

**SACRAMENTO MUNICIPAL UTILITY DISTRICT
UPPER AMERICAN RIVER PROJECT
(FERC NO. 2101)**

**DEEPWATER INTAKE ENTRAINMENT
TECHNICAL REPORT**

Prepared by:

Devine Tarbell & Associates, Inc.
Sacramento, California

Prepared for:

Sacramento Municipal Utility District
Sacramento, California

JULY 2004

TABLE OF CONTENTS

Section & Description	Page
1.0 INTRODUCTION	2
2.0 BACKGROUND	2
2.1 Deepwater Intake Entrainment Study Plan	2
2.2 Water Year Type	3
2.3 Agency Requested Information	3
3.0 METHODS	4
4.0 RESULTS	5
4.1 Description of Intakes and Fish Species Compositions	5
4.1.1 Loon Lake Reservoir	5
4.1.2 Ice House Reservoir	9
4.1.3 Union Valley Reservoir	13
4.1.4 Junction Reservoir	17
4.1.5 Camino Reservoir	19
4.1.6 Brush Creek Reservoir	22
4.1.7 Slab Creek Reservoir	24
4.2 Habits of Dominant Fish Species	28
4.2.1 Rainbow Trout	28
4.2.2 Brown Trout	29
4.2.3 Sacramento Sucker	29
4.2.4 Smallmouth Bass	30
4.2.5 Hardhead	30
5.0 ANALYSIS AND DISCUSSION	33
6.0 POTENTIAL APPROACH TO DEVELOP MITIGATION MEASURES	37
7.0 LITERATURE CITED	38

LIST OF TABLES

Table No. & Description	Page
Table 3.0-1. Bottom invert elevation, height, width and cross-sectional area behind the trash rack for selected UARP deepwater intakes.	4
Table 5.0-1. Summary of approach velocities and depth of deepwater intakes.	35
Table 5.0-2. Sustained and burst swimming speeds of fish reported in FishBase.	36
Table 6.0-1. Range of potentially entrained stocked fish at Loon Lake and Ice House reservoirs based on CDFG 2004 stocking records and an approach to estimate entrainment used by Pacific Gas and Electric Company for the Mokelumne Project.	38

LIST OF FIGURES

Figure No. & Description	Page
Figure 4.1-1. Loon Lake Reservoir monthly median, 10 percent exceedance and 90 percent exceedance water surface elevations, based on data from 1976 through 1998.	6
Figure 4.1-2. Loon Lake Powerhouse Penstock withdrawal exceedance curve based on period from 1976 through 1999.	7
Figure 4.1-3. Loon Lake Reservoir median monthly water surface elevation, depth of deepwater intakes, and flow through the deepwater intakes based on data from 1976 through 1998.	8
Figure 4.1-4. Ice House Reservoir monthly median, 10 percent exceedance and 90 percent exceedance water surface elevations, based on data from 1985 through 1998.	10
Figure 4.1-5. Jones Fork Power Tunnel withdrawal exceedance curve based on period from 1985 through 1999.	11
Figure 4.1-6. Ice House Reservoir median monthly water surface elevation, depth of deepwater intakes, and flow through the deepwater intakes based on data from 1985 through 1998.	12
Figure 4.1-7. Union Valley Reservoir monthly median, 10 percent exceedance and 90 percent exceedance water surface elevations, based on data from 1976 through 1998 and 2001 elevations.	14
Figure 4.1-8. Union Valley Powerhouse Penstock withdrawal exceedance curve based on period from 1976 through 1999.	15
Figure 4.1-9. Union Valley Reservoir median monthly water surface elevation, depth of deepwater intake, and flow through the deepwater intake based on data from 1976 through 1998.	16
Figure 4.1-10. Junction Reservoir monthly median, 10 percent exceedance and 90 percent exceedance water surface elevations, based on data from 1988 through 1998.	17
Figure 4.1-11. Junction Reservoir median monthly water surface elevation, depth of deepwater intake, and flow through the deepwater intake based on data from 1988 through 1998.	18

LIST OF FIGURES

Figure No. & Description	Page
Figure 4.1-12. Camino Reservoir monthly median, 10 percent exceedance and 90 percent exceedance water surface elevations, based on data from 1988 through 1998.	20
Figure 4.1-13. Camino Reservoir median monthly water surface elevation, depth of deepwater intake, and flow through the deepwater intake based on data from 1988 through 1998.	21
Figure 4.1-14. Brush Creek Reservoir monthly median, 10 percent exceedance and 90 percent exceedance water surface elevations, based on data from 1988 through 1998.	23
Figure 4.1-15. Monthly Brush Creek Reservoir elevations relative to intake elevations based on the period from 1988 through 1998.	24
Figure 4.1-16. Slab Creek Reservoir elevations, including 10% and 90% exceedance levels by month, based on the period from 1976 through 1998.	25
Figure 4.1-17. White Rock Power Tunnel withdrawal exceedance curve based on the period from 1976 through 1999.	26
Figure 4.1-18. Monthly Slab Creek Reservoir elevations and intake flows, based on a period from 1976 through 1998.	27

LIST OF APPLICABLE STUDY PLANS

Description

- Deepwater Intake Entrainment Study Plan

4.5 Deepwater Intake Entrainment Study Plan

This study is designed to provide information regarding the potential for fish to be entrained at Sacramento Municipal Utility District’s (SMUD) Upper American River Project (UARP) deepwater intakes in the UARP reservoirs. The study is based on the hypothesis that most of the UARP reservoirs have deepwater intakes (more than 50 feet deep when a reservoir is full) and the general fish species composition in the reservoirs are fish which exhibit pelagic behavior during some portion of the year. To evaluate the combination of these facts relative to Project effects, a paper study is proposed. Note that entrainment at UARP shallow water intakes (Gerle Creek Canal, Robbs Peak Reservoir intake, Rubicon Reservoir intake and Buck Island Intake) are addressed in a separate study plan. At an April 25, 2002 meeting, the Aquatics Technical Working Group (TWG) agreed that entrainment at the intakes in Pacific Gas and Electric Company’s Chili Bar Reservoir would be addressed by PG&E in a separate study plan.

4.5.1 Pertinent Issue Questions

The Deepwater Intake Entrainment Study Plan will be used, in part, to address the following Aquatics/Water Issue Question:

4. Do Project diversions have an effect on aquatic biota (e.g., are fish screens or low flow channels in dams necessary)?

4.5.2 Background

As described in Section A, Project Description, of the SMUD’s Initial Information Package (IIP), most of the UARP intakes are located in the deepest part of the reservoirs, and therefore could be considered deepwater intakes (Table 1). A review of the literature indicates that when water temperatures are suitable, trout are found near the surface of large reservoirs due to preferences for temperature, dissolved oxygen, food and cover (May 1973, Warner and Quinn 1995, Baldwin *et al.* 2000, Rowe and Chisnall 1995, McAfee 1966, Raleigh *et al.* 1984. The likelihood of fish entrainment at the UARP deepwater intakes is a function of the actual depth of the intake at different times of the year, the probability that a significant number of fish are in the vicinity of the intake, and the ability of fish to avoid entrainment (approach velocity at the intake as compared to the fishes’ swimming speed).

TABLE 1. Elevations and depths of power, diversion and low level intakes at Sacramento Municipal Utility District’s Upper American River Project Reservoirs. Number in parenthesis is the depth of the intake at normal maximum water surface elevation.				
Reservoir	Normal Max. Water Surface El. (feet)	Intake Invert El. (feet)		Intake Type
		Power/Diversion Intake	Low Level Valve	
Rubicon	6,545	6,533.50 (-11.50)	6,523.00 (-22.00)	Shallow
Buck Island	6,436	6,425.00 (-11.00)	6,420.00 (-16.00)	Shallow
Loon Lake	6,410	6,318.50 (-91.50)	6,325.50 (-84.50)	Deep
Gerle Creek	5,231	5,230.85 (-0.15)	5,186.50 (-44.50)	Shallow
Robbs Peak	5,231	5,201.50 (-29.50)	5,196.00 (-35.00) & 5,206.00 (-25.00)	Shallow
Ice House	5,450	5,363.50 (-86.50)	5,414.00 (-36.00)	Deep
Union Valley	4,870	4,504.68 (-365.32)	None	Deep
Junction	4,450	4,376.00 (-74.00)	4,335.00 (-115.00)	Deep
Camino	2,915	2,842.83 (-72.17)	2,840.00 (-75.00)	Deep
Brush Creek	2,915	2,826.50 (-88.50)	2,775.00 (-140.00)	Deep
Slab Creek	1,850	1,673.91 (-176.09)	1,680.00 (-170.00)	Deep

4.5.3 Study Objectives

The study objective is to determine how likely it is that fish are entrained at each of the UARP’s reservoir deepwater intakes.

4.5.4 Study Area and Sampling Locations

The study area includes Loon Lake, Ice House, Union Valley, Junction, Camino, Brush Creek and Slab Creek reservoirs. The intakes at Gerle Creek Canal and Rubicon, Robbs Peak and Buck Island reservoirs, which are considered shallow water intakes (less than 50 feet deep) and are addressed in a separate study plan. No fieldwork is proposed at the deepwater intakes, so no sampling locations are identified. Also, note that the study area does not include Chili Bar Reservoir. Entrainment at the intakes in Pacific Gas and Electric Company's Chili Bar Reservoir may be addressed by PG&E in a separate study plan.

4.5.5 Information Needed From Other Studies

Information needed from other studies includes 1) the composition of fish species in UARP reservoirs and downstream from the reservoirs from the Fish Survey Study; 2) reservoir elevations, storage and fluctuation from the Hydrology Study; 3) water temperature in the UASRP reservoirs from the Water Temperature Study; and 4) water quality information, especially dissolved oxygen, in the UARP reservoirs from the Water Quality Study Plan.

4.5.6 Study Methods And Schedule

Study methods will include: 1) reviewing the scientific literature (note that Aquatic TWG participants will be contacted to solicit germane information, especially with regards to catostomids in Union Valley Reservoir) to determine how fish species in each of the Project reservoirs likely utilize the reservoir (movement and habitat preference); 2) describe the location of any intakes in the UARP reservoirs including elevation and flow at different times of the year; and 3) when fish are likely to be in the vicinity of the intake, relate the approach velocity into the intake to the fishes' ability to avoid entrainment (swim speed). It is anticipated that a white paper on this subject will be developed for review by the Aquatic TWG and Plenary Group by late 2002. If the Aquatic TWG or Plenary Group conclude that additional information is needed at any intake (such as an entrainment study), the study will be developed by the Aquatic TWG and fieldwork will occur in 2003.

4.5.7 Analysis

Data analysis will include a discussion of the above data, and postulate an effect on fish populations in the reservoir.

4.5.8 Study Output

The white paper will be presented to the Aquatic TWG and Plenary Group by late 2002. Additional studies, if needed, will occur in 2003. The ultimate study output will be a written report that includes the issues addressed, objectives, study area including sampling locations, methods, analysis, results, discussion and conclusions. The report will be prepared in a format so that it can easily be incorporated into the Licensee's draft environmental assessment that will be submitted to FERC with the Licensee's application for a new license.

4.5.9 Preliminary Estimated Study Cost

A preliminary cost estimate for this study will be developed after approval by the Plenary Group.

4.5.10 Plenary Group Endorsement

The Aquatics TWG approved this plan on April 25, 2002. The participants at the meeting who said they could "live with" this study plan were PCWA, El Dorado County, BLM, CDFG, USFS, USFWS, SMUD, SWRCB and PG&E. None of the participants at the meeting said they could not "live with" this study plan. The Plenary Group approved the plan on June 5, 2002. The participants at the meeting who said they could "live with" this study plan were PCWA, El Dorado County, BLM, BOR, USFS, CSPA, SMUD, FOR, PG&E. None of the participants at the meeting said they could not "live with" this study plan.

4.5.11 Literature Cited

- Baldwin, C. M., Beauchamp, D. A., and J. J. Van Tassell. 2000. Bioenergetic assessment of temporal food supply and consumption demand by salmonids in the Strawberry Reservoir food web. *Trans. Am. Fish. Soc.*, 129:429-450.
- May, B. E. 1973. Seasonal depth distribution of rainbow trout (*Salmo gairdneri*) in Lake Powell. *Proc. Utah Acad. Sci., Arts, and Letters* 50:64-72.
- McAfee, W. R. 1966. Rainbow trout. Chapter 28 in: *Inland Fisheries Management*, A. Calhoun, ed. Calif. Dept. of Fish and Game.
- Raleigh, R. F., Hickman, T., Solomon, R.C., and P. C. Nelson. 1984. Habitat suitability information: Rainbow Trout. U.S. Fish and Wildl. Serv. FWS/OBS-82/10.60. 64 pp.
- Rowe, D. K., and B. L. Chisnall. 1995. Effects of oxygen, temperature and light gradients on the vertical distribution of rainbow trout, *Oncorhynchus mykiss*, in two North Island, New Zealand, lakes differing in trophic status. *New Zealand Journal of Marine and Freshwater Research*, 29(3):421-434.
- Sacramento Municipal Utility District. 2001. Initial Information Package for Relicensing of the Upper American River Project (FERC Project No. 2101). Sacramento, CA.
- Warner, E. J., and T. P. Quinn. 1995. Horizontal and vertical movements of telemetered rainbow trout (*Oncorhynchus mykiss*) in Lake Washington. *Can. J. Zool.* 73:146-153.

DEEPWATER INTAKE ENTRAINMENT TECHNICAL REPORT

SUMMARY

The Aquatic Technical Working Group (TWG) and Plenary Group identified seven UARP reservoirs that the Aquatic TWG considered to have associated “deepwater” intakes: Loon Lake, Ice House, Union Valley, Junction, Camino, Brush Creek and Slab Creek. Ice House, Junction, Camino and Slab Creek have both a power intake and a low level outlet. Loon Lake and Brush Creek reservoirs also have a power intake and a low level outlet, but the Loon Lake intakes are housed in one intake structure, and the Brush Creek Reservoir power intake is rarely used. Union Valley Reservoir has only a power intake. With the exception of the Ice House Power Tunnel intake, the power intakes transport water to UARP powerhouses that use Francis-type turbines. The Jaybird Powerhouse uses a Pelton turbine. The low-level intakes are controlled by globe, cone or Howell-Bunger valves, or some combination of these. Based on historic percent exceedance flows through the Loon Lake, Jones Fork, Union Valley and White Rock power tunnel intakes, median approach velocities to these intakes range from 0.14 fps at the Loon Lake Penstock Intake to 0.41 fps at the Union Valley Penstock Intake, and ten percent exceedances range from 0.96 fps to 1.18 fps. The range of possible approach velocities was calculated for other power intakes based on median historic monthly flows, and for low-level intakes based on the current downstream minimum flow requirements. Approach velocities at the other power intakes ranged from 0.22 fps to 0.61 fps, both at the Jaybird Power Tunnel Intake. Approach velocities at the low-level intakes ranged from 0.05 fps at the Brush Creek Dam low-level intake to 2.25 at the Slab Creek Dam low-level intake.

The Loon Lake, Ice House and Union Valley reservoirs, the three primary UARP storage reservoirs, intakes are normally deepest (between about 71 and 214 feet deep) in the summer and shallowest (39 to 159 feet deep) in winter as the reservoirs are drawn down. The depths of the intakes in the re-regulating reservoirs (Junction, Camino, Brush Creek and Slab Creek) show little variation over the year (about 1-3 foot change), but can change by up to ten feet in a day.

Each of the seven reservoirs shows some level of stratification, with strongest stratification occurring at Union Valley and Ice House reservoirs (in summer, about 20°C on the surface and 7°C on the bottom with a thermocline at about 60 feet), and the weakest stratification at Brush Creek, Camino and Slab Creek reservoirs.

California Department of Fish and Game (CDFG) currently stocks trout in the UARP storage reservoirs, and naturally-reproducing special-status fish species that may occur in the reservoirs include rainbow trout and brown trout (Forest Service Management Indicator Species and found in most of the seven reservoirs) and hardhead (California Species of Concern and found only in Slab Creek Reservoir).

A review of the life history of rainbow trout, brown trout, hardhead as well as smallmouth bass and Sacramento sucker suggests that adult trout generally prefer the upper portions of reservoirs, and young-of-the-year and juvenile trout, smallmouth bass and Sacramento sucker prefer nearshore habitat. In reservoirs, hardhead prefer the shallow areas at the upstream end of the reservoir.

A general literature review suggests that 3-inch-long trout are able to maintain a cruising speed of about 1 fps and a burst speed of about 2.5 fps, while a 6-inch-long trout can maintain a cruising speed of 2 fps and a burst speed of 5 fps.

Applying the approach used by Pacific Gas and Electric Company (PG&E) to estimate potential entrainment of stocked fish for its large Mokelumne River, UARP deepwater intakes (as requested by the Aquatic TWG) were studied, and in 2004 between 2,610 and 6,350 stocked fish may have been entrained collectively at Loon Lake, Ice House and Union Valley reservoirs. No estimate of entrained resident fish was made since the necessary data are not available for these reservoirs.

1.0 INTRODUCTION

This technical report is one in a series of a reports prepared by Devine Tarbell & Associates, Inc., (DTA) for the Sacramento Municipal Utility District (SMUD) as an appendix to SMUD's application to the Federal Energy Regulatory Commission (FERC) for a new license for the Upper American River Project (UARP or Project). The report provides information regarding the potential for fish entrainment to occur at UARP deepwater intakes and includes the following sections:

- **BACKGROUND** – Summarizes the applicable study plan approved by the UARP Relicensing Plenary Group; a brief description of the issue questions addressed, in part, by the study plan; the objectives of the study plan; the study area, and agency information requests. In addition, requests by resource agencies for additions to this technical report are described in this section.
- **METHODS** – A description of the methods used in the study, including a listing of study sites.
- **RESULTS** – A description of the salient data results. Raw data where copious and detailed model results are provided in a separate compact disc (CD) for additional data analysis and review by interested parties.
- **ANALYSIS AND DISCUSSION** - An analysis and discussion of the results, where appropriate.
- **LITERATURE CITED** – A listing of all literature cited in the report.

This technical report does not include a detailed description of the UARP Alternative Licensing Process (ALP) or the UARP, which can be found in the following sections of the SMUD's application for a new license: The UARP Relicensing Process, Exhibit A (Project Description), Exhibit B (Project Operations), and Exhibit C (Construction).

Also, this technical report does not include a discussion regarding the affects of the UARP on fish, nor does the report include a discussion of appropriate protection, mitigation and enhancement measures. An impacts discussion regarding the UARP is included in the applicant-prepared draft environmental assessment (PDEA) document, which is part of the SMUD's application for a new license. Development of resource measures will occur in settlement discussions and will be reported on in the PDEA.

2.0 BACKGROUND

The UARP Relicensing Plenary Group approved one study plan that pertained specifically to fish entrainment at the UARP's deepwater intakes: the Deepwater Intake Entrainment Study Plan. This study plan is discussed in Section 2.1 below.

2.1 Deepwater Intake Entrainment Study Plan

On June 5, 2002, the UARP Relicensing Plenary Group approved the Deepwater Intake Entrainment Study Plan that was developed and approved by the Relicensing Aquatic Technical

Working Group (TWG) on April 25, 2002. The study plan was designed to address, in part, the following issue question developed by the Plenary Group:

Issue Question 4. Do Project diversions have an effect on aquatic biota (e.g., are fish screens or low flow channels in dams necessary)?

Specifically, the objective of the study plan was:

- Determine how likely it is that fish are entrained at each of the UARP's reservoir deepwater intakes.

The study area included Loon Lake, Ice House, Union Valley, Junction, Camino, Brush Creek and Slab Creek reservoirs. The intakes at Gerle Creek Canal and Rubicon, Robbs Peak and Buck Island reservoirs, which were considered shallow water intakes (less than 50-feet-deep) by the Aquatic TWG, are not addressed in this study plan. Also, the study area did not include Chili Bar Reservoir: entrainment at the intakes in PG&E's Chili Bar Reservoir is expected to be addressed by PG&E in the Chili Bar relicensing.

The study plan specified that the study output would be a written report prepared in a format that could easily be incorporated into SMUD's application for new license, and data analysis would include a discussion of the results.

2.2 Water Year Type

Since this study did not include any field sampling, the water year types during the study are irrelevant.

2.3 Agency Requested Information

In a letter dated December 17, 2003 to the Licensee, the agencies did not specifically address the contents of the *Deepwater Intake Entrainment Technical Report*.

In a May 13, 2004, letter, the agencies requested that SMUD revise the January 2004 *Deepwater Intake Entrainment Technical Report* to include:

1. On page 29, include data describing recommended approach velocities of hardhead and Sacramento sucker as being less than 1.3 fps (from the publication *Environmental Biology of Fishes* 58(3) p. 289-295. July 2000). The Report does not describe any specific velocities for these species. This publication was provided to SMUD's consultants last year. Explain whether the data from this publication affect the analysis results.
2. Provide data to support the conclusion that Sacramento suckers that reside in deep water during the daylight hours would not be affected by the deepwater intakes (page 28 of the Report).

3. State in the methods section how the approach velocities were determined for Table 4.1-8 (even though it may have been in study plan).

In addition, in a June 10, 2004 meeting, the Aquatic TWG requested that SMUD include in the revised report:

- Calculate flow exceedances for Loon Lake, Union Valley, Jones Fork and the White Rock powerhouses, and use these data to estimate approach velocities to the power tunnel intakes.
- Include Water Year 2001 Union Valley Reservoir water surface elevation in the report, and compare 2001 to other years to determine if it was particularly atypical.
- Provide an estimate of entrainment at Loon Lake, Union Valley and Ice House reservoirs using methods used by PG&E for the Mokelumne project.

This revised *Deepwater Intake Entrainment Technical Report* includes the information requested by the agencies and Aquatic TWG.

3.0 METHODS

The study methods conformed to those approved by the UARP Relicensing Plenary Group. These were that SMUD would: 1) describe the location of any intakes in the UARP reservoirs including elevation and flow at different times of the year; 2) describe when fish are likely to be in the vicinity of the intake; 3) review the scientific literature to determine how these fishes likely utilize the reservoir (movement and habitat preference); and 4) relate the approach velocity into the intake to the fishes' ability to avoid entrainment (swim speed and burst speed).

To determine the elevation and cross sectional area of intakes, DTA used the information contained on the current Exhibit L drawings filed with FERC. These data are shown in Table 3.0-1.

Table 3.0-1. Bottom invert elevation, height, width and cross-sectional area behind the trash rack for selected UARP deepwater intakes.				
Intake	Bottom Invert Elevation (feet)	Height (feet)	Width (feet)	Cross-Sectional Area (square feet)
LOON LAKE RESERVOIR				
Loon Lake Powerhouse Penstock Intake/ Loon Lake Dam Low-Level Intake	6,317.0	16	28	448
Loon Lake Dam Howell Bunger Valve	6,301.5	5	5	25
ICE HOUSE RESERVOIR				
Jones Fork Power Tunnel Intake	5,363.5	9	18	162
Ice House Dam Low-Level Intake	5,326.0	3	3.33	7
UNION VALLEY RESERVOIR				
Union Valley Powerhouse Penstock Intake	4,628.0	20	50.0	1,010
JUNCTION RESERVOIR				

Table 3.0-1. Bottom invert elevation, height, width and cross-sectional area behind the trash rack for selected UARP deepwater intakes.				
Intake	Bottom Invert Elevation (feet)	Height (feet)	Width (feet)	Cross-Sectional Area (square feet)
Jaybird Power Tunnel	4,374.5	29	50.0	1,470
Junction Dam Low-Level Outlet Intake	4,333.0	4	4	16
CAMINO RESERVOIR				
Camino Tunnel Intake	2,841.33	28	47.5	1,330
Camino Dam Low-Level Intake	2,838.0	4	4	16
BRUSH CREEK RESERVOIR				
Brush Creek Tunnel Intake	2,825.0	30	46	1,385
Brush Creek Dam Low-Level Intake	2,773.5	6	8	42
SLAB CREEK RESERVOIR				
White Rock Power Tunnel Intake	1,670.0	32	74	2,370
Slab Creek Dam Low-Level Intake	1,678.32	4	4	16

To determine typical flows through the intakes, DTA calculated percent exceedance values for the Loon Lake, Jones Fork, Union Valley and Slab Creek power tunnels, as requested by the Aquatic TWG on June 10, 2004. For stand-alone low-level intakes, DTA used the range of minimum stream flow requirements in the existing UARP FERC license. For all other intakes, DTA calculated the mean monthly flows based on the period of record.

To calculate approach velocities, DTA divided the flow into the intake by the cross-sectional area of the intake provided in Table 3.0-1.

4.0 RESULTS

4.1 Description of Intakes and Fish Species Compositions

This section summarizes, by reservoir: reservoir fluctuation; flow through the deepwater intakes; depth of the deepwater intakes; and reservoir stratification and fish populations. This information is provided in summary format since a detailed discussion of the information is provided in the license application in Exhibit A, Project Description; Exhibit B, Project Operation; as well as the *Water Temperature Technical Report*; *Reservoir Shoreline Habitat Technical Report*, and the *Fish Survey Technical Report*.

4.1.1 Loon Lake Reservoir

4.1.1.1 Reservoir Fluctuation

The primary purpose of Loon Lake Dam is to store water captured from the Gerle Creek watershed upstream of the dam and water transported from the Buck Island Reservoir via the Buck Island-Loon Lake Tunnel. Loon Lake Dam can store about 69,308 ac-ft of water (65,786 ac-ft of usable storage) at normal maximum full pool (El. 6,410 feet).

Storage volume at Loon Lake Reservoir typically follows an annual cycle, with the reservoir elevation reaching its highest level during early summer months. The reservoir level gradually

lowers throughout the summer as water is passed through the Loon Lake Powerhouse, generating electricity to meet SMUD’s peak demand during this time period. This gradual lowering of the reservoir continues into the fall and winter months. In addition to providing water to generate energy flexibly to meet SMUD’s fall and winter peak energy needs, this operational regime enables SMUD to create adequate space at Loon Lake Reservoir for storage of rain and snowmelt runoff during the winter/spring, thus minimizing potential seasonal spillage. The water elevation slowly rises during the spring and early summer as rain and snowmelt runoff refill the reservoir.

Figure 4.1-1 shows the historical reservoir elevations by month for the water years 1976 through 1998, including the 10 percent and 90 percent exceedance levels. Over this 23-year period, median high water elevations (El. 6,406 feet) for June and July were near full pool. Median low water elevation occurred in March, averaging 6,370 feet. This represents a typical seasonal change in water elevation at Loon Lake Reservoir of approximately 36 feet. Because SMUD manages the operating storage reservoir levels based, in part, on the projected runoff for the remainder of the water year, more significant seasonal fluctuation may occur in individual years. Average elevation change per day (beginning around June 1 of each year) in Loon Lake Reservoir is about 0.4 feet, as reported in Table 4.2-1 of the *Reservoir Shoreline Habitat Technical Report*.

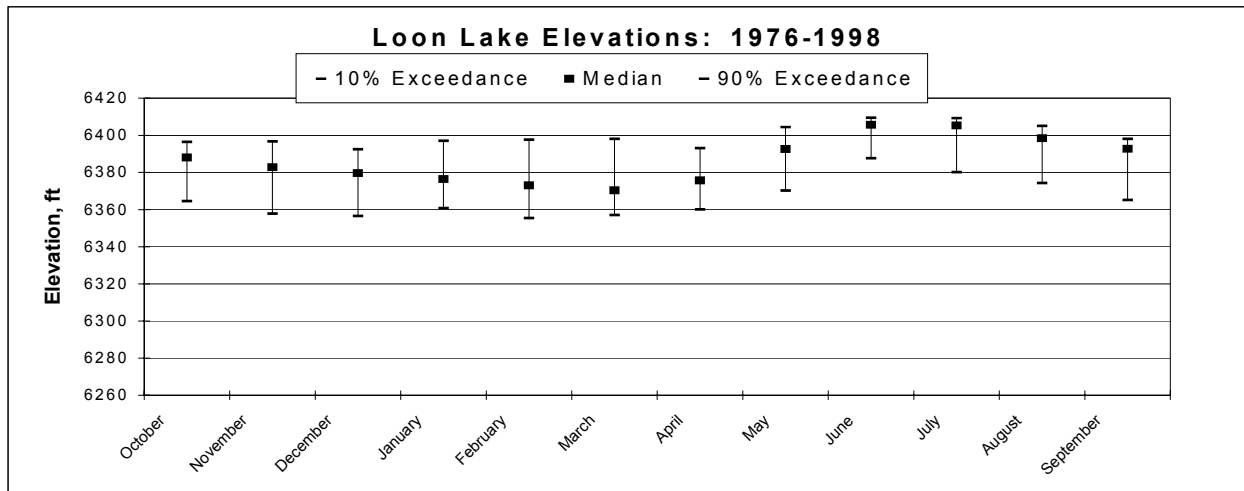


Figure 4.1-1. Loon Lake Reservoir monthly median, 10 percent exceedance and 90 percent exceedance water surface elevations, based on data from 1976 through 1998.

4.1.1.2 Flow Through Deepwater Intakes

Water is released from Loon Lake Reservoir by either passing over the Loon Lake Dam spillway, through the Loon Lake Powerhouse Penstock or through one of the Loon Lake Dam low-level outlets. The Loon Lake Powerhouse Penstock can pass a maximum of 997 cfs of water from Loon Lake Reservoir to the Loon Lake Powerhouse and then into Gerle Creek Reservoir. The Loon Lake Dam low-level outlet is comprised of two 10-inch-diameter, globe valves (combined maximum capacity or 41 cfs at a full pool) and one 42-inch-diameter Howell-

Bunger valve (600 cfs). The invert elevation, height, width and cross-sectional area of the combined Loon Lake Power Tunnel and low-level outlet intakes behind the trashrack are shown in Table 3.0-1.

As described above, the maximum amount of flow that can be passed through the combined Loon Lake Powerhouse Penstock/Loon Lake Dam Low-Level Intake is about 1,038 cfs (997 cfs through the power tunnel plus 41 cfs through the two low level globe valves). The maximum amount of water that can be passed through the Howell Bungler valve is 600 cfs, however, this flow has never occurred. The Howell-Bunger valve is never opened, except for very brief periods for testing as required by FERC or the California Division of Safety of Dams (DSOD). Based on historic records from 1976 through 1999, the median flow (50% exceedance) through the power tunnel/low-level outlet is 53 cfs, with 10 and 90 percent exceedances of 421 cfs and 0 cfs. The maximum flow was 925 cfs (0.5% exceedance) (Figure 4.1-2).

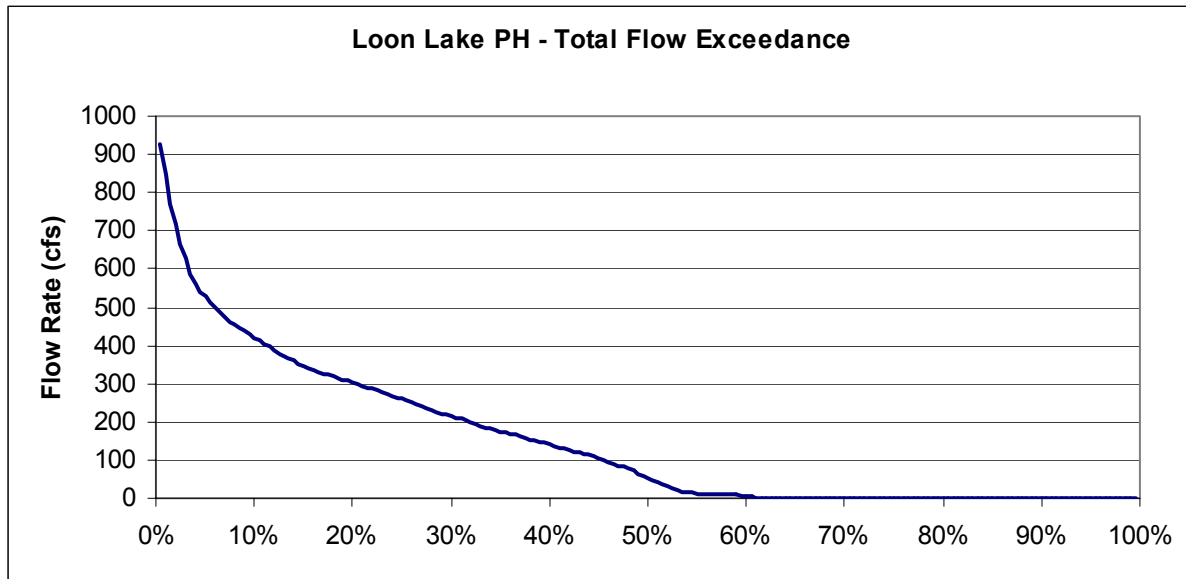


Figure 4.1-2. Loon Lake Powerhouse Penstock withdrawal exceedance curve based on period from 1976 through 1999.

Adding the power tunnel and minimum streamflows, one can assume that the median, 10 percent and 90 percent exceedance flows through the combined power tunnel/low-level intake structure are 61 cfs (53 cfs through the power tunnel plus 8 cfs through the low-level outlet), 429 cfs (421 through the power tunnel plus 8 cfs through the low level outlet) and 8 cfs (no flow through the power tunnel plus 8 cfs through the low-level outlet), respectively.

Based on the intake cross-sectional area of 448 square feet (Table 3.0-1), the approach velocities to the intake for the median, 10 percent and 90 percent exceedance flows are 0.14 feet per second (fps) (61 cfs divided by 448 sq ft), 0.96 fps (429 cfs divided by 448 sq ft) and 0.02 fps (8 cfs divided by 448 sq ft), respectively.

4.1.1.3 Depth of Deepwater Intakes

Figure 4.1-3 shows the average historical reservoir elevations by month for the water years 1976 through 1998 relative to the elevations of the top and bottom of the intake structure. Figure 4.1-3 also shows on the right-hand scale, the mean monthly power diversion intake flows in cfs. These flows not only represent average monthly withdrawals of water, but also relate directly to average monthly approach velocities at the intake structure.

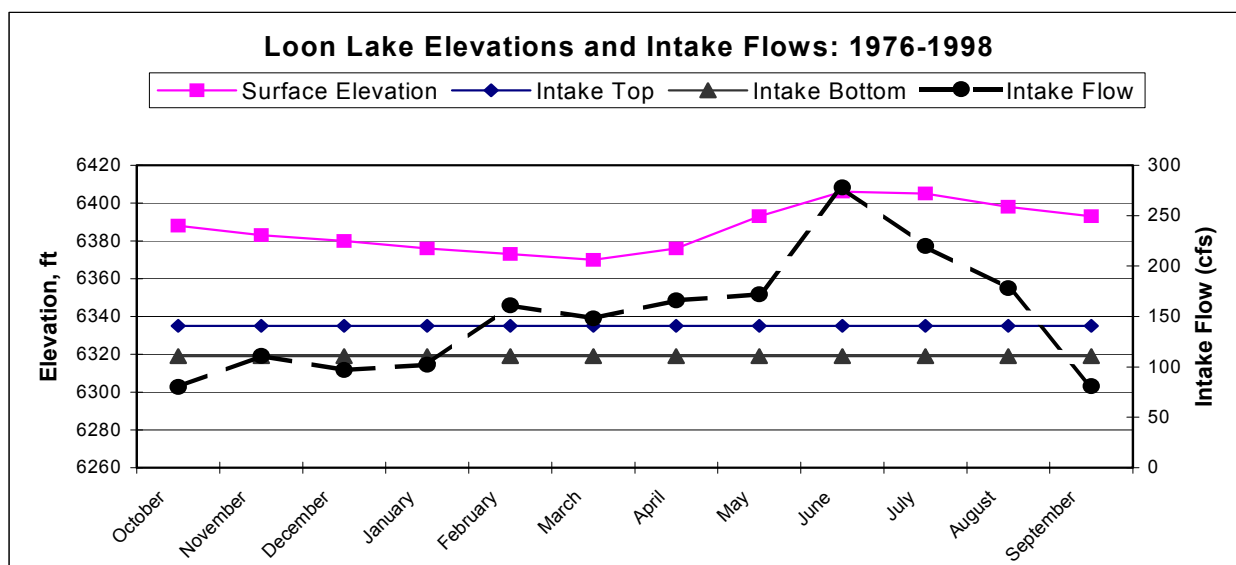


Figure 4.1-3. Loon Lake Reservoir median monthly water surface elevation, depth of deepwater intakes, and flow through the deepwater intakes based on data from 1976 through 1998.

4.1.1.4 Reservoir Stratification and Fish Populations

In general, Loon Lake Reservoir is a cold, clear, well-oxygenated reservoir. The reservoir is isothermal in fall and winter, with water temperatures between 11° and 12 °C. In early summer, the reservoir is weakly stratified with maximum surface temperatures between 13° and 15°C, and minimum temperatures at the bottom of the reservoir of approximately 8°C. A broad metalimnion gradually drops to low temperatures (8°C). A poorly defined hypolimnion also exists. Dissolved oxygen (DO) concentrations appear to be at or near saturation throughout the reservoir. See Section 4.1.4 of the *Water Temperature Technical Report* for a more detailed discussion of water temperature in Loon Lake Reservoir.

The *Reservoir Fisheries Technical Report* shows that fish species in Loon Lake Reservoir include rainbow trout, brown trout, California roach, chubs, Sacramento suckers, and green sunfish (Table 4.0-1 of the *Reservoir Fisheries Technical Report*). In 2002, SMUD’s fish surveys collected 39 brown trout, 37 California roach, seven rainbow trout, and two Sacramento sucker (Table 4.0-2 of the *Reservoir Fisheries Technical Report*). All trout species were evenly distributed throughout the reservoir. Brown trout, the numerically dominant fish collected, ranged in length from 300 to 499 mm and rainbow trout, with one outlier, ranged in length from

450 to 499 mm. Sacramento suckers were 250 to 350 mm in length. (Figure 4.1-2 of the *Reservoir Fisheries Technical Report*.)

4.1.2 Ice House Reservoir

4.1.2.1 Reservoir Fluctuation

The primary purpose of Ice House Dam is to store water inflowing from the South Fork Silver Creek. The maximum gross storage capacity of the reservoir is 43,504 ac-ft of water (35,065 ac-ft of usable storage) at the top of the spillway gates (El. 5,450 feet). DSOD requires that the gates be open from November through April 1, at which time the maximum elevation is 5,436.5.

Like Loon Lake, storage volume at Ice House Reservoir typically follows an annual cycle, with the reservoir elevation reaching its highest level typically in early June. The reservoir level gradually lowers throughout the summer as water is passed through the Jones Fork Power Tunnel, generating electricity at the Jones Fork Powerhouse to meet SMUD's peak demand during this time period. This gradual lowering of the reservoir continues into the fall and winter. SMUD's preferred minimum pool operating elevation in Ice House Reservoir is 5,380 feet to avoid vortexing. In addition to providing water to generate energy flexibly to meet SMUD's fall and winter peak energy needs, this operational regime also enables SMUD to create adequate storage space at Ice House Reservoir for storage of rain and snowmelt runoff during the winter/spring months, thus minimizing spillage. The water elevation slowly rises during the spring and early summer as the rain and snowmelt runoff refill this reservoir.

Figure 4.1-4 shows the historical reservoir elevations by month for the water years 1985 through 1998. Over this period, which starts after the completion of the 11.5 MW Jones Fork Powerhouse, median high water elevations for June and July were near full pool, averaging 5,446 feet. Median low water elevation occurred in March, averaging 5,404 feet. This represents a typical seasonal change in water elevation at Ice House Reservoir of about 42 feet. Because SMUD manages the operating storage reservoir levels, based in part on the estimated future runoff for the remainder of the water year, more significant seasonal fluctuations may occur in individual years. Average elevation change per day in Ice House Reservoir is about 0.3 feet, as reported in Table 4.2-1 of the *Reservoir Shoreline Habitat Technical Report*.

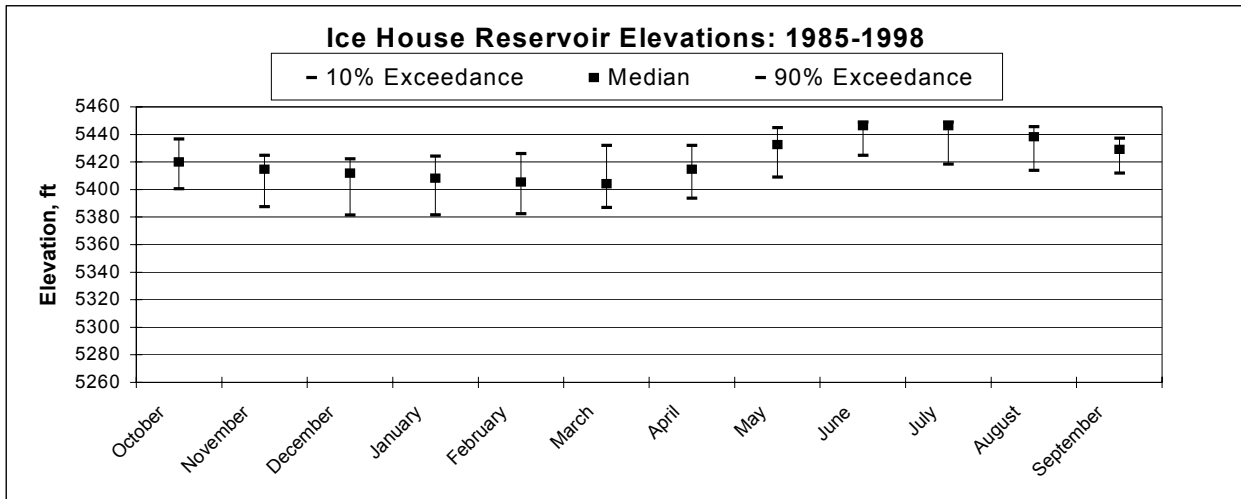


Figure 4.1-4. Ice House Reservoir monthly median, 10 percent exceedance and 90 percent exceedance water surface elevations, based on data from 1985 through 1998.

4.1.2.2 Flow Through Deepwater Intakes

Water is released from Ice House Reservoir by either passing over the Ice House Dam spillway, through the Jones Fork Power Tunnel or through the Ice House Dam low-level outlet. The Jones Fork Power Tunnel has a maximum capacity of 287 cfs. The Ice House Dam low-level is comprised of two 10-inch-diameter globe valves (combined maximum capacity of 47 cfs) and one 42-inch-diameter Howell Bungler valve (695 cfs). The invert elevation, height, width and cross-sectional area of the Jones Fork Power Tunnel intake and the Ice House Dam low-level intake behind the trashracks are shown in Table 3.0-1.

As described above, the maximum amount of flow that can be passed through the Jones Fork Power Tunnel is 287 cfs. Based on historic records from 1985 through 1999, the median flow through the power tunnel is 39 cfs, with 10 and 90 percent exceedances of 191 cfs and 0 cfs. The maximum flow was 280 cfs (0.5% exceedance). (Figure 4.1-5.)

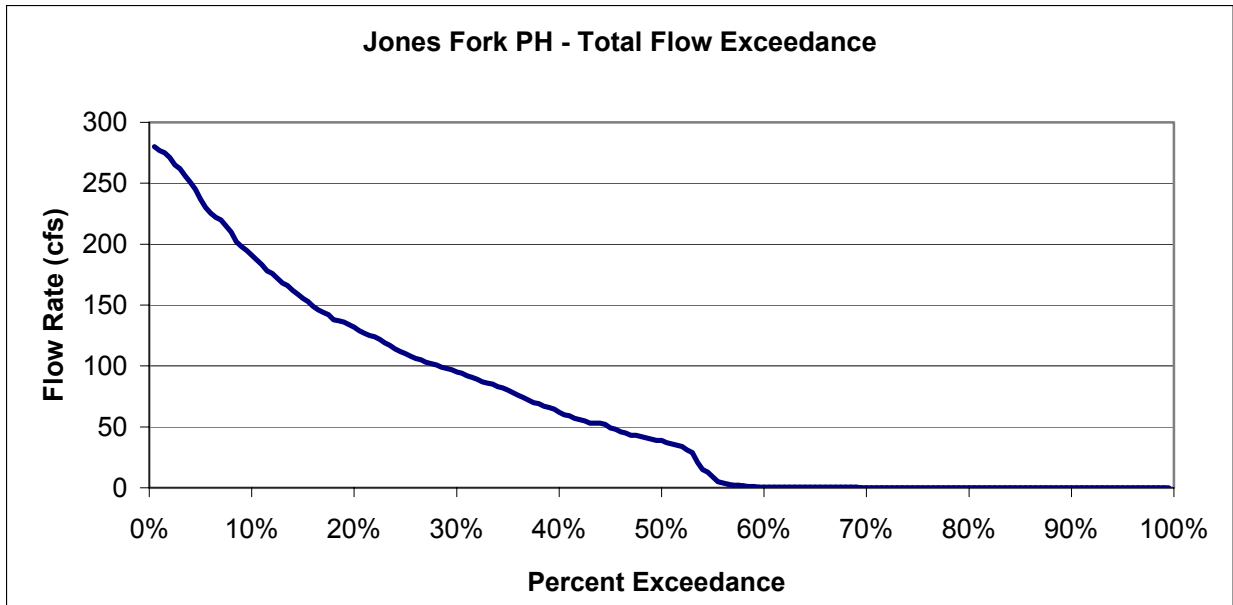


Figure 4.1-5. Jones Fork Power Tunnel withdrawal exceedance curve based on period from 1985 through 1999.

Based on these flows and the 162 square foot cross-sectional area of the intake structure (Table 3.0-1), one can assume that the approach velocities associated with the median, 10 percent and 90 percent exceedance flows through the Jones Fork Power Tunnel Intake are 0.24 fps (39 cfs divided by 162 sq-ft), 1.18 fps (191 cfs divided by 162 sq-ft) and 0 cfs (0 cfs divided by 162 sq-ft), respectively.

The maximum amount of flow that can be passed through the Ice House Dam low-level intake is about 1,638 cfs (47 cfs through the two low level globe valves plus 695 cfs through the Howell-Bunger valve). However, this flow has not occurred since the Jones Fork Powerhouse went into operation. Now, the Howell-Bunger valve is not opened, except for very brief periods for testing as required by FERC or the DSOD or for specific studies, such as the recent Ice House Dam Reach Whitewater Boating Test Flow Study performed for the UARP relicensing. Minimum streamflow release requirement is from 5 to 15 cfs, depending on water year type, and is released through the globe valves. Based on the range of historic minimum streamflows and the seven square foot cross-sectional area of the intake structure (Table 3.0-1), one can assume that approach velocities at the Ice House Dam Low-Level Intake range from 0.71 fps (5 cfs divided by 7 sq ft) to 2.14 fps (15 cfs divided by 7 sq ft).

4.1.2.3 Depth of Deepwater Intakes

Figure 4.1-6 shows the historical average reservoir elevations by month for the water years 1985 through 1998 relative to the elevations of the top and bottom of the submerged intake structure. Figure 4.1-6 also shows on the right-hand scale, the mean monthly power diversion intake flows in cfs. These flows not only represent average monthly withdrawals of water, but also relate directly to average monthly approach velocities at the intake structure.

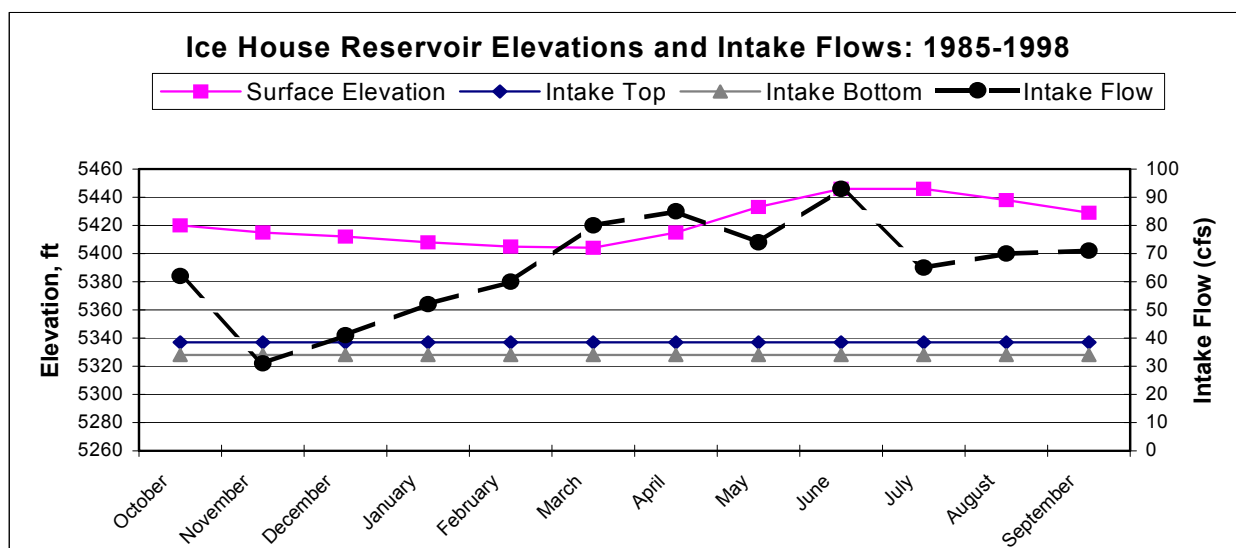


Figure 4.1-6. Ice House Reservoir median monthly water surface elevation, depth of deepwater intakes, and flow through the deepwater intakes based on data from 1985 through 1998.

4.1.2.4 Reservoir Stratification and Fish Populations

As described in Section 4.1.7 of the *Water Temperature Technical Report*, Ice House Reservoir is strongly stratified with surface water temperature highest in July and August at about 20°C and hypolimnetic bottom water at about 7°C. A thermocline, ranging from a depth of 15 to 60 feet, forms in June and persists into November. A strong metalimnion forms, with a deepening epilimnion throughout the summer. Ice House Reservoir exhibits an orthograde oxygen profile typical of moderately oligotrophic lakes. Dissolved oxygen levels in the epilimnion are close to saturation (8 to 9 mg/l), with dissolved oxygen (DO) levels at about 3 to 5 mg/l near the bottom. The reservoir is relatively clear with Secchi disk readings ranging from about 20 to 30 feet.

As described in the *Reservoir Fisheries Technical Report*, fish in Ice House Reservoir include rainbow trout, brook trout, brown trout, golden shiner, kokanee salmon and California roach (Table 4.0-1 of the *Reservoir Fisheries Technical Report*). In 2002, SMUD collected 38 brown trout, 11 rainbow trout, and six California roach were collected by beach seining and gill netting (Table 4.0-2 of the *Reservoir Fisheries Technical Report*). Brown trout were distributed across several size ranges, between 250-549 mm, and rainbow trout were predominantly observed between 250-399 mm with one fish in the 25-49 mm size range. California roach were observed only in the 25-49 mm size range (Figure 4.2-2 of the *Reservoir Fisheries Technical Report*).

4.1.3 Union Valley Reservoir

4.1.3.1 Reservoir Fluctuation

The primary purpose of Union Valley Dam is to store water transported via the Jones Fork and Robbs Peak powerhouses as well as tributary inflows. The maximum gross (and usable) storage capacity of Union Valley Reservoir is 266,303 ac-ft of water at elevation 4,870 feet, which is the top of the spillway gates when closed. DSOD requires that the gates be open from November through April 1, at which time the maximum reservoir elevation is 5,855.0 feet.

As with Loon Lake and Ice House reservoir, storage levels at Union Valley Reservoir typically follow an annual cycle, with the reservoir elevations reaching their highest levels typically by June 1 each year. The reservoir levels gradually lower throughout the summer as the water is passed through the Union Valley Powerhouse generating electricity to meet SMUD's peak demand during this time period. This gradual lowering of the reservoir continues into the fall and winter months. In addition to providing water to generate electricity to meet SMUD's fall and winter peak energy needs, this operational regime also provides adequate space at Union Valley Reservoir for storage of rain and snowmelt runoff during the winter/spring months, thus minimizing spillage. The water elevation slowly rises during the spring and early summer as the rain and snowmelt runoff refill this reservoir.

Figure 4.1-7 shows the historical minimum, maximum and median reservoir elevations by month for the water years 1976 through 1998. Over this 23-year period, median high water elevation for June and July were near full pool, averaging 4,862 feet. Median low water elevation occurred in January, averaging 4,809 feet. This represents a median seasonal change in water elevation at Union Valley Reservoir of about 53 feet. Because the reservoir levels are managed, based in part on the estimated future runoff for the remainder of the water year, more significant seasonal fluctuation may occur in individual years. Average elevation change per day in Union Valley Reservoir is about 0.6 feet, as reported in Table 4.2-1 of the *Reservoir Shoreline Habitat Technical Report*.

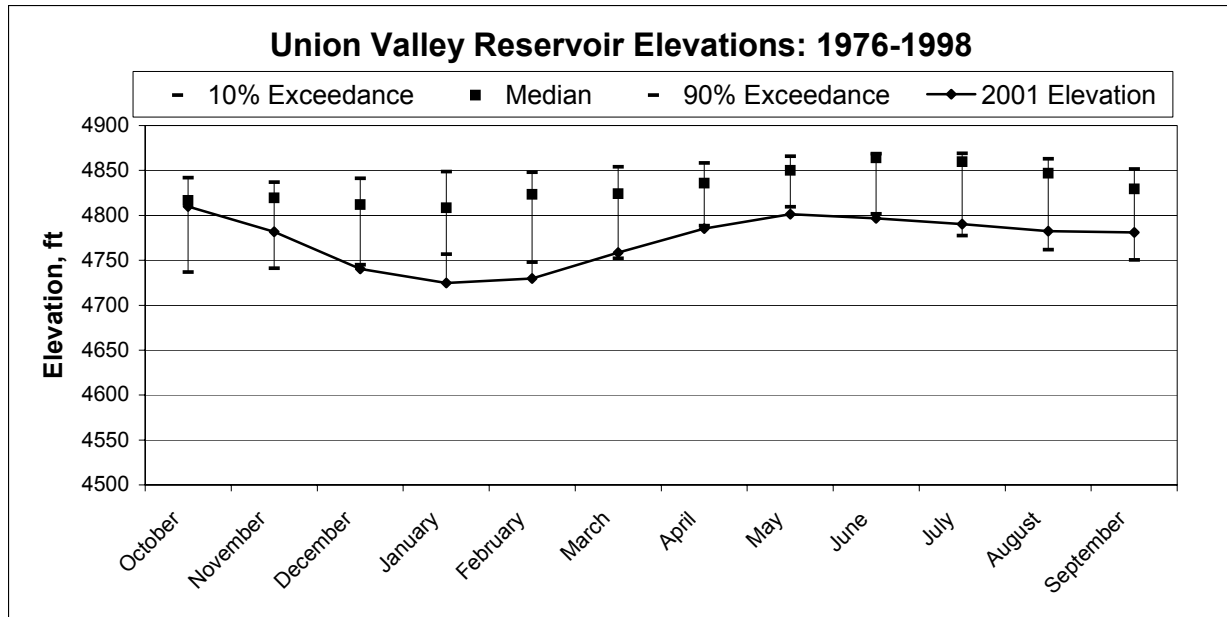


Figure 4.1-7. Union Valley Reservoir monthly median, 10 percent exceedance and 90 percent exceedance water surface elevations, based on data from 1976 through 1998 and 2001 elevations.

As requested by the Aquatic TWG on June 10, 2004, the above figure also shows Union Valley Reservoir water surface elevations in Water Year 2001. In that year, the reservoir was drawn down to lower than typical levels due to a state-wide electrical demand in California.

4.1.3.2 Flow Through Deepwater Intakes

Up to 1,577 cfs of water is released from Union Valley Reservoir through the Union Valley Powerhouse Penstock 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 invert elevation, height, width and cross-sectional area of the Union Valley Powerhouse Penstock Intake are shown in Table 3.0-1.

As described above, the maximum amount of flow that can be passed through the Union Valley Powerhouse Penstock Intake is about 1,577 cfs. Based on historic records from 1976 through 1999, the median flow through the power tunnel is 415 cfs, with 10 and 90 percent exceedances of 1,150 cfs and 1 cfs. The maximum flow was 1,560 cfs (0.5% exceedance) (Figure 4.1-8).

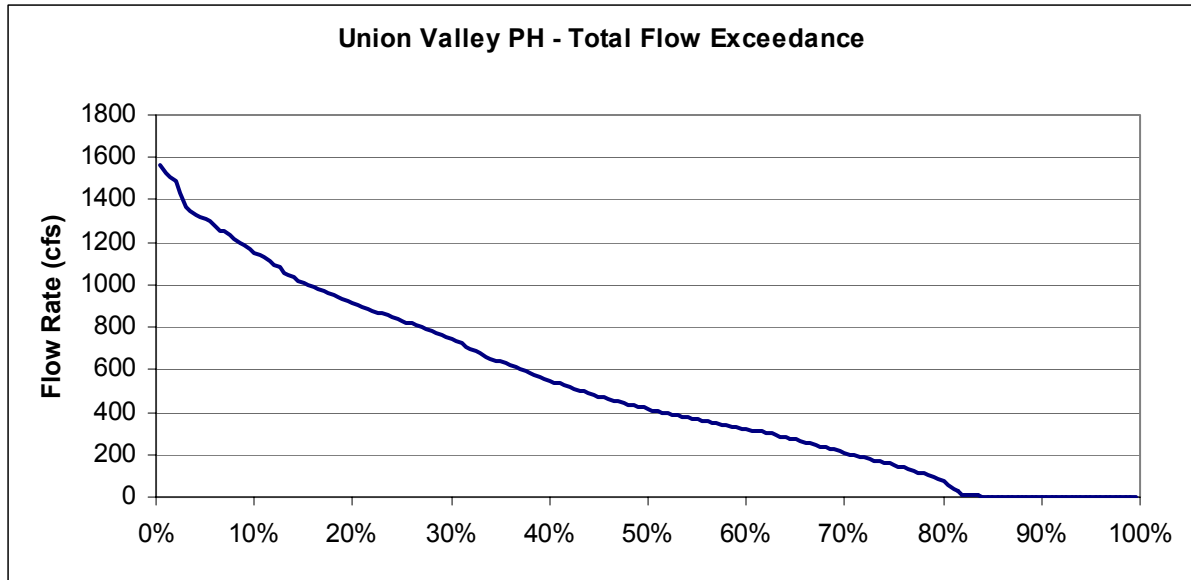


Figure 4.1-8. Union Valley Powerhouse Penstock withdrawal exceedance curve based on period from 1976 through 1999.

Therefore, one can assume that the median, 10 percent and 90 percent exceedance approach velocities at the Union Valley Powerhouse Penstock Intake associated with these flows are 0.41 fps (415 cfs divided by 1,010 sq-ft), 1.14 fps (1,150 divided by 1,010 sq-ft) and less than 0.01 fps (1 divided by 1,010 sq-ft), respectively.

4.1.3.3 Depth of Deepwater Intake

Figure 4.1-9 shows the historical reservoir elevations by month for the water years 1976 through 1998 relative to the elevations of the top and bottom of the submerged intake structure. Figure 4.1-9 also shows on the right-hand scale the mean monthly power diversion intake flows in cfs. These flows not only represent average monthly withdrawals of water, but also relate directly to average monthly approach velocities at the intake structure.

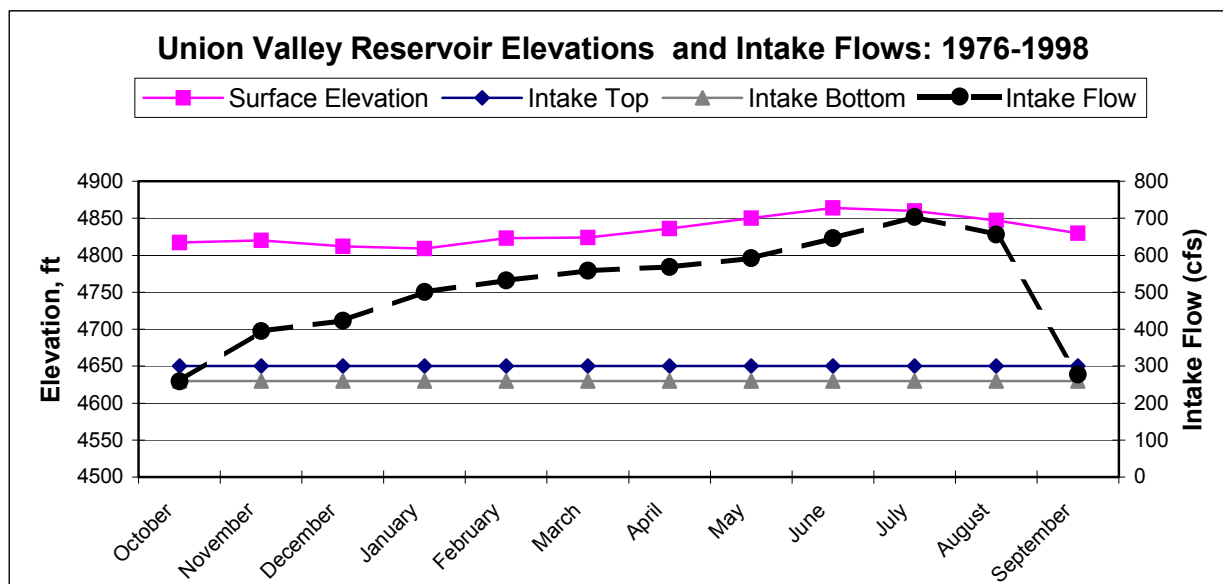


Figure 4.1-9. Union Valley Reservoir median monthly water surface elevation, depth of deepwater intake, and flow through the deepwater intake based on data from 1976 through 1998.

4.1.3.4 Reservoir Stratification and Fish Populations

Information in Section 4.1.8 of the *Water Temperature Technical Report* shows that Union Valley Reservoir strongly stratifies in summer with surface temperatures of 17°C to 18°C and bottom temperature of 7°C, a range of temperatures similar to those observed at Ice House Reservoir. In June and July, the epilimnion is approximately 20 feet deep, followed by a distinct metalimnion where temperatures drop approximately 10°C within 40 feet. In September, the reservoir is warmer with a deeper epilimnion at 20°C. In October 2002, temperatures of close to 18.0°C were found in the top 56 feet of the reservoir, followed by a metalimnion to around 213 feet, below which temperatures were stable around 5.9°C. The reservoir remains stratified in November with a thermocline in the 187 to 197 foot depth range. Epilimnion temperatures range from approximately 12.4°C at the surface to around 11.0°C at 187 feet, and the hypolimnion has water temperatures at about 6.0°C. In contrast to Ice House Reservoir, the DO profile in Union Valley Reservoir does not indicate obvious phytoplankton activity. Dissolved oxygen profiles are mildly orthograde in both June and July, exhibiting concentrations of approximately 7.0 mg/l. By November, Union Valley Reservoir exhibits a constant dissolved oxygen profile at 7.0 to 7.5 mg/l. Secchi disk depth ranged between 25 and 27 feet during June 2000, and was 24 feet in 1980.

As reported in Table 4.0-1 of the *Reservoir Fisheries Technical Report*, fish populations in Union Valley Reservoir include rainbow trout, lake trout, Sacramento suckers, smallmouth bass, cutthroat trout, kokanee salmon, lake trout (mackinaw), smallmouth bass, golden shiner, green sunfish and mosquitofish. In 2002, 64 smallmouth bass, 22 kokanee salmon, 16 Sacramento sucker, seven rainbow trout, and one lake trout were collected in gill nets (Table 4.0-2 of the

Reservoir Fisheries Technical Report). The length-frequency distribution for smallmouth bass found that the majority (35 fish) forms a peak in the 300-349 mm size range. Kokanee, with nearly 20 fish, were most common in the 300-349 mm size range. Rainbow trout were distributed in the 300-449 mm size range. Sacramento sucker were distributed from 350-499 mm, with a single Sacramento sucker in the 550-559 mm size range. A single lake trout was the largest fish sampled, observed in the 850-899 mm size class. (Figure 4.4-2 of the *Reservoir Fisheries Technical Report*.)

4.1.4 Junction Reservoir

4.1.4.1 Reservoir Fluctuation

The primary purpose of Junction Dam, which is located on Silver Creek, is to capture the local inflows from the South Fork Silver Creek and the Little Silver Creek, and function as an afterbay for the Union Valley Powerhouse and as a forebay to the Jaybird Powerhouse. The gross and usable storage capacity of Junction Dam at normal full pool (El. 4,450.0 feet) are 2,610 ac-ft and 2,104 ac-ft of water, respectively.

Figure 4.1-10 shows the average historical minimum, maximum and median reservoir elevations by month for the water years 1988 through 1998. Over this period, monthly median high water elevations varied only one foot, from 4,445 to 4,446 feet. This represents a negligible median seasonal change in water elevation at Junction Reservoir. Because the reservoir is operated as a re-regulating reservoir for daily peaking operation of the Jaybird Powerhouse, water level in the reservoir may fluctuate daily with changing volumes of inflows and powerhouse flow. Typical fluctuation is no more than 15 feet, ranging between the operating pool levels of 4,435 feet and 4,450 feet. Average elevation change per day in Junction Reservoir is about 20.7 feet, as reported in Table 4.2-1 of the *Reservoir Shoreline Habitat Technical Report*.

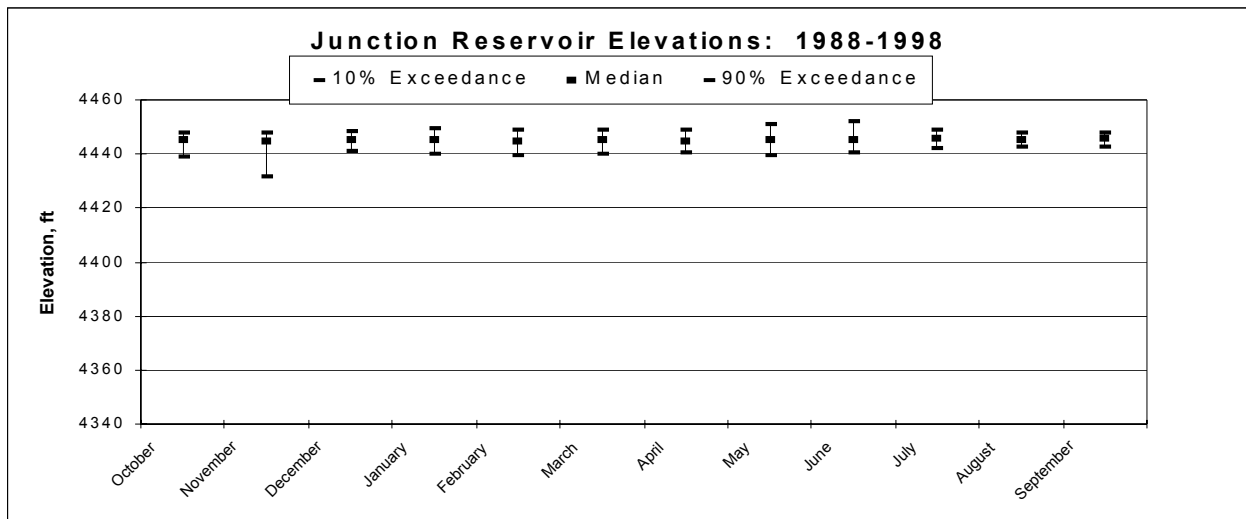


Figure 4.1-10. Junction Reservoir monthly median, 10 percent exceedance and 90 percent exceedance water surface elevations, based on data from 1988 through 1998.

4.1.4.2 Flow Through Deepwater Intakes

Water is released from Junction Reservoir by either passing over the Junction Dam spillway, passing through the Jaybird Power Tunnel or passing through the Junction Dam Low-Level outlet. At normal full pool (El. 4,450.0 feet), the maximum capacity of the Jaybird Power Tunnel is 1,345 cfs and the maximum capacity of the one 18-inch-diameter hollow cone valve low-level outlet is 138 cfs. The invert elevation, height, width and cross-sectional area of the Jaybird Power Tunnel intake and the Junction Dam Low-Level intake behind the trashracks are shown in Table 3.0-1.

To determine the range of typical flows through the Jaybird Power Tunnel, DTA calculated the average monthly flow through the power tunnel from 1988 through 1998 (Figure 4.1-11). This analysis indicated that the lowest average monthly flow through the Jaybird Power Tunnel intake occurs in November (328 cfs) while the highest average monthly flow occurs in March (901 cfs). Based on these data and the 1,470 sq ft cross-section area of the Jaybird Power Tunnel Intake (Table 3.0-1), the range of approach velocities typical for the intake is from 0.22 fps (328 cfs divided by 1,470 sq-ft) to 0.61 fps (901 cfs divided by 1,470 sq-ft).

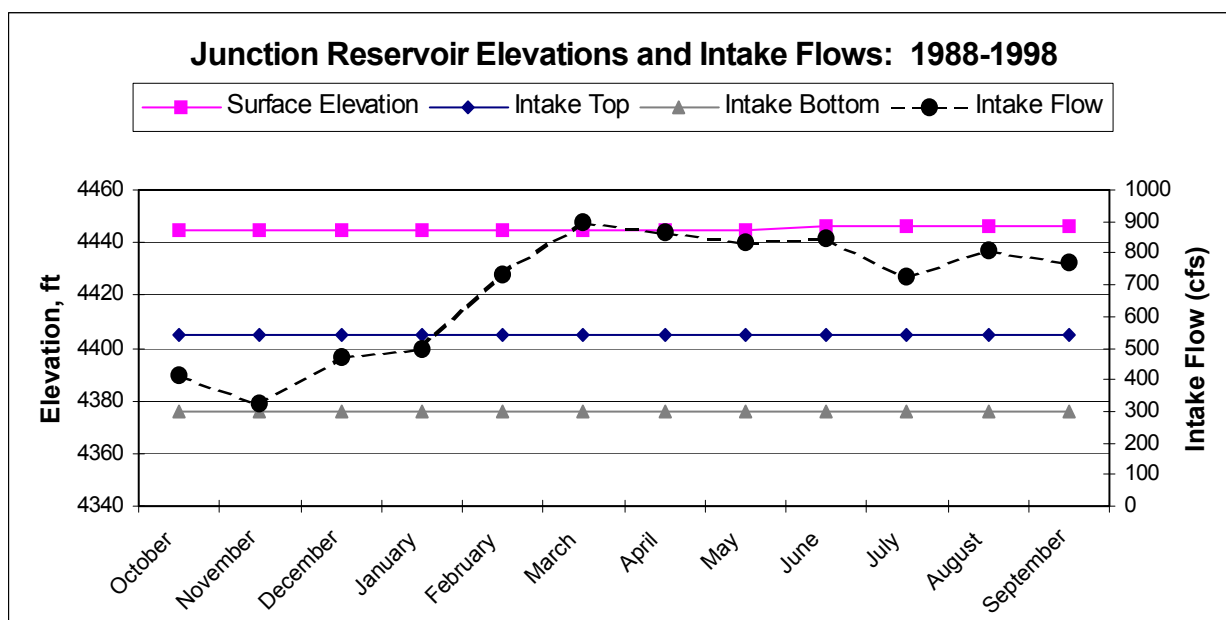


Figure 4.1-11. Junction Reservoir median monthly water surface elevation, depth of deepwater intake, and flow through the deepwater intake based on data from 1988 through 1998.

The maximum amount of flow that can be passed through the Junction Dam low-level intake is about 138 cfs. The minimum streamflow release requirement is from 5 to 20 cfs, depending on water year type. Based on the range of historic minimum streamflows and the 16 square foot cross-sectional area of the intake structure (Table 3.0-1), one can assume that the range of approach velocities at the Junction Dam Low-Level Intake is from 0.31 fps (5 cfs divided by 16 sq-ft) to 1.25 fps (20 cfs divided by 16 sq-ft).

4.1.4.3 Depth of Deepwater Intakes

Figure 4.1-11 shows the historical reservoir average elevations by month relative to the elevations of the top and bottom of the submerged intake structure. Figure 4.1-11 also shows on the right-hand scale, the mean monthly power diversion intake flows in cfs. These flows not only represent average monthly withdrawals of water, but also relate directly to average monthly approach velocities at the intake structure.

4.1.4.4 Reservoir Stratification and Fish Populations

Water temperature stratification in Junction Reservoir is evident in June, but the epilimnion is very shallow and temperatures decreased sharply below approximately 15 feet. Surface temperatures approach 19°C, approximately 10°C warmer than in November. Bottom temperatures (maximum depth of about 110 feet) are approximately 7°C. Dissolved oxygen ranges from approximately 8 to 10 mg/l in the reservoir. Secchi disk depth in November is about 8 to 10 feet deep. See Section 4.1.9 of the *Water Temperature Technical Report* for a more detailed discussion of water temperature in Junction Reservoir.

Fishes in Junction Reservoir include rainbow trout, brook trout, brown trout, Sacramento sucker and kokanee (Table 4.0-1 of the *Reservoir Fisheries Technical Report*). In 2002, 47 Sacramento sucker and ten brown trout in the gill netting surveys were collected. No other species were caught (Table 4.0-2 of the *Reservoir Fisheries Technical Report*). Sacramento suckers ranged in size from 300 to 499 mm, with a peak at 400-499 mm. Brown trout were spread across several different size ranges, most from 300-449 mm and one fish at 550-599 mm and one fish at 700-749 mm. The highest concentration of brown trout occurred in the 300-349 mm size range. (Figure 4.5-2 of the *Reservoir Fisheries Technical Report*.)

4.1.5 Camino Reservoir

4.1.5.1 Reservoir Fluctuation

Camino Reservoir, located on Silver Creek, is a small reservoir capable of impounding a maximum of 541 ac-ft of water (usable storage of 489 ac-ft) at a normal maximum full pool elevation of 2,915 feet, which is the top of the Camino Dam spillway gates, which are normally closed. The gates are only opened if water might spill over the gates. This reservoir serves as an afterbay to Jaybird Powerhouse and as one of the two forebays to Camino Powerhouse. The dam also captures accretion flows that enter Silver Creek downstream of Junction Dam.

