 0.015	<0.005 – 0.019	<0.005 – 0.01
Nickel	<1 – 3.2	0.4 - <2	<2
Selenium	<2	<2	<2
Silver	0.04 – 0.86	<0.04 – 0.051	<0.04 – 0.096
Zinc	<5 – 7	<5	<5

None of these readings are greater than the DHS Primary MCLs, but four are greater than Secondary MCLs, which do not have specific human health considerations but are related to taste and odor. These values were:

- *Aluminum* - Two of the aluminum values (1.4% of the aluminum samples in project reaches) were greater than the Secondary MCL for aluminum (200 µg/l):
    - Rubicon Dam Reach - October 7, 2002, during the fall-turnover sampling event, downstream from the dam (230 µg/l).
    - Slab Creek Dam Reach - May 11, 2003, during the spring-runoff sampling event, downstream from the Rock Creek confluence (230 µg/l).

- *Iron* - Two of the iron values (1.5% of the iron samples in project reaches) were greater than Secondary MCL for iron (300 µg/l). Both occurred on September 17 and 18, 2003 during summer low flow sampling:
    - Rubicon Dam Reach - September 17, 2003, during the summer-low-flow sampling event, downstream of the dam (340 µg/l).
    - Ice House Dam Reach - September 18, 2003, during the summer-low-flow sampling event, downstream from the dam (300 µg/l).

Dissolved Oxygen Water Quality Objective

All UARP project reaches are well-oxygenated with dissolved oxygen concentrations greater than 85 percent saturation and 7.0 mg/l of oxygen except for three occasions, only one of which was in a UARP–affected reach. On October 8, 2002 the outflow water of Loon Lake Reservoir was measured at 5.5 mg/l. The other two occasions were in stream reaches not affected by the UARP: 3.1 mg/l in Jerrett Creek on October 8, 2002, and 3.7 mg/l in Rocky Basin Creek on September 17, 2003, both tributaries to Gerle Creek in the Loon Lake Dam Reach.

pH Water Quality Objective

Of the 150 riverine pH measurements taken by the SMUD, 24 measurements (16%) were below 6.5 and none were greater than 8.5. Of the 24 measurements below 6.5, 21 occurred at sites in the upper reaches and three occurred in the middle reaches. The lower pH values occurred in reaches not affected by the UARP, with the lowest pH value occurring at the SFRR inflow to Robbs Peak Reservoir (5.0 on September 17, 2003). The sampler noted that flow on this occasion was very low, similar to flow from a 1-inch garden hose (see Table 5.3.1-6). The next two lowest pH values both occurred at Highland Creek inflow to Rockbound Lake on June 11, 2003 and May 12, 2004 (5.75 and 5.83, respectively). The remaining 21 values below 6.5 ranged from 6.02 to 6.49.

Sediment Water Quality Objective

The Basin Plan Sediment Water Quality Objective states: “The suspended sediment load and suspended-sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.” SMUD concluded that UARP roads and facilities did not contribute substantial amounts of sediment to surface waters. UARP reservoirs capture sediment, which could affect downstream beneficial uses. Refer to Section 5.3.2.2 of this PDEA for a discussion of channel morphology and sediment transport in project reaches.

Taste and Odor Water Quality Objective

As described above, four of the total metals samples were greater than Secondary MCLs, which do not have specific human health considerations but are related to taste and odor. These values were for aluminum and iron. SMUD is unaware of any reports regarding the taste or odor in these reaches.

Toxicity Water Quality Objective

During 2004, riverine water samples collected from UARP project reaches and from non-project reaches were analyzed for six metals as dissolved concentrations (cadmium, copper, lead, nickel, silver and zinc). Hardness in these samples ranged from approximately from 1-20 mg/l. The percent of project reach samples that exceeded the CCC and/or CMC ranged from 33 percent of lead samples to 16.6 percent of copper, 4.5 percent of zinc, 1.5 percent of silver samples (CMC only), 1.5 percent of cadmium samples and zero percent of nickel samples, as shown in Table 5.3.1-16. The percent of non-project reach samples that exceeded the CCC and/or CMC ranged from 33 percent of lead samples, 3.3 percent of copper, 6.6 percent of silver samples (CMC only) and zero percent of nickel samples, also shown in Table 5.3.1-16. One snow sample was taken in 2004 and it exceeded CCC and CMC for cadmium, copper, and lead, as shown above in Table 5.3.1-13. The snow sample is mentioned here since snowmelt is a major source of runoff to area streams within the project basins.

Table 5.3.1-16. Total number of 2004 samples (measured as dissolved concentrations) of cadmium, copper, lead, nickel, silver, and zinc from UARP project and non-project reaches that exceed CCC or CMC criteria. (DTA 2005d).

Metal	Number of Samples Exceeding CCC	Number of Samples Exceeding CMC	Total Samples	Percent of Samples Exceeding CCC/CMC
UARP Reaches				
Cadmium	1	3	66	1.5/4.5
Copper	11	11	66	16.6/16.6
Lead	22	0	66	33.3/0
Nickel	0	0	66	0/0
Silver	NA	1	66	NA/1.5
Zinc	3	3	44	4.5/4.5
Non-project Reaches				
Cadmium	0	0	30	0/0
Copper	1	1	30	3.3/3.3
Lead	10	0	30	33.0/0
Nickel	0	0	30	0/0
Silver	NA	2	30	NA/6.6
Zinc	0	0	20	0/0

The non-project reach samples (and the snow sample, in Table 5.3.1.13) are indicative of inflow conditions to the UARP. It is worth noting that a number of non-project samples, as well as the snow sample, have exceedances of the CCC and CMC for various metals, indicating that dissolved metals occur at the watershed scale at concentrations that exceed the toxicity criteria.

The 2004 riverine samples reported as dissolved metal concentrations that exceeded the CCC and CMC for project reaches and non-project reaches are listed in Table 5.3.1-17.

Table 5.3.1-17. 2004 UARP project reach and non-project riverine dissolved metal samples exceeding CCC and CMC criteria (DTA 2005d).

Site Number	Site Name	Date	Hardness (mg/L)	Cadmium (ug/L)			Copper (ug/L)			Lead[1] (ug/L)			Silver (ug/L)			Zinc (ug/L)		
				Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC
UARP REACHES																		
RUBICON DAM REACH																		
2	Rubicon R. outflow from Rubicon Res	9/21/04	3.80							0.31	0.04	1.01						
2	Rubicon R. outflow from Rubicon Res	11/2/04	2.20				0.75	0.34	0.37									
2	Rubicon R. outflow from Rubicon Res	11/2/04	2.20							0.08	0.02	0.50						
3a	Fox Lake reach flow from Rubicon Reservoir	11/2/04	2.20				0.52	0.34	0.37									
3a	Fox Lake reach flow from Rubicon Reservoir	11/2/04	2.20							0.06	0.02	0.50						
5	Rubicon Outflow from Rockbound Lake	9/21/04	1.60							0.035J	0.01	0.33						
5	Rubicon Outflow from Rockbound Lake	11/2/04	2.00							0.020J	0.02	0.44						
6	Little Rubicon Outflow from Buck Island	5/12/04	2.15							0.028J	0.02	0.49						
6	Little Rubicon outflow from Buck Island Lake	9/21/04	1.90							0.025J	0.02	0.42						
6	Little Rubicon outflow from Buck Island Lake	11/2/04	3.00							0.05	0.03	0.74						
LOON LAKE DAM REACH																		
7	Gerle Creek outflow from Loon Lake	9/22/04	1.00	0.14	0.06	0.02												
7	Gerle Creek outflow from Loon Lake	9/22/04	1.00				0.42	0.18	0.18									
7	Gerle Creek outflow from Loon Lake	9/22/04	1.00							0.016J	0.01	0.18						
7	Gerle Creek outflow	11/10/04	ND	0.043	0.06	0.02												

Table 5.3.1-17. 2004 UARP project reach and non-project riverine dissolved metal samples exceeding CCC and CMC criteria (DTA 2005d).

Site Number	Site Name	Date	Hardness (mg/L)	Cadmium (ug/L)			Copper (ug/L)			Lead[1] (ug/L)			Silver (ug/L)			Zinc (ug/L)		
				Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC
	from Loon Lake			J														
7	Gerle Creek outflow from Loon Lake	11/10/04	ND				0.32	0.18	0.18									
7	Gerle Creek outflow from Loon Lake	11/10/04	ND							0.019J	0.01	0.18						
7	Gerle Creek outflow from Loon Lake	11/10/04	ND													4.7 J	2.39	2.37
14	Gerle Creek inflow to Gerle Creek Reservoir	9/19/04	3.50										0.0090 J	NA	0.01			
14	Gerle Creek inflow to Gerle Creek Reservoir	11/10/04	ND	0.040 J	0.06	0.02												
14	Gerle Creek inflow to Gerle Creek Reservoir	11/10/04	ND				0.33	0.18	0.18									
14	Gerle Creek inflow to Gerle Creek Reservoir	11/10/04	ND							0.07	0.01	0.18						
GERLE CREEK DAM REACH																		
15	Gerle Creek outflow from Gerle Creek Reservoir	9/19/04	3.00							0.030J	0.03	0.74						
15	Gerle Creek outflow from Gerle Creek Reservoir	10/31/04	3.00				0.61	0.45	0.49									
15	Gerle Creek outflow from Gerle Creek Reservoir	10/31/04	3.00							0.030J	0.03	0.74						
16	Gerle Creek Canal inflow to Robb's Forebay	9/22/04	1.40				0.26	0.23	0.24									
16	Gerle Creek Canal inflow to Robb's Forebay	9/22/04	1.40													7.40	7.40	7.34
20	South Fork Rubicon upstream of Rubicon River.	9/20/04	3.80				0.85	0.55	0.62									

Table 5.3.1-17. 2004 UARP project reach and non-project riverine dissolved metal samples exceeding CCC and CMC criteria (DTA 2005d).

Site Number	Site Name	Date	Hardness (mg/L)	Cadmium (ug/L)			Copper (ug/L)			Lead[1] (ug/L)			Silver (ug/L)			Zinc (ug/L)		
				Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC
20	South Fork Rubicon upstream of Rubicon River.	9/20/04	3.80							0.07	0.04	1.01						
20	South Fork Rubicon upstream of Rubicon River.	9/20/04	3.80													3.4 J	2.39	2.37
20	South Fork Rubicon upstream of Rubicon River.	11/1/04	4.20							0.11	0.04	1.14						
ICE HOUSE DAM REACH																		
25	SF Silver Outflow from Ice House Res.	5/12/04	2.71							0.05	0.03	0.65						
25	SF Silver Ck outflow from Ice House	9/15/04	2.50							0.032J	0.02	0.59						
27	SF Silver Creek inflow to Junction Res.	5/12/04	5.12							0.35	0.06	1.47						
JUNCTION DAM REACH																		
29	SF Silver Creek outflow of Junction Dam	9/14/04	4.00							0.10	0.04	1.07						
CAMINO DAM REACH																		
34	Silver Creek outflow from Camino Dam	9/12/04	ND				0.26	0.18	0.18									
36	Silver Ck. Upstream of SFAR	9/21/04	4.10							0.09	0.04	1.11						
41	SFAR ds of Camino Powerhouse	9/12/04	ND				0.41	0.18	0.18									
41	SFAR ds of Camino Powerhouse	9/12/04	ND							0.012J	0.01	0.18						
SLAB CREEK DAM REACH																		
43	SFAR outflow from Slab Ck Res.-upstream of Iowa-Brushy Cnyn Ck confl.	9/13/04	ND				0.037J	0.01	0.18									

Table 5.3.1-17. 2004 UARP project reach and non-project riverine dissolved metal samples exceeding CCC and CMC criteria (DTA 2005d).

Site Number	Site Name	Date	Hardness (mg/L)	Cadmium (ug/L)			Copper (ug/L)			Lead[1] (ug/L)			Silver (ug/L)			Zinc (ug/L)		
				Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC	Lab	CCC	CMC
NON-PROJECT REACHES																		
1	Rubicon River Inflow to Rubicon Reservoir	5/12/04	3.73							0.13	0.04	0.98						
1	Rubicon River Inflow to Rubicon Reservoir	9/21/04	6.20							0.08	0.07	1.87						
1	Rubicon River Inflow to Rubicon Reservoir	11/2/04	2.00							0.03	0.02	0.44						
4	Highland Creek	5/12/04	ND							0.025J	0.01	0.18						
4	Highland inflow to Rockbound Res.	11/2/04	ND				0.30	0.18	0.18									
4	Highland inflow to Rockbound Res.	11/2/04	ND							0.045J	0.01	0.18						
21	Tells Ck. Upstream of UV Res	11/1/04	8.00							0.33	0.10	2.59						
22	Big Silver Ck upstream of UV Res	11/1/04	2.80							0.046J	0.03	0.68						
23	Jones Fork Silver Ck inflow to UV Res.	11/1/04	4.80										0.017J	NA	0.01			
24	SF Silver Upstrm of Ice House Res.	5/11/04	1.99							0.039J	0.02	0.44						
24	SF Silver Ck upstream of Ice House Res.	9/15/04	5.80							0.07	0.07	1.72						
24	SF Silver Ck upstream of Ice House Res.	11/1/04	2.80							0.15	0.03	0.68						
28	Little Silver Creek inflow to Junction Res.	11/8/04	3.10										0.014J	NA	0.01			

Total recoverable metals concentrations in 2002 and 2003 project and non-project reaches samples exceeded some CCC and/or CMC criteria for dissolved metals concentrations. Percentages of project reach samples exceeding criteria range from 29.5 percent of lead samples to 11.5 percent of copper, 4.2 percent of silver (CMC only), 3.9 percent of cadmium (CMC only) to zero percent of nickel or zinc samples exceeding either criteria, as shown in Table 5.3.1-18. Percentages of non-project reaches samples exceeding criteria range from 36.8 percent of lead samples to 5.3 percent of copper, 5.3 percent of cadmium (CMC only) to zero percent of nickel or zinc samples exceeding either criteria, as shown in Table 5.3.1-18.

Table 5.3.1-18. Total number of 2002-2003 samples (measured as total recoverable concentrations) of cadmium, copper, lead, nickel, silver, and zinc from project and non-project reaches samples that exceed CCC or CMC criteria.

Metal	Number of Samples Exceeding CCC	Number of Samples Exceeding CMC	Total Samples	Percent of Samples Exceeding CCC/CMC
UARP Reaches				
Cadmium	0	2	61	0/3.3
Copper	7	6	61	11.5/9.8
Lead	21	0	71	29.5/0
Nickel	0	0	61	0/0
Silver	NA	3	71	NA/4.2
Zinc	0	0	39	0/0
Non-project Reaches				
Cadmium	0	1	19	0/5.3
Copper	1	0	19	5.3/0
Lead	7	0	19	36.8/0
Nickel	0	0	19	0/0
Silver	NA	0	19	0/0
Zinc	0	0	10	0/0

Water Temperature of Project Reaches

The Basin Plan designates beneficial uses of the water in project reaches as Cold Freshwater Habitat and Cold Freshwater Spawning for aquatic biota, Warm Freshwater Habitat is listed in some lower elevation reaches (see Table 5.3.1-5). However, the Basin Plan does not provide numerical water temperature criteria for cold water other than with regard to the "natural receiving water temperature." The SWRCB advised SMUD that the Board does not apply this Temperature Water Quality Objective to hydro projects (TWG meeting notes, June 14, 2004).

Nevertheless, criteria are available to ascertain whether the project reaches support the Basin Plan's Cold Freshwater Habitat beneficial use. One may assume that water is considered "cold" if mean daily water temperatures are less than 20°C, which is normally considered the upper optimum growth limit for rainbow trout, and daily maximum water temperatures are less than 25°C, which is a conservative estimate of the lethal temperature for rainbow trout (Hokanson et al. 1977, Raleigh et al. 1984). CDFG's temperature policy for stocking catchable trout supports the general use of these temperature criteria. This policy states: *"Catchable trout shall not be stocked in streams when water temperatures reach 75°F and it appears that such temperatures will continue to occur regularly, or when stream flows drop below 10 cfs. The exception is that suitable streams with flows between 2 and 10 cfs may be planted if water temperatures do not exceed 70°F and other conditions are satisfactory"* . (http://dfg.ca.gov/fishplant/criteria.html).

Table 5.3.1-19 shows the amount of time that mean daily water temperatures were greater than 20°C and maximum daily water temperatures for each of the UARP reaches, excluding the Rockbound Dam reach for which data are not available. Based on the temperature criteria above, the project reaches can be subdivided into 15 segments: 8 of which are cold segments (about 38 river miles).

Cold Sections:

- All of Loon Lake Dam Reach (8.5 miles)
- All of Gerle Creek Dam Reach (1.2 miles)
- Downstream portion of Robbs Peak Dam Reach (about 4 miles)
- Upstream portion of Ice House Dam Reach (about 7 miles)
- All of Junction Dam Reach (8.3 miles)
- Upstream portion of Camino Dam Reach (about 3 miles)
- All of Brush Creek Dam Reach (2.2 miles)
- Upstream portion of Slab Creek Dam Reach (about 4 miles)

Other:

- All of Rubicon Dam Reach (mean daily water temperature is greater than 20°C about 7-12% of the time but maximum daily water temperature always less than 25°C) (4.2 miles)
- Buck Island Dam Reach (11-13% and 26.4°C in the downstream portion) (2.5 miles)
- Upstream portion of Robbs Peak Dam Reach (4% but maximum daily water temperature always less than 25°C) (about 2 miles)
- Lower middle and downstream portions of Ice House Dam Reach (0.6-2% of the time and maximum daily temperature of 26.0°C) (about 4 miles)
- Downstream portion of Camino Dam Reach (10% and 25.6°C) (about 3 miles)
- All of the SFAR Reach (13% and 25.8°C) (2.8 miles)
- Downstream portion of Slab Creek Dam Reach (28% and 26.7°C) (about 4 miles)

The generally cool water releases in the summertime keep UARP reaches below UARP facilities cooler than background or reference streams above project reservoirs. The Basin Plan Temperature objective for most of the UARP project reaches is for Cold Freshwater Habitat. Based on the temperature of water in tributaries entering project reservoirs, it is highly likely that the watershed, on the whole, would experience warmer water temperatures without the UARP. By making coldwater releases from the reservoirs, the UARP provides more Cold Freshwater Habitat in the basin than would otherwise occur.

Table 5.3.1-19. Frequency of mean daily water temperatures exceeding 20.0 °C in project reaches and the maximum instantaneous water temperature.

Location		Monitoring Period	Days with Readings	Number of Days with Mean Daily Temperature Equal to or Greater than 20.0 C						% of Monitoring Period	Maximum Mean Daily Value	Maximum Daily Value
Description	**Site**	**Dates**	**#**	**2000**	**2001**	**2002**	**2003**	**2004**	**Total**	**% of Period**	**C**	**C**
Rubicon Dam Reach (4.2 miles)												
Above Reservoir	RR4	5/13/02-8/27/04	838	-----	-----	10	7	16	33	3.94%	21.3	26.8
At Dam	RR3	10/28/00-9/30/04	1,434	0	30	22	26	33	111	7.74%	22.2	22.7
At Rubicon Springs	RR2	5/14/02-9/30/04	871	-----	-----	14	13	13	40	4.59%	21.9	24.1
Below Rubicon River/SFRR Confluence	RR1	10/28/00-9/30/04	1,435	-----	26	25	21	23	95	6.62%	22.9	23.7
Buck Island Dam Reach (2.5 miles)												
At Dam	LRR2	10/28/00-9/30/04	1,434	-----	65	43	36	36	180	12.55%	22.9	23.7
Mid-Reach	LRR1	7/24/02-9/30/04	800	-----	-----	21	28	37	86	10.75%	23.7	26.4
Loon Lake Dam Reach (8.5 miles)												
At Dam	GC6	10/18/00-9/30/04	1,423	0	0	0	0	0	0	0.00%	16.9	17.1
Above Gerle Creek Reservoir	GC3	10/27/00-9/30/04	1,435	0	0	0	0	0	0	0.00%	19.8	24.3

Table 5.3.1-19. Frequency of mean daily water temperatures exceeding 20.0 °C in project reaches and the maximum instantaneous water temperature.

Location		Monitoring Period	Days with Readings	Number of Days with Mean Daily Temperature Equal to or Greater than 20.0 C						% of Monitoring Period	Maximum Mean Daily Value	Maximum Daily Value
Description	**Site**	**Dates**	**#**	**2000**	**2001**	**2002**	**2003**	**2004**	**Total**	**% of Period**	**C**	**C**
Gerle Creek Dam Reach (1.2 miles)												
At Dam	GC2	4/7/01-9/30/04	1,209	-----	0	0	0	0	0	0.00%	18.4	18.6
Above Gerle Creek/SFRR Confluence	GC1	5/24/02-9/30/04	854	-----	-----	0	0	0	0	0.00%	17	19.3
Robbs Peak Dam Reach (5.9 miles)												
Above Reservoir	SFRR4	7/20/01-9/30/04	1,169	-----	-----	3	9	0	12	1.03%	21.3	24.5
At Dam	SFRR3	5/10/01-9/30/04	1,240	-----	34	0	0	0	34	2.74%	22.5	23.1
Above Gerle Creek Confluence	SFRR2	5/24/02-9/30/04	861	-----	-----	0	0	0	0	0.00%	18.4	20.2
Below Gerle Creek and SFRR Confluence	SFRR1	10/27/00-9/30/04	1,435	0	0	0	0	0	0	0.00%	18.8	20.4
Ice House Dam Reach (11.5 miles)												
Above Reservoir	SFSC6	7/23/01-9/30/04	1,166	-----	0	0	0	0	0	0.00%	19.7	21.7
At Dam	SFSC5	3/24/01-9/30/04	1,287	-----	0	0	0	0	0	0.00%	8	8.6
Mid-Reach	SFSC2	11/3/00-9/30/04	1,428	0	6	0	0	0	6	0.42%	20.7	26
Above Junction Reservoir	SFSC1	10/20/00-9/30/04	1,442	0	15	3	7	0	25	1.73%	21.3	26

Table 5.3.1-19. Frequency of mean daily water temperatures exceeding 20.0 °C in project reaches and the maximum instantaneous water temperature.

Location		Monitoring Period	Days with Readings	Number of Days with Mean Daily Temperature Equal to or Greater than 20.0 C						% of Monitoring Period	Maximum Mean Daily Value	Maximum Daily Value
Description	**Site**	**Dates**	**#**	**2000**	**2001**	**2002**	**2003**	**2004**	**Total**	**% of Period**	**C**	**C**
Junction Dam Reach (8.3 miles)												
Jones Fork Silver Creek	JFSC1	7/20/01-9/30/04	1,169	-----	5	12	13	0	30	2.57%	22	25
At Dam	SC4	10/21/00-9/22/04	1,433	0	0	0	0	0	0	0.00%	11.2	13.5
Above Camino Reservoir	SC3	11/3/00-9/30/04	1,428	0	1	0	1	0	2	0.14%	20.2	22
Camino Dam Reach (6.2 miles)												
At Dam	SC2	11/3/00-9/30/04	1,306	0	0	0	0	0	0	0.00%	12.7	14.7
Above SFAR Confluence	SC1	11/9/00-9/30/04	1,422	0	71	25	16	33	145	10.20%	23.2	25.6
SFAR Reach (2.8 miles)												
Above Silver Creek/SFAR Confluence	SFAR12	7/30/01-9/30/04	1,159	-----	27	46	42	63	178	15.36%	24.3	26.7
Below Silver Creek/SFAR Confluence	SFAR11	7/30/01-9/30/04	1,159	-----	27	44	32	66	169	14.58%	23.7	25.9
Brush Creek Dam Reach (2.2 miles)												
At Dam	BC2	11/10/00-9/30/04	1,420	0	0	0	0	0	0	0.00%	18.7	19

Table 5.3.1-19. Frequency of mean daily water temperatures exceeding 20.0 °C in project reaches and the maximum instantaneous water temperature.

Location		**Monitoring Period**	**Days with Readings**	**Number of Days with Mean Daily Temperature Equal to or Greater than 20.0 C**						**% of Monitoring Period**	**Maximum Mean Daily Value**	**Maximum Daily Value**
Description	**Site**	**Dates**	**#**	**2000**	**2001**	**2002**	**2003**	**2004**	**Total**	**% of Period**	**C**	**C**
Slab Creek Dam Reach (8.0 miles)												
At Slab Creek Powerhouse	SFAR9	3/23/01-9/30/04	1,288	-----	0	0	0	0	0	0.00%	16.2	16.7
Rock Creek	RC1	6/6/03-9/30/04	483	-----	-----	-----	22	38	60	12.42%	23.1	24.4
Above White Rock Powerhouse	SFAR6	6/1/02-9/30/04	852	-----	-----	70	66	75	211	24.77%	24.4	26.7

Water temperatures within the UARP project reaches exhibit a wide range of values due to a variety of factors, including the extensive elevation range of the reaches and differences in source waters (e.g., releases from stratified reservoirs vs. isothermal reservoirs). The following sections describe the existing thermal regime of each project reach, derived from the monitoring data generated during the UARP relicensing studies.

As described in Table 5.3.1-19, the monitoring period for the majority of water temperature study sites covers the water years 2001-2004. A review of long-term (1944-2004) mean monthly air temperature data from a nearby weather station provides insight into the ambient air temperatures that existed in the watershed during the monitoring time period (Table 5.3.1-20).

Table 5.3.1-20. Mean monthly air temperature percent exceedance values at Blue Canyon Weather Station for June-September over the four water years of UARP monitoring.

Year	June	July	August	September
2001	40 %	< 50%	10 %	10 %
2002	20 %	5 %	30 %	30 %
2003	10 %	0 %	30 %	5 %
2004	30 %	40 %	< 50 %	< 50 %

Summer ambient air temperatures were generally warm during the monitoring period. The warmest ambient conditions occurred in July 2002 and 2003, with July 2003 representing the hottest July over the 60-year period of record. The coolest ambient conditions occurred in July 2001 and August 2004.

Rubicon Dam Reach

The existing thermal regime in the Rubicon Dam Reach exhibits a wide range of water temperatures that is the direct result of two key features of the watershed: high elevation and limited water retention capability. The high elevation of the reach (6,509 – 6,046 feet) leads to extended winter periods of water temperatures very near to zero. From December through April, mean daily water temperatures throughout the reach generally do not exceed 5ºC (the temperature below which cold water fish are inactive) and typically are less than 2ºC. This is a time of year when the river reach, as well as the entire upper basin of the Rubicon River, is often covered with snow and ice.

Starting in May, water temperatures in the reach gradually ascend to highest values of the year in July and August. These summer months are a time of rapidly declining flow in the project reach, the result of the limited capability of the exposed-granite watershed to retain water. As previously demonstrated in Table 5.3.1.6, stream flows in the entire basin (above and below the reach watershed) fall to extremely low levels and even cease in many locations. Accretion from tributaries, such as Miller Creek, does not significantly contribute to flow or water temperature in the reach. Thus, it is in July and August, when the combination of declining flows and rising solar radiation and air temperature, result in water temperatures reaching their zenith, ranging between mean daily values of 18 and 22°C throughout the reach. The number of days per year when mean daily water temperatures that are equal to or above 20°C ranges from 13 to 30 throughout the project reach (see Table 5.3.1-19).

In September, despite the fact that streamflow in the reach remains low (typically around 1 cfs), water temperatures begin to decline due to the decreasing influence of ambient conditions. A gradual decline through September, October, and November returns water temperature to their winter levels.

The inflowing water to Rubicon Reservoir exhibits thermal trends that are similar to those of the project reach. Both the winter and summer extremes are similar between the Rubicon River above the reservoir and within the project reach. The number of days per year when mean daily water temperatures that are equal to or above 20°C in the Rubicon River above the reservoir ranges from 7 to 16 days (see Table 5.3.1-19).

Rockbound Dam Reach

As described in Section 5.3.1.2, Rockbound Lake is a natural lake with a small non-UARP masonry dam located at its outlet. Because the dam outlet facilities are currently inoperable, flows out of Rockbound Lake are the result of water passing over the dam into the stream reach below. Little is known of the existing thermal regime of this 0.3-mile project reach because it was not part of the studies performed during relicensing. However, it is likely that many aspects of the Rubicon Dam Reach thermal regime are repeated in the Rockbound Dam Reach. For example, the reach almost certainly exhibits the same December-April near zero water temperatures, when the entire upper Rubicon River basin, including this reach, is under snow. Also, the timing and duration of spring warming, summer peak temperatures, and fall cooling that occur in the Rubicon Dam Reach are likely occurring in the Rockbound Dam Reach.

The one area of divergence between the Rockbound Dam and Rubicon Dam reaches may be the high temperatures reached during the July-August period. A unique characteristic of the Rockbound Dam Reach is the source of water flowing into it during these summer months. The source is the epilimnion of the strongly-stratified Rockbound Lake. Inflow to Rockbound Lake, both natural from Highland Creek and water diverted from the Rubicon River, drops off in July. The epilimnion of Rockbound Lake was found to be 8 meters deep and 17°C in September. The epilimnion may be a degree warmer in July and August, but nevertheless cooler as a starting water temperature than the 20-21°C water that emerges from Rubicon Dam. Thus, it is likely that the existing thermal regime of the Rockbound Dam Reach is slightly cooler in summer than the Rubicon Dam Reach.

Buck Island Dam Reach

The existing thermal regime of the Buck Island Dam Reach is similar to that of the Rubicon Dam Reach. Winter low temperatures, for example, exhibit the same long period of near freezing conditions between December and April. This is largely explained by the similarities in elevation of the two reaches. However, the uniqueness of the stream character in the Buck Island Reach explains some differences between the two reaches. The Buck Island Dam Reach is composed of segments of river flowing over large slabs of exposed bedrock with no discernible stream channel or riparian vegetation to provide shading. This characteristic of the Little Rubicon River creates an environment where river waters are very susceptible to the influences of ambient conditions, particularly at low flow. The result is that summer water temperatures are warmer than the Rubicon Dam Reach. Water temperatures in the Little Rubicon River rise to summer high mean daily values of between 23°C and 24°C. There is no accretion flow within the 2.5-mile project reach during summer/fall months.

Loon Lake Dam Reach

The existing thermal regime of the Loon Lake Dam Reach is very different from that of the other upper elevation project reaches. Water temperatures are basically cooler than in the upper Rubicon River basin project reaches. This is due to a variety of factors, including the influence of Loon Lake Reservoir water storage and a higher level of shading provided by riparian vegetation along Gerle Creek.

Water released from Loon Lake Dam varies in temperature over the year from a low of approximately 2°C in December to a high of roughly 16°C in September/October. This variability is a function of the dynamics of Loon Lake Reservoir's thermal stratification. In fall and winter months, Loon Lake Reservoir is isothermal, but the reservoir develops a weak stratification each year between June and September. As the summer progresses, the water emanating from the reservoir gradually warms as the water from the lowermost and coolest portions of the hypolimnion is used up and gradually replaced by the progressively higher, and warmer, levels of the hypolimnion. In the late September/early October timeframe, Loon Lake Reservoir turns over with the cooler hypolimnetic water mixing with the warmer epilimnetic water. This results in a sharp increase in water temperature emanating from Loon Lake Dam, reaching the peak of about 16°C, immediately followed by a gradual decline as the reservoir cools off in the fall and winter months.

Water temperatures throughout the 8.5-mile-long project reach are a function of the Loon Lake Reservoir release temperatures and ambient conditions. In the winter, despite release of 2º to 3°C, temperatures throughout the project reach hover between 0º and 3°C from December through April, (i.e., the reach cools down). In essence, the buffering capacity of the isothermal reservoir leads to release temperatures that are above the near-freezing equilibrium temperatures dictated by the ambient conditions. During July and August, mean daily temperatures emanating from Loon Lake Reservoir range from 9º to 11°C and warm throughout the reach to values between 15º and 18°C. Again, the temperatures from the reservoir are below the equilibrium temperatures, and the stream warms as a result.

During the fall months of September through November, temperatures in the Loon Lake Dam Reach gradually decline to the winter low levels, which start in December. The upswing in temperatures emanating from the dam during fall turnover (in October) has little influence over the water temperatures in the reach. The ambient conditions during these fall months are the dominant factor influencing temperatures throughout the reach.

At no time during the multi-year monitoring program were the temperatures in the Loon Lake Dam Reach above 20°C (see Table 5.3.1-19).

Gerle Creek Dam Reach

The existing thermal regime of the 1.2-mile Gerle Creek Dam Reach includes moderate water temperatures that range from wintertime lows of 2º to 5°C to summer highs of 12º to 19°C. The temperature of the water released from Gerle Creek Dam exhibits a representative pattern of seasonal change, reaching a peak value in mid-August of just over 18°C. Despite some of these yearly differences in summertime water temperatures emanating from Gerle Creek Reservoir, the thermal regime at the bottom of the reach are very similar between years. In 2002, 2003, and 2004, mean daily summer water temperatures at the bottom of the reach ranged from 12.5º to 16°C.

Robbs Peak Dam Reach

The existing thermal regime of the Robbs Peak Dam Reach is similar to that of the Gerle Creek Dam Reach. This outcome is expected as both reaches are relatively short and lie within the same elevation range (see Table 5.3.1-3). Both Gerle Creek and Robbs Peak reservoirs are at the same elevation, both reaches are less than 1.5 miles in length, and both end at the confluence of SFRR and Gerle Creek.

Water inflowing to Robbs Peak Reservoir from SFRR ranges in temperature from mean daily wintertime lows of near zero to summertime peaks of 19ºC to 21°C. The high summertime water temperatures occur as flows in SFRR transition from values of approximately 10 cfs in early July to less than 1 cfs at the end of August (see Table 5.3.1-6).

The existing thermal regime of water downstream of Robbs Peak Reservoir is very similar to that of the water downstream of Gerle Creek Reservoir. Water temperatures emanating from Robbs Peak Reservoir were generally between 14ºC and 19°C. Water temperatures 1.3 miles downstream, above the confluence with Gerle Creek, were very similar to that of the water temperature at the dam. Downstream of the confluence, summer water temperatures were somewhat cooler than upstream of the confluence. This was particularly evident in the summer of 2001, where the high water temperatures emanating from Robbs Peak Reservoir had cooled at the confluence, clearly indicating that the high water temperatures from the reservoir were above the equilibrium temperature of the stream.

Ice House Dam Reach

Ice House Reservoir is the most strongly stratified reservoir of all UARP reservoirs. Each year, it develops a sharply defined epilimnion and hypolimnion, which last long into the fall. Turnover typically occurs at Ice House Reservoir in early December. The long-lasting stratified condition at the reservoir creates a very constant temperature of the hypolimnetic release water. From June 1 until December 1, the temperature of the water released from the reservoir ranges from 6°C to 7°C. Once the reservoir turns over and cools during winter months temperatures emanating from the reservoir drop to lows of approximately 4°C.

Downstream of the reservoir, the water temperatures throughout the 11.5-mile project reach are largely determined by ambient conditions as well as by the lack of riparian vegetation within the central portion of the reach due to the 1992 Cleveland fire. In the summer months, water temperatures throughout the unshaded reach gradually warm downstream from the starting 6ºC to 7°C values. Water temperatures at the bottom of the reach attained mean daily values of 20°C to 21°C in three of the four years of the monitoring study (see Table 5.3.1-19). Most of the above-20°C values occurred in July 2001, a month of moderate ambient conditions and low releases (minimum requirement 5 cfs). In contrast, July of 2003 was the hottest July of record with higher releases (minimum requirement 15 cfs), which resulted in water temperatures at the bottom of the reach that were greater than 20°C half as often (7 days). These water temperatures occur under conditions of no riparian shading throughout a majority of the reach.

During winter months, water temperatures in the project reach are generally cold (less than 5°C) from December through March. In many months during this period, the water temperatures in the reach cool down below the 4ºC to 5°C values emanating from the reservoir, at times approaching zero.

Water temperatures of the SFSC upstream of Ice House Reservoir are generally cooler than the entire project reach in the winter months but roughly equivalent to the temperatures in the mid portion on the project reach in the summer months. Streamflows measured above Ice House Reservoir in the summer months during the survey period range between 10 and 20 cfs in July and between 2 and 5 cfs in August.

Junction Dam Reach

The existing water temperatures in Silver Creek within the Junction Dam Reach are largely derived from reservoir releases and the substantial geographic shading afforded by the steep and 1,000-feet high canyon walls. Water temperatures emanating from Junction Reservoir range from winter lows of 2ºC to 5°C to summer highs of 8ºC to 10°C. These patterns are fairly constant from year to year, influenced by stable hypolimnetic water temperatures of Junction Reservoir. At the bottom of the 8.3-mile project reach, water temperatures are relatively unchanged from the reservoir release in the winter but warm to mean daily summer values of 18ºC to 20°C. There were only two days with temperatures above 20°C during the four-year study period, despite the very hot air temperatures that prevailed in July 2002 and 2003 (see Table 5.3.1-19). These thermal conditions are different from those of the feeder streams that flow into Union Valley Reservoir. The feeder streams exhibit colder winter temperatures and warmer summer temperatures. In the winter, all three tributary streams exhibit water temperatures that are near zero, while in the summer, Big Silver and Jones Fork creeks reached peak mean daily temperatures of between 20ºC to 22°C. The number of days that were greater than 20°C in Jones Fork Silver Creek ranged between 5 and 13 days.

Camino Dam Reach

The existing water temperatures in the Camino Dam Reach are warmer, but in general, very similar to those in the Junction Dam Reach. The 6.2-mile project reach is, in essence, an extension of the Junction Reach, framed by the same steep and high walls of Silver Creek canyon. Winter temperatures emanating from Camino Reservoir range between 2ºC and 5°C, while summer temperatures range between 9ºC and 12°C. At the mouth of the Silver Creek, winter temperatures have increased slightly above the temperatures below the dam, but the summer water temperatures have warmed to mean daily high values of between 20ºC and 23°C. At the bottom of the reach, temperatures above 20°C occur approximately ten percent of the time, largely confined to July and August.

The temperatures above 20°C at the bottom of the Camino Dam Reach are very likely similar to natural conditions for this location of the SFAR watershed. This determination stems from the comparison of these temperatures to two other sites. First, the Camino Dam Reach temperatures are only slightly warmer overall than the temperatures of the streams flowing into Union Valley Reservoir, 18 miles upstream. Thus, it is reasonable to assume that if the natural inflowing water to Union Valley Reservoir were to course the 18 miles to the mouth of Silver Creek, it would more than likely rise at least to the levels reflected in the monitoring data. Secondly, the Camino Dam Reach temperatures are essentially equivalent to those of the SFAR, directly above the confluence with Silver Creek. In the years 2002-2003, the number of days at the base of Silver Creek that exhibited temperatures above 20°C is roughly half the number days in the SFAR. However, in 2001 the trend is reversed, with the number of days above 20°C in Silver Creek being twice the number in the SFAR (Table 5.3.1-19). The reason for the difference lies principally in the releases between these years. In 2001, the Camino Dam release was 10 cfs; in 2002-2004, it was 20 cfs.

Brush Creek Dam Reach

The existing thermal regime of the Brush Creek Dam Reach is determined by a few features that are unique to this short (2.2-mile) stretch of Brush Creek. Like other project reaches, the Brush Creek Dam Reach lies within a steep canyon walls, but unlike all others, this reach contains a dense conifer forest along both banks that provides a closed canopy and complete shading to the narrow, mossy stream. As a result, little change in water temperature occurs within the relatively short reach. Water temperatures emanating from the Brush Creek Reservoir exhibit winter lows in the range of 6-8°C and summer high values of 12ºC to 18°C. Temperatures at the bottom of the reach did not warm by more than 2-3°C at any time. Furthermore, temperatures throughout the reach were not greater than 20°C at any time, even in the extreme air temperature month of July 2003.

Slab Creek Dam Reach

In keeping with the warming trend moving downriver, the water temperatures emanating from Slab Creek Dam are warmer than those of Camino Dam. Winter temperatures range between 3°C and 6°C, while summer temperatures range between 12ºC and 16°C. Approximately halfway through the reach at Mosquito Road Bridge, summer water temperatures increased to mean daily peak values of 20ºC to 21°C, while at the bottom of the reach, just upstream of White Rock Powerhouse, mean daily values peak at 22ºC to 23°C. Winter water temperatures upstream of White Rock Powerhouse range between 6ºC and 10°C.

In essence, the existing thermal regime of the Slab Creek Reservoir is consistent with the transition in west-slope Sierra Nevada from high elevation cold zones to low elevation warm zones. According to Moyle (2002), the transition from the rainbow trout assemblage (cold water zone) to the pikeminnow-hardhead-sucker zone (warm water zone) occurs in west-slope streams at approximately 450-550 meters in elevation, which is consistent with the 1,650-995 ft. elevation range of the Slab Creek Dam Reach.

Benthic Macroinvertebrates as an Indicator of Water Quality

Data from the Aquatic Bioassessment studies exhibit several notable trends. First, overall BMI composite metric scores increase moving downstream in the Ice House Dam, Loon Lake Dam, and Junction Dam reaches, which are downstream of the three largest UARP storage dams. This suggests potential decline immediately downstream of storage dams, but recovery further along the reach. Conversely, overall BMI composite metric scores decrease moving downstream in Camino Dam and Slab Creek Dam reaches, suggesting a decline in water quality at the lower ends of these reaches. No discernable BMI composite metric score trends were observed in the other UARP reaches.

Annual variation of water and habitat quality as represented by the BMI composite metric scores was moderate for most sites within the UARP project reaches. Sites that received relatively high or low water and habitat quality scores in 2002 tended to exhibit similar trends in 2003.

5.3.1.3 Environmental Effects of the Proposed Action

To determine the environmental effects of the Proposed Action on water resources, SMUD compared the effects of the proposed Action on water quantity and water quality in the reservoirs and reaches against the baseline conditions. In the case of water quantity, SMUD would consider the Proposed Action to have a significant effect if it changed the quantity of water within the reservoirs and reaches in such a way as to result in a significant adverse effect to water quality, aquatic resources, or recreation. Here, however, there was no such change. In fact, the Proposed Action will have a beneficial effect on water quantity because it maintains or increases flows in all reaches in all water year types.

In the case of water quality, the Proposed Action would have a significant effect if it caused the water quality of the reservoirs and reaches to be inconsistent with the Basin Plan. SMUD's studies demonstrate water quality in project reaches and reservoirs is generally excellent and consistent with Basin Plan Standards. However, some water quality parameters occasionally exceed numerical criteria in the Basin Plan or other established water quality guidelines. The Proposed Action does not include water resources measures to address these occasions because, as described in this section, water quality objectives are rarely exceeded. In addition, when water quality parameters exceed the Basin Plan objectives, the nexus to the project is unclear and is not a controllable factor; UARP operations and maintenance do not directly cause or control these exceedences.

As described below, and in Section 5.3.3.3, Aquatic Resources, the Proposed Action includes two measures: 1) adherance to five water year types to reflect annual flow variability in the watershed; and 2) periodic modification of releases from Ice House Dam to meet cold freshwater habitat criteria in the Ice House Dam Reach. The Proposed Action also includes two measures to protect water quality during construction of the Iowa Hill Development: 1) development of an Erosion and Sedimentation Control Plan; and 2) development of a Storm Water Pollution Prevention Plan. Each of these four measures and their expected benefits are discussed below.

<u>Proposed Measure – Water Year Types</u>

SMUD proposes five water types to best capture the variability of water year types in the watershed, though at some locations minimum stream flows might be the same in different water year types. The types are:

- *Critical Dry* - water years in which the availability of water in the watershed is a high societal priority – a drought might be declared. This is defined as when CDWR's forecast is less than 900,000 ac-ft total inflow into Folsom Reservoir.
- *Dry* - below normal runoff, but not critical. Defined as when CDWR's forecast is from 900,001 to 1,700,000 ac-ft total inflow into Folsom Reservoir.
- *Below Normal* - flows are about 25 percent below the 50-year median flow of 2.6 million acre-feet. Defined as when CDWR's forecast is from 1,700,001 to 2,600,000 ac-ft total inflow into Folsom Reservoir.
- *Above Normal* - flows are about 25 percent above the 50-year median flow. Defined as when CDWR's forecast is from 2,600,001 to 3,500,000 ac-ft total inflow into Folsom Reservoir.
- *Wet* - usually plenty of water in the watershed, and UARP dams are generally spilling in the spring. This water year type occurs when CDWR's forecast is for more than 3,500,000 ac-ft total inflow into Folsom Reservoir.

A review of the annual unregulated historical hydrology demonstrates that annual runoff in the American River watershed is highly variable (Figure 5.3.1-9). About 90 percent of annual runoff occurs from April through June as a result of snowmelt in the higher elevations. Little or no precipitation occurs from about June through October. The typical annual hydrograph shows lowest flows (base flows) occurring from the end of the snowmelt through about December, with fall and early winter storms producing very brief spikes in these base flows. As winter storms intensify, streamflow increases with highest flows occurring during peak snowmelt runoff. Even during high flow periods, winter storms (especially warm storms that result in heavy rain in the lower elevations and rain-on-snow in the upper elevations) produce numerous brief spikes in streamflow.

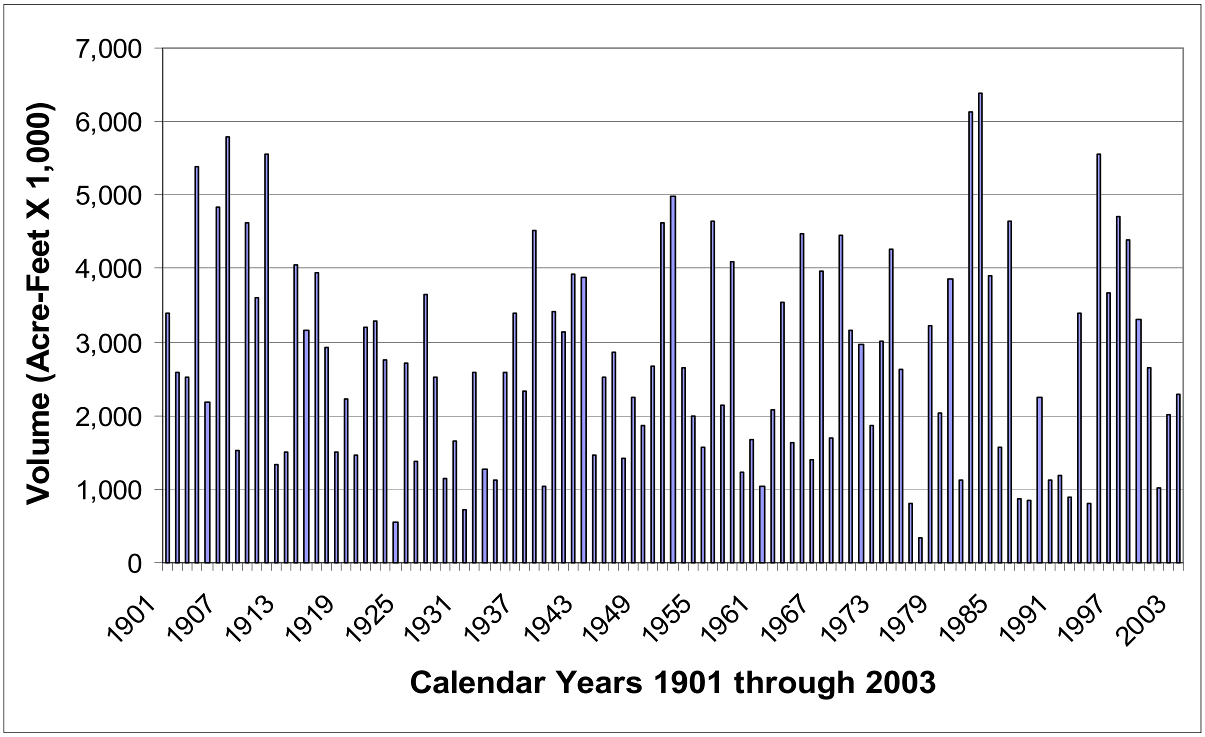

Figure 5.3.1-9. California Department of Water Resources estimate of total unimpaired runoff below Folsom Lake from Calendar Year 1901 through 2003 (CDWR).

The development of water year types that trigger various flow related measures would generally provide for a range of annual variability in the watershed.

One option considered was the Sacramento Valley Water Year Type Index, which is specified in the Basin Plan (RWQCB 2004). CDWR is impartial, is recognized as an expert in this type of forecasting, has been forecasting unimpaired runoff in California since 1930, and is expected to continue to do so over the course of the new license term.

For the Sacramento Valley Water Year Type Index, CDWR sums by month forecasted inflow into Shasta Lake, the Feather River inflow into Oroville Reservoir, the Yuba River flow near Smartville plus Deer Creek, and the American River flow below Folsom Lake. CDWR adjusts the sum as follows:

- 0.4 times the April through July forecast (in million ac-ft)
- 0.3 times the October through March forecast (in million ac-ft)
- 0.3 times the previous water year's index

The sum is then applied to the following water year type classifications (in millions of ac-ft) to establish water year type for the Sacramento Valley:

- Wet ≥9.2
- Above Normal >7.8 and <9.2

- Below Normal >6.5 and <7.8
- Dry >5.4 and <6.5
- Critical <5.4

While this classification system is readily available, it is not appropriate for the Proposed Action since it covers a much larger and diverse geographical area than the project area and includes the previous water year's classification.

Another readily available water year classification system is the one recently proposed for the El Dorado Project, which is based on a SWRCB Reconsideration of Decision 1635 (April-July forecast). This system is not appropriate because the El Dorado Project water year types are based on when the relatively small El Dorado Project reservoirs spill, which is very different from when the much larger UARP reservoirs spill.

CDWR's forecast for unimpaired runoff from the American River below Folsom Reservoir is most appropriate. The total water year forecast better reflects conditions in the watershed than CDWR's April through July forecast. Using the CDWR forecast at Silver Creek has little benefit because historically, CDWR back-calculates Silver Creek unimpaired runoff using a drainage area ratio after calculating the unimpaired flow below Folsom, and CDWR has not estimated the Silver Creek unimpaired flow since 1990.

CDWR publishes forecasts on February, March, April and May 1 and estimates total water year runoff on October 1. SMUD proposes water year types change soon after the tenth of each of these months, but not immediately to allow SMUD time to make the changes in the project. Specifically, the changes would be:

- CDWR February 1 Forecast would be used to set the water year type from February 10 through March 9;
- CDWR March 1 Forecast would be used to set the water year type from March 10 through April 9;
- CDWR April 1 Forecast would be used to set the water year type from April 10 through May 9;
- CDWR May 1 Forecast would be used to set the water year type from May 10 through October 9; and
- CDWR October 1 Estimate would be used to set the water year type from October 10 through February 9.

The application of these proposed water year types as part of the Proposed Action would allow for the development of regulated streamflow regime that generally approximates unregulated historical annual variability.

<u>Proposed Measure – Ice House Dam Reach Water Temperature Monitoring</u>

The Proposed Action contains a new release schedule for Ice House Dam. Releases from Ice House Dam, particularly in summer months, have the potential to affect water temperatures throughout the Ice House Dam Reach. Results of the relicensing temperature monitoring program (DTA 2005e) indicate that under the existing release schedule mean daily water temperatures in the Ice House Dam Reach are generally less than 20°C except on rare occasions at the downstream end of the reach. From October 20, 2000 through September 30, 2004 (total of 1,442 days), mean daily water temperature at the downstream end of the reach exceeded 20°C on 25 days (1.73% of the time). For all days sampled, the maximum mean daily and instantaneous water temperatures were 21.3°C and 26.0°C, respectively (see Table 5.3.1-19). These rare instances occur for 1-3 day periods during the hottest days of summer. During these times, water temperature in the lower portions of the reach may affect fish and other aquatic biota that rely on cold freshwater habitat.

This situation would be enhanced by the release of higher flows from Ice House Dam than currently occur. However, since the instances are rare, a continuous release to attenuate such short periods is not needed. Under the Proposed Action, SMUD will install a continuous water temperature recorder at a reasonably accessible location in the downstream end of Ice House Dam Reach, most likely near a bridge that crosses the stream just upstream of Junction Reservoir. SMUD will remotely monitor water temperature at this site and if mean daily water temperatures exceed 20°C for two consecutive days, will increase releases from Ice House Dam to 30 cfs, up from the Proposed Action release of 22 cfs. A release of this flow will result in mean daily water temperatures of less than 20°C throughout Ice House Dam Reach based on SMUD's SNTEMP Ice House Dam Reach water temperature model (Figure 5.3.1-10). SMUD will hold the Ice House Dam release at 30 cfs for three days, after which the release will decrease from 30 cfs to 22 cfs. These increased releases represent a substantial enhancement, since water temperature throughout the Ice House Dam Reach will always remain within optimal conditions for cold freshwater habitat under the Proposed Action.

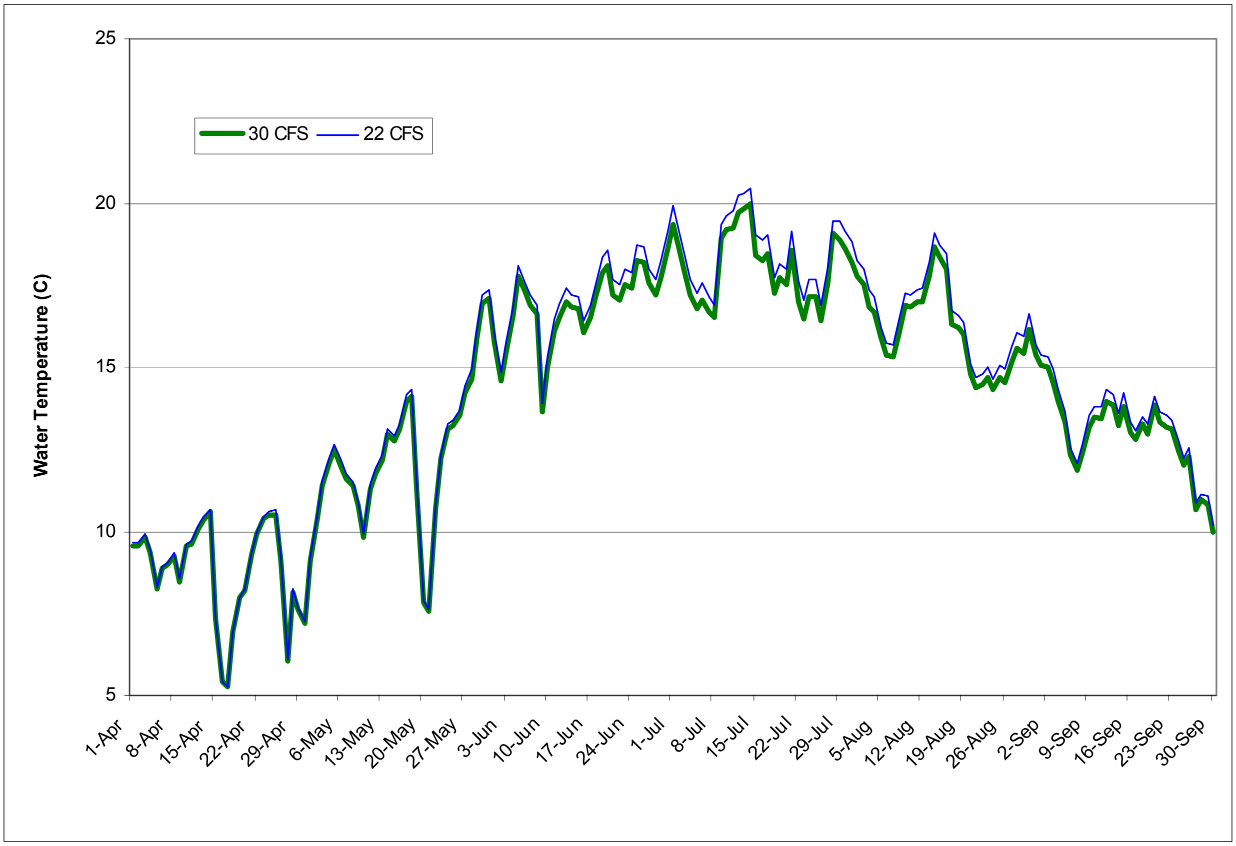

Figure 5.3.1-10. Predicted water temperature at the downstream end of the Ice House Dam Reach, with the Proposed Action summer release of 22 cfs and a 30 cfs from Ice House Dam.

<u>Proposed Measure – Iowa Hill Development Construction Erosion and Sedimentation Control Plan</u>

Under the Proposed Action, construction of the Iowa Hill Development has the potential to affect water quality as a result of soil erosion associated with construction activities. Soil erosion can result in increases in turbidity and nutrient loading. Potentially affected waterbodies include Slab Creek Reservoir, and Iowa Canyon Creek, which lies to the west of Iowa Hill and drains into the SFAR. During construction of the development, the upper reservoir area will be cleared of topsoil and graded. The topsoil will be placed in temporary laydown areas, which will also be cleared and graded. In addition, minor cut and fill areas will occur along roads, power cable conduit trenches and transmission line tower pads. Construction activities also include installation of the intake and outflow structures in Slab Creek Reservoir. Each of these areas and activities has the potential to result in soil erosion.

Under the Proposed Action, an Erosion and Sedimentation Control Plan will be developed and implemented to address each area of potential erosion. A draft version of the plan is provided in Appendix A. The draft plan identifies a variety of erosion and sediment control measures, or best management practices (BMP) that would be implemented to minimize erosion. Examples include construction of silt fences, straw bale barriers, maximum slope inclinations, temporary dikes and sedimentation basins (traps), culverts, and hydroseeding. The plan would also includea storm water pollution prevention component as well as monitoring, which is discussed in more detail below.

We conclude that construction of the Iowa Hill Development, with implementation of the Erosion Control Plan, will have a less-than-significant effect on turbidity and nutrient loading in local waterbodies, including Slab Creek Reservoir and the SFAR.

Proposed Measure – Iowa Hill Development Construction Storm Water Pollution Prevention and Hazardous Plan

Under the Proposed Action, construction of the Iowa Hill Development has the potential to affect water quality as storm water drains from the different construction sites, including the upper reservoir site, the powerhouse portal site, and the tunnel construction areas. Storm water runoff has the potential to increase turbidity through erosional forces and introduce contaminants to local streams and reservoirs. Potentially affected waterbodies include Slab Creek Reservoir, and Iowa Canyon Creek, which lies to the west of Iowa Hill and drains into the SFAR. To avoid contamination of receiving waterbodies, SMUD will prepare a Storm Water Pollution Prevention Plan that will:

- Define the characteristics of the Iowa Hill Development construction sites and the nature of the planned construction activities.
- Describe the site plan for the Iowa Hill Development and characterize the storm water drainage areas and location of potential sources of storm water contamination.
- List the potential construction site storm water pollutants associated with the different aspects of the construction activities.
- Describe the practices, or BMPs, that will be implemented to control erosion and the release of pollutants in the storm water, which may include placement of prevention devices such as silt fences and straw bale barriers.
- Describe construction practices that will be implemented to prevent spill of hazardous substances, including location and method of storing hazardous material.
- Present a schedule that includes the steps of implementation of BMPs that dovetails with the construction schedule, the timing of employee training, and the procedures for inspecting the effectiveness of the BMPs.
- Describe a stabilization/termination design to minimize erosion and prevent storm water effects after construction is complete.

We conclude that that construction of the Iowa Hill Development with implementation of a Storm Water Pollution Preventation Plan, once certified by appropriate state and Federal agencies, will result in less-than-significant effects to local waterbodies, including Slab Creek Reservoir and the SFAR, from contaminate pollution.

Other Water Quantity Issues

The operation of the UARP directly affects the quantity of water that is stored in project reservoirs and flows through project reaches. The basic plan for UARP operation, as described in Exhibit B of the License Application, coupled with the Proposed Action minimum release schedule for each project dam, will dictate the volume of water stored seasonally in the project reservoirs as well as the volume of water flow in the project reaches. These volumes of water will not only vary by season, but by the Proposed Action five water year types. This section will analyze the changes to the seasonal and yearly patterns of water quantities in project reaches and reservoirs. With respect to reservoirs, the focus of the description is the three storage reservoirs (Loon Lake, Union Valley, and Ice House reservoirs) as storage patterns in the other reservoirs will not vary significantly by season or water year type.

Flow in Project Reaches

Under the Proposed Action, the quantity of water flowing in most of the project reaches will increase because of higher releases from project dams. As discussed in Section 5.3.1.2 (Affected Environment – Water Quantity), flows in the project reaches are a function of reservoir releases, spill events at project dams, and accretion. The Proposed Action will result in increases in flow volumes in all project reaches except the Rubicon, Rockbound, and Buck Island reaches. In these upper reaches, the volume of water will remain the same as the baseline, as identified under the No Action Alternative (see Figure 5.3.1-1). In general, flows will follow a pattern largely dictated by accretion, reaching high levels in snowmelt runoff months close to 100 cfs in the Rubicon Dam Reach. When accretion ceases in the summer and fall months, flows in these upper reaches will be dictated by the minimum releases, or close to 1 cfs. The Proposed Action is not expected to alter the frequency and magnitude of spill events at Rubicon or Buck Island dams.

The quantity of flow in all other project reaches will increase under the Proposed Action. In the higher elevation reaches (Loon Lake Dam, Robbs Peak Dam, Gerle Creek Dam, and Ice House Dam reaches), the largest increase in quantity of flows will be in Critical Dry and Dry water years and in the summer and fall months. However, the accretion from tributary streams, particularly those of the Loon Lake Dam and Ice House Dam reaches, will still largely dictate the quantity of flow during winter and spring months. Thus, the quantity of flows passing through these project reaches will be greater than those of the baseline under the No Action alternative (see Figures 5.3.1-2 through 5.3.1-4). Similar to the uppermost reservoirs, the seasonal pattern of flows will be driven by snowmelt accretion. The highest flows will occur in during winter and spring, reaching levels near 100 cfs, followed by summer/fall low flows that will be determined largely by the new release schedule. It is in these later seasons that the most significant increases in flows will occur on a proportional basis.

Increases in the flows will also occur in the Junction Dam, Camino Dam, Brush Creek Dam, and Slab Creek Dam reaches, however the seasonal pattern of flows will be different in these reaches because the accretion flows occur during winter rather than spring (see Figures 5.3.1-5 through 5.3.1-8). In the Slab Creek Dam Reach, the Proposed Action release schedule will significantly increase the base flow during winter months. The daily quantity of flow passing through during the winter months will be volatile, driven by the accretion associated with sporadic winter rainstorms, but the base flow upon which the accretion flows will build, will be roughly two or three times the existing flow. This issue is discussed more thoroughly in Section 5.3.2.3 (Aquatic Resources – Environmental Effects).

Water Stored in UARP Reservoirs

Under the Proposed Action there will be little change in the seasonal volumes of water stored in project reservoirs. The amount of water to be stored in the UARP reservoirs under the Proposed Action is displayed in Figures 5.3.1-11 through 5.3.1-25, by storage reservoir and water year type. These 15 figures, as generated by the CHEOPS™ Water Balance Model, illustrate the expected water surface elevations and storage volumes that will occur under the Proposed Action in various representatives of each of the five water year types. The pattern of water storage varies not only between water year types, other than within water year types as shown on the figures. Variability in storage patterns within a water year type is due to a variety of factors, including the previous year water type and runoff patterns. In general, these patterns of water storage are very similar to those of the baseline condition under the No Action Alternative. They reflect the seasonal management of water in the storage reservoirs that is discussed in Exhibit B of the License Application.

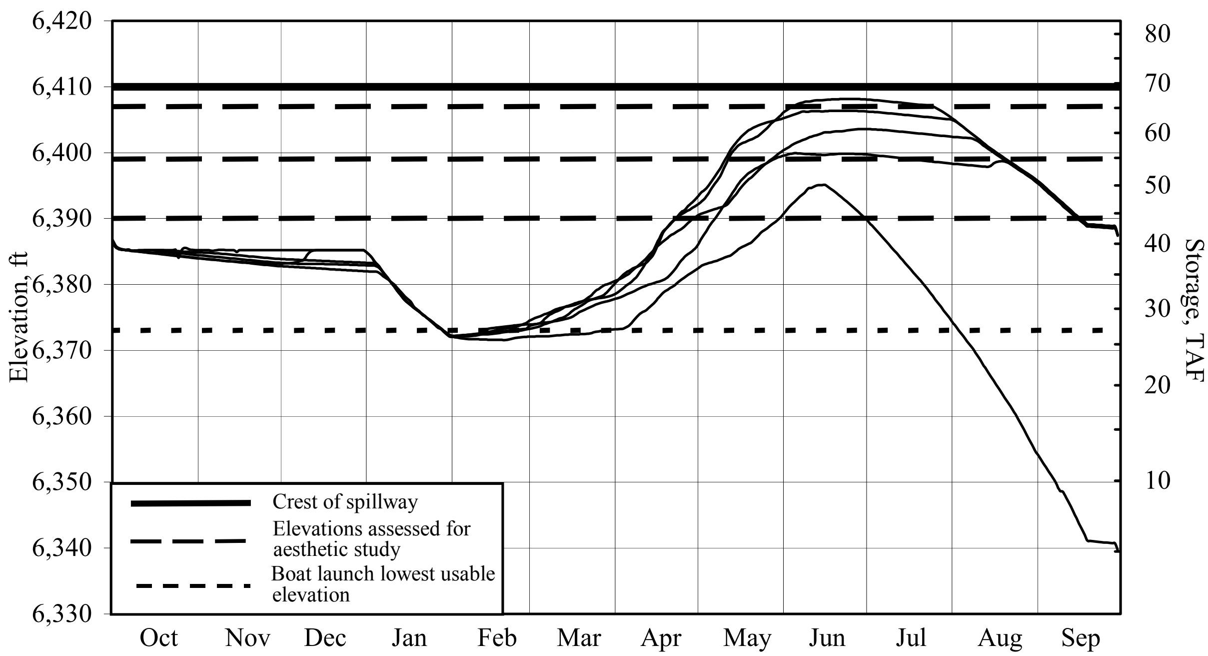

Figure 5.3.1-11. Predicted elevation and storage at Loon Lake Reservoir for Critical Dry water years, 1976–2000.

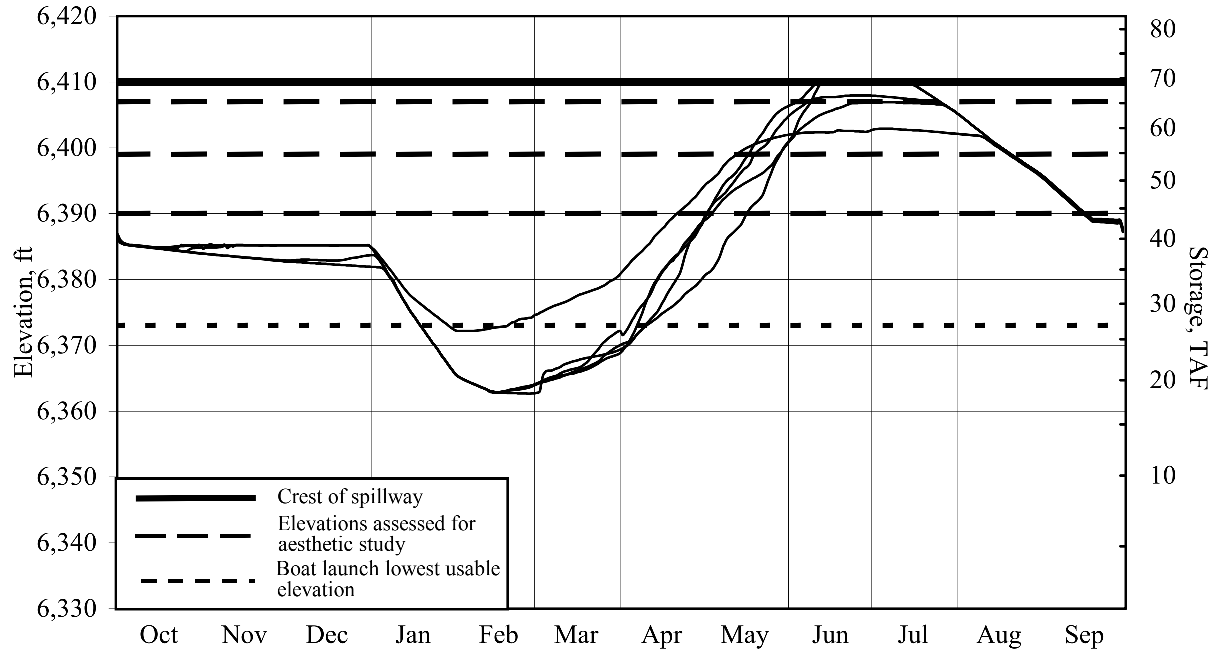

Figure 5.3.1-12. Predicted elevation and storage at Loon Lake Reservoir for Dry water years, 1976–2000.

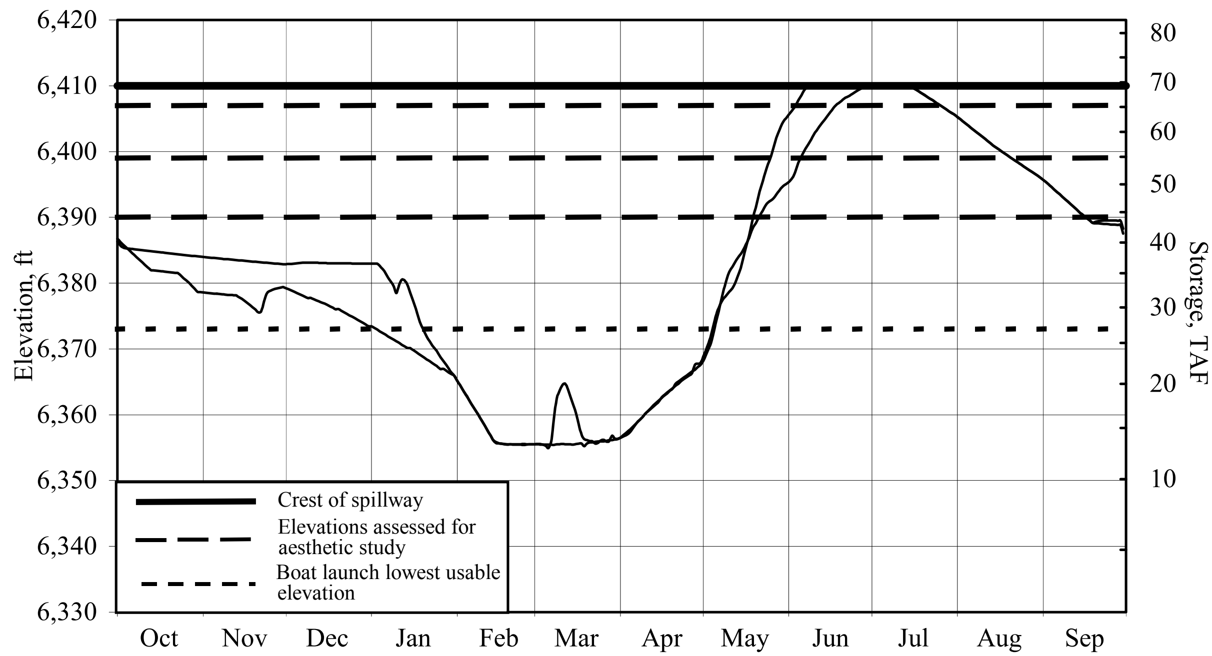

Figure 5.3.1-13. Predicted elevation and storage at Loon Lake Reservoir for Below Normal water years, 1976–2000.

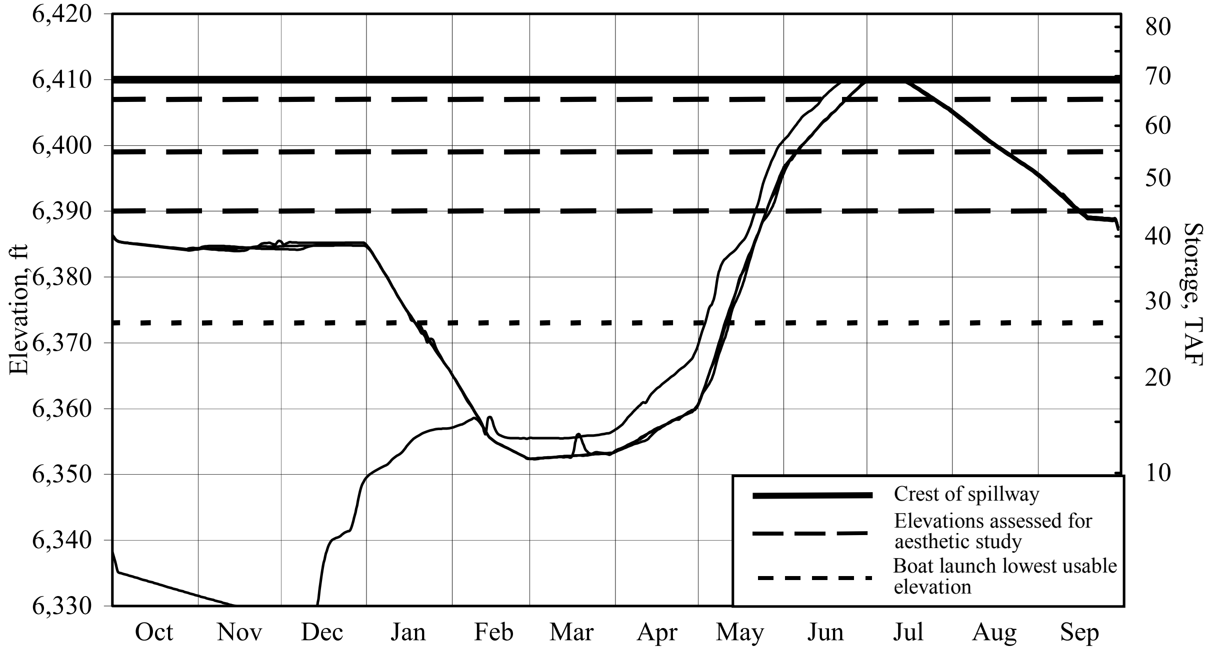

Figure 5.3.1-14. Predicted elevation and storage at Loon Lake Reservoir for Above Normal water years, 1976–2000.

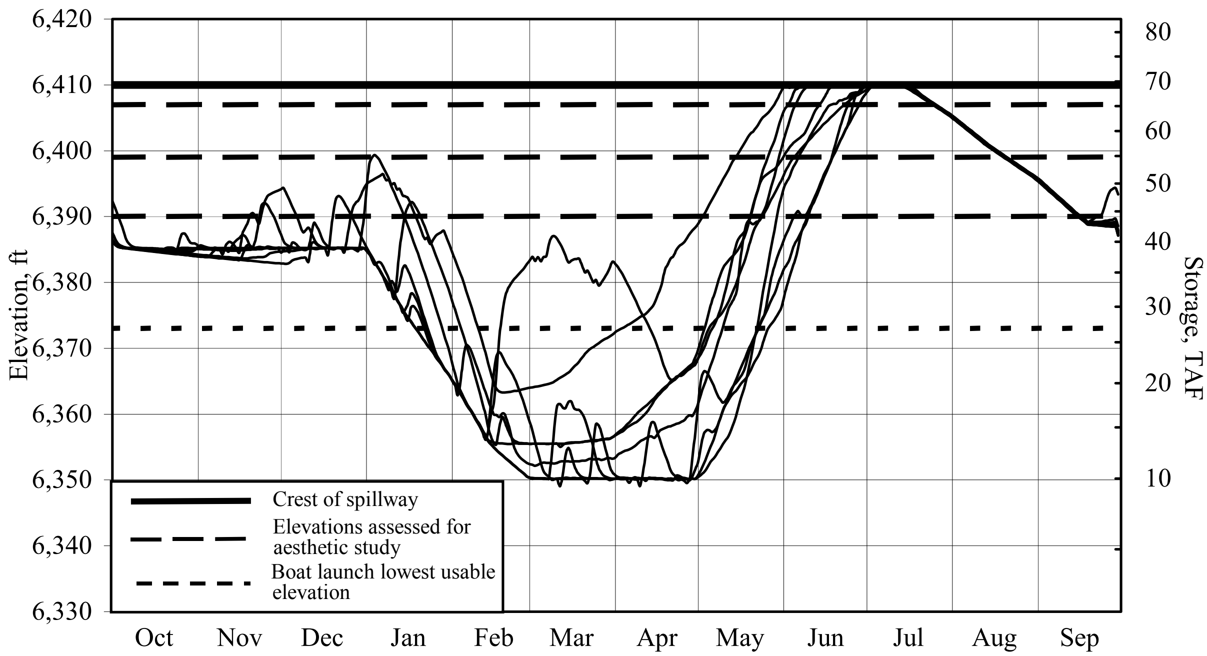

Figure 5.3.1-15. Predicted elevation and storage at Loon Lake Reservoir for Wet water years, 1976–2000.

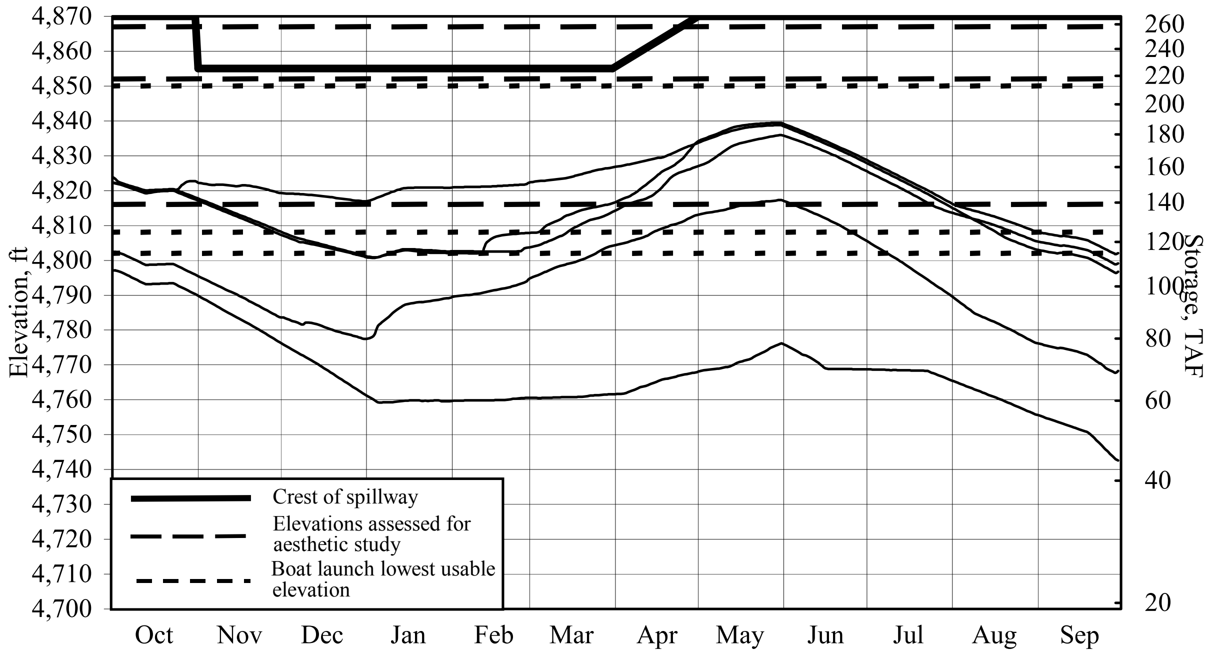

Figure 5.3.1-16. Predicted elevation and storage at Union Valley Reservoir for Critical Dry water years, 1976–2000.

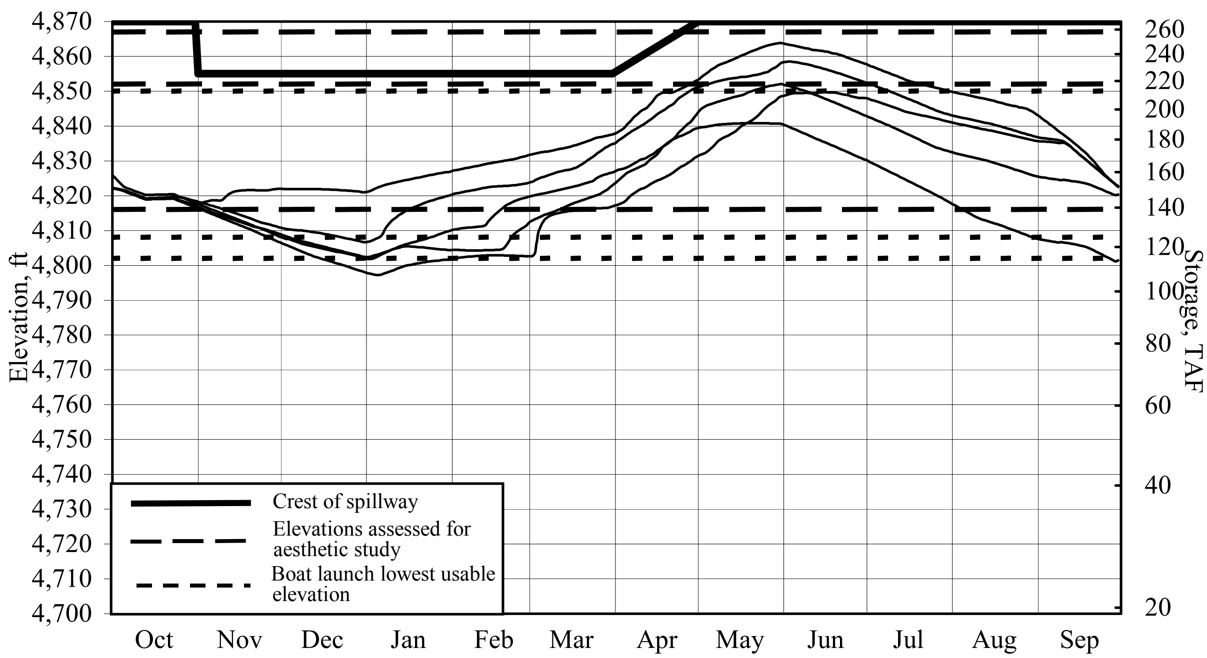

Figure 5.3.1-17. Predicted elevation and storage at Union Valley Reservoir for Dry water years, 1976–2000.

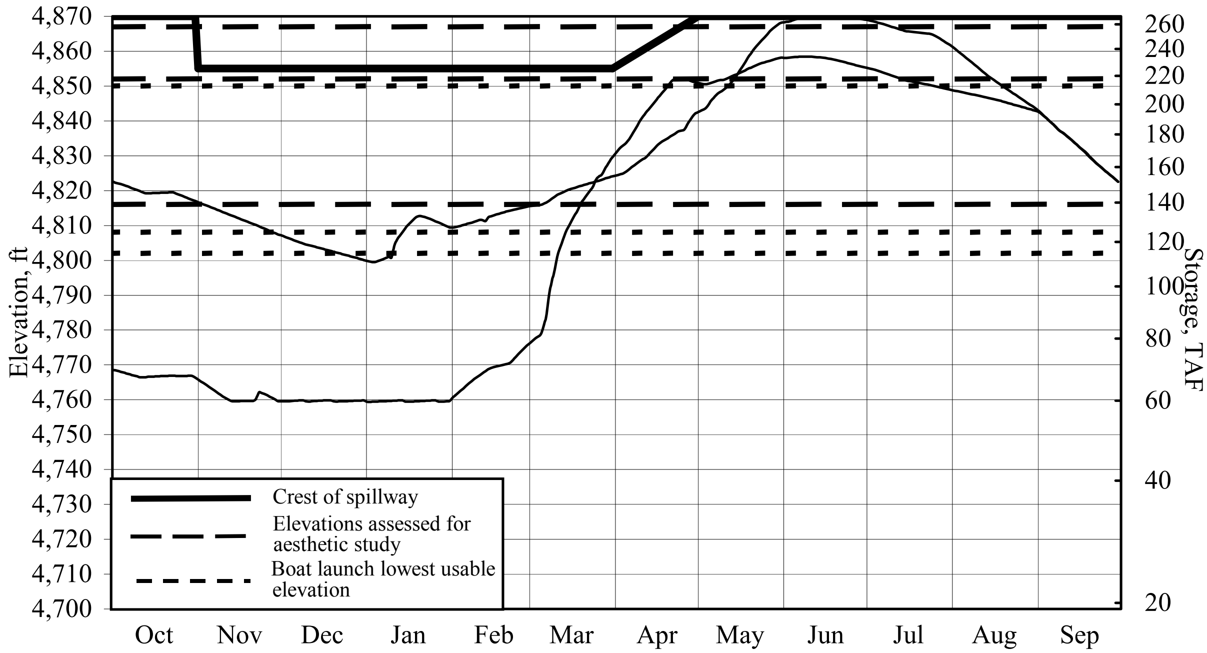

Figure 5.3.1-18. Predicted elevation and storage at Union Valley Reservoir for Below Normal water years, 1976–2000.

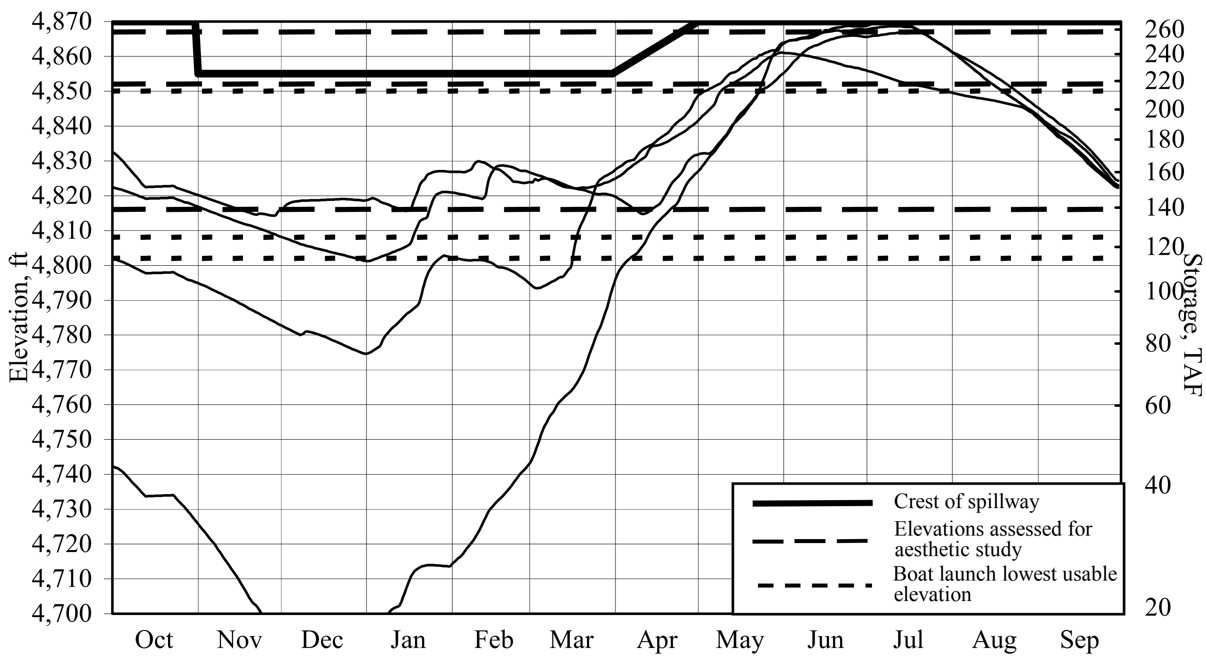

Figure 5.3.1-19. Predicted elevation and storage at Union Valley Reservoir for Above Normal water years, 1976–2000.

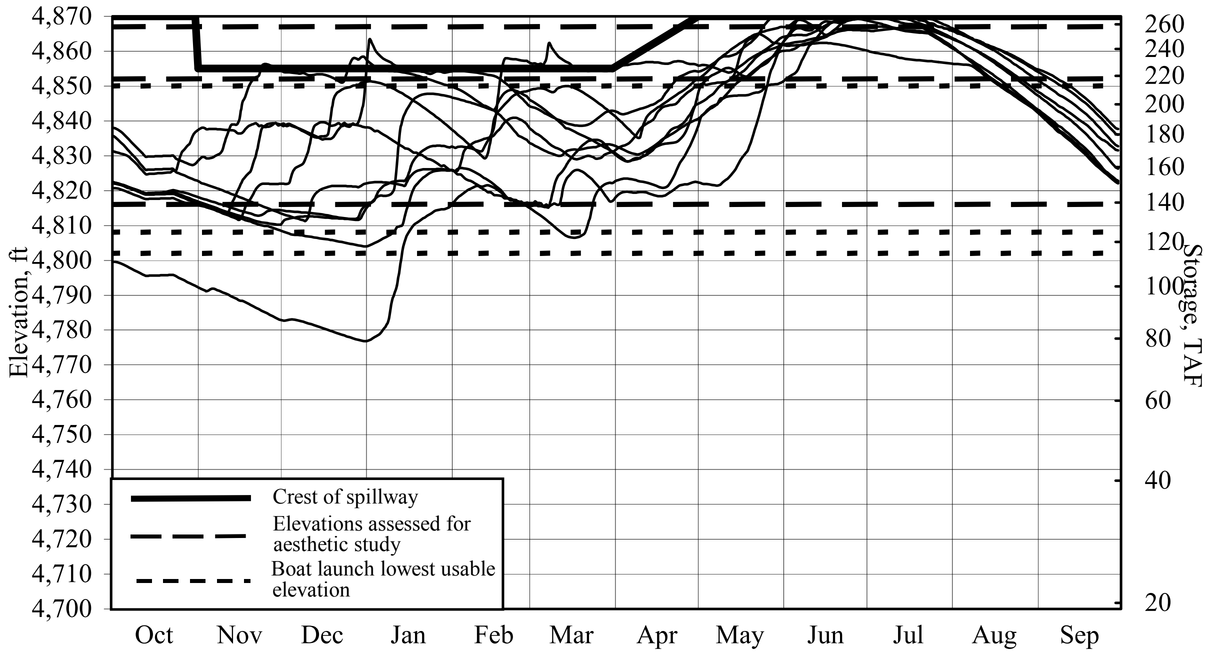

Figure 5.3.1-20. Predicted elevation and storage at Union Valley Reservoir for Wet water years, 1976–2000.

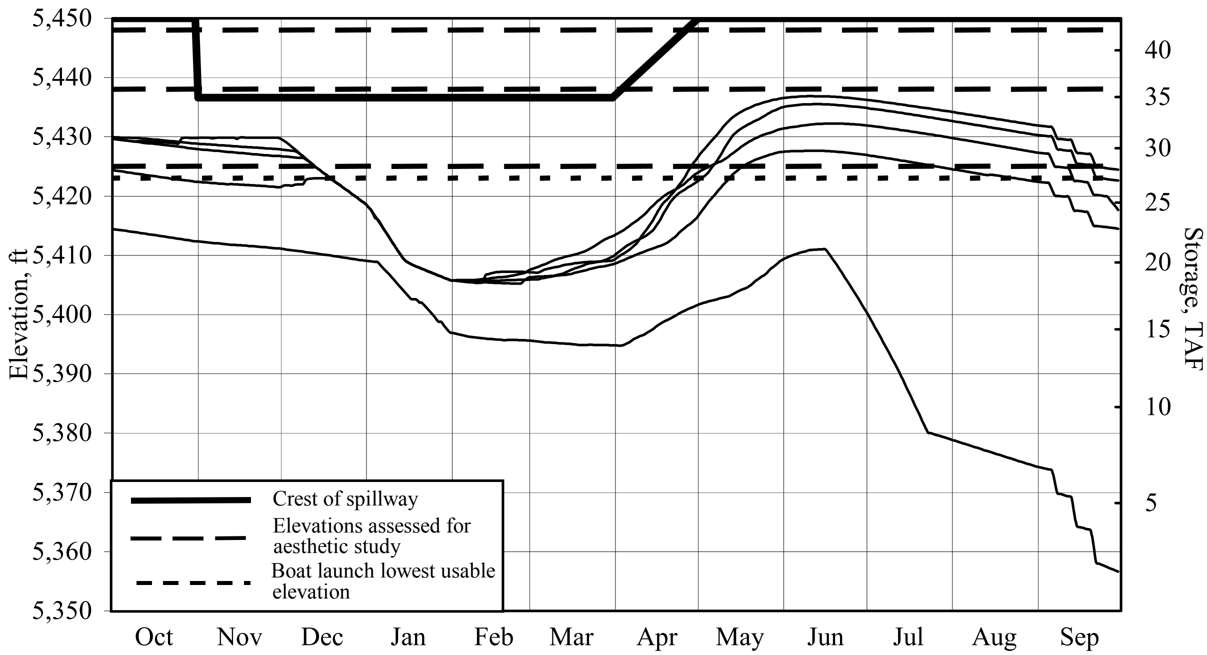

Figure 5.3.1-21. Predicted elevation and storage at Ice House Reservoir for Critical Dry water years, 1976–2000.

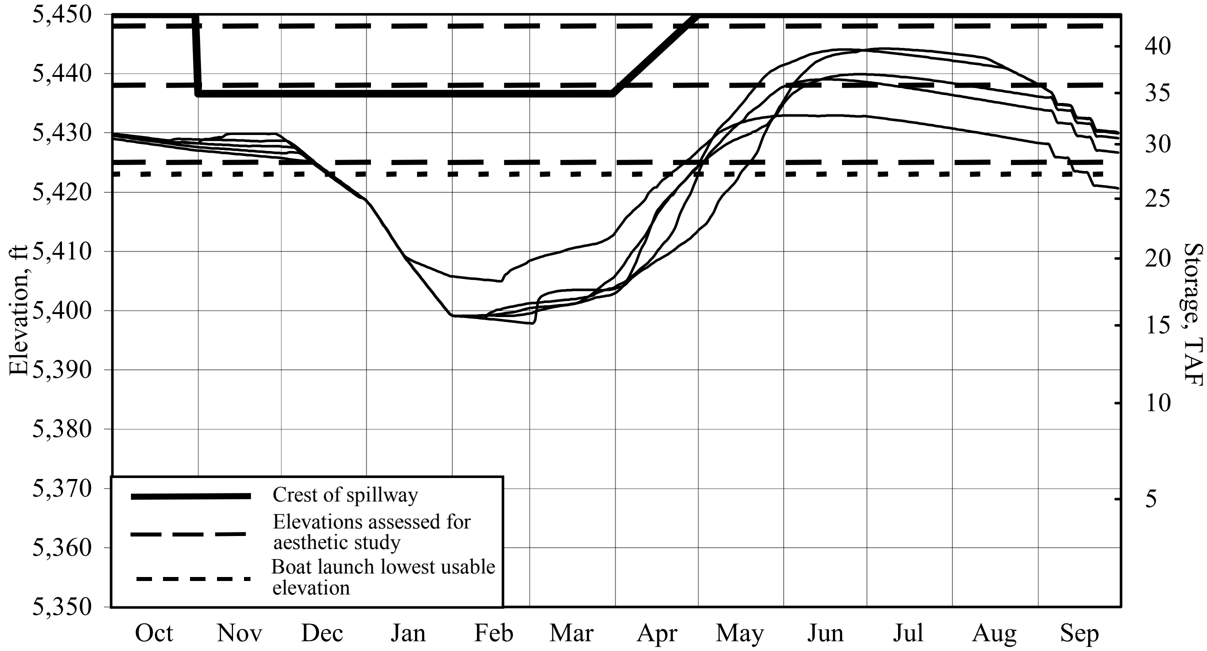

Figure 5.3.1-22. Predicted elevation and storage at Ice House Reservoir for Dry water years, 1976–2000.

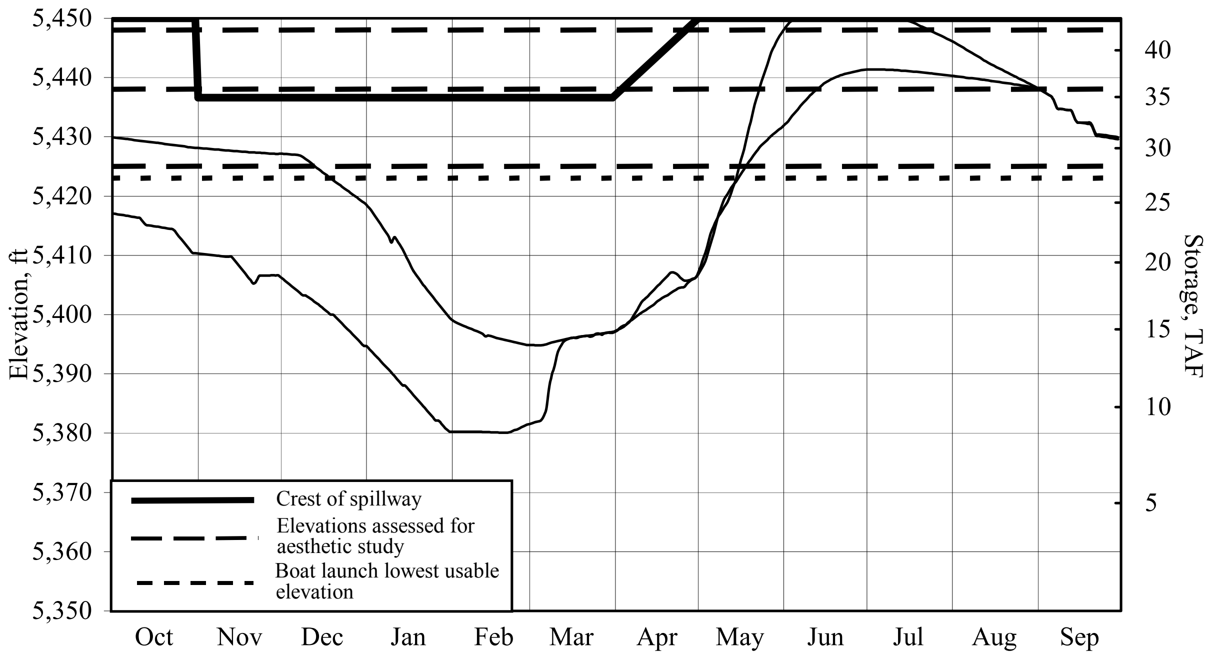

Figure 5.3.1-23. Predicted elevation and storage at Ice House Reservoir for Below Normal water years, 1976–2000.

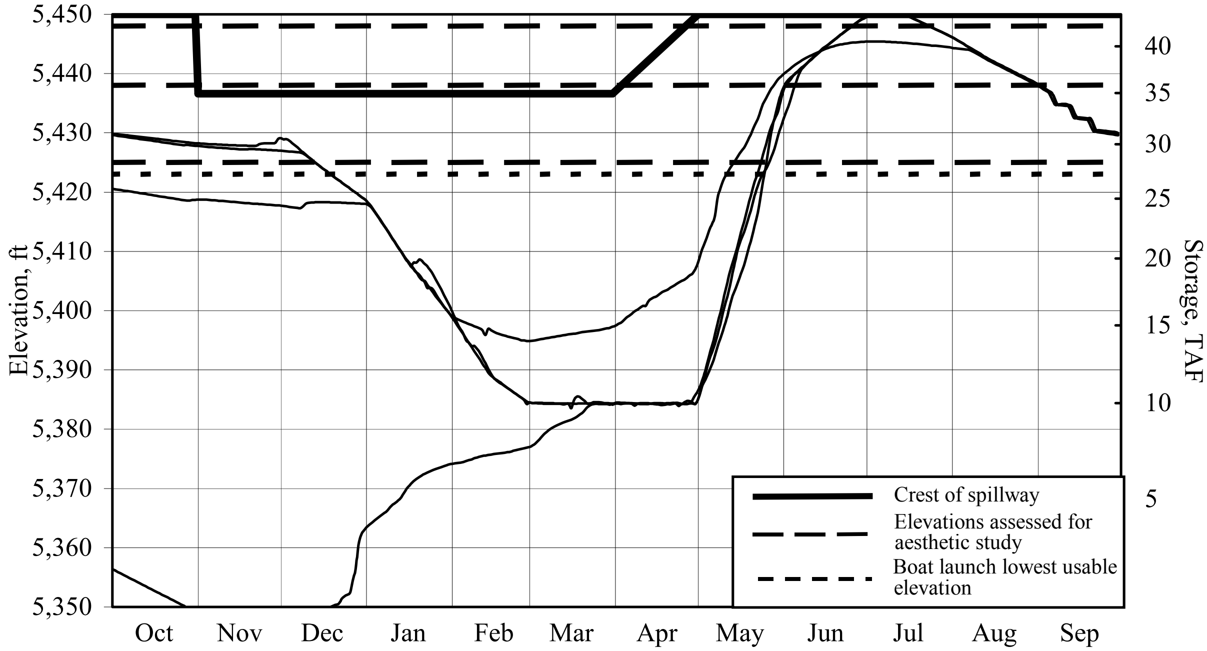

Figure 5.3.1-24. Predicted elevation and storage at Ice House Reservoir for Above Normal water years, 1976–2000.

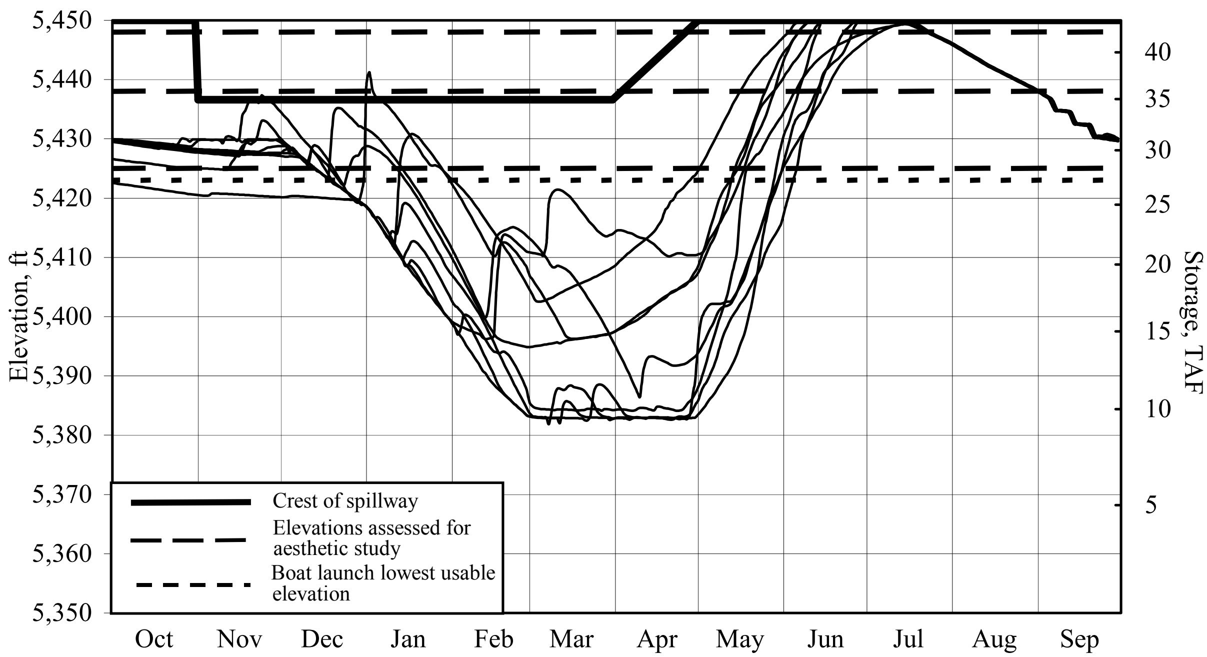

Figure 5.3.1-25. Predicted elevation and storage at Ice House Reservoir for Wet water years, 1976–2000.

<u>*Water Temperature in the Project Reaches*</u>

In general, the environmental measures included in the Proposed Action will have a cooling effect on water temperatures in the project reaches. Because the Proposed Action does not significantly alter the water management practices of the project reservoirs, the thermal stratification, turnover timing, and hypolimnetic releases of each project reservoir, as described in Section 5.3.1.2 (Affected Environment – Water Quality) will remain unchanged through the next license term.

The release schedule of the Proposed Action will result in beneficial changes to the thermal regime of some of the project reaches. Water temperatures in the Rubicon Dam and Buck Island Dam reaches will not change as the release schedules at those locations will remain the same. The changes to the thermal regime of the other project reaches are described below.

Loon Lake Dam Reach

The thermal regime of the Loon Lake Dam Reach will be largely unaffected by the Proposed Action release schedule. The higher releases in the fall and winter months will lead to a general reduction in water temperatures, but the reduction will be small because ambient conditions (e.g., cold air temperatures) will affect water temperatures far more than stream flow during this time of the year. The higher reservoir releases in the summer months of Above Normal and Wet water years will result in a slight cooling of water temperatures throughout the project reach. Thus, in general, the reach will continue to be characterized by very cold winter temperatures and cool summer water temperatures that do not exceed mean daily values of 20°C. We conclude that these reductions in water temperature represent an enhancement to water temperatures, as this project reach is designated as Cold Freshwater Habitat under the Basin Plan.

Gerle Creek Dam Reach

The Proposed Action release schedule will not alter water temperatures in the Gerle Creek Dam Reach. Under the existing release schedule, water temperatures in the reach are below 20°C throughout the 1.2-mile-long reach. Under the Proposed Action, the temperature regime is expected to continue to fall below 20°C because the summer flows will increase during all water year types. The higher summer flows will lead to a slight cooling of the water temperatures within the project reach. We conclude that these reductions in water temperature represent an enhancement to water temperatures, as this project reach is designated as Cold Freshwater Habitat under the Basin Plan.

Robbs Peak Dam Reach

Water temperature in the upper portion of the Robbs Peak Dam Reach was above 20°C during July and August in 2002. Under the Proposed Action, increased stream flows in the new release schedule are expected to lower water temperature during summer months. Winter flows of 7 cfs will have a beneficial effect because it will reduce the chance of significant ice formation in Robbs Peak Dam Reach. A field visit to the SF Rubicon River upstream of Robbs Peak

Reservoir in November of 2003 revealed a stream that was largely frozen compared to an unfrozen and flowing stream below the reservoir (DTA and Stillwater 2005h). This general condition is expected to persist under the Proposed Action.

Ice House Dam Reach

Under the Proposed Action, increased releases from the Ice House Reservoir in June, July and August will reduce stream temperature. Figure 5.3.1-25, above, shows that the Proposed Action release of 22 cfs during summer months will keep temperatures from exceeding 20°C except for rare occaisons. This assessment is based on the fact that the data used to calibrate the temperature model was from 2003, a year that experienced the hottest July on record (pg. 35, DTA 2005b) in the basin. Thus, the temperature modeling results represent worst-case conditions, at least in the month of July. Nevertheless, the continuous water temperature monitoring at the downstream end of the reach that is included in the Proposed Action provides a mechanism to ensure that water temperatures do not exceed mean daily values of 20°C.

The most significant change in water temperature will occur in Dry and Critical Dry water years. Under the existing release schedule, summer releases in both these water year types are 5 cfs, such as occurred in summer of 2001 (a dry year), when mean daily temperatures at the bottom of the reach exceeded 20°C for 15 days (see Table 5.3.1-19). Under the Proposed Action, summer flows in Critical Dry and Dry years will be 22 cfs. The thermal regime that will exist in these conditions will be a substantial improvement not only over existing conditions, but in relation to natural background conditions as represented by the SFSC above Ice House Reservoir, where flows would be expected to drop below 1 cfs in August (see Table 5.3.1-6).

We conclude that the water temperature measure of the Proposed Action, which is designed to ensure water temperatures remain below 20°C in all years and at all times of the year, represent a significant enhancement to water temperatures, as this project reach is designated as Cold Freshwater Habitat under the Basin Plan.

Junction Dam Reach

The Proposed Action will increase flows in the Junction Dam Reach. With few exceptions, water temperatures along the Junction Dam Reach remain at or below 20° C throughout the year under the existing release schedule. Increasing summer flows under the Proposed Action will help keep temperatures in the lower segment of the reach within the optimal range for rainbow trout, especially during Critical Dry and Dry years, where releases increases from the current 5 cfs to 18 cfs during summer months. In general, the increased release during summer months for all water years under the Proposed Action will limit the incidence of high water temperatures in Junction Dam Reach. We conclude that the reductions in water temperature represent an enhancement to water temperatures, as this project reach is designated as Cold Freshwater Habitat under the Basin Plan.

Camino Dam Reach

The Proposed Action will increase flows in the Camino Dam Reach, which will have a general cooling effect on water temperatures in the summer months. Although stream temperatures at the downstream end of the Camino Dam Reach under existing conditions are often greater than 20°C, these values are likely reflecting the natural effect of ambient conditions during summer months (see Section 5.3.1.2 Affected Environment – Water Quality). A water temperature model developed for the Camino Dam Reach predicts that increasing flows to 18 cfs during Critical Dry, Dry and Below Normal years and 26 in Above Normal and Wet years will reduce the incidence of high mean daily stream temperatures in the Camino Dam Reach. Although temperatures will still exceed 20°C in the lower portion of the reach (pg. 54, DTA 2005e), the incidences of these events will, on average, be less than that predicted by the model (the model used was calibrated with 2003 ambient air temperatures, which includes the hottest July on record)(see Table 5.3.1-20). Also, as discussed in Section 5.3.1.2 (Affected Environment – Water Quality), the warm thermal regime of the Camino Dam Reach is consistent with the naturally warm thermal regime of the streams feeding into Union Valley Reservoir and the warm thermal regime of the South Fork American River directly upstream of its confluence with Silver Creek.

We conclude that the overall cooling of the project reach and reduction in the incidences of temperatures exceeding 20°C represent an enhancement, as this project reach is designated as Cold Freshwater Habitat under the Basin Plan.

Brush Creek Dam Reach

The Proposed Action release schedule for Brush Creek, which consists of higher flows in the summer months, will not affect temperatures in the already cool and well-shaded project reach.

Slab Creek Dam Reach

The Proposed Action release schedule for Slab Creek dam will result in a slight cooling of water temperatures throughout the bypass reach during summer months of Below Normal, Above Normal and Wet water years, when dam releases will increase from 36 to 50 cfs. The cooling of the river will be confined to the upper segment of the project reach, essentially extending the 20°C threshold further downstream from its location under the existing 36 cfs release. The lower portion of the reach will likely remain at the same equilibrium water temperature as the 36 cfs release, as dictated by ambient conditions. That is, the difference in buffering capacity between 36 and 50 cfs will be negligible under the existing ambient conditions by the time the water arrives at the bottom of the project reach. In Critical Dry and Dry water years, the Proposed Action release schedule will result in a drop from 36 to 30 cfs, which will result in a slight warming of the reach. Again, the lowermost segment of the project reach will attain the same equilibrium temperature as the 36 cfs release, but the 20°C threshold will extend a little further upstream. The Proposed Action release schedule for winter and spring months, which consists of increases in Slab Creek Dam releases from 36 to 84 cfs in Below Normal, Above Normal, and Wet water years will result in slight cooling of the project reach. We conclude that the overall cooling of the project reach represents an enhancement to water temperature, as the lower portions of this project reach are designated as Cold Freshwater Habitat and Warm Freshwater Habitat under the Basin Plan.

Water Quality in Project Waters

Bacteria

About 6.6 percent of the SMUD's 75 fecal coliform samples in UARP reservoirs were greater than the Basin Plan's maximum concentration limit. These instances occurred in Union Valley Reservoir.

There are no project O&M activities that would lead to an increase in bacteria in Union Valley Reservoir. The most plausible source of the bacteria is recreation at the Forest Service's Camino Cove, Fashoda Beach and Jones Fork campgrounds, which are near the sampling locations. The non-project source of bacteria is further supported by the fact that during the same period higher fecal coliform concentrations were found in Union Valley Reservoir, high levels of fecal coliform were found in two tributaries to Union Valley Reservoir not affected by the UARP: one instance in Big Silver Creek (1,160 organisms/100 ml on July 22, 2002) and three other in Jones Fork Silver Creek (730, 400, and 1,500 organisms/100 ml on June 23, July 15 and July 22, 2002, respectively).

This condition is less-than-significant. None of SMUD's fecal coliform sampling in UARP reservoirs were greater than the five-day geometric mean limit in the Basin Plan, and only about 6.6 percent of the samples were greater than the Basin Plan's maximum concentration limit. These instances were rare (only occurred for a few days in June and July 2002), and fecal coliform concentrations in the other samples collected at these sites were generally low. Further, SMUD is unaware of any reports or complaints of illness due to recreation in and around these areas. This less-than-significant assessment is supported by the fact that concentrations of *E. coli* in SMUD's samples throughout the project area were less than *E. coli* maximum numerical limit in SWRCB staff proposed amended Bacteria Water Quality Objective.

Chemical Constituents, and Taste and Odor

There are no specific project O&M activities that would result in increased concentrations of mercury, lead, iron or aluminum in UARP reservoirs and project reaches. As noted above, about 1.5 percent of the 4,446 total metals samples collected by SMUD had concentrations greater than Primary or Secondary MCL numerical limits. For Primary MCLs, this included: 6 of the 215 mercury samples (2.7%), all of which occurred in 2003; and 46 of the 406 lead samples (11.3%), all of which occurred in 2004. For Secondary MCLs, this included 2 of the 398 aluminum samples (0.5%) and 16 of 382 iron samples (4.1%). As noted above, SMUD believes the elevated lead and mercury concentrations may be due to sampling error. Until this is resolved, we have conservatively assumed the iron and mercury readings are reliable.

Anoxic conditions in reservoirs can leach metals from bottom sediments into the water column, but do not occur in project reservoirs. The most plausible sources of the metals are anthropogenic or naturally occurring. For lead, anthropogenic sources include the burning of petroleum fuels with lead and other additives, which once dispersed, enter the aquatic environmental through surface runoff and airborne lead. While mercury was used in gold mining, this activity did not normally occur in higher elevations: the source of mercury is unknown, but project operation and maintenance does not use mercury. Sources of iron and aluminum are likely leachate from local soils.

SMUD does not propose an enhancement measure related to elevated levels of metals as these levels are less-than-significant and are not project-controllable factors. Elevated levels are relatively infrequent (less than 4% of the samples for that metal) except for lead. Most of the higher lead concentrations occurred during the spring runoff sampling period. Primary MCLs are set from health-based criteria from Public Health Goals, or from a one-in-a-million incremental cancer risk estimate for carcinogens and threshold toxicity levels for non-carcinogens. Since public use of the reservoirs during spring runoff is extremely low, exposure to lead is unlikely. The elevated mercury samples occurred in less than 0.5 percent of the samples. Additionally, the mercury and lead levels may be the result of sampling error. Our less-than-significant conclusion is also predicated on the fact that Secondary MCL numerical limits have no human health considerations, but are established with regards to taste, odor, etc. The instances where concentrations were greater than Secondary MCLs numeric limits were infrequent and SMUD is unaware of any taste and odor complaints at any UARP reservoirs or in any downstream reaches.

Dissolved Oxygen

There are no specific project O&M activities that would reduce DO concentrations in UARP reservoirs or project reaches. The likely mechanism is the normal stratification that occurs in most deep reservoirs in the Sierra Nevada and elsewhere. Of 277 DO concentration measurements in project reaches, 2 (<1%) were less than the Basin Plan numerical limits. Also, DO concentrations in the deeper portions of some UARP reservoirs were less than Basin Plan numerical limits for DO.

Regardless, this is less-than-significant. Lower DO concentrations in project reaches were very rare (<1%) and DO concentrations increased to levels within Basin Plan criteria downstream, as expected to occur in steep gradient, Sierra streams. DO concentrations in the upper portions of UARP reservoirs were always greater than 7 mg/l. This less-than-significant conclusion is supported by: 1) DO concentrations in watershed tributaries not affected by the project were much lower than the two instances in project-affected reaches; 2) DO concentrations less than 7 mg/l in the deeper portions of large man-made reservoirs and natural lakes in the Sierra Nevada are common; and 3) SMUD's relicensing studies do not suggest in any way that fish and aquatic biota are adversely affected by DO concentrations in project reaches and UARP reservoirs.

pH

There are no specific project O&M activities that would reduce pH below 6.5 or increase it above 8.0 in UARP reservoirs or project reaches. Although SMUD found some pH levels outside the numerical criteria in the Basin Plan, the likely mechanism affecting pH is natural runoff from watershed soils and normal stratification that occurs in most deep reservoirs in the Sierra Nevada.

This is less-than-significant. Most of the pH values are no less than 6.1 (Basin Plan lower limit is 6.5), with the lowest values occurring in the bottom of reservoirs. The instances occur only rarely, are not excessive, are localized, and do not appear to affect fish and other aquatic resources in the reservoirs based on SMUD's relicensing studies. All pH levels in releases from UARP reservoirs are within Basin Plan numerical limits. This assessment is supported by the fact that pH values in the deeper portions of many Sierra Nevada man-made reservoirs and natural lakes are lower than Basin Plan limits with no apparent affect on fish and other aquatic biota.

Sediment

Potential effects of the Proposed Action on sediment and measures related to sediment that SMUD has included in the Proposed Action are discussed under the Geological Resources section (Section 5.4.2) below.

Toxicity Criteria – Human Health

There are no specific project O&M activities that would result in increased mercury concentrations in fish. As described elsewhere, anoxic conditions, which can leach metals from bottom sediments into the water column, do not occur in project reservoirs.

Of the 30 fish fillets analyzed, two samples exceeded the USEPA Screening Value (SV) of 0.026 ppm for arsenic: at Union Valley Reservoir (0.06 ppm) and Ice House Reservoir (0.16 ppm). Two samples exceeded the USEPA SVs for both the Target Analytes and Green Areas of 0.4 ppm for mercury, and three samples exceeded the National Recommended Water Quality Criteria (USEPA 2002b) of 0.3 ppm for mercury: at Gerle Creek Reservoir (brown trout, 0.32 ppm), Union Valley Reservoir (smallmouth bass, 0.42 ppm) and Slab Creek Reservoir (brown trout, 0.59 ppm). These guidelines are not established for human health risk, but only to suggest monitoring may be prudent. In addition, as far as SMUD is aware, over the 40 years of fishing in UARP reservoirs, no reports of illnesses have been reported from ingesting fish caught in Union Valley or Slab Creek reservoirs.

Toxicity Criteria – Aquatic Life

There are no specific project O&M activities that would result in increased dissolved concentrations of cadmium, copper, silver, lead, and zinc in project reservoirs or reaches. As described elsewhere, anoxic conditions, which can leach metals from bottom sediments into the water column, do not occur in project reservoirs. In fact, it is most likely that these increased concentrations are the result of natural conditions in the watershed. This is supported by the fact that similar conditions occur in surface waters unaffected by the UARP as well as snow in the upper watershed.

As discussed in the Affected Environment section, SMUD found that dissolved concentrations of cadmium, copper, silver, lead, and zinc were greater than CMC and CCC numerical limits in some samples collected from UARP reaches and reservoirs. A number of non-project samples, as well as a snow sample, have exceedences of the CCC and CMC for various metals, indicating that dissolved metals occur in water flowing into the UARP at concentrations that also exceed the toxicity criteria. The Proposed Action would not affect this condition, and SMUD does not consider it to be a factor that is controllable by the UARP. SMUD is unaware of any reasonable resource measure that could be implemented that would result in a decrease of these metals in surface waters.

Iowa Hill Development Operation

Based on the results of a detailed modeling study, the operation of the Iowa Hill Development will not significantly alter the thermal regime of Slab Creek Reservoir or the SFAR (DTA and EES 2005a). According to a pair of linked CE-QUAL-W2 simulation models developed for Iowa Hill and Slab Creek reservoirs, daily operations of the Iowa Hill Development will slightly cool the water column of Slab Creek Reservoir. The predicted mean water column temperature in Slab Creek Reservoir over the simulation time period (April through October) decrease by as much as 0.73°C (in August) as compared to the predicted mean value without the operation of the Iowa Hill Development. The average level of water column cooling over the entire simulation period is expected to be 0.39°C. The reason for the cooling effect is that, despite the development of a warm epilimnion in the Iowa Hill Reservoir, the proposed operational plan for the development does not include the release of all the water in the upper reservoir at any time, thereby preserving the warm water layer on the top of the reservoir. The water released downstream of Slab Creek Reservoir into the SFAR would also be slightly cooler under the Proposed Action, although the reduction in release temperatures is negligible, (i.e., an average cooling of approximately 0.25°C). In the unlikely event that the Iowa Hill Development is not operated on a daily basis during the spring and summer, but remains unused for as long as into mid summer (or July 27, as simulated in the model), thereby allowing for a strongly stratified Iowa Hill Reservoir, a start up of operations would result in similar negligible effect on the thermal regime of Slab Creek Reservoir. We conclude that the operation of the Iowa Hill Development will not affect water temperatures in Slab Creek Reservoir or in the SFAR.

5.3.1.4 Environmental Effects of the UARP-Only Alternative

Under the UARP-only Alternative, all components of the Proposed Action will be in place except those dealing with the addition of the 400 MW Iowa Hill Development. SMUD will operate the existing UARP facilities in a manner identical to the Proposed Action, with few exceptions. All project reservoirs, except Slab Creek Reservoir, will be operated in the same manner described in Exhibit B of the License Application; the seasonal changes in water levels of the three project storage reservoirs (e.g., Figures 5.3.1-11 through 5.3.1-25 of Section 5.3.1.3), will occur under the alternative. However, the increased frequency of water level fluctuation at Slab Creek Reservoir described under the Proposed Action will not occur under the UARP-only Alternative. Slab Creek Reservoir water level fluctuations, under this alternative, will be the same as baseline. The release schedule for the ten project dams will be the same as the Proposed Action. Thus, the quantity of water stored in project reservoirs (with seasonal and daily changes) and the volume of water passing through project reaches will be the same as the Proposed Action. All environmental measures contained in the Proposed Action will occur under the UARP-only Alternative, except for those pertaining to the Iowa Hill Development. This includes the following two measures: 1) defining five water year types; and, 2) monitoring water temperatures in the Ice House Dam Reach and increasing summer releases from Ice House Reservoir to ensure water temperatures throughout the reach remain below 20ºC.

The effects of the UARP-only Alternative on water resources resources will be, in large measure, identical to those described for the Proposed Action in Section 5.3.1.3. In general, operation of the UARP under this alternative will have the same reservoir release schedule as the Proposed Action. This alternative, like the Proposed Action, will not significantly affect water quality parameters in project reservoirs or reaches, such as pH, DO, and water chemistry constituents. It will result in the same reductions in summer water temperature at the same project reaches described in Section 5.3.1.3. Because this alternative does not include the construction or operation of the Iowa Hill Development, potential effects of the development on water quality will not occur. Without the 400 MW of capacity from the Iowa Hill Development, SMUD will have to meet future peak generation needs with less efficient simple-cycle peaking plants rather than power purchased from the energy market, which would likely be produced by a more efficient mix of fossil fuel generation sources.

5.3.1.5 Unavoidable Adverse Impacts

None.