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

ICE HOUSE REACH WHITEWATER BOATING FLOW STUDY TECHNICAL REPORT

Prepared by:

Devine Tarbell & Associates, Inc.
Sacramento, California

The Louis Berger Group
Oakhurst, California

Prepared for:

Sacramento Municipal Utility District
Sacramento, California

SEPTEMBER 2004

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8.10 Ice House Whitewater Boating Study
(Note: Above Chili Bar)

8.10.1 Pertinent Issue Questions

This study focuses on the Ice House Reach however there are references to the Slab Creek Reach in the study plan since the controlled flow studies on the Ice House and Slab Creek reaches were originally developed as one study plan.

The Ice House Whitewater Boating Study addresses the following recreational resource questions:

3a. What are the effects of potential boating flows on water levels of Project reservoirs?
6. What maximum and minimum flow regimes are required for whitewater boating in the stream reaches affected by the Project, including Upper Rubicon River
19. Can there be a flow management hydrology model (unimpaired hydrograph) built with a whitewater filter that estimates flows assuming UARP/Chili Bar presence and absence?
68. What is the need for, and feasibility of, whitewater boating in the reaches below Project dams?

Other issue questions relating to whitewater boating that were developed for the relicensing include:

1a. Is it possible to have consistent and regular releases that support boating in the reach between Slab Creek Dam and Chili Bar Reservoir?
2. What are the optimal and minimum boating flows between Slab Creek Dam and Chili Bar, for all crafts, and all classes of boating?

8.10.2 Background

The objectives of the Whitewater Boating Feasibility Study included:

- Identify and describe reaches where there are existing or potential whitewater opportunities
- Quantify how the Project affects these opportunities (i.e., flows, boatable days, season of use, access)
- Characterize whitewater opportunities affected by Project operations based on physical characteristics, existing information and interviews (e.g., gradient, length, access, channel characteristics, flows, reservoir storage and diversion capacity)
- Determine current and future demand for whitewater boating on Project reaches
- Develop a range of possible flows to provide other TWG's before conducting additional studies
- Describe and assess the adequacy and availability of existing flow information
- Recommend additional studies needed for whitewater resources (e.g., Single Flow Feasibility Study or Controlled Flow Study)

Reconnaissance conducted as part of the Whitewater Boating Feasibility Study was completed in 2002 and a presentation of the methods and results was made to the Recreation TWG on January 22, 2003. Subsequent documentation of the reconnaissance was presented to the Recreation TWG on February 5, 2003. Helicopter reconnaissance of South Fork Rubicon below Robbs Forebay and Silver Creek below Junction Reservoir was conducted on June 11, 2003. Based on the presentation, documentation and field reconnaisance the Recreation TWG participants determined that additional investigation including flow studies are warranted at the Slab Creek and Ice House reaches in order to have enough information to address all of the pertinent issue questions relating to these reaches. A study plan for both of these reaches was developed and approved by the TWG February 26, 2003. The TWG subsequently asked to prepare separate study plans for each reach. The study plans were presented to the Aquatics TWG in August for review and comment. The Aquatics TWG did not have concerns with the range of flows proposed in the study plan. They also agreed that the whitewater flow study for the Slab Creek reach could be initiated as soon as November 2003.

Flows for this study will be provided to the Ice House Reach by opening the Howell-Bunger valve in the Ice House Dam. This valve is periodically tested as part of the Licensee' dam safety program. The current minimum flow requirement in the Ice House Reach is 5 cfs, year-round when the annual forecasted runoff into Folsom Reservoir is

less than 1.499 million acre feet. When the forecasted runoff into Folsom Reservoir is more than 1.5 million acre-feet, the minimum instream flow requirements are: 12 cfs in October; 10/4 cfs in November; 4 cfs in December; 3 cfs in January through April; 8 cfs in May and June and 15 cfs in July, August and September.

It should be noted that this reach was burned in the Cleveland fire. Field reconnaissance revealed that there appears to be a notable amount of large woody debris in the reach.

8.10.3 Study Objectives

The objectives of this study include:

- Identify current and potential boating opportunities on the Ice House reach. Opportunities may vary by craft, skill level, or preferences for different types of whitewater conditions.
- Identify flow-related attributes for each of those opportunities, including a description and classification of key rapids.
- Develop relationships between flow levels and quality of whitewater experience for the Ice House Reach. Resulting "flow evaluation curves" will identify minimum and maximum acceptable flows and optimum flow ranges for each reach for a variety of watercraft.
- Determine the whitewater difficulty using the International Scale of Whitewater Difficulty (American Whitewater 1963) for the reach within the range of test flows.
- Determine what types of watercraft are suited for the reach within the range of test flows.
- Characterize the whitewater resource in the reach in terms of quality of the opportunity and suitability for whitewater boating.
- Determine what operational challenges may exist in providing flows in the boatable range.
- Quantify how the Project has affected the frequency and timing of boatable days available in this reach.

8.10.4 Study Area and Sampling Locations

The study area is defined as the Project reach directly downstream of Ice House Dam (between Ice House Dam and Junction Reservoir).

8.10.5 Information Needed From and Coordination with Other Studies

Hydrology data to determine the annual number of days and timing of boatable flows that occur under regulated and unimpaired conditions in this reach. Channel morphology and habitat mapping information may be useful to review in the analysis.

Provide timing, duration and magnitude of test flows as soon as practical to other TWG's. The Aquatics TWG will develop a set of concurrent studies that will focus on aquatic resources that could potentially be affected by the study flows.

8.10.6 Study Methods And Schedule

The Ice House Whitewater Boating Study requires that a team of boaters paddle a given stream reach multiple times in succession while the independent variable, flow, is changed. The objective is to record how changes in flow alter the quality of the experience for individual participants and the group. The group of participants paddle each pre-selected flow then individually complete a single flow survey questionnaire querying them on a number of whitewater characteristics specific to that flow. Upon completion of all the test flows participants complete the comparative survey form enabling them to evaluate one flow over another for specific characteristics. Focus group discussions structured with specific questions are conducted at the conclusion of each single flow and upon completion of the comparative evaluations.

The methodology to complete the Ice House Whitewater Boating Study will include an organized boating trip on the Project reach. Boating teams of between six to 12 kayaks and other crafts suitable for small creek type of boating on the Ice House reach will be organized to make runs of the reach at the following target flows:

Ice House Reach: 200, 300 and 500 cfs

The actual flows may be adjusted, within this range, while the study is in progress based on results of single flow responses and focus group discussions.

The existing information about the whitewater resource on the Ice House Reach indicates that current boating opportunities are constrained by the Project diversions around the reach. The target flows for this run are selected to gain information about the entire range of boatable flows.

The boating team members will have the skills necessary to boat the reach and will commit to participate in the entire test flow series. Boating participants will be selected by interested TWG participants. Each boater will sign a waiver of liability prior to participating in the study. The primary data for this study will consist of the boaters' responses to questionnaires that they will complete at the conclusion of each run. The questionnaire will include a section to gather data for a comparative flow evaluation for each reach. A draft of the questionnaire has been prepared and is attached to this study plan (***The questionnaire was distributed at the 2/26/03 Recreation TWG meeting)***. Comments and changes to the questionnaire will be incorporated prior to initiating the study. The type of data to be collected include: 1) boatability, 2) quality of the reach, 3) suitability of the run for different crafts and boater skill levels, 3) quality of the put-in/take-out locations, 4) boater's opinion of the class of difficulty of the run, 5) comparison of each run at its different flows, 6) quality and length of the shuttle, 7) any safety concerns or hazards, 8) scenic quality, 9) number and difficulty of portages, 10) availability of play areas, and 11) boater's opinion of the flows that would represent the general paddling public preference.

If practical, the locations of any significant boating hazards or log jams in the reach will be made using GPS equipment during the study flows.

The study methods will include videotaped recordings and/or photographs taken at key locations on the run. The post-run discussion among the boaters (after the team has completed the questionnaires) will also be recorded on videotape. The post run group discussions, will include identifying suitable locations in the reach for lunch or break stops, possible overnight use locations, access and potential for commercial boating use in the reach as well as discussing other general aspects of the reach. The questions for the focus group discussion will be developed with interested TWG participants during the process of reviewing and finalizing the questionnaires that will be used in the study.

The schedule for conducting the Ice House Whitewater Boating Study will depend on the type of water year and the timing of snowmelt. The schedule will need to be flexible to respond to these climatic conditions however for planning purposes, the estimated schedule for conducting the flow study for the reach is listed below:

Ice House Reach: April 30 to May 30, 2004
(Tentative dates are April 30, May 1, and 2 with alternate dates of May 7, 8 and 9)

This is an approximate schedule that will be revisited and updated based on hydrologic events in the coming months. Although the Licensee has every intention of completing this study by 2004, this study plan needs to include a contingency for the occurrence of a dry water year, unforeseen power generation needs or because of biological concerns raised by the Aquatics TWG. The Licensee would like to accomplish the work associated with this study plan late spring during a period of the year when the flows necessary for the study would occur within the natural hydrograph.

8.10.7 Analysis

The information developed in this study will be used to describe the whitewater boating opportunities on this reach, quality of the run, ease of the shuttle (in terms of time, distance, quality of route), access at both put-ins and take-

outs, scenic quality, class of difficulty and boatability. The data collected will be summarized and analyzed for frequencies of responses and general trends that may exist in the data. The questionnaire responses will be used to estimate by watercraft type, the minimum and maximum acceptable boating flows and optimum boating flow for the reach that is within the normal peaks of the natural hydrograph. These definitions (Whittaker et al. 1993) are:

Minimum Acceptable Flow: the lowest flow at which 50% of the survey respondents will return to paddle.

Maximum Acceptable Flow: the highest flow at which 50% of the survey respondents will return to paddle.

Optimum Flow: The flow level that provides the best combination of flow conditions for a whitewater opportunity. The optimum flow is the peak of the flow preference curve.

Flow Preference Curve: the graphic relationship between flow (horizontal axis) and survey responses (vertical axis).

Hydrology data for the period of record (1975 to 2001) will be analyzed to display how often boatable flows, as identified by the boaters, including optimum flows, have occurred under unimpaired and regulated conditions. The analysis will also identify when these flows have occurred over the period of record (number of days with boatable days per month and water year type) under unimpaired and regulated conditions. Hourly data will be used, where available or where it can be synthesized.

Other hydrologic factors that may affect boating opportunities will also be analyzed. These will include how quickly typical spill flows move through the boatable range and whether there other flow fluctuations that make it difficult to boat this reach under current operations.

8.10.8 Study Output

A written report will be prepared to include documentation of survey findings with presentation in graphical and discussion format in a manner which appropriately answers issue questions. The study output will include a USGS quad map showing basic information about the runs including the location of the put-ins and take-outs, potential break or lunch stop locations, portages, locations of barriers/log jams, areas with safety concerns, shuttle route, and locations of photographs or videotape recordings taken during the study. If areas of concern or interest present themselves at different flows, this will be noted on the maps (i.e. a log was portaged at 200 cfs but the log was not a barrier at the 500 cfs flow). The study output will also include the summarized responses to the questionnaires, flow preference curves, photographs showing portions of the runs, put-ins and take-outs, and edited videotape of the run and post-run group discussion. The edited video will capture watercraft at each pre-selected rapid for each test flow. The output will also include graphical and tabular data to compare the number and timing of boatable days that occur under unimpaired and regulated conditions in this reach. Operational aspects of the Project such as the Howell-Bunger valve and the minimum instream flow requirements will be presented in the report.

8.10.9 TWG and Plenary Group Endorsement

This study plan was approved on January 28, 2004 by the following entities of the TWG: ENF, BLM, American River Recreation Association/Camp Lotus, NPS, SWRCB, CDFG, Chris Shackleton, Chris Shutes and SMUD. The Plenary Group approved this plan on February 4, 2004. The participants at the meeting who said they could "live with" the plan were Taxpayers Association of El Dorado County, Friends of El Dorado County, USFS, American River Recreation Association & Camp Lotus, El Dorado County Water Agency, Pacific Gas & Electric Company, SMUD, El Dorado County, El Dorado Irrigation District, NPS, SWRCB, USBLM, City of Sacramento, CDFG, and FOR. None of the participants at the meeting said they could not "live with" this study plan.

8.10.10 Literature Cited

American Whitewater, 1963. International Scale of Whitewater Difficulty.

Whittaker et al. 1993. Instream Flows for Recreation: A Handbook on Concepts and Research Methods. U.S. Department of the Interior.

Ice House Run
(Ice House Dam to Junction Reservoir)
WHITEWATER BOATING FLOW STUDY, 2004

BOATER EVALUATION FORM

This questionnaire is organized in three sections. **Section 1**—Contact information and characterization of your boating skills/experience. (You will need to complete this section only once during the study.) **Section 2**—Questions regarding your experience on today's run. **Section 3**—A comparative evaluation of different flows (To be completed after completing all test flows).

SECTION 1--BOATER BACKGROUND INFORMATION—*(COMPLETE THIS SECTION ONLY ONCE)*

1. Name _____
2. Affiliation _____
3. Home Address _____
4. Telephone _____
5. E-Mail Address _____
6. Preferred Craft _____
7. What is your age? _____ years
8. Gender (*circle one*): Male Female
9. Please indicate your current boating skill level below. *(Circle one)*

a) Novice
b) Intermediate
c) Advanced
d) Expert
e) Elite

10. How many years have you been boating at this level? _____

11. In the past 3 years, how many days a month do you boat? _____

12. Have you ever participated in a hydro relicensing whitewater boating study before? _____

    If yes, how many, when and for which hydro projects? _____

13. How many times have you boated this run before today? ____/year

    If you have boated this run before *(Leave blank if you have not boated the run before today.)*:
    what were the flows? _____ cfs

    what type of craft(s) did you use? _____

14. How long does it take you to get to this reach from your home? _____hrs_____min

15. Please respond to each of the following statements about your river-running preferences.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I prefer running rivers with difficult rapids (Class IV and V).	1	2	3	4	5
Running challenging whitewater is the most important part of my boating trips.	1	2	3	4	5
I often boat short river segments (under 4 miles) to take advantage of whitewater play areas.	1	2	3	4	5
I often boat short river segments to experience a unique and interesting place.	1	2	3	4	5
I often boat short river segments to run challenging rapids.	1	2	3	4	5
Good whitewater play areas are more important than challenging rapids.	1	2	3	4	5
I am willing to tolerate difficult put-ins and portages in order to run interesting reaches of whitewater.	1	2	3	4	5
I prefer boating rivers that feature large waves and powerful hydraulics.	1	2	3	4	5
I prefer boating steep, technical rivers.	1	2	3	4	5
I enjoy boating both technical and big water rivers.	1	2	3	4	5

SECTION 2-- BOATER POST-RUN EVALUATION FORM

Date of run: _____ / _____ / 2004

Reach: **Ice House**

1. What was the target flow on this run? _____ cfs as measured at _____.

2. What type of craft did you use for this run *(Circle one)*?

1.	Hard shell kayak	5.	Cataraft (please indicate length: _____)
2.	Inflatable kayak	6.	Raft (please indicate length: _____)
3.	Closed deck canoe	7.	No craft: I road/trail-scouted this run
4.	Open canoe with floatation	8.	Other: (please explain) _____

3. Please identify the put-in and take-out locations you used and estimate the time you put-in and took out on this run.

   Put-in location:_____ Time: _____

   Take-out location:_____ Time: _____

4. About how many times did you stop and get out of your boat for breaks, or for scouting and portaging?

   About _____ times for breaks.

   About _____ times for scouting or portaging.

5. Please estimate the total amount of time you spent out of your boat for breaks, or for scouting and portaging.

   About _____ minutes for breaks.

   About _____ minutes for scouting or portaging.

*6. In general, how would you rate the whitewater difficulty on this reach at this flow? (Use the International Whitewater Scale that ranges from Class I to Class VI).*_____

7. Are you likely to return for future boating if today's flow were to be provided? (c*ircle one)*
   a) Definitely No *b) Possibly* *c) Probably* *d) Definitely Yes*

8. Relative to today's flow would you prefer a flow that was higher or lower or was this optimum flow?
   a) Much Lower b) Lower c) Higher d) Much Higher e) Optimum

9. Please respond to each of the following statements about the characteristics of this run at today's flow.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
This reach is boatable at these flows.	1	2	3	4	5
This reach offers challenging and technical boating.	1	2	3	4	5
This reach has nice water features such as waves and holes.	1	2	3	4	5
This reach has good play spots.	1	2	3	4	5
This run offers good overall whitewater challenge.	1	2	3	4	5
This is a safe run.	1	2	3	4	5
This is an aesthetically pleasing run.	1	2	3	4	5
This run is a good length.	1	2	3	4	5
The portages on this run are not a problem.	1	2	3	4	5
There are enough places to take a break or have lunch on this run.	1	2	3	4	5

10. If you feel qualified to offer an opinion of the boatability of this run at today's flow using different types of crafts, please respond to the following statements. Leave blank if you do not have experience with a particular type of craft. *(Circle one number for each type of craft)*

.

This run at this flow would work well for:	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
Kayaks	1	2	3	4	5
Rafts	1	2	3	4	5
Catarafts	1	2	3	4	5
Open Canoes	1	2	3	4	5
Inflatable Kayaks	1	2	3	4	5

11. Please estimate the number of **hits**, **stops**, **boat drags**, and **portages** you had on this run.

I **hit** rocks or other obstacles (but did not stop) about ____ times.

I was **stopped** after hitting rocks or other obstacles about _____ times (but did not have to get out of my boat to continue downstream).

I had to get out to **drag or pull my boat** off rocks or other obstacles about _____ times.

I had to **portage** around logs about _____ times.

I had to **portage** around unrunnable rapids, or other sections about _____ times.

12. Please identify particularly challenging rapids or sections and rate their difficulty at this flow (using the International Whitewater Scale). Also note if you portaged any of these rapids.

Location (Name or site)	***Rating (Whitewater Scale of Difficulty)***	***Portage? (Yes or No)***

*13. If you portaged any portion of the run, please identify rapids or sections you chose to portage and rate the **difficulty of those portages** (using your type of craft at this flow level).*

Location	***Not at all difficult***	***Slightly difficult***	***Moderately difficult***	***Extremely difficult***
	1	*2*	*3*	*4*
	1	*2*	*3*	*4*
	1	*2*	*3*	*4*
	1	*2*	*3*	*4*
	1	*2*	*3*	*4*
	1	*2*	*3*	*4*

14. Did you observe or experience any significant safety issues on your run today (swims, pins, wrapped boats, man-made or natural river features etc…)? Please explain.

_____

_____

_____

_____

15. Please use the space below to provide any comments about your boating experience today on the Ice House run.

_____

_____

_____

_____

_____

SECTION 3—Comparative Evaluation Form—(*COMPLETE AFTER THE LAST TEST FLOW EVENT)*

Name _____ Date _____ / _____ / 2004

1. Please evaluate the following flows for your craft and skill level (please circle one in each column). In making your evaluations, please consider all the flow-dependent characteristics that contribute to a high quality trip (e.g., boatability, whitewater challenge, safety, availability of surfing or other play areas, aesthetics, and rate of travel).

Ice House	**150 cfs**	**200 cfs**	**250 cfs**	**300 cfs**	**350 cfs**	**400 cfs**	**450 cfs**	**500 cfs**	**550 cfs**	**600 cfs**	**650 cfs**	**700 cfs**
Totally acceptable	5	5	5	5	5	5	5	5	5	5	5	5
Acceptable	4	4	4	4	4	4	4	4	4	4	4	4
Marginal	3	3	3	3	3	3	3	3	3	3	3	3
Unacceptable	2	2	2	2	2	2	2	2	2	2	2	2
Totally Unacceptable	1	1	1	1	1	1	1	1	1	1	1	1

2. Based on your boating trips on this reach, please answer the following questions. *(Note: you can specify flows that you have not seen, but which you would predict based on your experience.)*

	Flow in cfs
What is the lowest flow you need to simply get down the river in your craft?	_____
What is the lowest flow that provides a quality technical boating experience for this reach?	_____
What is the optimal range of flows that provides the best whitewater characteristics for this run?	_____ to _____
What do you feel the highest safe flow for your craft and skill level?	_____

3. In your experience, what whitewater runs in California do you believe offer a whitewater experience similar to this one at the optimum flow for this reach? Also list how often you boat these reaches and how long it takes you to travel the run from your home.

a) _____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _____hours What months do you usually boat this run?_____

b) _____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _____hours What months do you usually boat this run?_____

c) _____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _____hours What months do you usually boat this run?_____

d) _____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _____hours What months do you usually boat this run?_____

4. Compared to the runs you listed above, how would you rate boating opportunities on the Ice House Reach. *(Circle one number for each; if you are unsure about a comparison, leave that item blank).*

Compared to:	Much Worse	Worse	About the Same	Better	Much Better
_____	1	2	3	4	5
_____	1	2	3	4	5
_____	1	2	3	4	5
_____	1	2	3	4	5

5. Please respond to the following statements about the non-whitewater characteristics of this run

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Length of Shuttle is not a problem.	1	2	3	4	5
The put -in for this run is good.	1	2	3	4	5
The take-out for this run is good.	1	2	3	4	5
The total shuttle to boating ratio on this run is good.	1	2	3	4	5

6. If you have any suggestions for improving the access or shuttle for this run please describe these improvements below.

a) _____

b) _____

c) _____

d) _____

e) _____

7. Please use the space below to provide any comments about your overall boating experience on the Ice House run.

_____

_____

_____

_____

_____

Addendum 2 to the WWB Study Plan
(based on a document as developed by the Aquatic TWG on 09-08-03)

Concurrent with the three whitewater boating flow releases and at four locations in the South Fork Silver Creek Reach (immediately below Ice House Dam at the gage station, at the Silver Creek Campground, at Chicken Hawk Springs, and above Junction Reservoir), the Licensee shall collect the information below. The Licensee shall make a reasonable effort to gather information on the up ramp. This effort is similar in scope to a data retrieval effort conducted in fall 2003 for the Whitewater Boating Study conducted on South Fork American River (SFAR) below Slab Creek Reservoir. Although this is a longer reach (11+ miles) than the SFAR reach (7.6 miles), four locations are proposed due to timely access along the reach.

- Water temperature (°F) (existing *hourly* recorders at the gage station, Chicken Hawk Springs and inflow to Junction Reservoir), turbidity (NTU) and Total Suspended Solids (mg/l). Licensee will strive to obtain continuous recording devices for turbidity. The Licensee shall take TSS samples once every 2-3 hours during daylight hours and more frequently on the up ramp if possible. At least one sample of each should be taken the day prior to the first boating flow release.
- Once around midday at peak flow on each day and from a standard location at each site, a photo looking upstream, across the stream and downstream.
- Stage at all four sites at least every 15 minutes during the up ramp and down ramp through the full range of the highest flow as measured by a temporary staff gage installed by the Licensee prior to the first boating flow release. Take photos described above every 15 minutes.
- Prior to the boating releases, the Licensee will assess areas of high fish stranding potential in the reach. During the down ramp and to the extent possible, the Licensee will note any stranded fish in these areas.
- During the boating flow study, the Licensee will obtain 15-minute elevation data at Ice House Reservoir and 15-minute flow data at the USGS gage below Ice House Dam for comparison to readings at the downstream temporary gage readings.
- Inundation of bed form features (e.g., bars, riffles, floodplains) associated with aquatic habitat at the three peak flows, at least.

The ENF will identify any locations where bullfrogs and foothill/mountain yellow-legged frogs have been recorded in the reach, and a boater will place pins at the water line at these sites and collect other observations when he rafts during the boating flow study.

ICE HOUSE REACH WHITEWATER BOATING FLOW STUDY TECHNICAL REPORT

SUMMARY

SMUD initially investigated the feasibility of whitewater boating on the UARP Reaches in the Whitewater Boating Feasibility Study. Based on the findings in the study, it was determined that there was not enough existing information about the Ice House Reach of the South Fork Silver Creek to assess the effects of the UARP on whitewater boating opportunities and more information was warranted. Specifically, the class of difficulty, boating suitability and the range of boatable flows could not be determined from existing information. SMUD developed the Whitewater Boating Flow Study for Ice House Reach to collect this information to use in characterizing the UARP effects on boating opportunities.

Subsequent to Plenary Group approval of this study plan on February 4, 2004, additional reconnaissance and review of the reach revealed a concern with the amount of large woody debris in the reach. This concern was discussed at the Recreation and Aesthetic Technical Working Group (TWG) on April 6, 2004, and the study plan was modified. The group agreed to modify the study plan from assessing three flows to assessing only one flow of approximately 400 cfs.

This study included a team of six kayakers who boated the Ice House Reach at a target flow of 400 cfs. The actual flow, as measured during the release was 396 cfs. The study was conducted on May 1, 2004. Upon completion of the run, boaters completed evaluation forms that provided information about various reach characteristics including class of difficulty and the desirability of various flow levels. Boaters also answered a number of questions that were specific to the presence of large woody debris in the river channel.

The difficulty class for the entire reach is between class III and IV, and it is most suited for boaters with advanced skills or better. Considering the amount of large wood in the channel on the day of the test flow, boaters felt that class IV skills were required to safely navigate the reach. The evaluation responses indicate that the minimum navigable flow for the reach is approximately 350 cfs. Most boaters felt that flows between 400 cfs and 550 cfs would be optimal for this reach.

The boating team portaged three logs during the run. Two of the most difficult rapids on the run were portaged by some of the participants. The portage routes were generally considered easy. The boaters rated the rapids at these portages as class IV+. The boaters reported that the reach is aesthetically pleasing in the upper and lower sections and less aesthetic in the area burned by the Cleveland Fire in 1992. They also noted many attractive attributes for whitewater boating such as a short shuttle, challenging whitewater, the presence of numerous play spots, and plenty of locations for breaks. At boatable flow levels, this reach would be a desirable run for private and commercial boaters.

In addition, SMUD characterized the boating opportunities that existed with the current UARP operations over the past 25 years. This analysis was done using water year types recommended by the Plenary Group. Under the current operations, boating opportunities would only occur under spill conditions and since the addition of Jones Fork Powerhouse, spills below Ice House Dam have been rare. Under unimpaired conditions, a typical hydrograph for the reach shows that flows would rise above the minimum acceptable boatable flow of 350 cfs during the winter months. Flows in the acceptable boating range, 350 to 600 cfs, would be more likely to occur during the spring run-off which typically begins in late April and extends through the middle to end of June. There are variations to this pattern, however in general, storm events typically occur in the winter months and the highest sustained flows are associated with the spring runoff.

1.0 INTRODUCTION

This technical report is one in a series of reports prepared by Devine Tarbell & Associates, Inc., and The Louis Berger Group, Inc. 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). This technical report focuses on the whitewater boating resources, which were evaluated under a controlled flow study, in the 11.2-mile section of the South Fork Silver Creek between Ice House Dam and Junction Reservoir (Ice House Reach). In addition to focusing on the whitewater boating resources in the Ice House Reach, this report includes the results of the Ice House Whitewater Boating Flow Ecological Monitoring Study. The Ecological Monitoring Study appears in Appendix I of this report. A summary of the results is located in section 6.0, Findings. This report includes the following sections:

- **BACKGROUND** – Includes when the applicable study plan was 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; and the study area. 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.
- **ANALYSIS** - An analysis of the results, where appropriate.
- **LITERATURE CITED** – A listing of all literature cited in the report.
- **FINDINGS** – A summary of the study findings.

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 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 effects of the UARP on whitewater boating or associated environmental resources, nor does the report include a discussion of appropriate protection, mitigation and enhancement measures. A discussion regarding resource impacts associated with the UARP is included in the applicant-prepared preliminary 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, which will commence in 2004, and will be reported on in the PDEA.

2.0 BACKGROUND

The UARP Recreation and Aesthetics Technical Working Group (TWG) developed a total of eight recreation studies to collect information to answer the issue questions relating to recreation resources associated with the UARP. One of these studies, the Whitewater Feasibility Study, determined that there was insufficient information regarding the whitewater resources related to

the Ice House Reach (see *Whitewater Feasibility Technical Report*). Consequently, the Whitewater Boating Flow Study for the Ice House Reach was developed to provide this additional information and this report contains the results of the study.

2.1 Whitewater Boating Flow Study Plan for Ice House Reach

On February 4, 2004 the UARP Relicensing Plenary Group approved the Whitewater Boating Flow Study Plan for Ice House Reach. Subsequent to Plenary Group approval of this study plan, additional reconnaissance and review of the reach revealed a concern with the amount of large woody debris in the reach. This concern was discussed at the Recreation and Aesthetic TWG on April 6, 2004, and the study plan was modified. The group agreed to modify the study plan from assessing three flows to assessing one flow of approximately 400 cfs on May 1, 2004. The study plan was designed to address, in part, the following issues questions developed by the UARP Relicensing Plenary Group:

Issue Question 3a	What are the effects of potential boating flows on water levels of UARP reservoirs?
Issue Question 6	What maximum and minimum flow regimes are required for whitewater boating in stream reaches affected by the UARP, including upper Rubicon River?
Issue Question 68	What is the need for, and feasibility of, whitewater boating in the reaches below UARP dams?

Specifically, the objectives of the study plan were to:

- Identify current and potential boating opportunities in the Ice House Reach. Opportunities may vary by craft, skill level, or preferences for different types of whitewater conditions;
- Identify flow-related attributes for each of those opportunities, including a description and classification of key rapids;
- Develop relationships between flow levels and quality of whitewater experience for the Ice House Reach. Resulting "flow evaluation curves" would identify minimum and maximum acceptable flows and optimum flow ranges for a variety of watercraft;
- Determine the whitewater difficulty using the International Scale of Whitewater Difficulty (American Whitewater 1963) for the reach within the range of test flows;
- Determine what types of watercraft are suited for the reach;
- Characterize the whitewater resource in the reach in terms of quality of the opportunity and suitability for whitewater boating;
- Determine what operational challenges may exist in providing flows in the boatable range;
- Quantify how the UARP has affected the frequency and timing of boatable days available in this reach; and

- Determine the effect of the quantity and placement of large woody debris on the whitewater resource in this reach.

As discussed above, this technical report does not address UARP impacts or protection, mitigation or enhancement measures. Therefore, this report does not address Issue Questions 1a, 3a, 19, and 68 or the study objective relating to operational challenges to providing flows in the boatable range. Note that Issue Questions 3a and 19 may be addressed using the UARP CHEOPS Water Balance Model.

The study area included the Ice House Reach. Two figures are included in this report that provide information about the reach. Figure 2.1-1 shows the Ice House Reach, possible put-in and take-out locations, and access roads. It should be noted that there are many roads depicted on the map that appear to provide some level of access to the reach. Many of these roads were used during salvage logging operations after the Cleveland Fire and some of them are no longer passable. In exploring access to the reach, SMUD identified the routes with drivable access and these routes are identified on the map as 'Roads with access to the reach.' Figure 2.1-2 shows various points of interest that were identified during the study such as locations of the run portaged because of large woody debris and the point on the run where boaters entered the area burned by the Cleveland Fire.

Figure 2.1-1 Ice House Whitewater Boating Study

USDA Forest Service

Sierra Pacific Industries

Other Private

Paved Roads

Roads with Access to the Reach

Other Roads

Ice House Reach

Driveable Access to Reach (High Clearance/4WD)

North

0 1000 2000 3000 4000 5000 6000 Feet

Scale 1:26,000

August 13, 2004

Informal Boat Launch

Junction Reservoir

Road 12N13

Ice House Campground

Ice House Reservoir

Ice House Day Use Area

Ice House Road

Silver Creek Campground

Road 11N08

Gaging Station

Road 17N12U

Ice House Resort

Bryant Springs Road

Road 11N15.1B

Chicken Hawk Springs

Road 11N14Y

Peavine Ridge Road

Figure 2.1-2 Ice House Whitewater Boating Study
Features of Interest in the Reach

- USDA Forest Service
- Sierra Pacific Industries
- Other Private
- Paved Roads
- Roads with Access to the Reach
- Other Roads
- Ice House Reach
- Large Woody Debris

North

0 1000 2000 3000 4000 5000 6000 Feet

Scale 1:26,000

August 06, 2004

Informal Boat Launch
Junction Reservoir
Break/Stop
Log Portage 3
Log Portage 2
Log Portage 1
Lunch Stop
Chicken Hawk Springs
Road 11N 5.1B
Bryant Springs Road
Road 12N
Peavine Ridge Road
Road 11N14Y
Ice House Campground
Ice House Day Use Area
Ice House Reservoir
Ice House Road
Silver Creek Campground
Road 11N98
Gaging Station
Road 17N12U
Ice House Resort
Buttbuster Rapid
Start of Burn Area

2.2 Water Year Types

The information in this subsection is provided for informational purposes, as requested by the resource agencies. The UARP Relicensing Water Balance Model Subcommittee established five water year types to be applied to all preliminary analysis with the understanding that the UARP Relicensing Plenary Group, with cause, may modify the current water year types in the future based on California Department of Water Resources (CDWR) forecast for total water year unimpaired inflow into Folsom Reservoir. An additional trigger is CDWR's October 1 estimate of the actual total water year unimpaired inflow into Folsom Reservoir. The February 1 forecast determines the water year type applied for the period from February 10 through March 9; the March 1 forecast the period from March 10 through April 9; the April 1 forecast the period from April 10 through May 9; the May 1 forecast the period from May 10 through October 9; and the October 1 estimates the period from October 10 through February 9. The inflow levels are:

- Critically Dry (CD) Water Year — Less than 900,000 acre-feet
- Dry (D) Water Year — From 900,001 to 1,700,000 acre-feet
- Below Normal (BN) Water Year — From 1,700,001 to 2,600,000 acre-feet
- Above Normal (AN) Water Year — From 2,600,001 to 3,500,000 acre-feet
- Wet (W) Water Year: — More Than 3,500,000 acre-feet

The study described in this technical report covers the period of record. For this period, the water year types by month are shown in Table 2.2-1.

Table 2.2-1. Application of UARP Relicensing Plenary Group water year types for the period from Calendar Year 1975 through 2001.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1975	W	D	BN	BN	AN	AN	AN	AN	AN	AN	AN	AN
1976	AN	D	D	CD	CD	CD	CD	CD	CD	CD	CD	CD
1977	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD
1978	CD	AN	AN	AN	W	W	W	W	W	AN	AN	AN
1979	AN	D	BN	BN	BN	BN	BN	BN	BN	BN	BN	BN
1980	BN	AN	W	W	W	W	W	W	W	W	W	W
1981	W	D	D	D	D	D	D	D	D	D	D	D
1982	D	W	W	W	W	W	W	W	W	W	W	W
1983	W	W	W	W	W	W	W	W	W	W	W	W
1984	W	W	W	W	W	W	W	W	W	W	W	W
1985	W	BN	BN	BN	D	D	D	D	D	D	D	D
1986	D	BN	W	W	W	W	W	W	W	W	W	W
1987	W	D	D	D	CD	CD	CD	CD	CD	CD	CD	CD
1988	CD	BN	D	CD	CD	CD	CD	CD	CD	CD	CD	CD
1989	CD	D	D	BN	BN	BN	BN	BN	BN	BN	BN	BN
1990	BN	D	D	D	D	D	D	D	D	D	D	D
1991	D	CD	CD	D	D	D	D	D	D	D	D	D
1992	D	D	D	D	D	D	D	D	D	CD	CD	CD
1993	CD	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN
1994	AN	D	D	D	CD	CD	CD	CD	CD	CD	CD	CD
1995	CD	W	AN	W	W	W	W	W	W	W	W	W

Table 2.2-1. Application of UARP Relicensing Plenary Group water year types for the period from Calendar Year 1975 through 2001.												
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1996	W	BN	AN	AN	AN	AN	AN	AN	AN	W	W	W
1997	W	W	W	W	W	W	W	W	W	W	W	W
1998	W	AN	W	W	W	W	W	W	W	W	W	W
1999	W	AN	W	AN	AN	AN	AN	AN	AN	AN	AN	AN
2000	AN	BN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN
2001	AN	D	D	D	D	D	D	D	D	D	D	D

2.3 Agency Requested Information

In a letter dated December 17, 2003 to SMUD, the agencies requested that SMUD provide the information in various study reports. The agencies had no specific requests for information or comments about the content of the *Ice House Whitewater Boating Study Flow Technical Report*.

3.0 METHODS

The study methods conformed to those approved by the UARP Relicensing Plenary Group. This study required that a team of boaters paddle the Ice House Reach at a single flow of 400 cfs. Then, each participant individually completed a questionnaire regarding a number of whitewater characteristics specific to this flow. Participants were also asked to complete a comparative survey form that provided an evaluation of a range of flows for this reach. The comparative survey asked boaters to provide opinions about different flows they had not seen. Boaters were instructed to provide their responses about flows other than the study flow only if they felt confident in providing this information based on their boating experience. After the participants completed their questionnaires, a post-run group discussion was conducted and videotaped. In addition, portions of the runs were recorded on videotape during the test flow.

3.1 Target Flows and Schedule

The target flow used in this study was developed from the following sources:

- Interview responses collected as part of the Whitewater Feasibility Study (see *Whitewater Feasibility Technical Report*);
- Video photography of the Project Reach taken from low-flight helicopter; and
- USGS quadrangle maps.

The Recreation and Aesthetics TWG participants evaluated this information and initially agreed upon three target flows for the study. These flows were: 200, 300 and 500 cfs. After information from the fisheries studies revealed the extent of the large woody debris (LWD) in the river channel (over 90 logs), concern was expressed that boating the reach could be an arduous task, particularly at the lower flow levels. The TWG members agreed that a single flow event would be prudent and a flow level of 400 cfs was selected.

The study was conducted, as scheduled, on May 1, 2004.

3.2 Boating Participants

Given the concerns of the large amount of LWD in the reach a small group consisting of six participants was selected for the study. The small number of participants were selected in order to improve the study team's ability to move quickly down the rather long, 11.2-mile reach. The participants were selected based on several criteria. First, boaters needed to have the skills necessary to boat rivers of class IV difficulty. This was important because of the safety concerns due to the large amount of wood in the river could pose for the study team. Participants also needed to have the ability to rate the river for paddlers with different skill levels and for other craft types. All participants paddled the reach in hard-shell kayaks. Rafts were not included in the study because it was believed it would be difficult for them to navigate the reach with the large amounts of LWD in the river. Lastly, there was a desire to have paddlers that had participated in the Slab Creek Study, conducted in the fall of 2003, in order to give a relative assessment of other whitewater opportunities on reaches below UARP dams. Prior to conducting the study, boater safety was thoroughly reviewed by the study team and all participants signed an assumption of risk and release of liability form.

3.3 Project Operations During the Study

The flow for the study was provided in the reach by releasing water through the Howell-Bunger valve at the base of the Ice House Dam. The release was monitored continuously at Ice House Dam during the study. The flows were measured every 15 minutes using a gage that is approximately 0.5 mile downstream from the dam. The test flows were ramped at a rate of one foot per hour. The ramp up, test flow and ramp down is shown in fifteen-minute intervals in Table 3.3.1. The total time when the flows in the reach were above the minimum instream flow requirement was 10 hours and 25 minutes.

Table 3.3-1. Flows below Ice House Dam as measured at the gauging station on May 1, 2004 during the Ice House Whitewater Flow Study. (SOURCE: SMUD)

Ramp up		Test Flow				Ramp Down	
Time	Flow cfs	Time	Flow cfs	Time	Flow cfs	Time	Flow cfs
600	9.6	845	345.4	1130	396.1	1415	331.9
615	56.2	900	393.6	1145	396.1	1430	235.7
630	105.5	915	396.1	1200	396.1	1445	203.6
645	108.2	930	396.1	1215	396.1	1500	203.6
700	108.2	945	396.1	1230	396.1	1515	171.2
715	108.2	1000	393.6	1245	396.1	1530	85.8
730	203.9	1015	391.0	1300	396.1	1545	26.5
745	299.7	1030	391.0	1315	396.1	1600	16.0
800	299.7	1045	391.0	1330	393.6	1615	11.3
815	299.7	1100	393.6	1345	393.6	1630	10.9
830	299.7	1115	396.1	1400	396.1	1645	10.7

Prior to the release SMUD employees scouted and posted warning signs at areas prone to dispersed recreation use to inform visitors of increased flows in the reach. Two additional

employees, a hydrographer and a hydrographer field staff, were also needed onsite in order to deliver and monitor the release. The main operational challenge related to the release was stabilizing the flow in the reach at the end of the release without dropping the flows below the minimum instream flow requirement. Although the study team completed the run at about 2 p.m. the flows were not back to normal until 4:45 p.m. The elevation of Ice House Reservoir on May 1, 2004 prior to releasing the flows for the study was 5,434.02 feet. At the end of the study the reservoir elevation was 5,433.87, which amounts to a decrease of 0.15 feet. A total of 244.0 acre-feet of water were used to provide the releases for the study. The inflow to Ice House Reservoir from South Fork Silver Creek. during the hours of the study was 175 acre-feet.

3.4 Data Collection

The data for this study included: 1) general participant profile information; 2) single-flow evaluation; 3) comparative flow evaluation; 4) video recordings and photographs of portions of the runs at different test flows; 5) longitude and latitude of certain features using a Global Positioning System device; and 6) video recordings of the post-run group discussions.

The flow evaluation forms were prepared by SMUD and presented to the Recreation and Aesthetics TWG for review and comment. SMUD incorporated the suggested changes and these forms were approved by the TWG. The evaluation forms included questions about: 1) boatability; 2) quality of the reach; 3) suitability of the run for different crafts and boater skill levels; 4) quality of the put-in/take-out locations and shuttle; 5) boater's opinion of the class of difficulty of the run; 6) boaters assessment of different flows on this run; 7) any safety concerns or hazards; 9) aesthetic quality of the run; 10) number and difficulty of portages; 11) availability of play areas; 12) boater's opinion of the flows that would represent the general paddling public preference; and 13) the impact of LWD on the various characteristics of the run. A copy of the flow evaluation form is included in Appendix A of this report.

SMUD's staff was available to clarify questions for the participants while they were filling out the questionnaires at the conclusion of the test flow, however the staff did not interpret the survey questions for the participants. The completed evaluation forms were checked by SMUD staff for legibility, incomplete responses, and for responses that were not consistent with the directions on the forms. The study staff directed the participants to correct any of these responses on their evaluation forms before they departed for the day.

After the evaluations were completed, a group discussion took place. The post-run group discussion topics included: 1) access at the put-in/take-out location; 2) shuttle; 3) suitability of the run for commercial use; 4) the time of year when boaters would be likely to boat the reach; 5) names of rapids; 6) class of difficulty; 7) suitability for different crafts; 8) safety concerns; 9) alternate locations for take-outs; 10) availability of lunch or break stops in the run; and 11) the impact of LWD on the various characteristics of the run. SMUD compiled a videotape of pertinent recordings made during the study, which is made part of this report.

4.0 RESULTS

4.1 Study Participants

A list of all of the study participants is included in Appendix B. There were six boaters who participated in the study; all of the participants boated the run in hard shell kayaks. None of the participants had boated the reach prior to participating in this study. Only one known run had been recorded in the previous investigation (see *Whitewater Feasibility Technical Report*). Most of the participants reside within one to two hours of driving time to this run. The skill level of the participants ranged from 'Expert' to 'Advanced.' The group consisted of five men and one woman, with ages ranging between 30 and 49 years and an average age of 44 years. The participants' whitewater boating experience ranged from 5 to 30 years with an average of 12 years at their current boating skill level. Based on the responses to a series of questions about each participant's boating preferences, the team showed a preference for boating technically challenging whitewater in interesting places. The group responses did not indicate a preference for play paddling. Members of the group generally felt confident to rate rivers for people with different skill levels. This was important given the small size of the group and the safety concerns presented by the large number of logs that were in the river. A summary of all of the evaluation data is included in Appendix C.

4.2 Run Description

All six of the boaters who began the run at Ice House Dam completed the run to Junction Reservoir. The entire group completed the run in six hours and fifteen minutes, putting on the river below Ice House Dam at 9:45 a.m. and taking off at Junction Reservoir at 4:10 p.m. The group stopped for breaks three times during the run. Time for these breaks totaled about 40 minutes.

Water temperature on the run was quite cold and most of the boating participants agreed that they would have preferred to have worn warmer gear during the study. The water, which was released from the base of Ice House Dam, projected in a forceful stream to about 150 feet downstream of the release outlet. This made entering the first rapid somewhat difficult and several boaters chose to portage this rapid. Below this first section was one of the only rapids on the run that seemed very rocky, or "boney," at this flow. Shortly below the stream flow gauge, the boaters encountered several class IV rapids one of which was portaged by two of the participants. The next mile of the run is class II/III until a short class IV section just above the beginning of the Cleveland Fire burn area at river-mile 2.1. In this section boaters described two class IV rapids and one class IV+ rapid that were portaged by all but one of the paddlers. The group took a short break. This break occurred at the beginning of the burn area which is located at approximately river-mile 2.3. The next eight miles were very continuous class III with very few distinct rapids. Paddlers did note a large number of play features in this section. The first portage around a log occurred at river-mile 6, just above Chicken Hawk Springs. The amount of wood in the river increased throughout this section particularly in the area below Chicken Hawk Springs. The team portaged two more times due to logs. These portages occurred at river-mile 7.4 and at river-mile 9. The team was able to maneuver around numerous other logs and they were able to paddle over three other logs that spanned the river channel. Boaters reported that

the run difficulty decreased as they progressed down this section. The group took one more break at river-mile 9.3. The last mile of the run contains several class IV rapids; all six boaters on the team ran these rapids. The boating team finished the run by padding approximately ten minutes across Junction Reservoir to the boat ramp area where the boaters took out. The team returned to Ice House Resort to complete the evaluations and participate in the group discussion.

4.3 Boater Evaluations

4.3.1 Boatability

Because of the amount of large woody debris reported to be in this reach, many of the survey questions were devised so that the participants could evaluate the run in its current state and how they would rate the run as if an acceptable amount of LWD was in the river. Four of the six boaters agreed that there is currently an unacceptable amount of LWD in the reach for boating. Only two of the six boaters provided a percentage estimate of how much LWD would have to be removed in order to make the run more boatable; one boater estimated two percent and one boater estimated five percent of the total amount of the wood. Four of the participants stated that in order to make the run more boatable, between five and twenty logs would need to be removed from the reach with an average of six logs. One participant recommended that removing five logs would make the run boatable for class IV paddlers and the removal of 15 to 20 logs would make the run more boatable for class III paddlers.

In general, all of the paddlers stated that the run was far more boatable than they had expected considering the reported amount of LWD in the reach. With the run in its current state, two of the paddlers responded that they would possibly return at this flow, three of the paddlers would probably return and one stated he would definitely return. The participants indicated that their opinion of the reach would improve with a reduced amount of LWD in the river. With a reduced amount of LWD in the river, five of the boaters responded that they would definitely return to this reach and one would probably return, at the test flow of 400 cfs.

4.3.2 Difficulty

The boaters rated the difficulty of the Ice House Reach between class III and IV on the International Scale of River Difficulty (see Appendix D). However, two members of the team rated one of the rapids on the run as a class V-. Participants felt that the class III/IV rating applies consistently throughout the run even if an acceptable amount of LWD was removed from the reach. There was general agreement that a class III paddler could safely navigate the run by portaging the roughly six class IV rapids on the run. However, there was also agreement that the current amount of wood in the river could create unsafe conditions for paddlers with only class III skills. The primary concern was that if a paddler was swimming, the numerous logs that extended into the river channel could create a serious risk.

All of the participants responded that 400 cfs is their optimum flow with the river in its current condition. With a reduced amount of LWD on the run, five of the boaters indicated that they would like to have a higher flow than 400 cfs. Focus group information and the comparative

flow data indicate that these paddlers would prefer a flow that is 50 to 100 cfs higher if less LWD was present in the reach.

4.3.3 Reach Characteristics

The boaters were asked to evaluate the whitewater characteristics of the Ice House Reach by indicating the degree to which they agreed or disagreed with a series of statements. The participants were also asked to evaluate each of these statements for the reach assuming the reach had an acceptable amount of LWD in the river channel. The responses to these statements are summarized in Figure 4.3-1.

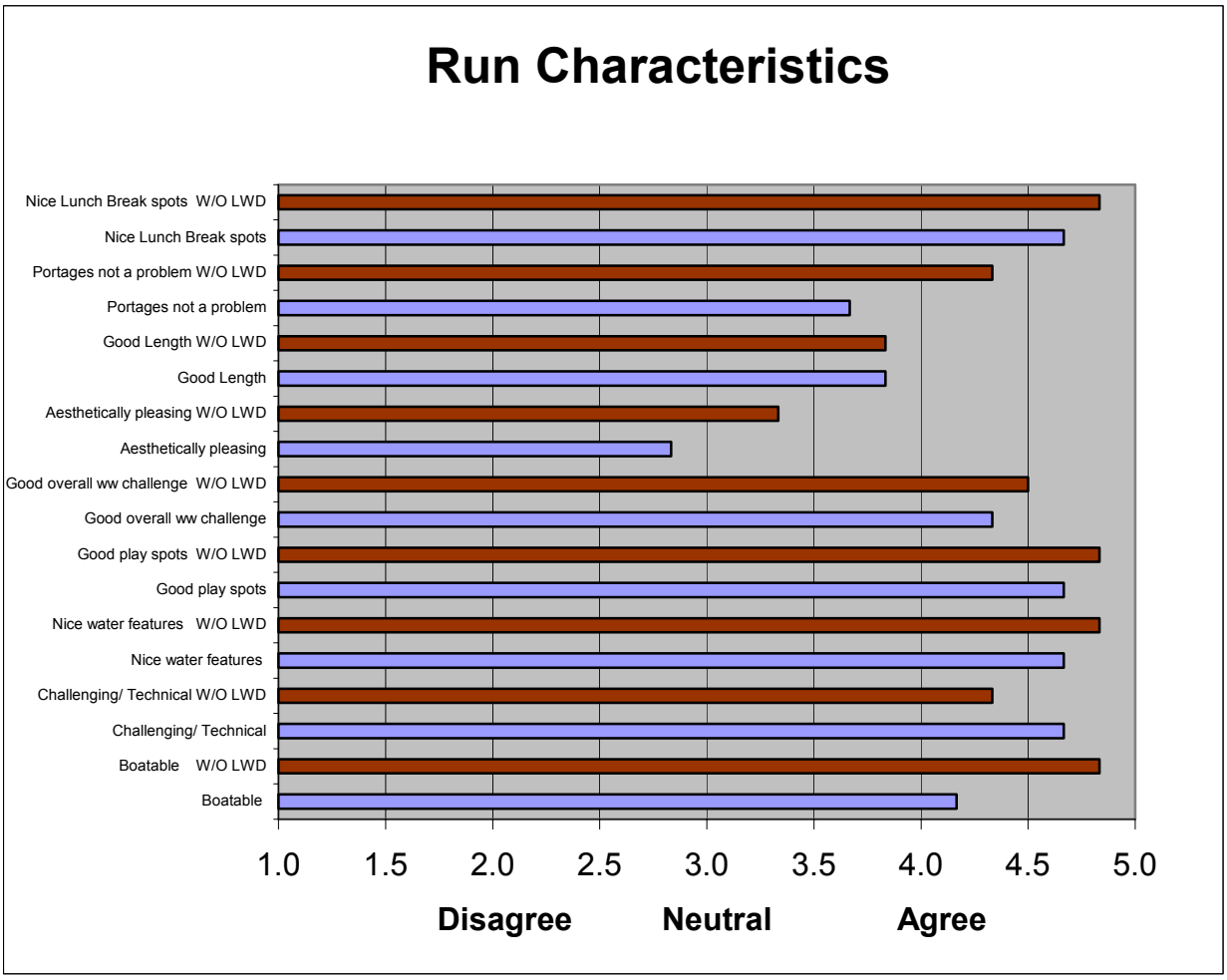


Figure 4.3-1. Boater responses (averaged) regarding the whitewater characteristics of the Ice House Run at 400 cfs.

In general, the boaters indicated that the Ice House Reach has a number of favorable characteristics at 400 cfs. These include: good technically challenging whitewater with nice water features, good play spots, and nice places to stop for breaks or lunch. Pictures and video of these play features and break spots are included in the video that accompanies this report.

Boaters did feel that the run is not particularly aesthetically pleasing, primarily because much of the run is within the area burned by the Cleveland Fire. The boaters did feel that the aesthetics of the run would improve if some of the LWD were removed. One statement that showed a significant difference between the responses for 'with' and 'without' LWD was the difficulty of the portages on the run. The responses to the question that portages were not a problem on the run improved from 3.7 to 4.3, with a reduced amount of LWD in the river. All of the rapids on the reach were run by at least part of the group. Those that did choose to portage some of the more difficult rapids on the run, generally found these portages to be relatively easy. The logs that were portaged on the run were portaged by all of the paddlers. The boaters did not report any difficulty with these portages. Participant responses to the surveys and in the focus group discussion indicated that the run may have been a little long at six hours and fifteen minutes. In the focus group the participants suggested that since there are multiple points of access along the reach that boaters could boat portions thereby shortening the run length.

All of the members of the team agreed that the run is suitable for kayaks. The four participants who were comfortable making a judgment about the run's suitability for open canoes and inflatable kayaks, agreed that this run would work well for these craft types. With the current amount of LWD, most of the participants felt that the run is unacceptable for rafts and they were split in their opinions on the suitability for boating in catarafts. With a reduced amount of LWD on the reach, respondents improved their suitability rating for rafts but only to an average of 3.3, or neutral. If there were less LWD in the river channel, respondents considered catarafts to be a more acceptable craft choice.

4.3.4 Flow Assessment

To determine what flows would be acceptable to provide whitewater boating opportunities on the Ice House Reach, the participants were asked to provide their opinions on the acceptability of the run at various flow intervals between 150 and 700 cfs. Even though the participants had only boated the reach at 400 cfs, based on their experience, boaters were asked to speculate about this range of flows to the degree that they felt confident in their ability to do so. All of the boaters provided information for the entire range of flows provided in the comparative evaluation. A summary of this information is provided in Figure 4.3-2 below.

The flow preference graph, Figure 4.3-2, provides a basis to evaluate how acceptable various flows would be for the Ice House Reach. Assuming that boaters would return for a flow rated 'Marginal', 'Acceptable' or 'Totally Acceptable', the averaged responses provided on the comparative flow evaluations indicate a minimum acceptable flow of approximately 300 cfs.

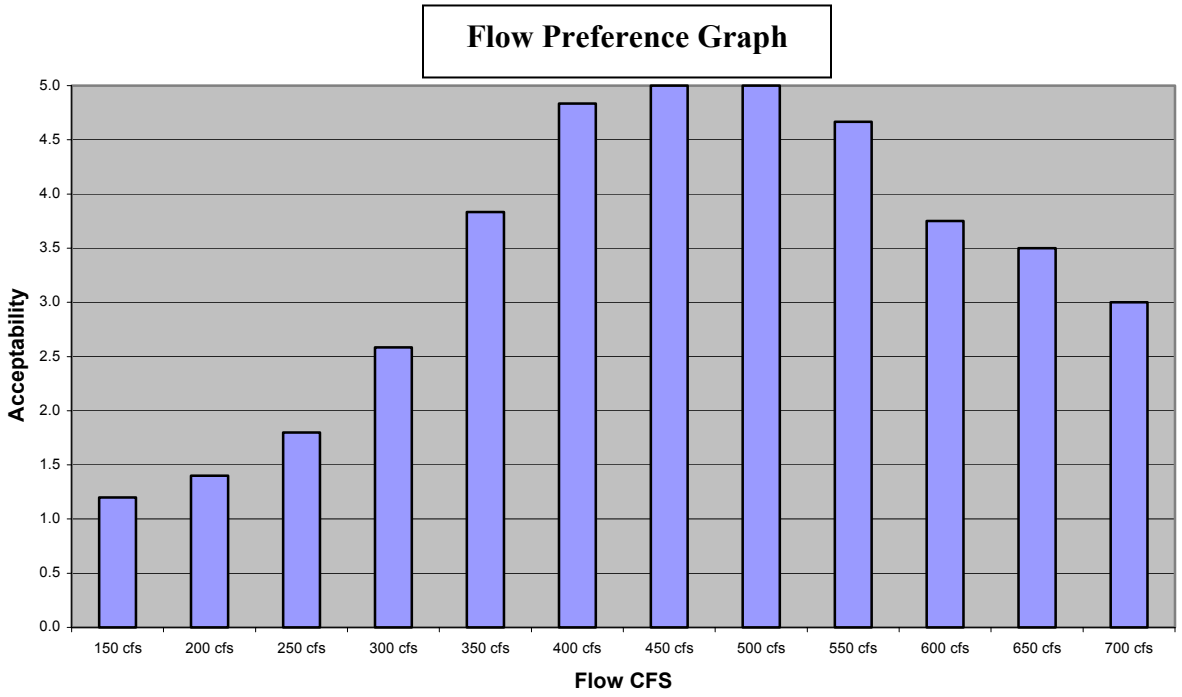


Figure 4.3-2. **Average Boater Acceptability of Flows.**
(Scale: 1=Totally Unacceptable, 2=Unacceptable, 3=Marginal, 4=Acceptable, 5=Totally Acceptable)
(Source: Data from the Comparative Evaluation Form)

4.3.5 Range of Optimum Flows

To further examine the whitewater boating opportunities at various flows, the boaters were asked to suggest the optimum range of flows that would provide the best whitewater characteristics for the run. Figure 4.3-2 indicates that the boater's optimum range of flows is between 400 and 550 cfs. This information is consistent with the post run focus group discussion. However, participants also stated a flow of 50 to 100 cfs higher than the 400 cfs test flow, could be optimal with less LWD in the river channel. In looking at the individual responses, the participants provided an optimal range of flows that were very consistent and there were no significant deviations within the responses.

4.4 Access

The comparative flow evaluation included questions about river access for whitewater boating. Overall, boaters thought that the run has good access. The length of the shuttle is excellent at approximately 20 minutes, and the boaters strongly agreed that the shuttle-to-boating ratio is good. Some of the boaters stated during the focus group discussion that an earlier take-out option would be desirable and that less skilled boaters would prefer to put in below the Ice House Road Bridge.

The main roads used to access this reach from Highway 50 include Ice House, Peavine Ridge and Bryant Springs roads. All of these roads are paved and open to the public without restrictions. Ice House Road is a county road and Peavine Ridge (FS No. 11N55.1) and Bryant Springs (FS No. 12N30.2) roads are under ENF jurisdiction. Although it is possible to boat the entire length of the reach from the Ice House Dam to Junction Reservoir, boaters may choose to run only specific portions of the run. Accordingly, information about different access routes is presented below including a discussion of the whitewater qualities afforded or avoided by choosing to boat different segments of the reach. The access routes are identified on Figure 2.1-1 and the existing condition of access is explained below. The points of access to the reach are described in terms of river miles below the Ice House Dam.

There are four locations that would be the most likely put-in locations. These include: (1) Ice House Dam Outlet; (2) the Ice House Gauging Station; (3) Ice House Resort or in the vicinity of the Ice House Road bridge crossing of SF Silver Creek; and (4) Silver Creek Campground. These potential put-in locations are in proximity to each other and they are within the uppermost 1.6-mile of the reach. These potential put-in locations are on or near Ice House Road, approximately 9.1 miles from Highway 50. There are five other points of access in the reach that are also described below that may be potential take-out locations or provide access for boating only portions of the run. These include: (1) Forest Road No. 11N14Y; (2) Forest Road No. 11N55.1B-Chicken Hawk Springs; (3) Forest Road 12N45; (4) Bryant Springs Road Bridge Crossing at SF Silver Creek; and (5) Junction Reservoir Boat Launch Access Road.

4.4.1 Ice House Dam Outlet Road

The uppermost potential put-in location is at the beginning of the reach at the Ice House Dam outlet. Access to this location from the Ice House Road is by way of FS Road No. 11N98. This is an unpaved road suitable for two-wheel drive vehicles and it is approximately one mile from Ice House Road to the Ice House Dam. To access the reach from this point on the west side of the dam, there is a 0.2-mile, gated, one-lane road that leads to the base of the dam. There is limited parking for approximately five vehicles at the end of this road where it terminates at the low-level outlet of the dam. This site is within the UARP FERC Project Boundary and it is located on National Forest System (NFS) land. The road has a gate that is closed and locked to restrict public vehicular traffic on this road. A photograph of this location is shown in Appendix H (see H-1).

4.4.2 Ice House Gauging Station Road

Access to this location from the Ice House Road is by way of FS Road No. 11N98. This is an unpaved road suitable for two-wheel drive vehicles and it is approximately 0.5 mile from Ice House Road to the intersection of the access road that leads to the gauging station. From this intersection there is a 0.1-mile, rough, unpaved road that leads to the reach. This potential put-in location and the 0.1-mile access road are located on private land (Sierra Pacific Industries (SPI)). Although this area could probably accommodate up to 15 vehicles, currently this area is heavily used for dispersed overnight camping which could, at any given time, occupy much of the surface suitable for parking. This road provides access to the Ice House Reach at river-mile 0.5. A photograph of this location is shown in Appendix H (see H-2).

4.4.3 Ice House Road Bridge Crossing at SF Silver Creek and the Ice House Resort

This potential put-in location is adjacent to Ice House Road which is a county road. This site is surrounded by private land, including the Ice House Resort. Areas available for parking would be limited by the private land ownership and most people would have to park along the road in the right-of-way. This road provides access to the Ice House Reach at river-mile 1.0. A photograph of this location is shown in Appendix H (see H-3).

4.4.4 Forest Service Road No. 17N12U-Silver Creek Campground

This road begins at Ice House Road and it is the 0.33-mile access road for the Silver Creek Campground. The road terminates in the campground near the reach where it flows through this public campground, which has 11 campsites and is managed by ENF. The campground access road is unpaved and passable by two-wheel drive vehicles. The campground is usually open between Memorial Day and October 1 and outside of this timeframe the access road to the campground is gated to restrict public vehicular access. The reach flows adjacent to campsites in the campground and currently there is no space available for parking because of the presence of the campground. This site provides access to the Ice House Reach at river-mile 1.6. A photograph of this location is shown in Appendix H (see H-4).

4.4.5 Forest Service Road No. 11N14Y

This road begins at Peavine Ridge Road approximately one mile from Ice House Road. The road is gated at Peavine Ridge Road and it is posted with 'No Trespassing' signs by the landowner, SPI. Beyond the gate where the public is not permitted, the road is unpaved and passable by two-wheel drive vehicles. It is approximately 0.94 mile from the gate at Peavine Ridge Road to the reach. The portion of the reach accessed at this point is within the area burned by the Cleveland Fire. This is not a legal route of public access to the Ice House Reach, and the road terminates at the reach at river-mile 4.16. A photograph of this gated access road is shown in Appendix H (see H-5).

4.4.6 Forest Service Road No. 11N55.1B -Chicken Hawk Springs

This road begins at Peavine Ridge Road approximately two miles from Ice House Road. This road has a gate, however, it is usually observed in an open position and there are no signs indicating that there are any restrictions on public access. The road appears to be on NFS land however it also crosses land owned by SPI. The road is 0.83 mile long, unpaved and passable only to high clearance vehicles. Access by four-wheel drive vehicle is advisable. The route is currently narrow with steep banks and encroaching vegetation in some locations making it difficult to turnaround and pass oncoming vehicles. There is an old landing at the end of the road and from that point it is approximately 200 feet to the reach. This road provides access to the Ice House Reach at river-mile 6.5. A photograph of this access road is shown in Appendix H (see H-6).

4.4.7 Forest Service Road No. 12N45

This road begins at Bryant Springs Road approximately 5.8 miles from Ice House Road. This access road is approximately 1.2 miles long and it crosses NFS and SPI lands. The road is unpaved and encroaching vegetation makes the road narrow in several places making it difficult to turnaround or pass oncoming vehicles. It is passable by two-wheel drive vehicles but high clearance is necessary. It is possible to drive within 50 feet of the reach, however, there are no suitable areas available for parking. The access road leads to the reach at river-mile 9.3 which appears to be located on SPI land. A photograph of this access road is shown in Appendix H (see H-7).

4.4.8 Bryant Springs Road Bridge Crossing at SF Silver Creek

The Bryant Springs Road crosses the SF Silver Creek approximately 6.9 miles from Ice House Road. This is a paved road leading to the reach at river-mile 11.2. This site is located on NFS land. There are turnouts within 200 feet of the bridge crossing that are suitable for parking approximately 20 vehicles. The shoreline downstream of the bridge appears to be occasionally used for overnight camping and may be used by anglers and other day users. A photograph of the bridge crossing is shown in Appendix H (see H-8).

4.4.9 Junction Reservoir Boat Launch Access Road

This would be the most likely take-out location for boaters using this reach. The access road to this location begins at Bryant Springs Road approximately 6.6 miles from Ice House Road. The 0.2-mile access road to the take out is unpaved, narrow, steep and passable by two-wheel drive vehicles. This potential take-out is used as a boat launch for small trailerable and hand launchable boats and it is located on NFS land. There are no restrooms or other developed recreation facilities at this location. The shoreline is steep and the reservoir fluctuates up to 15 feet, generally on a weekly basis; daily fluctuations may also occur. Although this area could possibly accommodate parking for up to ten vehicles, this area is used for dispersed overnight camping and day use which could, at any given time, occupy much of the surface suitable for parking. The distance from the Junction Reservoir Boat Launch to the Ice House Resort is approximately ten miles and the driving time is approximately 19 minutes. A photograph of the Junction Reservoir boat launch area is shown in Appendix H (see H-9).

4.5 Comparison to Other Runs in California

The study participants most frequently compared the Ice House Reach to the Kyburz and Riverton to Peavine runs on the SFAR, although, many of the boaters felt that this run is easier than the Kyburz run. Other similar runs listed by the participants included the Mc Cloud River, the Sloat run on the Middle Fork Feather River and the North Fork Salmon River. It was also noted during the focus group discussion that a high altitude (above 5,000 feet) in the Sierra Nevada such as the Ice House Reach, with only a class III/IV level of difficulty is very unique. Most runs at this high of an elevation in the Sierra Nevada are class V.

4.5.1 Nearby Population Centers

The communities where boaters live who may use this run and that are within a reasonable driving distance of the Ice House Reach are listed below in Table 4.5-1.

Table 4.5-1. Distance and driving time to Ice House Reach from nearby population centers.

Location	Distance (miles)	Driving Time to Ice House Reach
Placerville, CA	27.9	40 minutes
Coloma, CA	36.3	50 minutes
Sacramento, CA	73.0	1.5 Hours
San Francisco, CA	156.5	2.8 Hours
Redding, CA	233.3	3.8 Hours
Reno, NV	104.2	2.5 Hours

4.5.2 Whitewater Boating Opportunities in the American River Watershed

A review of *California Whitewater: A Guide to the Rivers* (Cassady and Calhoun, 1995), *The Best Whitewater in California: The Guide to 180 Runs* (Holbek and Stanley 1998) and *California Boating and Water Sports* (Stienstra 1996) identifies 19 runs in the American River (including the Rubicon River) watershed with a total distance of over 168 miles. These runs are listed in Table 4.5-2 below.

Table 4.5-2. Whitewater boating opportunities in the American River watershed. (SOURCE: Cassaday and Calhoun 1995, Holbek and Stanley 1998, Stienstra 1996).

Name of Run	Put-In & Take Out	Length (miles)	Gradient (feet per mile)	Class	Boating Range and (Optimum Flow) [1]	Boating Season
North Fork American River						
Generation Gap	Tadpole Creek to Colfax-Foresthill Rd.	12.3	75	IV-V 0 portages	600-2,000 (1,200)	Spring
Giant Gap	Euchre Bar to Colfax-Iowa Hill Rd.	14.5	54	IV-V 0 portages	600-2,500 (1,000)	Winter, Spring
Chamberlain Falls	Colfax-Iowa Hill Rd. to Colfax-Foresthill Rd.	4.8	44	III-IV+ 0 portages	800-2,500 (1,500)	Winter, Spring
Ponderosa Way	Colfax- Foresthill Bridge to Ponderosa Way Bridge	5	21	II+ to III 0 portages	500-1,500 > 1,500 (1,200)	Spring
Middle Fork American River						
No. Middle Fk. American River	Last Chance Bridge to Middle Fk. American	12.9	129	V 7 portages	600-800 (600)	Winter, Spring

Table 4.5-2. Whitewater boating opportunities in the American River watershed. (SOURCE: Cassaday and Calhoun 1995, Holbek and Stanley 1998, Stienstra 1996).

Name of Run	Put-In & Take Out	Length (miles)	Gradient (feet per mile)	Class	Boating Range and (Optimum Flow) [1]	Boating Season
Tunnel Run	Ralston Afterbay to Spring Garden Rd.	17	23	IV 1 portage	800-1,500 (1,200)	Spring, Summer
Rubicon River						
Lower Run	Ellicott Bridge to Ralston Afterbay	20.3	108	V- to V 2 portages	500-1,000 1,000-2,000 (1,200)	Spring
South Fork American River						
Lovers Leap	Strawberry to Kyburz	9.6	171	V 3 portages	500-1,200 (1,000)	Spring
Dugald Bremner	Upper Bridge to Girard Cr.	3.5	191	V 1 portage	300-800 (500)	Winter, Spring
Lower Run	China Flat to So. Fk. American	3.3	236	V+ 2 portages	350-550 (400)	Spring, Summer
Kyburz to Riverton	Kyburz to Route 50 Bridge	9.6	90	III-IV+ IV-V 2 portages	700-1,200 1,200-1,300 (1,200)	Spring
Riverton to Peavine	Route 50 Bridge to Peavine Ridge Rd.	3.5	69	III-IV 0 portages	700-4,000 (1,500)	Spring
Golden Gate	Peavine Ridge Rd. to Forebay Rd.	9.4	117	V+ 5 portages	700-1,500 (1,000)	Spring
Silver Creek	Near FF Rd. 12N25 to Ice House Reservoir	1.75	481	V	50-300[2] (150-200)	Spring
Silver Creek	Camino Reservoir to SFAR	9.2	119	V 8 portages	600-800 (600)	Spring
Ice House	Slab Cr. Dam to White Rock PH	7	89	V 1 portage	500-2,000 (1500)	Spring
Rock Creek	Near Dutch Cyn to Rock Cr. Rd.	6.3	110	IV+ 2 portages	300-800 (600)	Winter, Spring
Chili Bar	Route 193 to Coloma	5.8	31	III+ III-IV 0 portages	700 –1,500 1,500-10,000 (2,000)	Year-round
Coloma to Lotus	Coloma Park to Lotus Campground	3	24	II II+ III 0 portages	500-1,500 1,500-3,000 >3,000 (1,500)	Spring, Summer
The Gorge	Lotus Campground to Folsom Lake	11.2	21	III+ III-IV 0 portages	800-2,000 2000-10,000 (2,000)	Year-round

[1]Boatable range and optimum flow from Holbek and Stanley (1995)
[2]Boatable range and optimum flow from boater interviews

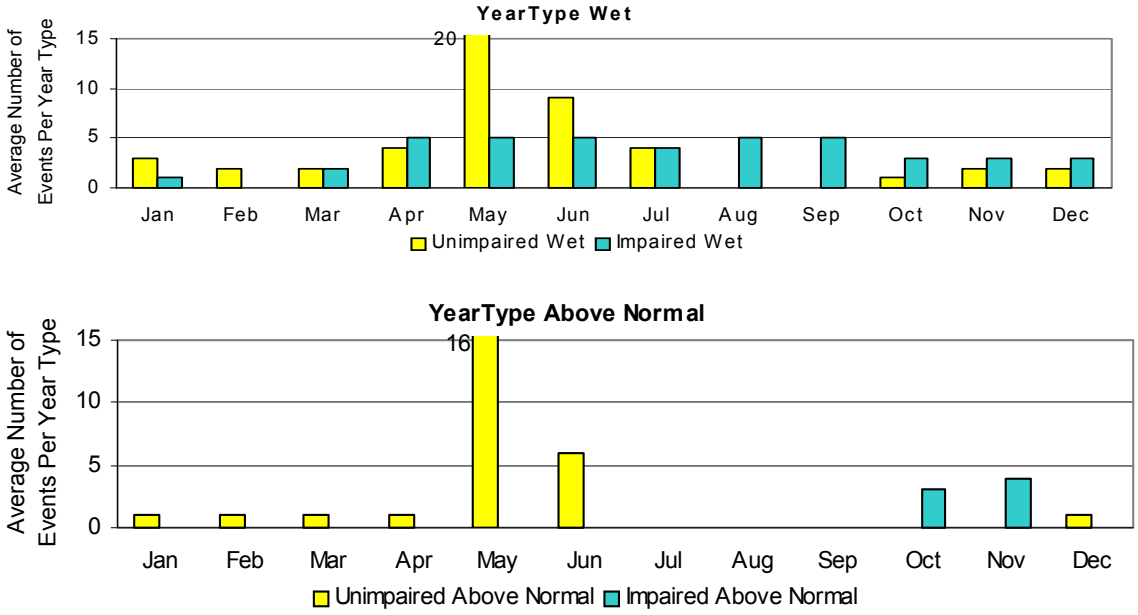
4.6 Hydrology

SMUD summarized the measured regulated and synthesized unimpaired flow information for the reach. These data can be used to characterize the boating opportunities that existed with the current UARP operations from Water Year 1975 through 1999, and the boating opportunities that might have existed over that same period without the UARP. Hydrologic data were analyzed using two methods; histograms based on boatable days and flow exceedance curves.

Histograms developed for the study show the number of boatable days that exist in the Ice House Reach under regulated and that might have existed if the UARP were not in place. To make this analysis, SMUD relied on a range of boatable flows as revealed by responses to the boater evaluations relating to the acceptability of different flows. This information indicated that flows between 350 and 600 cfs would be a reasonable range of flows to use to in this evaluation. Based on the averaged hydrologic data for each of the five water year types, the average number of days in each month is shown on a graph for each water year type that existed under regulated conditions. These graphs are shown below in Figure 4.6-1.

Hydrologic information was evaluated based on exceedance curves for each of the respective months within each type of the five water year types. The data were combined and averaged to develop monthly flow exceedance curves for each type of water year. The graphs show the probability for exceeding a range of flows between 0 and 1000 cfs in Ice House Reach under the regulated and unimpaired conditions. This information is presented in Appendix E.

SF Silver Creek Below Ice House Dam



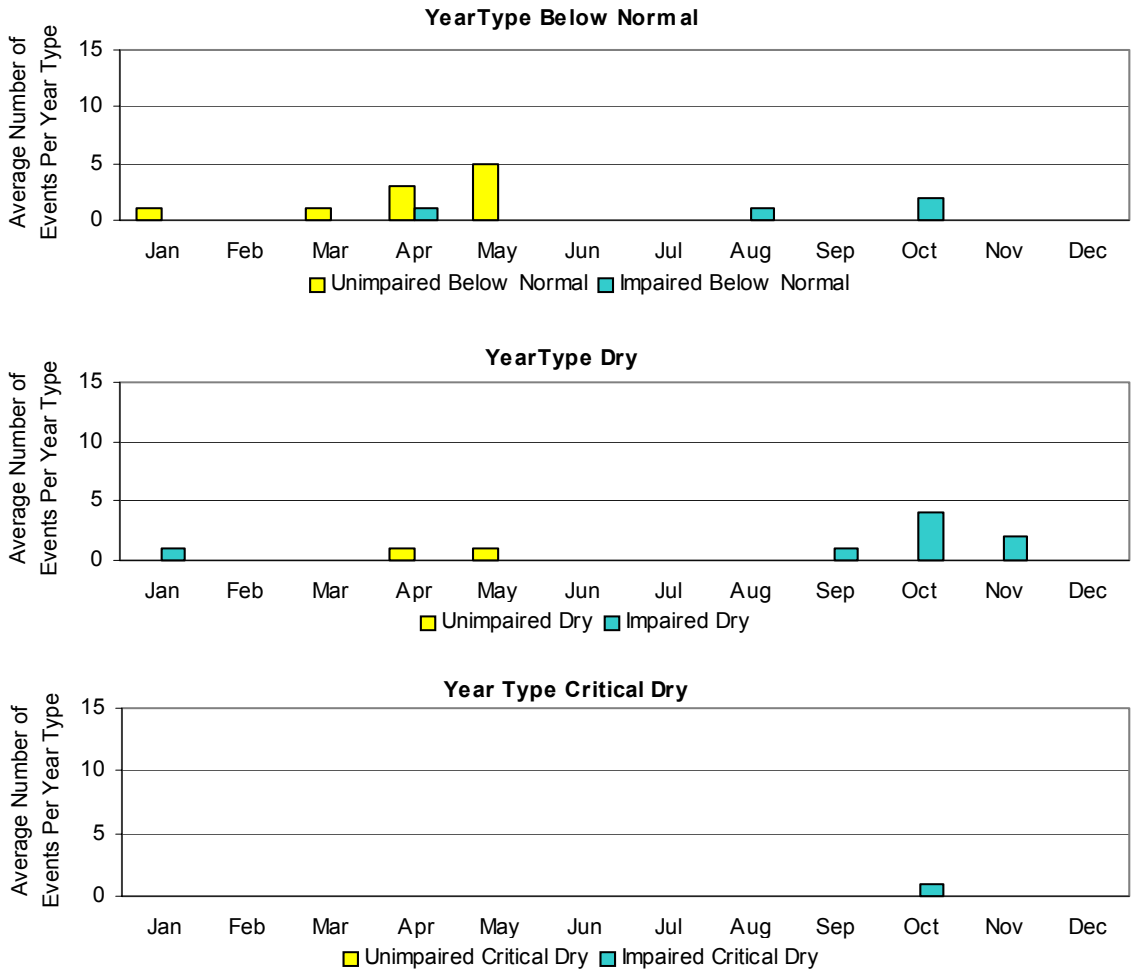


Figure 4.6-1. Number of 1-day Events Between Mean Daily Flow of 350 cfs and 600 cfs in the Ice House Reach (WY 1975-1999).

4.7 Potential for Commercial Use

The study participants felt that the reach is potentially suitable for commercial boating trips. The participants said that the class of difficulty, length of run and location are attributes that would be attractive for commercial boating use. Additional information on commercial viability was provided by Bill McGinnis (Whitewater Voyages, Coloma, California) who agreed with the study participants' assessment and offered additional factors supporting this assessment. First, and foremost, there needs to be a demand for the type of boating run. Currently the demand for commercial Class III and IV boating opportunities appears to be high as compared to Class V opportunities. This run would contribute to satisfying the demand for Class III and IV boating opportunities. Secondly, commercial boating clients prefer long runs. As an example, he stated that the NF Feather River has low commercial potential because of the relatively short run lengths which are five to eight miles long. The 11.2-mile Ice House run would be attractive to potential customers because of its length. And finally, regulated rivers provide certainty for

commercial boating businesses as compared to unregulated rivers where the suitable boating flows depend on natural conditions, which can be hard to predict. Customers can expect boatable flows on regulated rivers regardless of hydrologic conditions and commercial businesses can plan their operations to provide dependable, high quality service to their customers. Mr. McGinnis did not think that the scenic impact of the Cleveland Fire would affect commercial viability. He felt that the quality of the run would not be drastically reduced by the view of the hillsides burned by the fire. The scenic quality will improve into the future as the vegetation continues to grow.

4.8 Videotape

A video was prepared by SMUD as a part of the study. This video shows the participants boating various rapids in the Ice House Reach and excerpts from the post-run group discussions with the study participants (see Appendix F).

5.0 ANALYSIS

5.1 Hydrology Analysis

The South Fork of Silver Creek is a high altitude watershed with a classic Sierra snowmelt drainage pattern. Unlike reaches at lower elevations, this reach shows relatively small flow changes during the winter months.

Figure 5.1-1 shows the hydrograph that occurred in 1992-93 that reflects this general flow pattern of this reach. It should be noted that there is an extreme variability in the flow patterns from one year to the next in regard to either the regulated or the unimpaired flow patterns. A typical regulated hydrograph for the reach shows that only rarely would flows rise above the minimum acceptable boatable flow of 350 cfs during the winter months. Flows in the acceptable boating range, 350 to 600 cfs, would be more likely to occur during the spring run-off. The typical spring run-off begins in late April and extends through the middle to end of June. There are variations to this pattern, however in general, storm events typically occur in the winter months and the highest sustained flows are associated with the spring runoff.

Figure 4.6-1 in the previous section, shows the number of boatable days between 350 to 600 cfs per year averaged over a 25-year period from 1975 to 1999. This histogram shows a number of boatable days occurring in the unimpaired hydrograph in an Above Normal and Wet Water year types and a limited number of days in Below Normal and Dry Water years. The histogram based on regulated data shows some days with flows in the boatable range occurring in the fall in all water year types and in virtually all months in wet water years. This information is somewhat misleading in that it is a result of how the project was operated before the Jones Fork Powerhouse came online in 1986. Before that time, the Ice House Reservoir was operated as a storage facility and the South Fork Silver Creek was not a bypassed reach. Consequently, the only way to transfer water to the powerhouses downstream was via the river channel. After the Jones Fork Powerhouse came online, spill events in this reach have been extremely rare. In fact, there have only been a total of nine days of spill in the boatable range between 1986 and 1999.

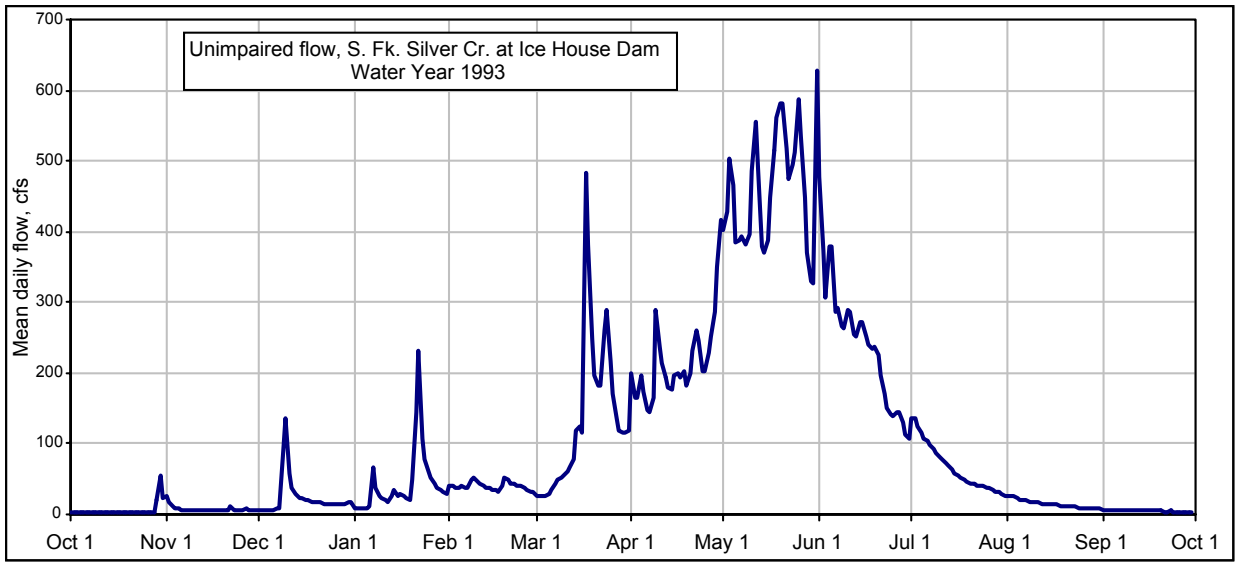


Figure 5.1-1. Synthesized unimpaired hydrograph for the SFSC October, 1992 through September 1993. (SOURCE: SMUD)

The exceedance curve for the month of May, Figure 5.1-2, shows a more accurate picture of the boatability of this reach under regulated and unimpaired conditions. The exceedance plots for all other months are provided in Appendix E. Analysis of these data indicates that flows in the optimal boating range, 400 to 550 cfs, would most likely occur through the month of May in Wet, Above Normal and Below Normal water year types. The curves also show that there is at least a 30 percent probability of flows above 400 cfs occurring in May in each of these types of water years. Flows above 400 cfs in Dry and Critically Dry water year types would not likely occur during May based on this analysis. The exceedance values for the month of June shows that flows above 400 cfs would occur about 30 percent of the time in a Wet year, about 25 percent of the time in an Above Normal year and would be nonexistent in all other water year types. The month of July shows that flows above 400 cfs would be unlikely even in Wet Years in that they would occur less than six percent of the time. Looking at the magnitude of flows in the spring run-off period, it appears that flows from 400 to 500 cfs would have been fairly common in wetter years, however, flows above 600 cfs would be extremely rare in all but the wettest of years.

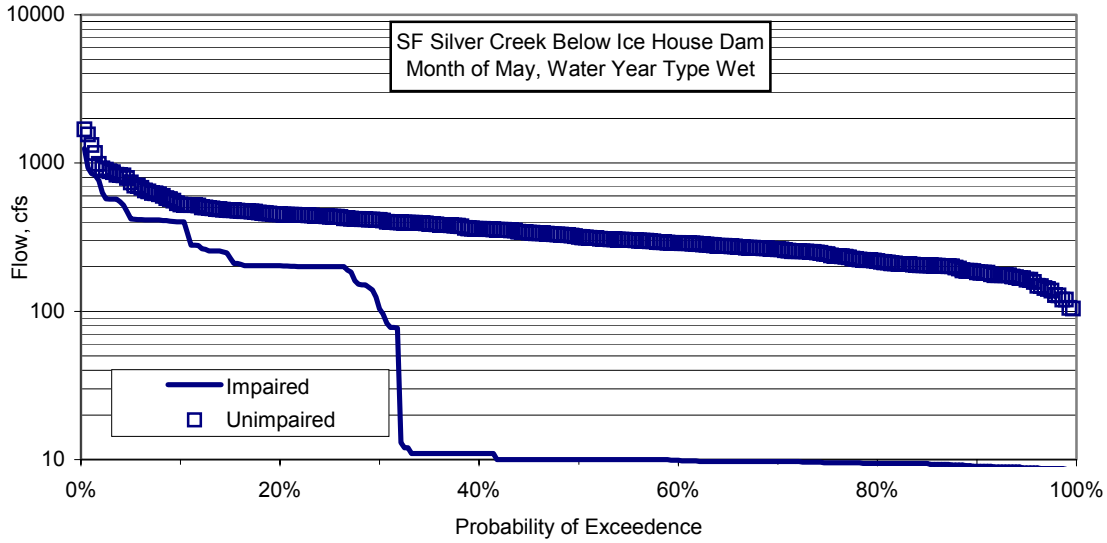


Figure 5.1-2. Exceedance curve for May Wet (Water Years 1975-1999).

5.2 Minimum Acceptable Flows

The minimum acceptable flow, as defined in the study plan, is the lowest flow at which 50 percent of the survey respondents would return to paddle the reach. The minimum acceptable flow determined by the study results is approximately 300 cfs. Based on the comparative evaluation data, the minimum flow that would allow boaters to simply get down the river is 297 cfs. The lowest quality technical flow that boaters identified averages 367 cfs. Figure 4.3-2 shows that flows up to 650 cfs as acceptable, however, the highest safe flow based on the average response from the participants is 600 cfs. During the focus group discussion participants stated that they generally felt more confident about their predictions about flows in the lower end of the entire range of flows (150 to 700 cfs) they were asked to evaluate than they did for flows that were significantly higher than the test flow of 400 cfs. It should be noted that based on the synthesized unimpaired hydrograph of this reach, flows would rarely reach a level higher than 600 cfs during the spring run-off period.

5.3 Optimal Range of Flows

The optimum flow, as defined in the study plan, is the peak of the flow preference curve and represents the flow level that provides the best combination of flow conditions for a whitewater opportunity. Figure 4.3-2 provides a graphical representation of the average acceptability of a range of flows from the comparative flow evaluation data. This information shows that the optimum range of flows is between 400 and 550 cfs. The average response for the optimum range of boatable flows is 392 to 515 cfs. During the focus group interview the participants felt fairly confident in providing their opinions of the run within this range of optimum flows based upon their one run at 400 cfs.

5.4 Craft Types

Although all of the participants were paddling hardshell kayaks during the study, the participants had the breadth of boating experience necessary to make recommendations on the suitability of the Ice House reach for a number of other craft types. The participants agreed that the reach in its current condition was unsuitable for rafts. This was primarily due to the narrow nature of the reach and the difficulty of maneuvering around and portaging over the LWD present in the reach. The group was somewhat split as to whether the removal of logs would improve the suitability of rafts for this reach. The participants agreed that at best, only smaller rafts, generally 13 feet or shorter in length, would be suitable for this run and flow would need to be at least 500 cfs. The participants felt that catarafts could also work well on this run if boaters did not have to contend with the portages over the logs on the reach. Open canoes and inflatable kayaks would also be acceptable crafts for this run.

5.5 Access

Access to the Ice House Reach is generally good. Nine locations were documented where the reach could be accessed. The access at the Ice House Dam Outlet is the only access location that was used during the study that is currently gated, however, several of the access locations are on private land. Under current access conditions, the most likely put-in locations would be at the gauging station and near the Ice House Resort. Both of these locations are on private land, as such, the ability for boaters to use these areas to access the river is not certain into the future. The Ice House Resort is the only location on the reach with room to park more than twenty vehicles. Members of the study team expressed a desire to have a takeout option in the lower third of the reach. The main desire for an earlier takeout location was because of the length of the run and the large amount of play boating features on the run. The second break stop, at river mile 9.3, would be the likely location for this takeout. Boaters completing the entire run could take out at the Bryant Springs Road Bridge or at the Junction Reservoir boat launch.

5.6 Large Woody Debris

One of the concerns in conducting this study was the large amount of LWD in the river channel. Aquatics studies completed in 2002-03 recorded over 90 logs in the river channel. The field inventory map is included in Appendix G. High quantities of LWD in the river channel cause concern for boater safety and require additional time for boaters to portage. Consequently the study team was limited to six participants to facilitate communication between boaters regarding hazards and minimize the time spent portaging during the study.

Logs are one of the most significant hazards that paddlers can encounter on a river. Logs are a particular hazard as a boat can wrap on them endangering participants and potentially damaging their craft. Another hazard is the potential to entrap swimmers. The team felt that the amount of wood in the channel did not pose a serious risk to skilled class IV paddlers, however, they also generally felt that the removal of approximately 5 to 15 logs would improve the safety of the run considerably and make the run more acceptable for class III boaters.

The possibility of having to portage a large number of logs on a run of this length generated apprehension about the time that would be required to complete the run. Fortunately, the LWD was less of a problem, in terms of portages, than had been anticipated. The team was only required to make three portages due to logs in the channel. All of the participants were able to paddle over three other sites where trees spanned the entire channel. Of the three portages, one was a substantial log-jam made up of three or more logs. Another instance was a log that spanned two rocks in one of the narrower parts of the river. This log was actually floating and appeared that it could possibly move. The last of the three portages was a log that spanned the channel above the access point located at Forest Road 12N45. Although there were fewer portages than expected, the amount of wood in the river did require the paddlers to be regularly maneuvering to avoid logs that extended out into the river channel and to be mindful of logs being carried with the current in the channel.

The team encountered significantly more wood in the lower end of the reach. This could have been partially due to the amount of wood that was mobilized during the test flow. Many of these logs seem to have collected in the area between Chicken Hawk Springs and the last gorge due to the fact that this area seemed to have slightly less gradient. However, following the flow study, approximately 150 cubic yards (11 rock truck loads) were collected by the Licensee and removed from Junction Reservoir, making it clear that the releases for the study mobilized a significant amount of LWD and passed it through the entire reach.

5.7 Carrying Capacity

The Ice House Reach is a small high Sierra stream with class IV difficulty both because of the challenge some of the rapids on the run and the amount of wood present in the river channel. Other reaches with this difficulty have carrying capacity targets of one group launching every 30 minutes where a group is defined as three rafts or six kayakers. For reference, on the Chamberlain Falls reach of the North Fork American River a commercial group of four boats is allowed to launch every twenty minutes. Commercial outfitters are allowed 24 launches per day.

On the Ice House Reach, if a group of six kayakers launched every 30 minutes over a six hour release period, this would constitute 72 users per day. Rafting group numbers would be larger and typically there are about three rafts in a group. On this reach smaller twelve to thirteen foot rafts would be used, with three to four passengers on each boat. This would create a group size of nine to 12 paddlers per group. Because this reach is better suited for boating in kayaks, it is likely that the number of rafters on the reach would be small. However, if rafting use is included in the estimate of carrying capacity, the number of boaters on the reach could increase to 80 to 90 users per day. These numbers are similar to capacity numbers agreed to on Belden Reach of the Upper North Fork Feather River which is similar in length to the Ice House Reach. These numbers are also consistent with the physical carrying capacity as determined specifically by the space available for parking. The likely shuttle scenario for this run would be that boaters would drive to one of the possible take-out locations and leave a car. Between the Junction Boat Launch, the Bryant Springs Road Bridge, and the early take-out option on Forest Service Road No. 12N45, there are over 40 parking spaces available combined at all of these sites. Even conservatively estimating two people per car, this would exceed the social carrying capacity of

approximately 80 boaters. Assuming boaters would then combine four people per car to shuttle to the put-in, twenty vehicles would need to be able to park in total at the various put-in options listed in the access section. This could be accomplished easily if parking is available at the Ice House Resort which is a privately owned and operated resort. If parking is not available at the Ice House Resort, there is space for parking along Ice House Road near the South Fork Silver Creek Bridge and along of FS Road No. 11N98 which could provide enough parking for boaters to meet a social carrying capacity limit of 80 boaters per day.

6.0 FINDINGS

The Ice House Whitewater Flow Study revealed a number of significant findings regarding the quality of this resource. The first significant finding relates to the overall difficulty rating of the Ice House Reach which is determined to be Class IV. The Class IV rapids are located in three sections of the reach; at the top of the reach below the gauge, just above the Cleveland Fire burn area, and just above the Bryant Springs Road Bridge near the end of the run. The remainder of the run, which constitutes most of the 11.2-mile run, was determined to have class III whitewater. The run is currently suitable for kayaks and possibly catarafts. The run may be suitable for small rafts if areas of large woody debris were removed from the reach.

A second significant finding relates to the boatability of this reach. This was one of the key concerns prior to completing the study due to the reported large number of logs in the river. The run was found to be boatable in its current condition. The boating team was only required to portage three logs during the run, which was far less than anticipated. The boating team did note that they had to maneuver around a significant amount of wood during the run. It was determined that the wood in the channel increased the difficulty level of the run. The consensus of the study team was that while a class III boater could portage the class IV rapids and complete the run, the logs in the rest of the river would make the run unsafe for boaters with only class III skills. The boating team estimated that removal of five logs would improve the run for class IV boaters and the removal, or relocation, of 15 to 20 logs could make the run acceptable for intermediate paddlers with class IV skills.

Thirdly, the optimal range of flow was determined via boater surveys completed following the test flow. This responds to Issue Question 6, “What maximum and minimum flow regimes are required for whitewater boating in stream reaches affected by the Project, including upper Rubicon River?” The test flow of 400 cfs was determined to be within the optimal range. Boaters’ responses indicate that the optimal range of flows for whitewater boating is between 400 cfs and 550 cfs. Although the study participants only experienced one flow level, they were confident about their predictions about other flows, particularly flows lower than the 400 cfs test flow. The hydrologic analysis showed that flows significantly higher than 600 cfs would have rarely occurred in this reach under unimpaired conditions, however, flows between 400 to 550 cfs flows could have occurred in the spring, typically April through June.

Another significant finding pertains to the access to and parking available for this reach. There is parking for a significant number of cars at various locations along the reach, however, there is

no single location with public access that can accommodate more than 20 vehicles. A reasonable estimate of the carrying capacity for this reach is 80 to 90 boaters per day.

In regard to Issue Question 3a, "What are the effects of potential boating flows on water levels of Project reservoirs?" it was found that the test flow release required 244.0 acre-feet of water. The combination of releases for the study combined with the estimated inflow to Ice House Reservoir from SF Silver Creek of 175 acre-feet caused the elevation of Ice House Reservoir to decrease 0.15 feet from the pre-test flow reservoir level of 5434.02 feet.

Finally, Issue Question 68 asks, "What is the need for, and feasibility of, whitewater boating in the reaches below Project dams?" Runs that require intermediate to advanced boating skills are rare at such a high altitude in the Sierra. It is likely that large numbers of paddlers would be attracted to this reach if flows were provided. As an indicator, currently the run above Ice House Reservoir has seen significant increasing use over the past few years. Members of the study team indicated that they would return to boat this section if flows coincided with the boatable flows of the run above the Ice House Reservoir. In addition, the run has potential for commercial boating use.

In addition to the whitewater boating study, four locations (IH-1, IH-2, IH-3, and IH-4) along the South Fork Silver Creek between Ice House Reservoir Dam and the inflow to Junction Reservoir were monitored for total suspended solids, turbidity, temperature, and stage.
As the flows increased at each of the four stations the data loggers recorded an increase in turbidity and total suspended solids. The monitoring sites located nearest to Ice House Dam (IH-1 and IH-2) experienced a small increase in turbidity and total suspended solids while the lower monitoring sites (IH-3 and IH-4 in the Cleveland Fire burn area) showed significant increases in these two parameters. However as the flows stabilized near their maximum and during the descending limb of the test flow hydrograph the total suspended solids and turbidity of the water decreased. The temperature of the water increased as the flows increased and as the distance from Ice House Dam increased.

Evaluation for the fish stranding potential was restricted to the four samples sites due to limited access of the reach. Only site IH-1 exhibited the potential for fish stranding as this was the only sample site where water was not entirely contained by the stream banks. The area of concern is located across from the SMUD gaging station. The three other sample sites were located in portions of the reach that has steep banks therefore containing the water within the stream channel. However above IH-3 at one of the Amphibian study sites (NE1/4 of the NE1/4 section 17 T.11N, R.14E) a secondary stream channel exists and does contain a small amount of water flowing through it at all times. This area also contains some pockets that could potentially be filled during flows similar to the May 1st flow event. During the fall of the boating flow hydrograph these pockets may have become isolated from the main-stream channel.

Bed form inundation occurred at two of the four sample sites (IH-1 and IH-2). IH-1 has been described above while IH-2 had a shallow sloping shelf (river left) located just above the sampling site. Water did not remain on the shelf after the flows had receded however the shelf became entirely inundated during the test flow. A riparian vegetation margin (dominated by

alder and grasses) was present at all four sites and during the higher flows. The vegetation margin was inundated during the test flow study.

7.0 LITERATURE CITED

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APPENDIX A

BOATER EVALUATION FORM
ICE HOUSE RUN

Ice House Run
(Ice House Dam to Junction Reservoir)
WHITEWATER BOATING FLOW STUDY, May 1, 2004

BOATER EVALUATION FORM

This questionnaire is organized in three sections. ***Section 1****—Contact information and characterization of your boating skills/experience.* ***Section 2****—Questions regarding your experience on today's run and your opinions about the whitewater boating resource as if there was an acceptable amount of LWD in the channel.* ***Section 3****—A comparative evaluation of different flows using your best estimate of what the reach would be like at flows higher and lower than today's flow and comparing the Ice House Reach to other runs.*

SECTION 1--BOATER BACKGROUND INFORMATION—*(COMPLETE THIS SECTION ONLY ONCE)*

1. Name _____
2. Affiliation _____
3. Home Address _____
4. Telephone _____
5. E-Mail Address _____
6. Preferred Craft _____
7. What is your age? _____ years
8. Gender (*circle one*): Male Female
9. Please indicate your current boating skill level below. *(Circle one)*

   a) Novice
   b) Intermediate
   c) Advanced
   d) Expert
   e) Elite

10. How many years have you been boating at this level? _____
11. Do you have any commercial guiding experience? _____ In what craft types? Raft Kayak Other_____
12. In the past 3 years, how many days a month do you boat? _____
13. Have you ever participated in a hydro relicensing whitewater boating study before? _____
14. If yes, how many, when and for which hydro projects? _____
15. How many times have you boated this run before today? _____Approximate dates_____

    If you have boated this run before *(Leave blank if you have not boated the run before today)*:

    15a. What were the flows? _____ cfs

    15b. What type of craft(s) did you use? _____

16. How long does it take you to get to this reach from your home? _____hrs_____min

17. Please respond to each of the following statements about your river-running preferences.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I prefer running rivers with difficult rapids (Class IV and V).	1	2	3	4	5
Running challenging whitewater is the most important part of my boating trips.	1	2	3	4	5
I often boat short river segments (under 4 miles) to take advantage of whitewater play areas.	1	2	3	4	5
I often boat short river segments to experience a unique and interesting place.	1	2	3	4	5
I often boat short river segments to run challenging rapids.	1	2	3	4	5
Good whitewater play areas are more important than challenging rapids.	1	2	3	4	5
I am willing to tolerate difficult put-ins and portages in order to run interesting reaches of whitewater.	1	2	3	4	5
I prefer boating rivers that feature large waves and powerful hydraulics.	1	2	3	4	5
I prefer boating steep, technical rivers.	1	2	3	4	5
I enjoy boating both technical and big water rivers.	1	2	3	4	5
I feel able to evaluate rivers for boaters of different skill levels than my own.	1	2	3	4	5

SECTION 2-- BOATER POST-RUN EVALUATION FORM

Date of run: _____ / _____ / 2004

Reach: **Ice House**

1. What was the target flow on this run? _____ cfs as measured at _____.

2. What type of craft did you use for this run *(Circle one)*?

1.	Hard shell kayak	5.	Cataraft (please indicate length: _____)
2.	Inflatable kayak	6.	Raft (please indicate length: _____)
3.	Closed deck canoe	7.	No craft: I road/trail-scouted this run
4.	Open canoe with floatation	8.	Other: (please explain) _____

3. Please identify the put-in and take-out locations you used and estimate the time you put-in and took out on this run.

   Put-in location:_____ Time: _____

   Take-out location:_____ Time: _____

4. About how many times did you stop and get out of your boat for breaks, or for scouting and portaging?

   About _____ times for breaks.

   About _____ times for scouting or portaging.

5. Please estimate the total amount of time you spent out of your boat for breaks, or for scouting and portaging.

   About _____ minutes for breaks.

   About _____ minutes for scouting or portaging.

6. Please estimate the number of **hits**, **stops**, **boat drags**, and **portages** you had on this run.

   I **hit** rocks or other obstacles (but did not stop) about ____ times.

   I was **stopped** after hitting rocks or other obstacles about _____ times (but did not have to get out of my boat to continue downstream).

   I had to get out to **drag or pull my boat** off rocks or other obstacles about _____ times.

   I had to **portage** around logs about _____ times.

   I chose to **portage** around rapids, or other sections about _____ times.

7. Please respond to each of the following statement regarding the amount of LWD in the river channel.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The amount of LWD in the river channel is unacceptable.	1	2	3	4	5

8. If your response to question no. 7 was '4' or '5', please estimate how much of the LWD in the river channel would need to be removed in order to make this run acceptable to you. *(Leave blank if your response to no. 7 was a '1', '2' or '3'.)*

   Approximately _____% of the LWD would need to be removed.

9. In general, how would you rate the whitewater difficulty on this reach at this flow? (Use the International Whitewater Scale that ranges from Class I to Class VI)._____

10. **If the reach had an acceptable amount of LWD**, how would you rate the whitewater difficulty on this reach at this flow? (Use the International Whitewater Scale that ranges from Class I to Class VI)._____

11. In your opinion, would a boater looking for an experience of this difficulty be likely to return for future boating if today's flow were to be provided? *(Circle one)*

    a) Definitely No b) Possibly c) Probably d) Definitely Yes

12. **If the reach had an acceptable amount of LWD**, in your opinion, would a boater looking for an experience of this difficulty be likely to return for future boating if today's flow were to be provided? *(Circle one)*

    a) Definitely No b) Possibly c) Probably d) Definitely Yes

13. Relative to today's flow would you prefer a flow that was higher or lower or was this optimum flow? *(Circle one)*

    a) Much Lower b) Lower c) Higher d) Much Higher e) Optimum

14. If the reach had an acceptable amount of LWD, relative to today's flow would you prefer a flow that was higher or lower or was this optimum flow? *(Circle one)*

    a) Much Lower b) Lower c) Higher d) Much Higher e) Optimum

15. Please respond to each of the following statements about the characteristics of this run at today's flow.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
This reach is boatable at these flows.	1	2	3	4	5
If an acceptable amount of LWD were present, this reach is boatable at these flows	1	2	3	4	5
This reach offers challenging and technical boating.	1	2	3	4	5
If an acceptable amount of LWD were present, this reach offers challenging and technical boating.	1	2	3	4	5
This reach has nice water features such as waves and holes.	1	2	3	4	5
If an acceptable amount of LWD were present, this reach has nice water features such as waves and holes.	1	2	3	4	5
This reach has good play spots.	1	2	3	4	5
If an acceptable amount of LWD were present, this reach has good play spots.	1	2	3	4	5
This run offers good overall whitewater challenge.	1	2	3	4	5
If an acceptable amount of LWD were present, this run offers good overall whitewater challenge.	1	2	3	4	5
This is an aesthetically pleasing run.	1	2	3	4	5
If an acceptable amount of LWD were present, this is an aesthetically pleasing run.	1	2	3	4	5
This run is a good length.	1	2	3	4	5
If an acceptable amount of LWD were present, this run is a good length.	1	2	3	4	5
The portages on this run are not a problem.	1	2	3	4	5
If an acceptable amount of LWD were present, the portages on this run are not a problem.	1	2	3	4	5
There are enough places to take a break or have lunch on this run.	1	2	3	4	5
If an acceptable amount of LWD were present, there are enough places to take a break or have lunch on this run.	1	2	3	4	5

16. Please identify particularly challenging rapids or sections and rate their difficulty at this flow (using the International Whitewater Scale). Also note if you portaged any of these rapids.

Location (Name or site)	Rating (Whitewater Scale of Difficulty)	Portage? (Yes or No)

17. If you portaged any rapids on the run, please identify rapids you chose to portage and rate the **difficulty of those portages** (using your type of craft at this flow level).

Location	Not at all difficult	Slightly difficult	Moderately difficult	Extremely difficult
	1	2	3	4
	1	2	3	4
	1	2	3	4
	1	2	3	4
	1	2	3	4
	1	2	3	4

18. Did you observe or experience any significant safety issues on your run today (swims, pins, wrapped boats, man-made or natural river features etc…)? Please explain.

_____

_____

_____

_____

_____

_____

_____

19. If you feel qualified to offer an opinion of the boatability of this run at today's flow using different types of crafts, please respond to the following statements. **Leave blank if you do not have experience with a particular type of craft.** *(Circle one number for each type of craft)*

This run at this flow would work well for:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Kayaks	1	2	3	4	5
Rafts	1	2	3	4	5
Catarafts	1	2	3	4	5
Open Canoes	1	2	3	4	5
Inflatable Kayaks	1	2	3	4	5

20. If you feel qualified to offer an opinion of the commercial viability of this run using different types of crafts, please respond in the space provided below.

_____

_____

_____

_____

_____

_____

SECTION 3—Comparative Evaluation Form

PLEASE ANSWER THE FOLLOWING QUESTIONS AS IF THE RUN HAD AN ACCEPTABLE AMOUNT OF LWD IN THE RIVER CHANNEL

1. Please evaluate the following flows for your craft and skill level (please circle one in each column). In making your evaluations, please consider all the flow-dependent characteristics that contribute to a high quality trip (e.g., boatability, whitewater challenge, safety, availability of surfing or other play areas, aesthetics, and rate of travel).

Ice House	150 cfs	200 cfs	250 cfs	300 cfs	350 cfs	400 cfs	450 cfs	500 cfs	550 cfs	600 cfs	650 cfs	700 cfs
Totally acceptable	5	5	5	5	5	5	5	5	5	5	5	5
Acceptable	4	4	4	4	4	4	4	4	4	4	4	4
Marginal	3	3	3	3	3	3	3	3	3	3	3	3
Unacceptable	2	2	2	2	2	2	2	2	2	2	2	2
Totally Unacceptable	1	1	1	1	1	1	1	1	1	1	1	1

2. Based on your boating trips on this reach, please answer the following questions. *(Note: you can specify flows that you have not seen, but which you would predict based on your experience.)*

	Flow in cfs
What is the lowest flow you need to simply get down the river in your craft?	_____
What is the lowest flow that provides a quality technical boating experience for this reach?	_____
What is the optimal range of flows that provides the best whitewater characteristics for this run?	_____ to _____
What do you feel the highest safe flow for your craft and skill level?	_____

3. In your experience, what whitewater runs in California do you believe offer a whitewater experience similar to this one at the optimum flow for this reach? Also list how often you boat these reaches and how long it takes you to travel to the run from your home.

a) _____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _____hours What months do you usually boat this run?_____

b) _____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _____hours What months do you usually boat this run?_____

c) _____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _____hours What months do you usually boat this run?_____

d) _____

Trips per year on this reach (circle one) 0-3 4-8 9-15 15+

Travel Time: _____hours What months do you usually boat this run?_____

4. Compared to the runs you listed above, how would you rate boating opportunities on the Ice House Reach? *(Circle one number for each; if you are unsure about a comparison, leave that item blank).*

Compared to:	Much Worse	Worse	About the Same	Better	Much Better
_____	1	2	3	4	5
_____	1	2	3	4	5
_____	1	2	3	4	5
_____	1	2	3	4	5

5. Please respond to the following statements about the non-whitewater characteristics of this run.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Length of Shuttle is not a problem.	1	2	3	4	5
The put -in for this run is good.	1	2	3	4	5
The take-out for this run is good.	1	2	3	4	5
The total shuttle to boating ratio on this run is good.	1	2	3	4	5

6. If you have any suggestions for improving the access or other attributes for this run please describe these improvements below.

_____

_____

_____

_____

_____

7. Please use the space below to provide any comments about your overall boating experience on the Ice House run.

_____

_____

_____

_____

_____

APPENDIX B

LIST OF STUDY TEAM PARTICIPANTS

List of Study Team Participants

	0	1	6	7	8		10	11	11.1	12	13		14			15				16	17								
Flow	ID	Name	Preferred Craft	Age	Gender	Skill Level (N/I/A/X/E)	Years Boating @ this Level	Commercial Experience	Commercial Experience Craft	boat days/month (last 3 yrs)	ww boating study before YES	ww boating study before NO	how many?	when?	which?	#times boated Ice House run (per year)	year	what flow (cfs)	type of craft	Time to this reach (minutes)	difficult (Class IV-V)	challenging whitewater	short rvr ww play areas	short rvr exp new/int place	short rvr challenging rapids	ww play > challenging rapids	tolerate difficult for good ww	large waves/ hydraulics	steep, technical rivers	technical, big water rivers	evaluate different skill level
400	1	Chris Shackleton	kayak	49	M	X	5	No		8	1		1	10/30/03	Slab Creek SMUD	0				120	5	4	3	5	5	2	4	2	5	4	4
400	2	Dan Bolster	raft or kayak	49	M	A	10	Yes	Raft/ Kayak	5	1		1	10/30/03	Slab Creek SMUD	0				45	4	3	4	4	3	2	4	4	4	4	4
400	3	Dave Steindorf	kayak	43	M	X	5	Yes	Kayak	4	1		10	98/04	Slab Creek;Klamath; Stan; RCC; Pit 4; Belden; Seneca	0				195	4	4	5	5	5	3	4	3	4	4	5
400	4	Justin States	kayak	30	M	X	4	No		6	1		1	10/30/03	Slab Creek SMUD	0				120	4	4	3	3	3	3	4	2	4	3	5
400	5	Phil DeRiemer	kayak	46	M	X	18	Yes	Raft/ Kayak	12	1		1	10/30/03	Slab Creek SMUD	0				60	4	3	3	5	5	2	4	3	3	5	5
400	6	Susan Norman	raft	46	F	A	30	Yes	Raft/ Kayak	7	1		6	98/04	Slab Creek; RCC; Pit 4 & 5; Belden	0				60	2	2	2	4	3	3	3	3	3	4	5

ID	1	6	7	8		10			11	12				13				14	15										
	Name	Preferred Craft	Age	Gender	Skill Level	Years Boating @ this Level	Commercial Experience	Commercial Experience Craft	boat days/month (last 3 yrs)	ww boating study before YES	ww boating study before NO	how many?	when?	which?	#times boated Ice House run (per year)	year	what flow (cfs)	type of craft	Time to this reach (minutes)	difficult (Class IV-V)	challenging whitewater	short rvr ww play areas	short rvr exp new/int place	short rvr challenging rapids	ww play > challenging rapids	tolerate difficult for good ww	large waves/ hydraulics	steep, technical rivers	technical, big water rivers	evaluate different skill level
6		0	6	67%		6	6	0	6	0		6	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6
44			12.0			7.0	100%	0%	3.3			0.0				100	3.8	3.3	3.3	4.3	4.0	2.5	3.8	2.8	3.8	4.0	4.7		

Male	5	83%	6
Female	1	17%	6

Novice (N)	0	0%	6
Intermediate (I)	0	0%	6
Advanced (A)	2	33%	6
Expert (X)	4	67%	6
Elite (E)	0	0%	6

APPENDIX C

SUMMARIZED RESPONSES OF BOATER EVALUATIONS

Summarized Responses of Boater Evaluations

Run Data

Summarized Responses of Boater Evaluations
Run Data

0	1	2	0	1			2	3				
ID	**Name**	Affiliation	Date of Run	Target Flow	Actual Flow	Measured At	Craft	Put-in	Takeout	Start Time	End Time	Trip Time
1	**Chris Shackleton**	AW/private	1-May	400	400	IHD	KAYAK	IHD	Junction Res	9:45	16:10	6:25
2	**Dan Bolster**	Eldorado County	1-May	400	400	IHD	KAYAK	IHD	Junction Res	9:45	16:10	6:25
3	**Dave Steindorf**	Louis Berger	1-May	400	400	IHD	KAYAK	IHD	Junction Res	9:45	16:10	6:25
4	**Justin States**	AW/private	1-May	400	400	IHD	KAYAK	IHD	Junction Res	9:45	16:10	6:25
5	**Phil DeRiemer**	AW	1-May	3	400	IHD	KAYAK	IHD	Junction Res	9:45	16:10	6:25
6	**Susan Norman**	USFS	1-May	400	400	IHD	KAYAK	IHD	Junction Res	9:45	16:10	6:25

0:00

ID	1	2	0	1			2	3				
	Name	Affiliation	Date of Run	Target Flow	Actual Flow	Measured At	Craft	Put-in	Takeout	Start Time	End Time	Trip Time
			6	6	6	IHD	KAYAK	IHD	Junction Res	6	6	6
				334	400					9:45	16:10	6:25

Summarized Responses of Boater Evaluations
Run Data

0	1	2	0	4		5		6					7
ID	**Name**	Affiliation	Date of Run	# Breaks	# Scout/ Portage	Break (minutes)	Scout/ portage (minutes)	Hits	Stops	Drags	Portages Logs	Portages	LWD Unacceptable
1	**Chris Shackleton**	AW/private	1-May	3	8	40	20	0	0	0	3	1	4
2	**Dan Bolster**	Eldorado County	1-May	3	5	40	20	2	0	0	3	2	4
3	**Dave Steindorf**	Louis Berger	1-May	3	5	40	20	20	3	0	3	1	4
4	**Justin States**	AW/private	1-May	3	8	45	30	7	0	0	3	1	4
5	**Phil DeRiemer**	AW	1-May	3	3	40	20	5	0	0	3	0	3
6	**Susan Norman**	USFS	1-May	3	8	40	30	10	0	0	6	3	4

ID	1	2	0	4		5		6					7
	Name	Affiliation	Date of Run	# Breaks	# Scout/ Portage	Break (minutes)	Scout/ portage (minutes)	Hits	Stops	Drags	Portages Logs	Portages	LWD Unacceptable
			6	6	6	6	6	6	6	6	6	6	6
				3.0	6.2	41	23	7	1	0	4	1	4

Summarized Responses of Boater Evaluations
Run Data

0	1	2	0	8		9	10	11				12			
ID	**Name**	Affiliation	Date of Run	%LWD Removed	# of Logs Removed	WW Scale (Class I-VI)	WW Scale (Class I-VI) W/O LWD	No	Possibly	Probably	Yes	No W/O LWD	Possibly W/O LWD	Probably W/O LWD	Yes W/O LWD
1	**Chris Shackleton**	AW/private	1-May		6	III+/ (5 IV, 1 V-)	III/ (5 IV, 1 V-)		1						1
2	**Dan Bolster**	Eldorado County	1-May		5	IV (2 IV+)	V				1				1
3	**Dave Steindorf**	Louis Berger	1-May	5%	5	III+/ (5 IV, 1 V-)	III/ (5 IV, 1 V-)			1					1
4	**Justin States**	AW/private	1-May	2%	6	IV (2 IV+)	III/ IV			1					1
5	**Phil DeRiemer**	AW	1-May			III/ IV	III/ IV			1				1	
6	**Susan Norman**	USFS	1-May		5	III/ IV	III/ IV		1						1
					5 class IV 15-20 Class III										

ID	1	2	0	8		9	10	11				12			
	Name	Affiliation	Date of Run	%LWD Removed	# of Logs Removed	WW Scale (Class I-VI)	WW Scale (Class I-VI) W/O LWD	No	Possibly	Probably	Yes	No W/O LWD	Possibly W/O LWD	Probably W/O LWD	Yes W/O LWD
			6	2	5	0	0	0	2	3	1	0	0	1	5
				0	5			0%	33%	50%	17%	0%	0%	17%	83%

Summarized Responses of Boater Evaluations
Run Data

0	1	2	0	13					14					15			
ID	**Name**	Affiliation	Date of Run	Much lower	Lower	Higher	Much higher	Optimum	Much lower W/O LWD	Lower W/O LWD	Higher W/O LWD	Much higher W/O LWD	Optimum W/O LWD	Boatable	Boatable W/O LWD	Challenging/ Technical	Challenging/ Technical W/O LWD
1	**Chris Shackleton**	AW/private	1-May					1			1			4	5	5	4
2	**Dan Bolster**	Eldorado County	1-May					1					1	5	5	5	5
3	**Dave Steindorf**	Louis Berger	1-May					1					1	4	5	5	5
4	**Justin States**	AW/private	1-May					1			1			4	5	4	3
5	**Phil DeRiemer**	AW	1-May					1			1			4	4	4	4
6	**Susan Norman**	USFS	1-May					1			1			4	5	5	5

ID	1	2	0	13					14					15			
	Name	Affiliation	Date of Run	Much lower	Lower	Higher	Much higher	Optimum	Much lower W/O LWD	Lower W/O LWD	Higher W/O LWD	Much higher W/O LWD	Optimum W/O LWD	Boatable	Boatable W/O LWD	Challenging/ Technical	Challenging/ Technical W/O LWD
			6	0	0	0	0	6	0	0	4	0	2	6	6	6	6
				0%	0%	0%	0%	100%	0%	0%	67%	0%	33%	4.2	4.8	4.7	4.3

Summarized Responses of Boater Evaluations
Run Data

0	1	2	0	15										
ID	**Name**	Affiliation	Date of Run	Nice water features	Nice water features W/O LWD	Good play spots	Good play spots W/O LWD	Good overall ww challenge	Good overall ww challenge W/O LWD	Aesthetically pleasing	Aesthetically pleasing W/O LWD	Good Length	Good Length W/O LWD	Portages not a problem
1	**Chris Shackleton**	AW/private	1-May	5	5	5	5	5	5	2	2	4	4	4
2	**Dan Bolster**	Eldorado County	1-May	5	5	5	5	4	4	3	4	4	4	4
3	**Dave Steindorf**	Louis Berger	1-May	5	5	5	5	4	5	3	4	4	4	3
4	**Justin States**	AW/private	1-May	4	5	4	5	4	4	2	3	3	3	3
5	**Phil DeRiemer**	AW	1-May	4	4	4	4	4	4	3	3	4	4	4
6	**Susan Norman**	USFS	1-May	5	5	5	5	5	5	4	4	4	4	4

ID	1	2	0	15										
	Name	Affiliation	Date of Run	Nice water features	Nice water features W/O LWD	Good play spots	Good play spots W/O LWD	Good overall ww challenge	Good overall ww challenge W/O LWD	Aesthetically pleasing	Aesthetically pleasing W/O LWD	Good Length	Good Length W/O LWD	Portages not a problem
			6	6	6	6	6	6	6	6	6	6	6	6
				4.7	4.8	4.7	4.8	4.3	4.5	2.8	3.3	3.8	3.8	3.7

Summarized Responses of Boater Evaluations
Run Data

0	1	2	0	15			16			16.1		
ID	**Name**	Affiliation	Date of Run	Portages not a problem W/O LWD	Nice Lunch Break spots	Nice Lunch Break spots W/O LWD	Chall. Rapid Location/ Name	WW Scale	Portage?	Chall. Rapid Location/ Name	WW Scale	Portage?
1	**Chris Shackleton**	AW/private	1-May	5	4	5	Upper	IV	No	Rooster tail	IV+	No
2	**Dan Bolster**	Eldorado County	1-May	4	5	5	Upper	IV	Yes	2mile	V-	Yes
3	**Dave Steindorf**	Louis Berger	1-May	4	5	5	Upper	IV	No	2mile	V-	Yes
4	**Justin States**	AW/private	1-May	4	4	4	Upper	IV+	No	2mile	III+ (V-)	Yes
5	**Phil DeRiemer**	AW	1-May	4	5	5	Upper	IV	No	2mile	IV	No
6	**Susan Norman**	USFS	1-May	5	5	5	Upper	IV	Yes	2mile	III	Yes

ID	1	2	0	15			16			16.1		
	Name	Affiliation	Date of Run	Portages not a problem W/O LWD	Nice Lunch Break spots	Nice Lunch Break spots W/O LWD	Chall. Rapid Location/ Name	WW Scale	Portage?	Chall. Rapid Location/ Name	WW Scale	Portage?

6	6	6	6
	4.3	4.7	4.8

Summarized Responses of Boater Evaluations
Run Data

0	1	2	0	16.2			17		18	19.a				
ID	**Name**	Affiliation	Date of Run	Chall. Rapid Location/ Name	WW Scale	Portage?	Portage Rapid Location	Difficulty	Safety-related - comments	Kayaks	Raft	Cataraft	Open Canoes	Inflatable Kayaks
1	**Chris Shackleton**	AW/private	1-May	Lower	IV-	No	Butt Buster	3	LWD	4	1			5
2	**Dan Bolster**	Eldorado County	1-May	Lower	IV	No	Upper, 2mile	3	Portages easy. Log jams	5	2	4	4	4
3	**Dave Steindorf**	Louis Berger	1-May	Lower	IV	No	Butt Buster	1	LWD	5	2	4	4	5
4	**Justin States**	AW/private	1-May	Lower	IV	No	Butt Buster	1	LWD	5				
5	**Phil DeRiemer**	AW	1-May	Lower	IV	No	Chicken Hawk Springs	1	LWD	4			4	
6	**Susan Norman**	USFS	1-May	Lower	IV	No	Upper, 2mile	2		5	1	1	4	4

ID	1	2	0	16.2			17		18	19.a				
	Name	Affiliation	Date of Run	Chall. Rapid Location/ Name	WW Scale	Portage?	Portage Rapid Location	Difficulty	Safety-related - comments	Kayaks	Raft	Cataraft	Open Canoes	Inflatable Kayaks
			6					6		6	4	3	4	4
								1.8		4.7	1.5	3.0	4.0	4.5

Summarized Responses of Boater Evaluations
Run Data

0	1	2	0	19.b					20
ID	**Name**	Affiliation	Date of Run	Kayaks W/O LWD	Raft W/O LWD	Cataraft W/O LWD	Open Canoes W/O LWD	Inflatable Kayaks W/O LWD	Commercial Viability
1	**Chris Shackleton**	AW/private	1-May	5	2			4	Not Qualified
2	**Dan Bolster**	Eldorado County	1-May	5	4	4	4	4	Very viable
3	**Dave Steindorf**	Louis Berger	1-May	5	3	5	4	5	Not Qualified
4	**Justin States**	AW/private	1-May	5					Not Qualified
5	**Phil DeRiemer**	AW	1-May	5			4	4	Kayakers W/ good class III/ IV skills
6	**Susan Norman**	USFS	1-May	5	4	4	4	4	Limited
ID	**1**	**2**	**0**	**19.b**					**20**
	Name	Affiliation	Date of Run	Kayaks W/O LWD	Raft W/O LWD	Cataraft W/O LWD	Open Canoes W/O LWD	Inflatable Kayaks W/O LWD	Commercial Viability
			6	6	4	3	4	5	
				5.0	3.3	4.3	4.0	4.2	

Summarized Responses of Boater Evaluations

Comparative

Summarized Responses of Boater Evaluations
Comarative Data

					3. What CA whitewater runs are similar to Ice House at optimal flow?																	
					A						B						C					
ID	Date	Name	Skill Level	Kayak OR Raft	Name of Run	0-3	4-8	9-15	15+	Travel Time	Name of Run	0-3	4-8	9-15	15+	Travel Time	Name of Run	0-3	4-8	9-15	15+	Travel Time
1	1-May	Chris Shackleton	X	K	M.F. Consumnes	1					None						None					
2	1-May	Dan Bolster	X	K	SFAR, Kyburz	1					McCloud	1				4	SFAR, Peavine to Riverton	1				0.75
3	1-May	Dave Steindorf	X	K	Sloat M.F. Feather	1					McCloud	1				2.5						
4	1-May	Justin States	A	K	None						None	1					None					
5	1-May	Phil DeRiemer	X	K	SFAR, Kyburz	1				1	Cal Salmon	1				7	None	1				
6	1-May	Susan Norman	A	K	none						None	1					None	1				

3. What CA whitewater runs are similar to Ice House at optimal flow?																
A						B						C				
Name of Run	0-3	4-8	9-15	15+		Name of Run	0-3	4-8	9-15	15+		Name of Run	0-3	4-8	9-15	15+

Summarized Responses of Boater Evaluations
Comarative Data

					4. Compared to runs listed above, how would you rate boating on the Ice House Reach?						5. Non Whitewater characteristics			
					A		B		A					
ID	Date	Name	Skill Level	Kayak OR Raft	Name of Run	Scale 1 to 5	Name of Run	Scale 1 to 5	Name of Run	Scale 1 to 5	Length of Shuttle	Put-in Good	Take-out Good	Shuttle: Boating Ratio Good
1	1-May	Chris Shackleton	X	K	M.F. Consumnes	3	None		None		5	4	4	5
2	1-May	Dan Bolster	X	K	SFAR, Kyburz	5	McCloud	4	SFAR, Peavine to Riverton	4	5	5	5	5
3	1-May	Dave Steindorf	X	K	Sloat M.F. Feather	4	McCloud	3	0		5	5	5	5
4	1-May	Justin States	A	K	None		None		None		5	5	5	5
5	1-May	Phil DeRiemer	X	K	SFAR, Kyburz	4	Cal Salmon	3			5	4	5	5
6	1-May	Susan Norman	A	K	none	3	None	4	None		5	5	5	5

4. Compared to runs listed above, how would you rate boating on the Ice House Reach?						5. Non-Whitewater characteristics			
A		B		A					
Name of Run	Scale 1 to 5	Name of Run	Scale 1 to 5	Name of Run	Scale 1 to 5	Length of Shuttle	Put-in Good	Take-out Good	Shuttle: Boating Ratio Good
						6	6	6	6
						5.0	4.7	4.8	5.0

Summarized Responses of Boater Evaluations
Comarative Data

ID	Date	Name	Skill Level	Kayak OR Raft	6. Suggestions for access/shuttle improvements	7. Other comments
1	1-May	**Chris Shackleton**	X	K	Access point half way through the run would be an improvement.	Good quality class III run. Unsual for its high elevation.
2	1-May	**Dan Bolster**	X	K	Remove major LWD.	the top and bottom sections. Middle full of great play spots. Will be beautiful as forest grows back. Continuous nature
3	1-May	**Dave Steindorf**	X	K		
4	1-May	**Justin States**	A	K	Need access point half way through the run.	Great run, needs some LWD removed. Class III/IV runs are in short supply. Upper& lower nice alpine scenery.
5	1-May	**Phil DeRiemer**	X	K	More space for put in at Dam	Good continuous run. Boaters need good skills. WW good scenery mixed due to burn
6	1-May	**Susan Norman**	A	K		

Summarized Responses of Boater Evaluations
Comarative Data

					1. Evaluate the following flows for your **craft** and skill **level**												2. Answer following questions based on trips on Ice House				
ID	**Date**	**Name**	**Skill Level**	**Kayak OR Raft**	150 cfs	200 cfs	250 cfs	300 cfs	350 cfs	400 cfs	450 cfs	500 cfs	550 cfs	600 cfs	650 cfs	700 cfs	Lowest Flow	Technical Flow	Optimal range		Highest Safe Flow
1	1-May	**Chris Shackleton**	X	K	1	1	2	3	4	5	5	5	5	4	3	3	250	350	400	500	600
2	1-May	**Dan Bolster**	X	K	1	1	1	3	4	5	5	5	5	4	4	3	300	400	400	600	600
3	1-May	**Dave Steindorf**	X	K	1	2	3	3	4	5	5	5	4	4	3	3	200	300	350	500	700
4	1-May	**Justin States**	A	K	1	1	1	1	3	4	5	5	5	4	4		300	350	400	500	600
5	1-May	**Phil DeRiemer**	X	K	2	2	2	3	4	5	5	5	5	4			300	400	400	500	600
6	1-May	**Susan Norman**	A	K				2.5	4	5	5	5	4	2.5			400	400	400	500	500

	1. Evaluate the following flows for your **craft** and skill **level**												2. Answer following questions based on trips on Ice House				
	150 cfs	200 cfs	250 cfs	300 cfs	350 cfs	400 cfs	450 cfs	500 cfs	550 cfs	600 cfs	650 cfs	700 cfs	Lowest Flow Get Down	Technical Flow	Optimal Range		Highest Safe Flow
Count	5	5	5	6	6	6	6	6	6	6	4	3	6	6	6	6	6
Average	1.2	1.4	1.8	2.6	3.8	4.8	5.0	5.0	4.7	3.8	3.5	3.0	292	367	392	517	600

APPENDIX D

INTERNATIONAL SCALE OF RIVER DIFFICULTY (AS REVISED BY AMERICAN WHITEWATER, 1998)

Appendix D
International scale of river difficulty
(as revised by American Whitewater, 1998)

this is the American version of a rating system used to compare river difficulty throughout the world. this system is not exact; rivers do not always fit easily into one category, and regional or individual interpretations may cause misunderstandings. it is no substitute for a guidebook or accurate first-hand descriptions of a run.

The six difficulty classes:

class I: easy. fast moving water with riffles and small waves. few obstructions, all obvious and easily missed with little training. risk to swimmers is slight; self-rescue is easy.

class ii: novice. straightforward rapids with wide, clear channels which are evident without scouting. occasional maneuvering may be required, but rocks and medium sized waves are easily missed by trained paddlers. swimmers are seldom injured and group assistance, while helpful, is seldom needed. rapids that are at the upper end of this difficulty range are designated "class ii+".

class iii: intermediate. rapids with moderate, irregular waves which may be difficult to avoid and which can swamp an open canoe. complex maneuvers in fast current and good boat control in tight passages or around ledges are often required; large waves or strainers may be present but are easily avoided. strong eddies and powerful current effects can be found, particularly on large-volume rivers. scouting is advisable for inexperienced parties. injuries while swimming are rare; self-rescue is usually easy but group assistance may be required to avoid long swims. rapids that are at the lower or upper end of this difficulty range are designated "class iii-" or "class iii+" respectively.

class iv: advanced. intense, powerful but predictable rapids requiring precise boat handling in turbulent water. depending on the character of the river, it may feature large, unavoidable waves and holes or constricted passages demanding fast maneuvers under pressure. a fast, reliable eddy turn may be needed to initiate maneuvers, scout rapids, or rest. rapids may require must make moves above dangerous hazards. scouting may be necessary the first time down. risk of injury to swimmers is moderate to high, and water conditions may make self-rescue difficult. group assistance for rescue is often essential but requires practiced skills. a strong Eskimo roll is highly recommended. rapids that are at the upper end of this difficulty range are designated "class iv-" or "class iv+" respectively.

class v: expert. extremely long, obstructed, or very violent rapids which expose a paddler to added risk. drops may contain large, unavoidable waves and holes or steep, congested chutes with complex, demanding routes. rapids may continue for long distances between pools, demanding a high level of fitness. what eddies exist may be small, turbulent, or difficult to reach. at the high end of the scale, several of these factors may be combined. scouting is recommended but may be difficult. swims are dangerous, and rescue is often difficult even for experts. a very reliable Eskimo roll, proper equipment, extensive experience, and practiced rescue skills are essential. because of the large range of difficulty that exists beyond class iv, class 5 is an open ended, multiple level scale designated by class 5.0, 5.1, 5.2, etc... each of these levels is an order of magnitude more difficult than the last. example: increasing difficulty from class 5.0 to class 5.1 is a similar order of magnitude as increasing from class iv to class 5.0.

class vi: extreme and exploratory. these runs have almost never been attempted and often exemplify the extremes of difficulty, unpredictability and danger. the consequences of errors are very severe and rescue may be impossible. for teams of experts only, at favorable water levels, after close personal inspection and taking all precautions. after a class vi rapids has been run many times, it's rating may be changed to an appropriate class 5.x rating.

APPENDIX E

FLOW EXCEEDANCE GRAPHS

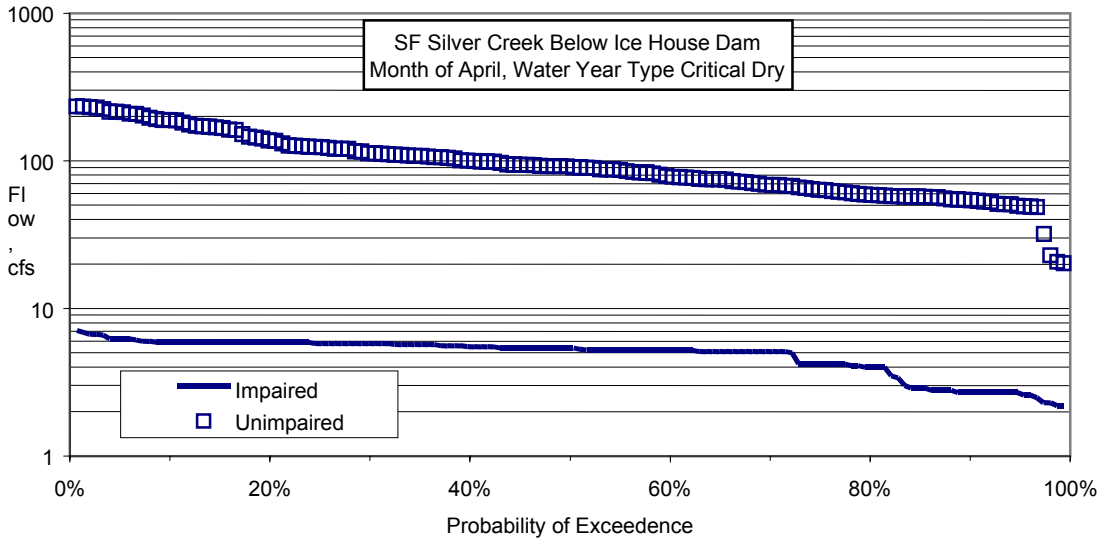
APPENDIX E
FLOW EXCEEDENCE GRAPHS

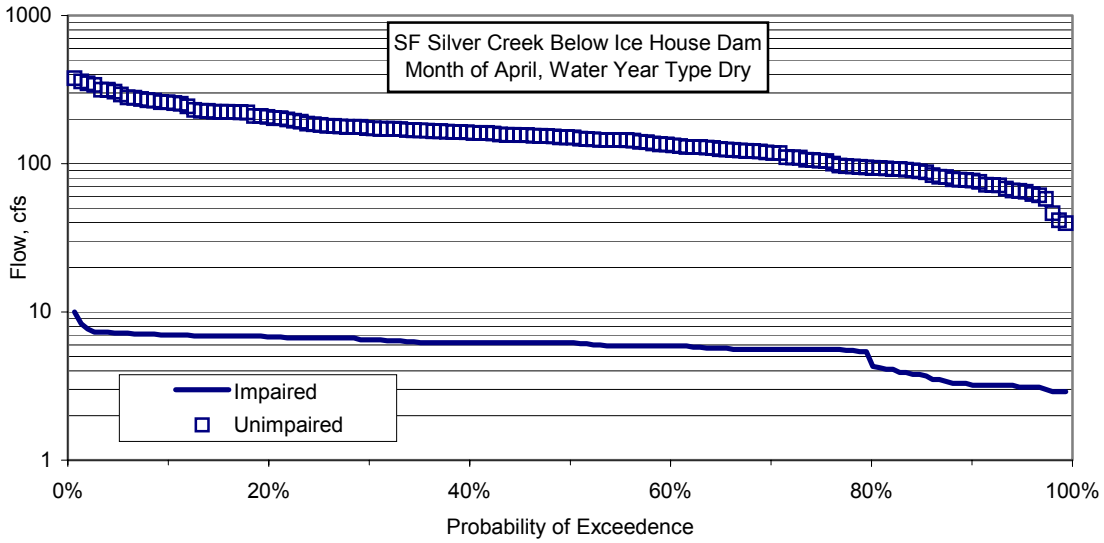
The following pages show graphs of mean daily flow, grouped by month and then by water year type. Months April through October are included. Flow values are ranked by magnitude and plotted using Weibull plotting positions. On each graph are both impaired and unimpaired flow data.

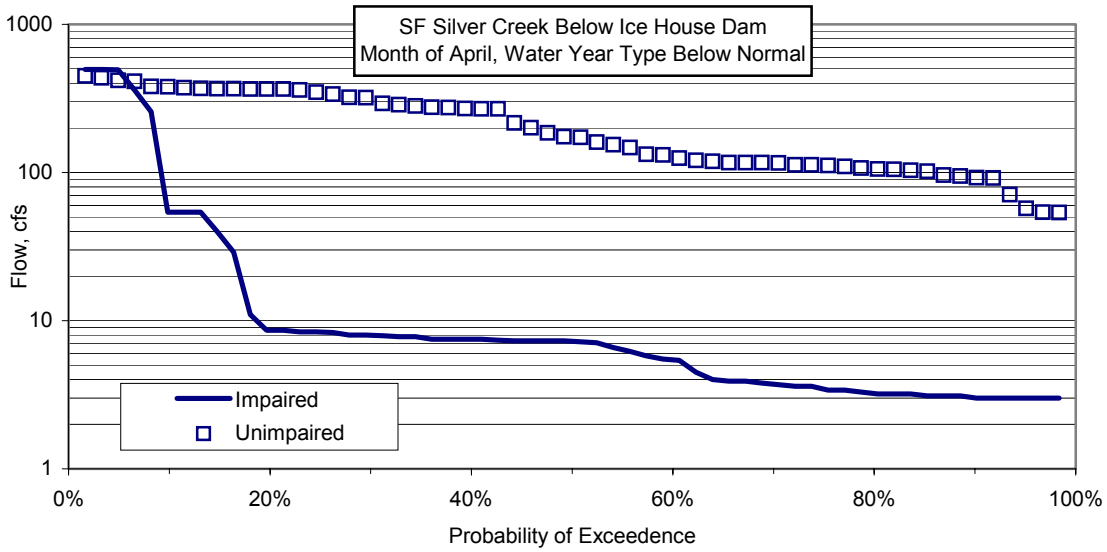
The number of data points varies with each graph. This is because each of the five water year types are not uniformly represented in the period of record, 1975-1999. Table E1 lists the number of years included in each water year type.

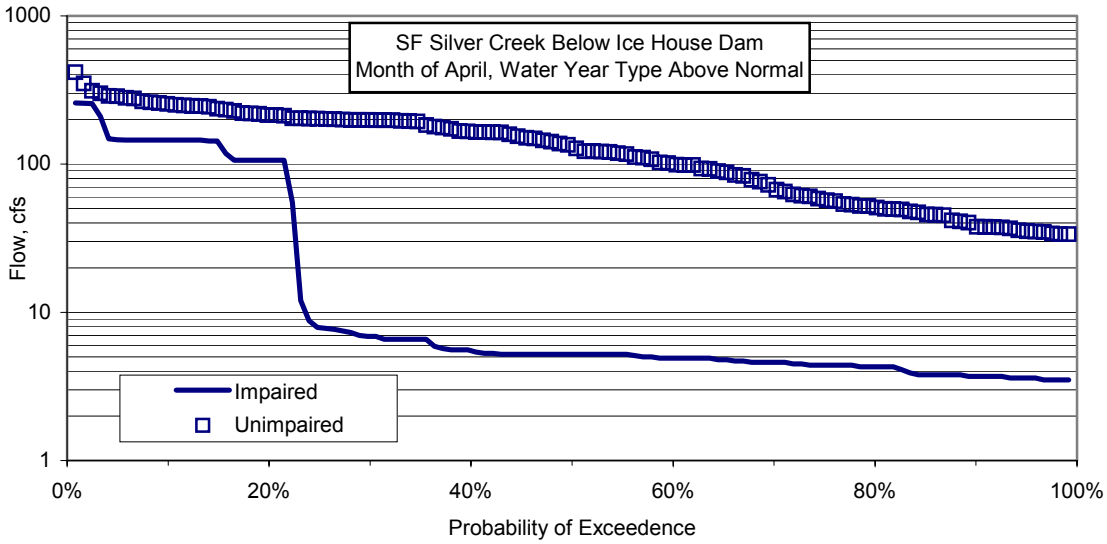
Table E1. Number of years represented by each water year type, 1975-1999.

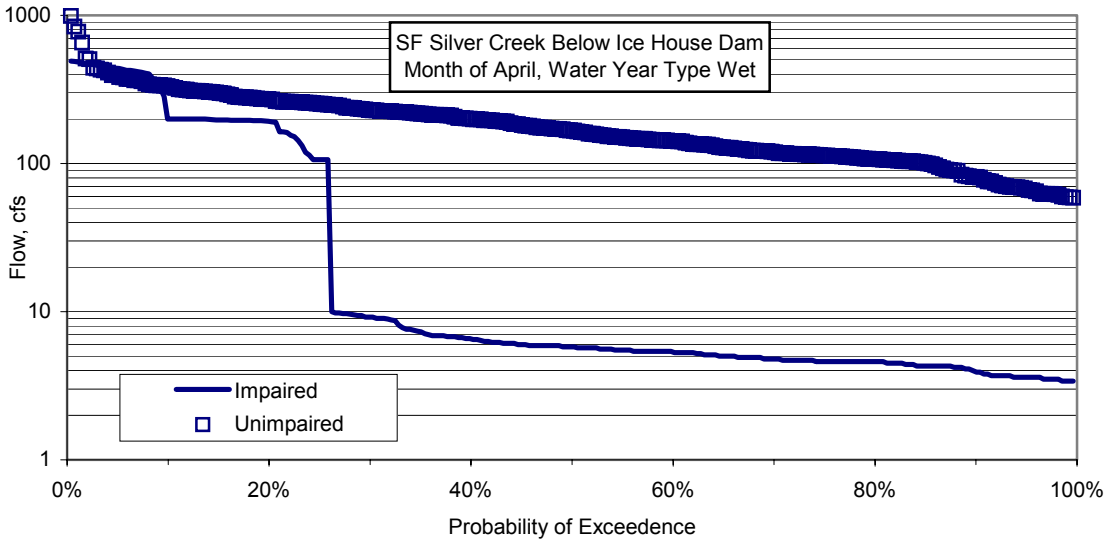
Water year type	Number of years
Above normal	4
Below normal	2
Critical dry	5
Dry	5
Wet	9

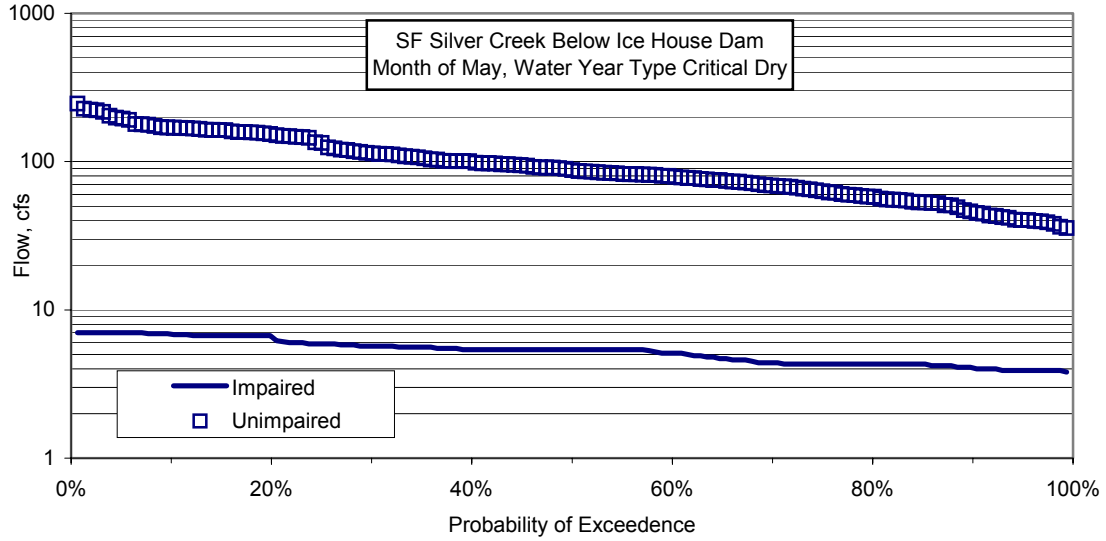

SF Silver Creek Below Ice House Dam
Month of April, Water Year Type Critical Dry
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

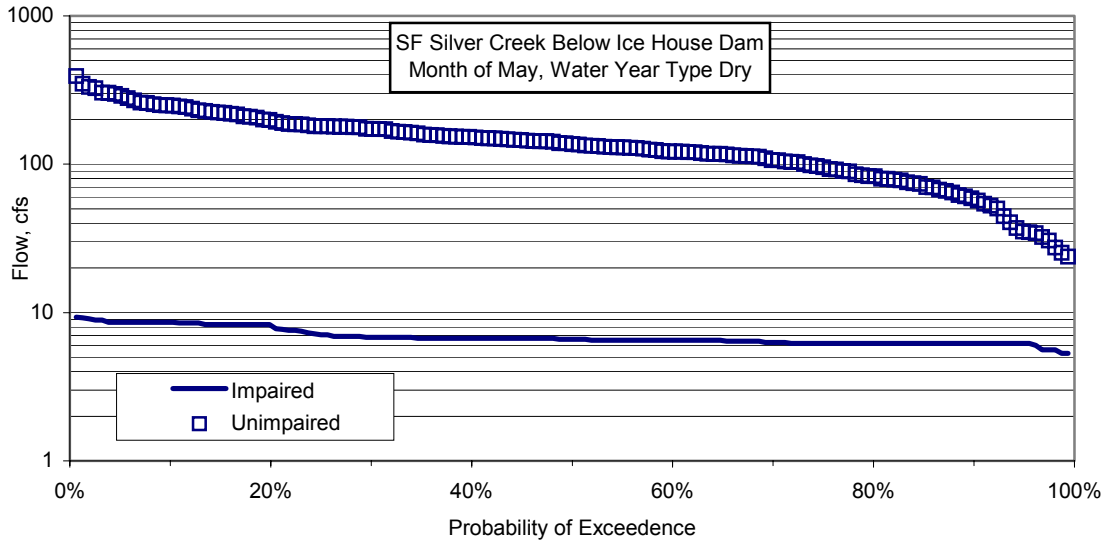

SF Silver Creek Below Ice House Dam
Month of April, Water Year Type Dry
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

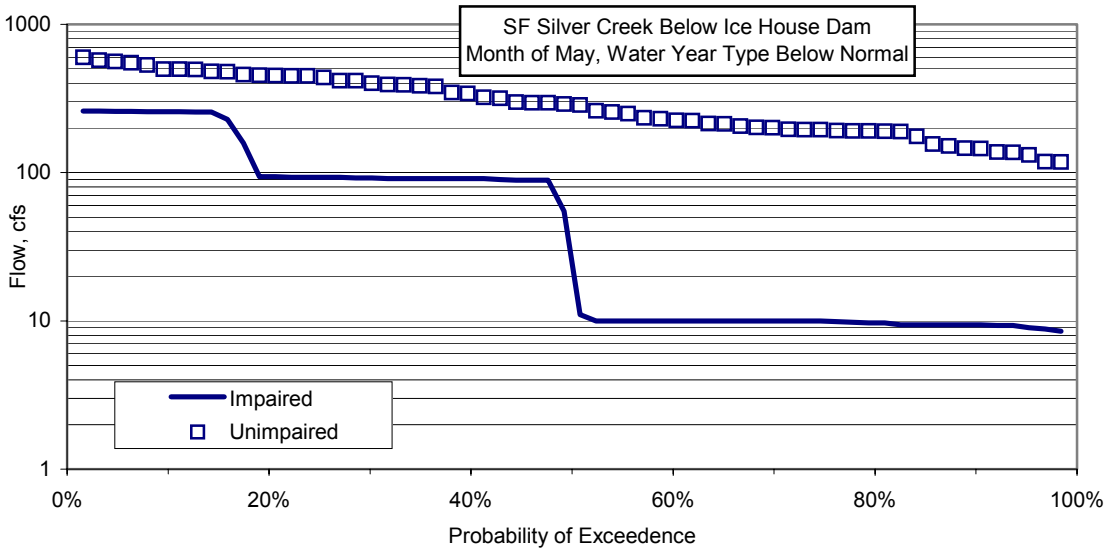

SF Silver Creek Below Ice House Dam
Month of April, Water Year Type Below Normal
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

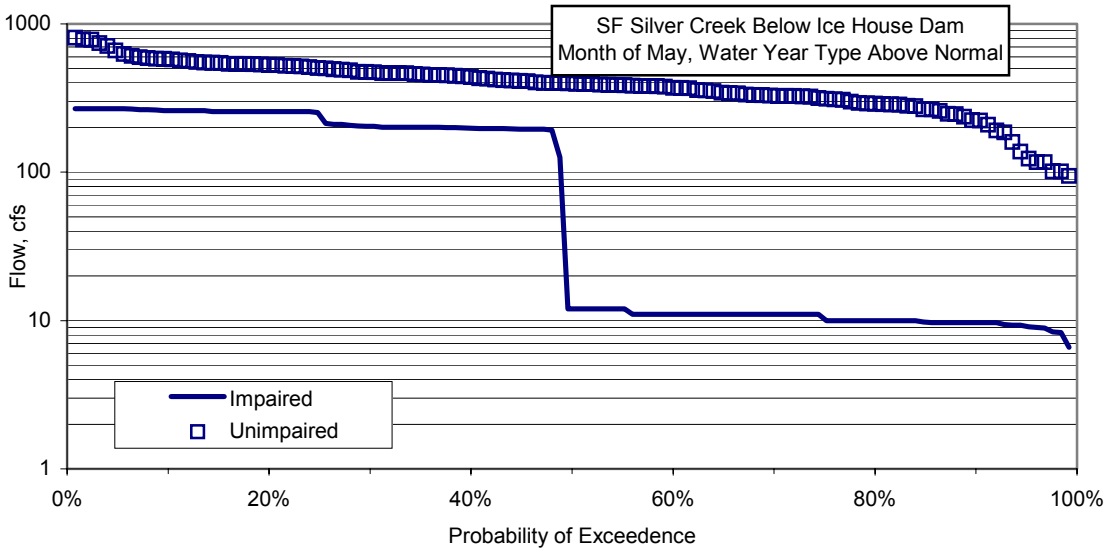

SF Silver Creek Below Ice House Dam
Month of April, Water Year Type Above Normal
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

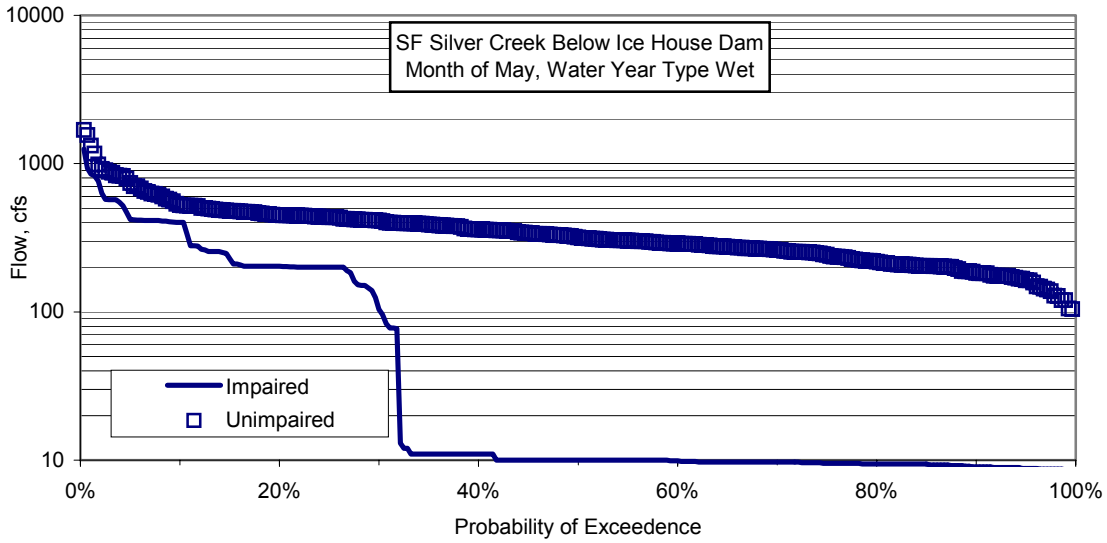

SF Silver Creek Below Ice House Dam
Month of April, Water Year Type Wet
1000
100
10
1
Flow, cfs
0%
20%
40%
60%
80%
100%
Probability of Exceedence
Impaired
Unimpaired

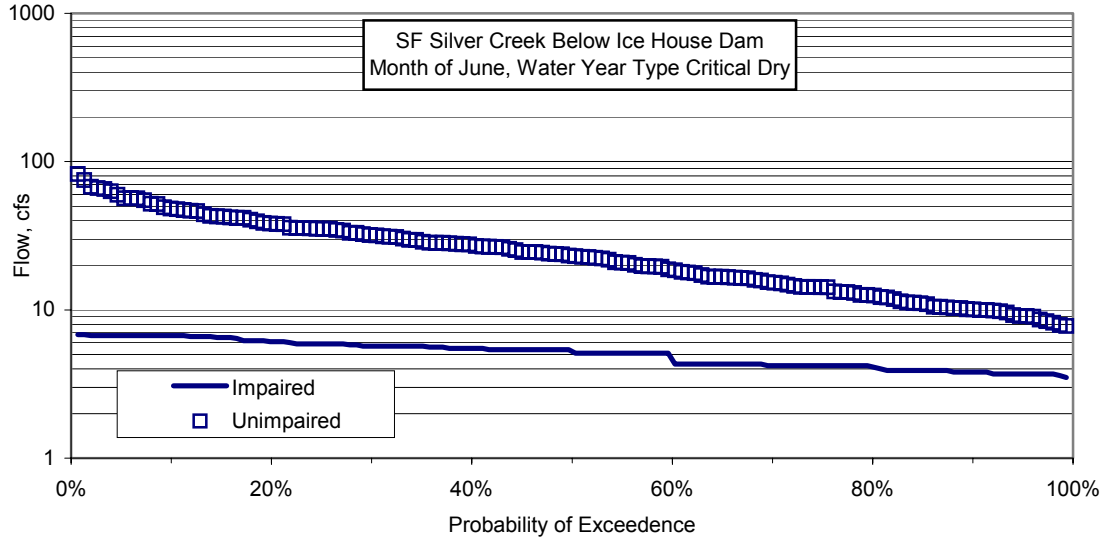

SF Silver Creek Below Ice House Dam
Month of May, Water Year Type Critical Dry
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

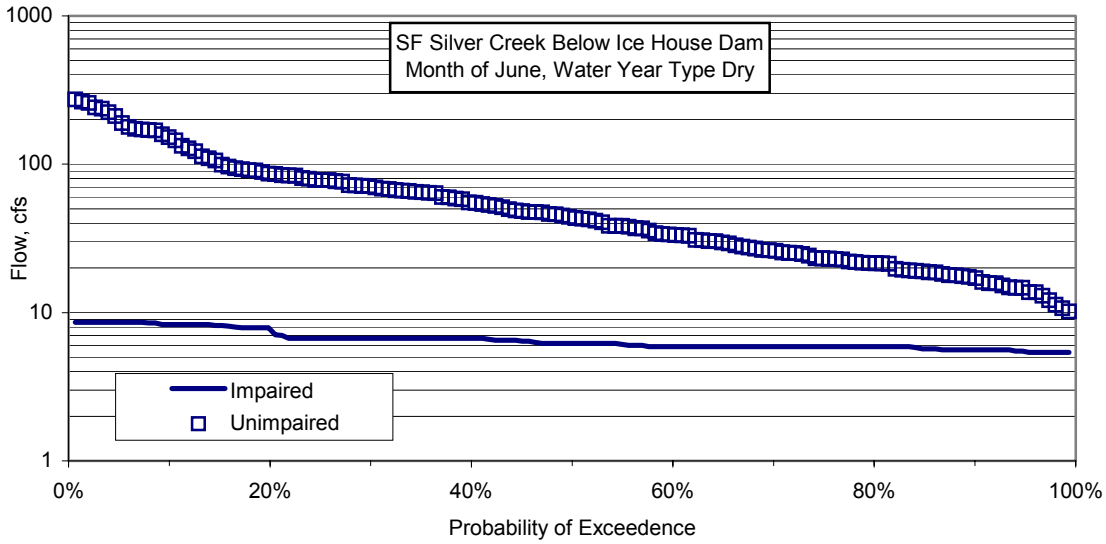

SF Silver Creek Below Ice House Dam
Month of May, Water Year Type Dry
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

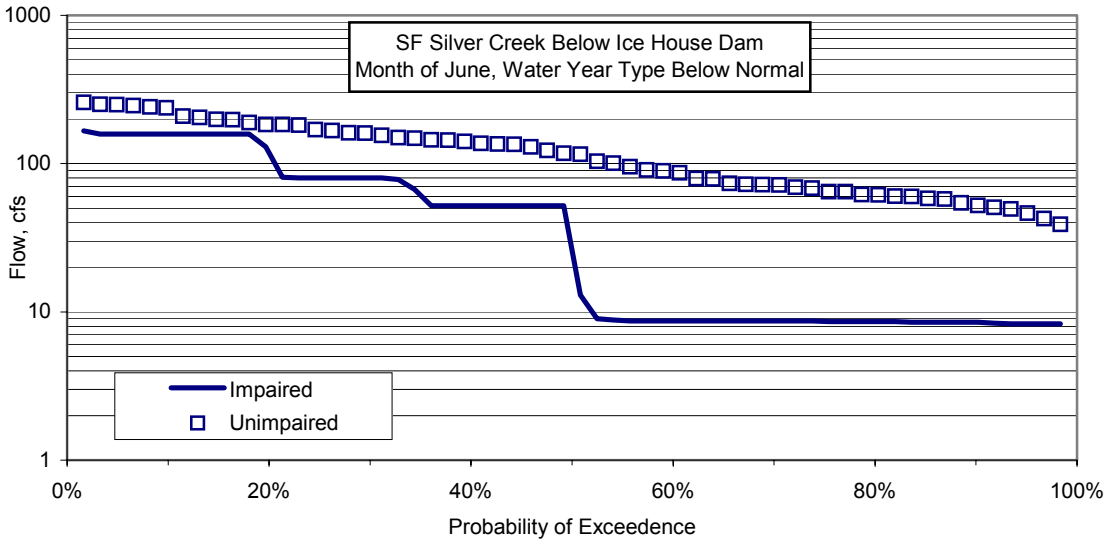

SF Silver Creek Below Ice House Dam
Month of May, Water Year Type Below Normal
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence

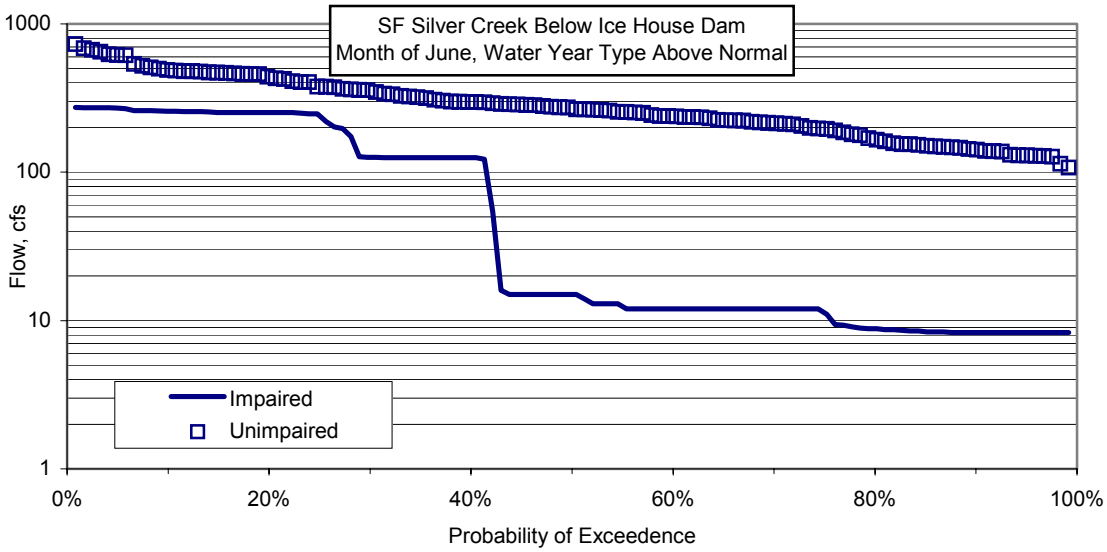

SF Silver Creek Below Ice House Dam
Month of May, Water Year Type Above Normal
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence


SF Silver Creek Below Ice House Dam
Month of May, Water Year Type Wet
10000
1000
100
10
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence


SF Silver Creek Below Ice House Dam
Month of June, Water Year Type Critical Dry
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence


SF Silver Creek Below Ice House Dam
Month of June, Water Year Type Dry
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence


SF Silver Creek Below Ice House Dam
Month of June, Water Year Type Below Normal
1000
100
10
1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
60%
80%
100%
Probability of Exceedence


SF Silver Creek Below Ice House Dam
Month of June, Water Year Type Above Normal
1000
100
10
1
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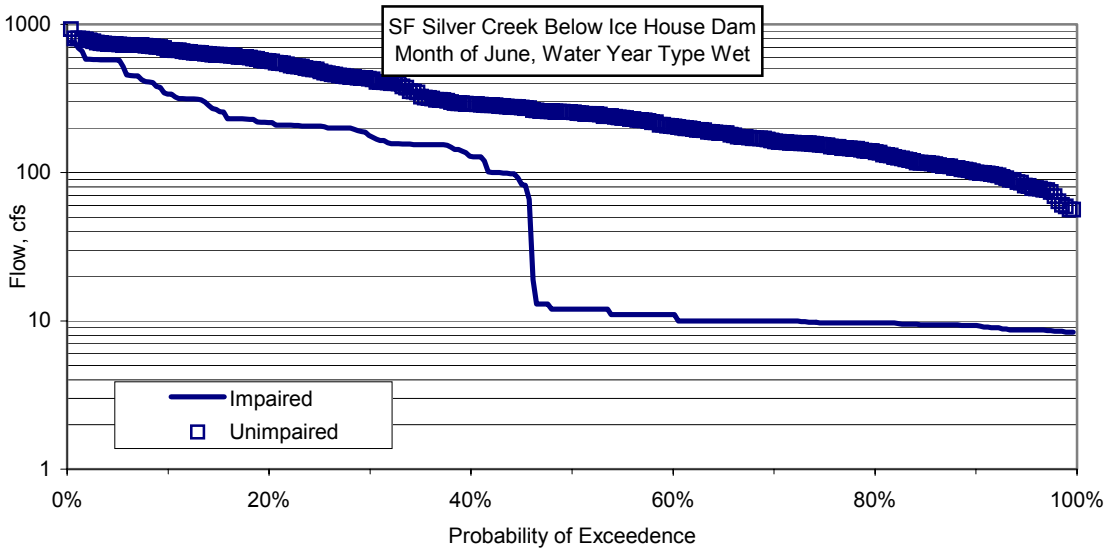
Probability of Exceedence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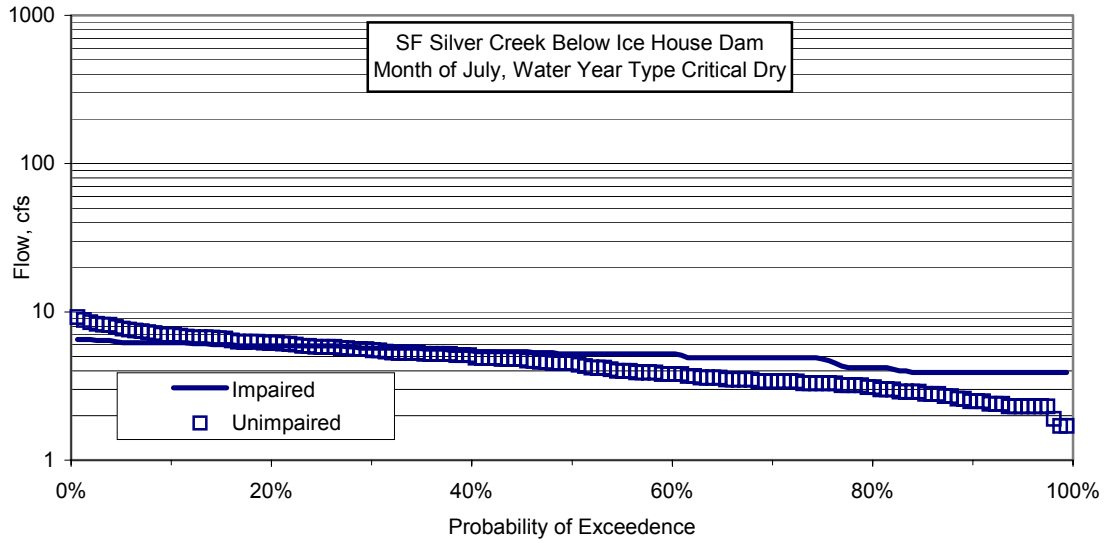
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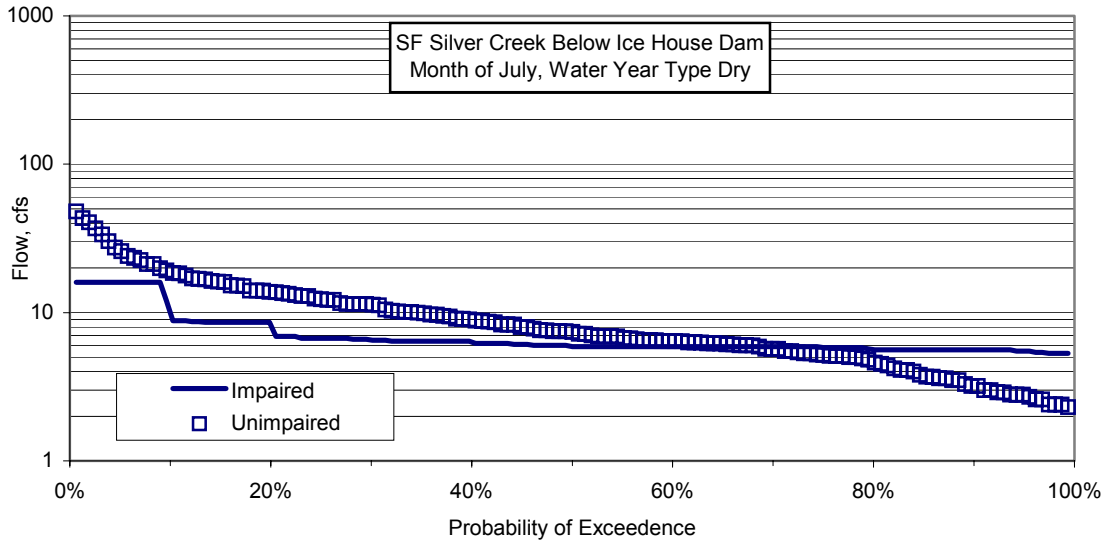
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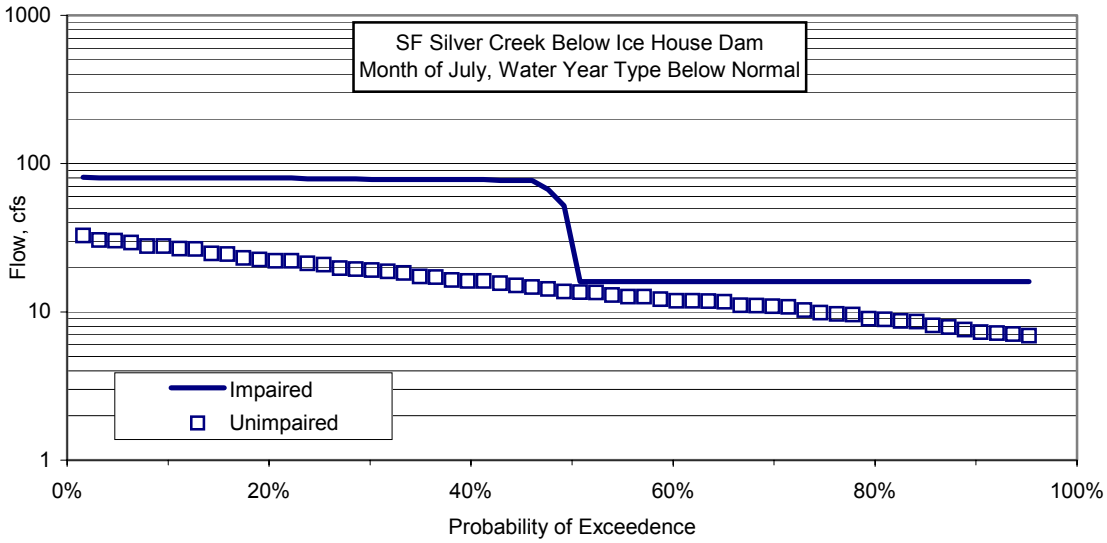
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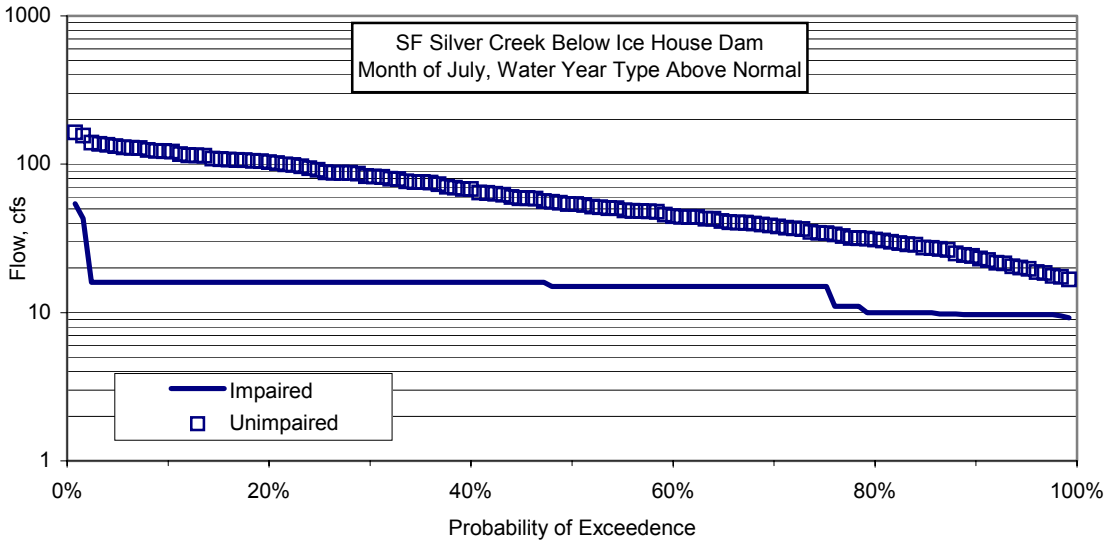
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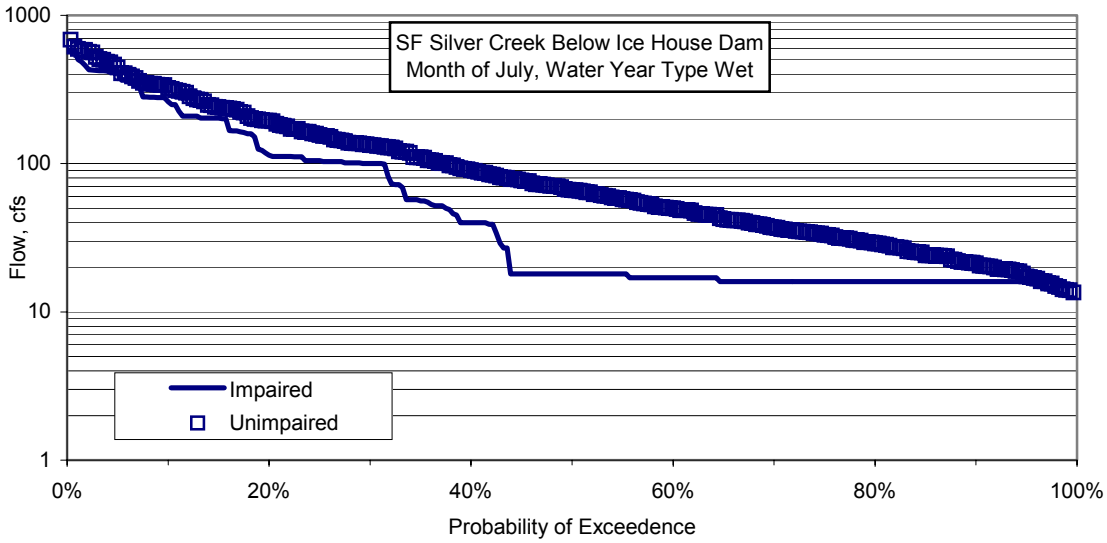
Probability of Exceedence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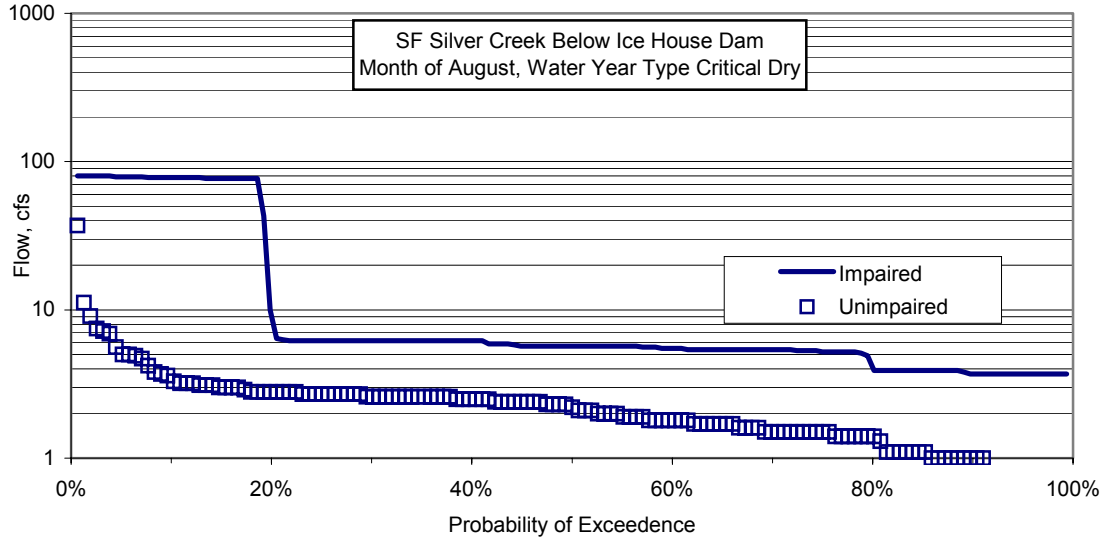
Probability of Exceedence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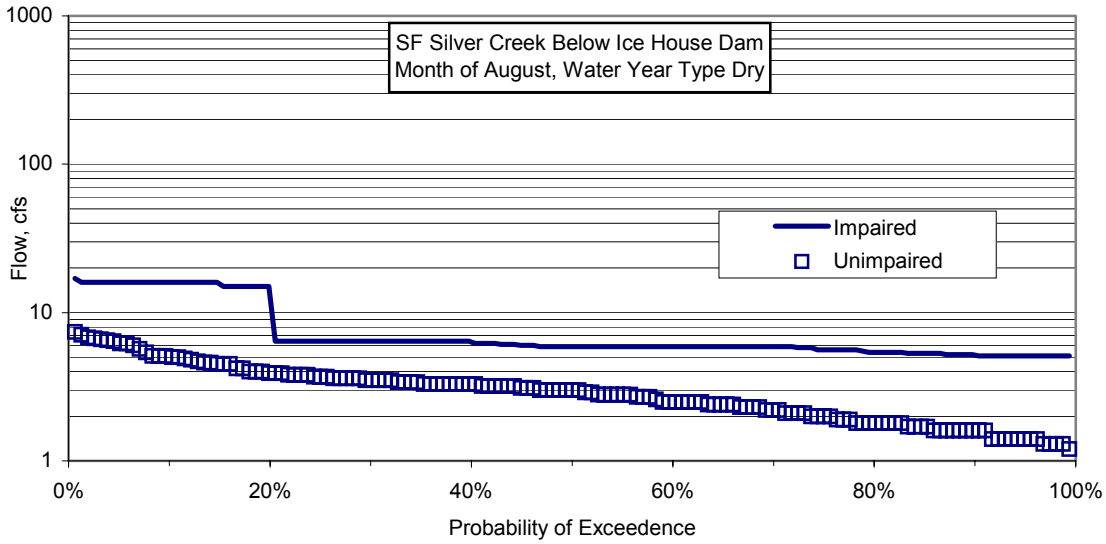
Probability of Exceedence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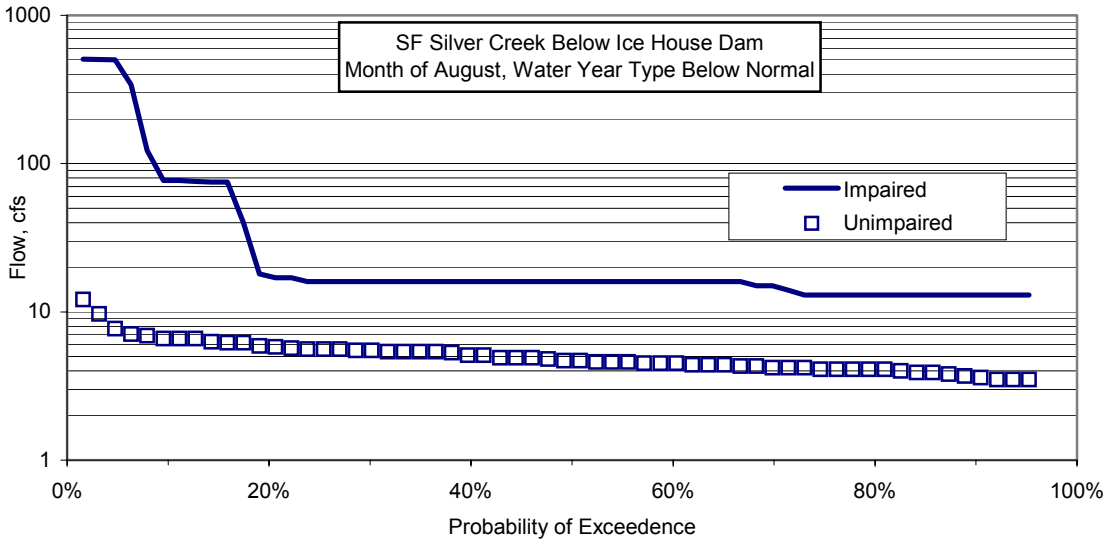
Probability of Exceedence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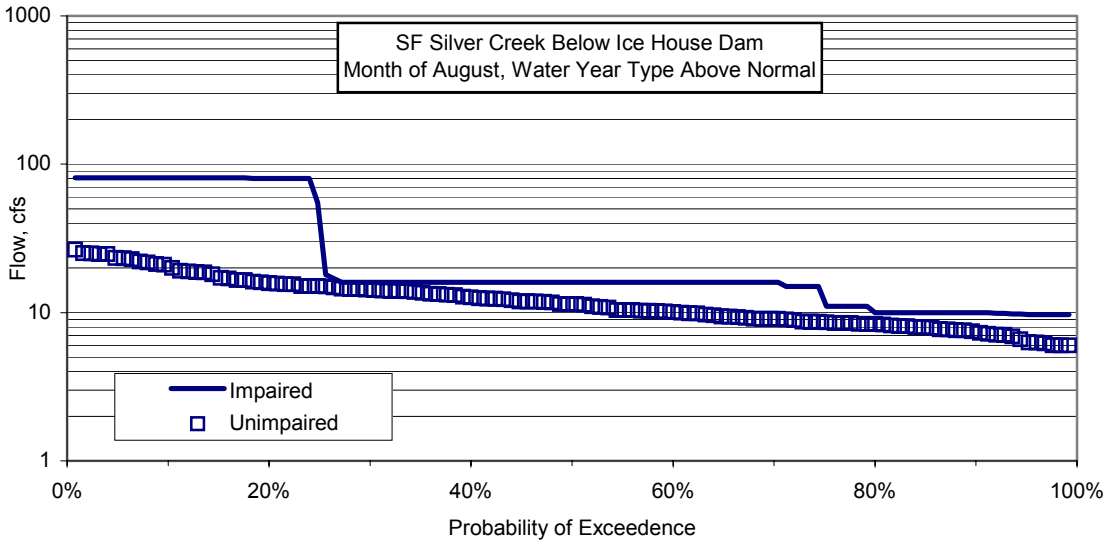
Probability of Exceedence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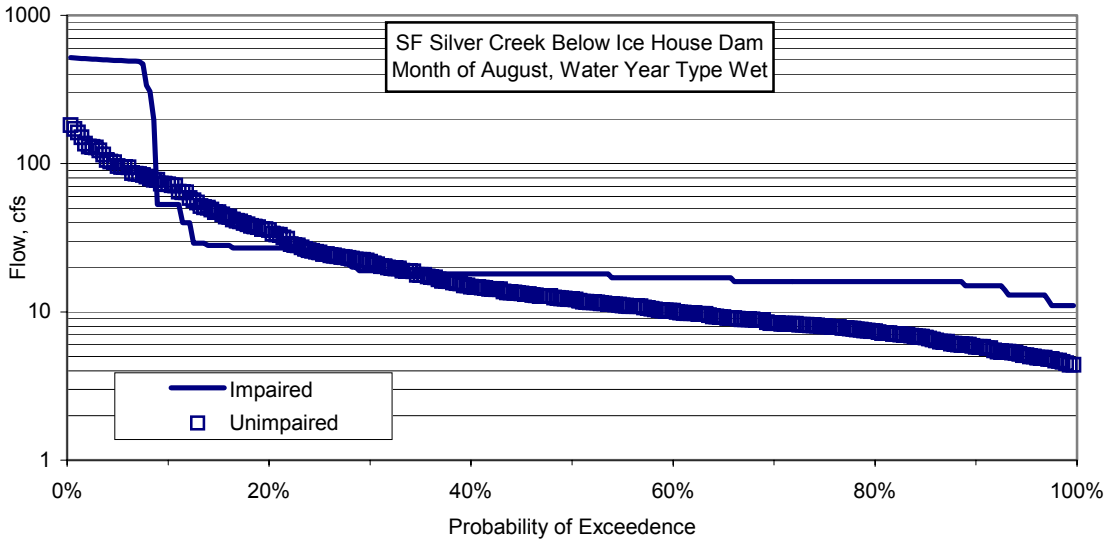
Probability of Exceedence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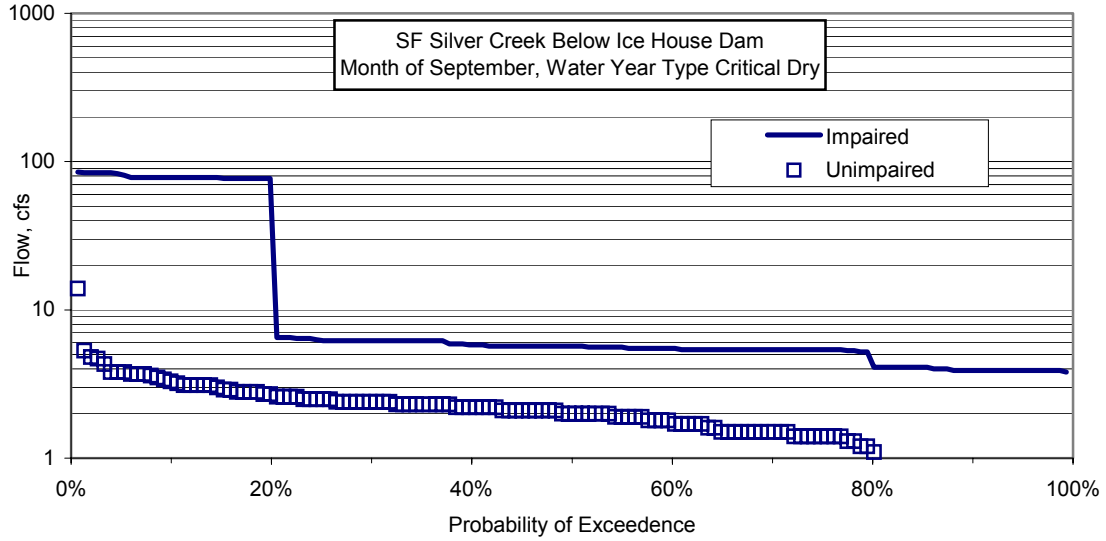
Probability of Exceedence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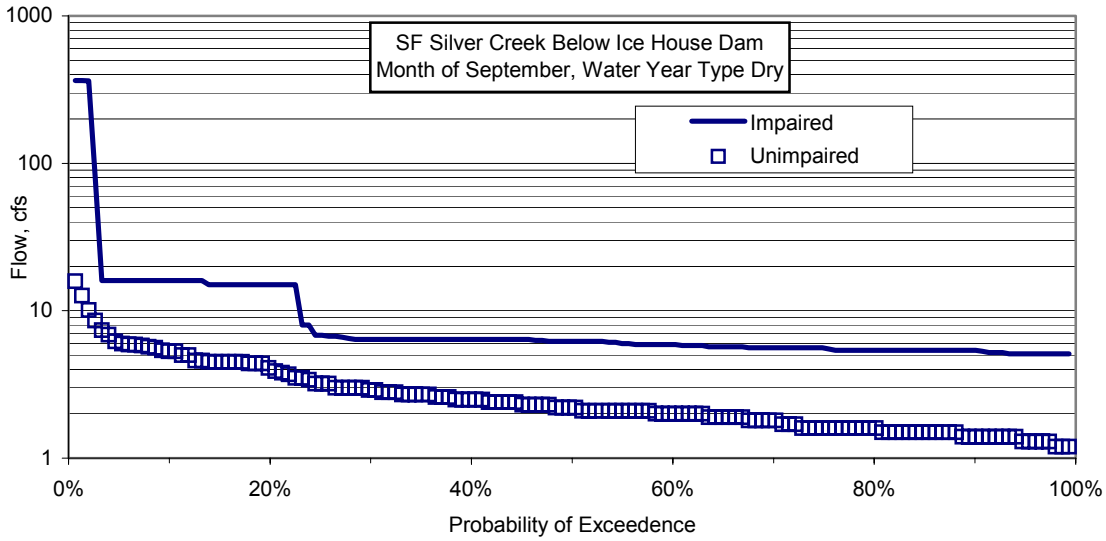
Probability of Exceedence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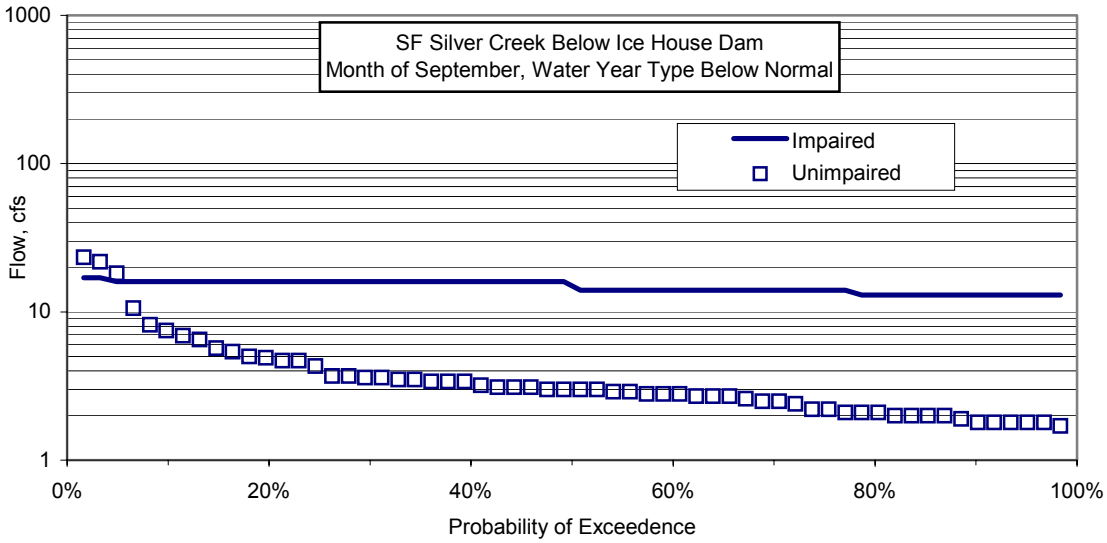
Probability of Exceedence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Month of September, Water Year Type Below Normal
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Flow, cfs
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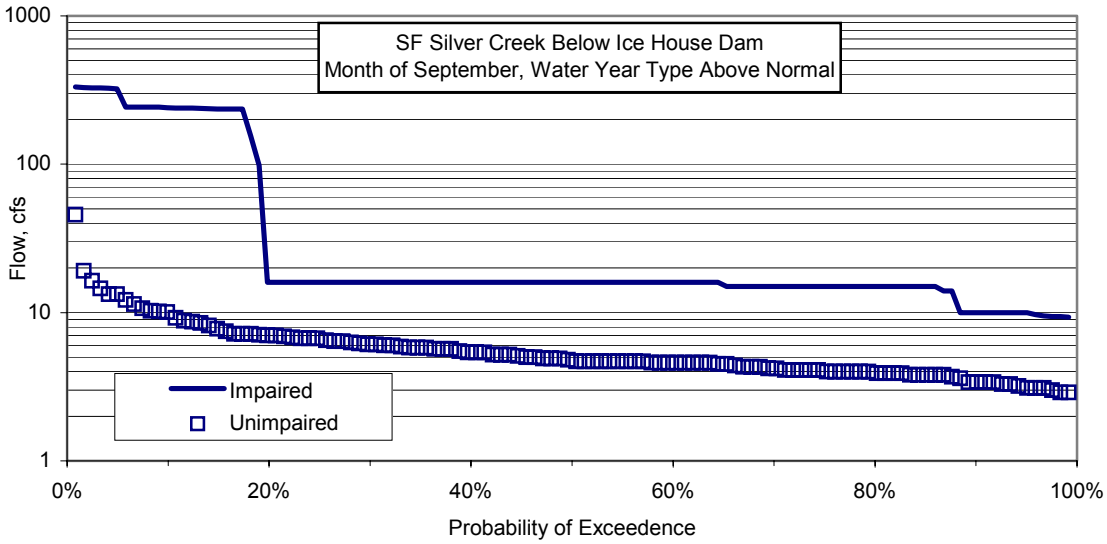
Probability of Exceedence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Month of September, Water Year Type Above Normal
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Flow, cfs
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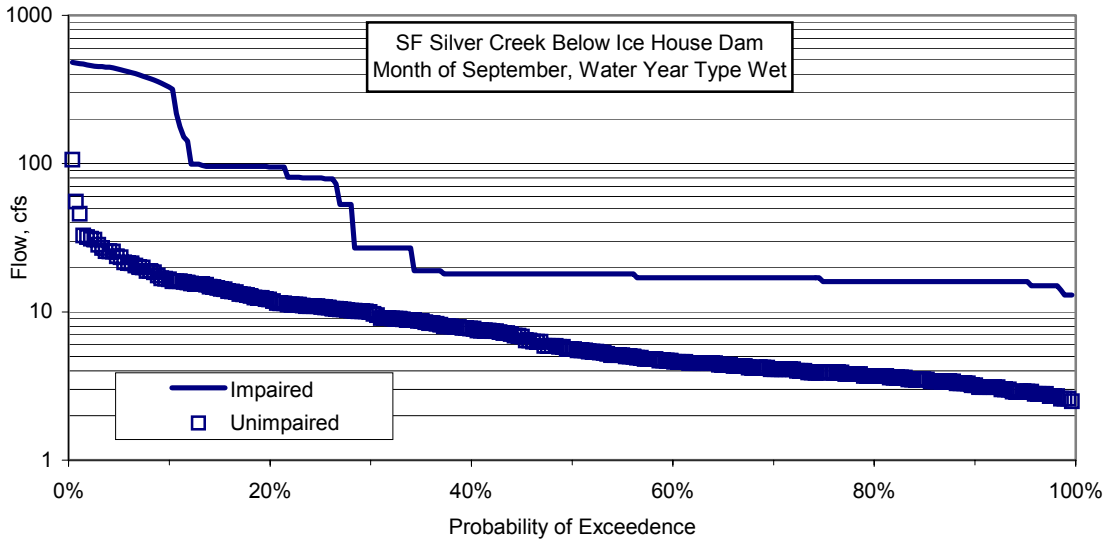
Probability of Exceedence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Month of September, Water Year Type Wet
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Flow, cfs
Impaired
Unimpaired
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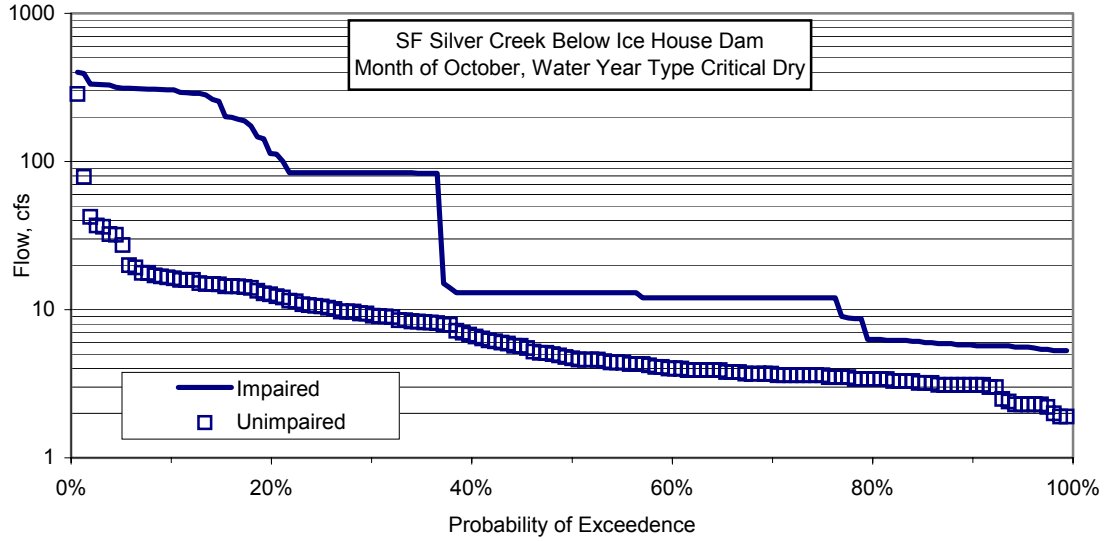
100%
Probability of Exceedence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Month of October, Water Year Type Critical Dry
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Flow, cfs
Impaired
Unimpaired
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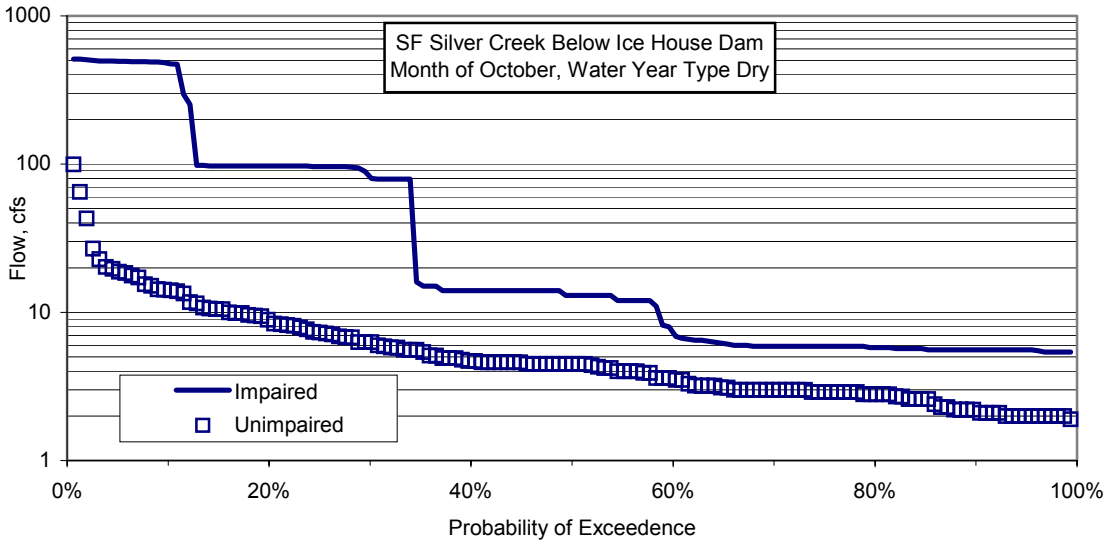
Probability of Exceedence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Month of October, Water Year Type Dry
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Flow, cfs
Impaired
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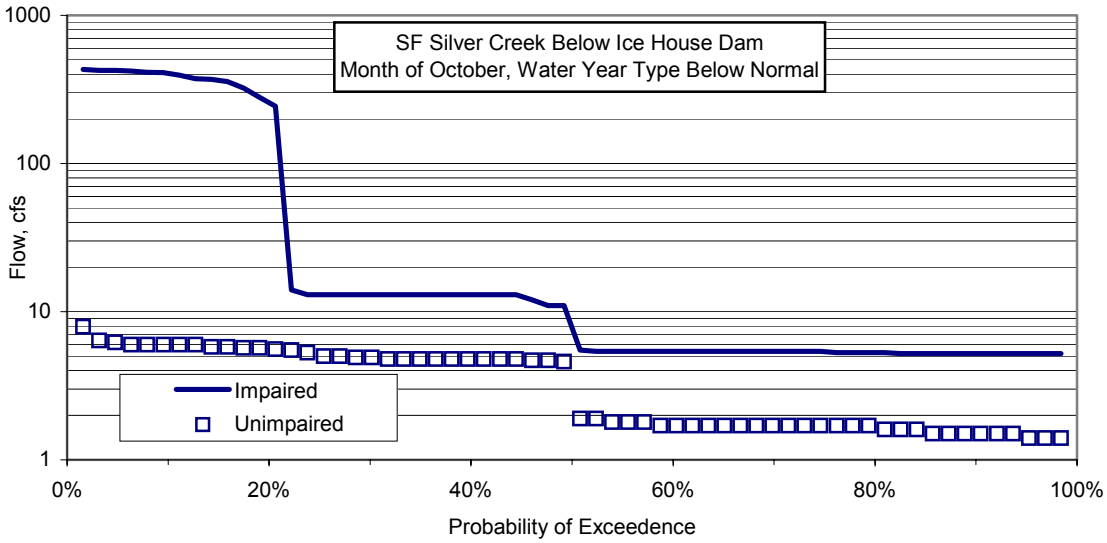
Probability of Exceedence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Month of October, Water Year Type Below Normal
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Flow, cfs
Impaired
Unimpaired
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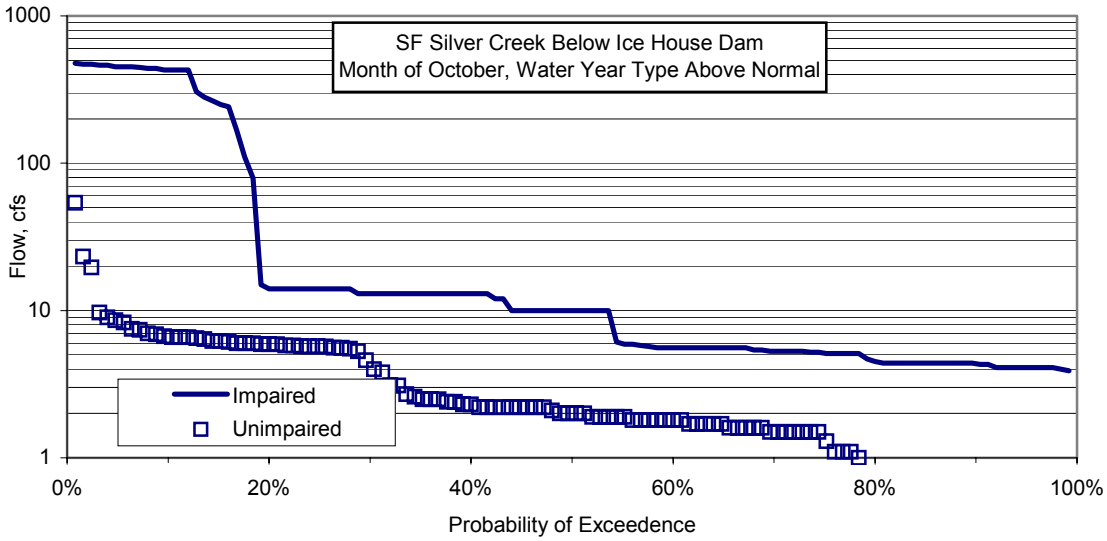
Probability of Exceedence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Month of October, Water Year Type Above Normal
1000
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Flow, cfs
Impaired
Unimpaired
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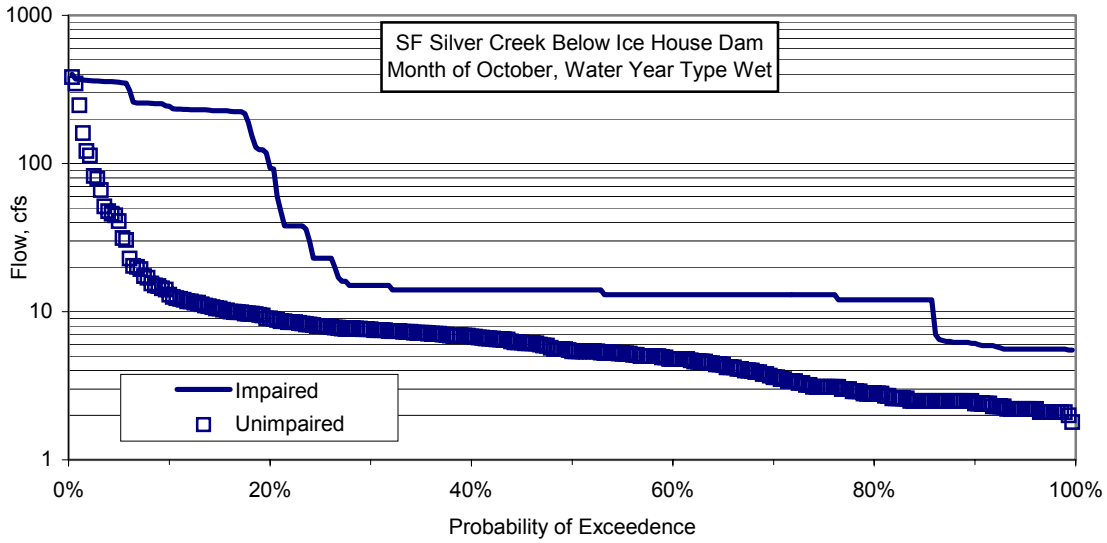
Probability of Exceedence


SF Silver Creek Below Ice House Dam
Month of October, Water Year Type Wet
1000
100
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1
Flow, cfs
Impaired
Unimpaired
0%
20%
40%
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80%
100%
Probability of Exceedence

APPENDIX F

VIDEO FOR ICE HOUSE STUDY
VARIOUS RAPIDS AND POST-RUN
GROUP DISCUSSION

(Provided in DVD by Request)

APPENDIX G

INVENTORY MAPS OF LARGE WOODY DEBRIS IN THE ICE HOUSE REACH, 2002-03

APPENDIX H

SITE PHOTOS

- Access
- Large Woody Debris
- Run Description

APPENDIX I

ECOLOGICAL MONTORING STUDY

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Attachment & Description

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- Flow Photographs Index

ATTACHMENT I2 RAW DATA (Provided on CD by Request)

APPENDIX I
ECOLOGICAL MONITORING STUDY

I1.0 ICE HOUSE WHITEWATER ECOLOGICAL MONITORING STUDY BACKGROUND

I1.1 Ice House Whitewater Boating Ecological Study Plan

The UARP Aquatic/Water Quality/Geomorphology/Hydrology Resources Technical Working Group (TWG) identified the following objectives related to the Ice House Whitewater Boating Ecological study:

- Monitor the temperature, total suspended solids, turbidity, and stage of the river at four different locations during the test flows(s).
- Assess areas of high fish stranding potential.
- Document inundation of bed form features associated with aquatic habitat at the peak flow.

The study area for the Ice House Whitewater Boating Ecological Study included the 11.2-mile Ice House Reach of the South Fork Silver Creek. The Ice House Reach includes the South Fork Silver Creek from immediately below Ice House Dam downstream to its junction with Junction Reservoir.

I2.0 METHODS

During the test flow study (May 1, 2004) water temperature (ºF), turbidity (NTU), total suspended solids (mg/L), and flow stage (ft) were collected at the following locations: 1) IH-1 located approximately 0.20 mile below Ice House dam at the SMUD gaging station; 2) IH-2 located at Silver Creek Campground; 3) IH-3 located at the confluence of South Fork Silver Creek and Chicken Hawk Springs and; 4) IH-4 located at Bryant Springs Rd. bridge at South Fork Silver Creek (upstream of Junction Reservoir).

On April 29, 2004, baseline *in situ* data was taken at each of the four stations for temperature, turbidity, TSS, and flow stage. Concurrently, areas adjacent to each station were visually evaluated for fish stranding potential. Bed form features associated with aquatic habitat were documented. Observations to identify potential fish stranding and inundation effects were restricted to sites adjacent to each station since access was limited by steep canyon topography and high flows.

Water temperature and turbidity data were recorded every ten minutes via four Troll XP MPT 9000 *in situ* samplers. Total suspended solids (TSS) were collected every two hours. TSS samples were placed into 250mL poly plastic bottles and stored at 4ºC until delivery to a certified laboratory. Portable staff gages were installed at each of the four stations to measure flow stage. Flow stage on the temporary staff gages were measured every 15 minutes for comparison to the 15-minute elevation data recorded at the SMUD gaging station downstream of

Ice House Dam. Photos were taken every half hour at each station to visually document various flow stages (see Attachment I1 for available photos including baseline photos taken one day prior to the flow event). However photos taken at IH 4 prior to 12:30 were damaged and unavailable. The photos taken after 12:30 are available in Attachment I1 and do provide the same information (i.e., what the river looks like at a particular stage albeit on the down ramp vs. the up ramp) as the damaged photos.

I3.0 RESULTS

I3.1 Baseline Sampling

Prior to the boating flow release on the Ice House Reach of the South Fork Silver Creek the following data was collected (Table I3.1-1).

Table I3.1-1. Baseline data for the South Fork Silver Creek.

Location	Temperature (ºF)	Turbidity (NTU)	TSS (mg/L)	Time samples taken
IH-1	55.30	0.1	ND[1]	16:40
IH-2	51.90	0.0	ND[1]	15:55
IH-3	60.45	0.3	ND[1]	14:48
IH-4	56.09	0.5	ND[1]	12:35

[1] **Results indicating ND for TSS are less than the 5.0mg/L reporting limit**

I3.1.1 Stranding Potential

Evaluation for the fish stranding potential was restricted to the four samples sites due to limited access of the reach. Only site IH-1 exhibited the potential for fish stranding as this was the only sample site where water was not entirely contained by the stream banks. The area of concern is located across from the SMUD gaging station. The three other sample sites were located in portions of the reach that has steep sloping banks therefore containing the water within the stream channel. However above IH-3 at Amphibian study sites IH-A3a and IH-A3b the stream is braided (e.g., the stream splits into two channels) (Figure I3.1-1). The peripheral channel does contain a small amount of water (an estimated <1cfs) flowing through it at all times. This area also contains some pockets that could potentially be filled during flows similar to the May 1st flow event. During the fall of the boating flow hydrograph these pockets may become isolated from the main-stream channel.

Figure I3.1-1. South Fork Silver Creek upstream of IH-3 at Amphibian sites IH-A3a and IH-A3b.

I3.1.2 Bed Form and Vegetation Inundation

Bed form inundation occurred at two of the four sample sites (IH-1 and IH-2). IH-1 has been described above (Section I3.1.1) while IH-2 had a shallow sloping shelf (river left) located just above the sampling site (Figure I3.1-2) and a large sandbar downstream right of the sample site (Figure I3.1-3). Water did not remain on the shelf or sandbar after the flows had receded however the shelf and sandbar became entirely inundated during the test flow. A second area that may become inundated during the elevated releases is located upstream of IH-3 at Amphibian study sites IH-A3a and IH-A3b (Figure I3.1-1). Because of the braiding in this area the gravel/cobble bars separating the channels are likely to become inundated during higher flows.

Figure I3.1-2. Shallow shelf upstream of IH-2.

Figure I3.1-3. South Fork Silver Creek immediately downstream of IH-2 sampling site.

The potential inundation of riparian vegetation exists throughout the entire reach. Alder is the dominant riparian vegetation species and is present along the shoreline throughout the reach. It was noted that Alder is generally growing within one foot of the base flow water surface elevation.

I3.2 Ecological Monitoring

Table I3.2-1 provides the maximum, minimum, and mean values for temperature, turbidity, TSS, and gage readings taken at each of the four sample locations (See Attachment I2 for Raw data). The release of water from the low level outlet at Ice House dam began at 06:00 and continued at a rate of one foot per hour (as measured at the SMUD gaging station downstream of Ice House Dam), and continued for two hours. This translates into an increase of 198.05cfs per hour for a maximum flow of 396.1cfs. The release remained at 396.1cfs until approximately 14:00, at which time the flows were decreased at a rate of one foot per hour until 16:00.

Table I3.2-1. Maximum, Minimum, and Mean values for sampling parameters collected during the whitewater boating flow study.

Location	Temperature (ºF)	Turbidity (NTU)	TSS (mg/L)	River stage (ft)
IH-1				
Maximum	53.19	53.9	13	1.83
Minimum	41.52	0.1	5	0.00
Mean	43.80	5.82	8.4	1.45
IH-2				
Maximum	61.72	484.3	240	3.76
Minimum	42.00	0.00	ND	0.00
Mean	44.92	43.93	64.57	1.67
IH-3				
Maximum	49.60	656.5	160	2.00
Minimum	45.16	1.20	ND	0.00
Mean	48.09	79.97	55.8	1.67
IH-4				
Maximum	54.93	2867.1	300	1.81
Minimum	50.31	0.00	ND	0.00
Mean	51.96	166.70	65.25	1.55

I4.0 ANALYSIS

I4.1 River Stage

At the IH-1, IH-3 and H-4 sampling locations the average river stage during the maximum study flow was at 1.88ft while the maximum stage at IH-2 was 3.76ft (Figure I4.1-3). The river stage at IH-2 was 1.88ft higher than average suggesting the channel width at this point is narrow or channel features downstream are causing the water to pool up at IH-2. Based on reconnaissance of the sample site it was noted that the channel is similar in width (Figure I4.1-1) to the three other sample sites and therefore the additional depths recorded at this site may be attributed to a channel feature immediately downstream of IH-2. Figure I4.1-2 shows a constriction of the channel immediately downstream of IH-2 that may result in the higher stage measurements at the sample location.

Figure I4.1-1. South Fork Silver Creek at IH-2 sample site.

Figure I4.1-2. South Fork Silver Creek immediately downstream of IH-2 sampling site.

The change in river stage at IH-1 generally reflects the ramping rate of one foott per hour for a total of two hours. The initial release from Ice House Dam at 06:00 is immediately noticed at IH-1 with the hydrograph leveling off at around 07:00 with a second spike in the hydrograph signaling the continuation of the ramping schedule. The target release of 396.1cfs (1.83ft) was reached at 08:30. On the downward end of the hydrograph (starting a 14:00) the river stage fell

0.43ft to 1.38ft where it remained until 15:00. From 15:00 to 16:00 the river stage returned to base flows at 0.0ft.

The change in river stage at IH-2, while much greater in depth, was over a longer period of time (2 hours and 15 minutes). The ascending limb of the hydrograph at IH-2 climbs smoothly until 3.76ft (396.1cfs) is reached at this point in the river. The descending limb of the hydrograph is fairly uniform only tailing off slightly at about 15:00 before continuing to descend.

The hydrograph at IH-3 and IH-4 are similar as both sites show a very rapid increase in flow and a similar drawn out tail on the descending limb of their respective hydrographs.

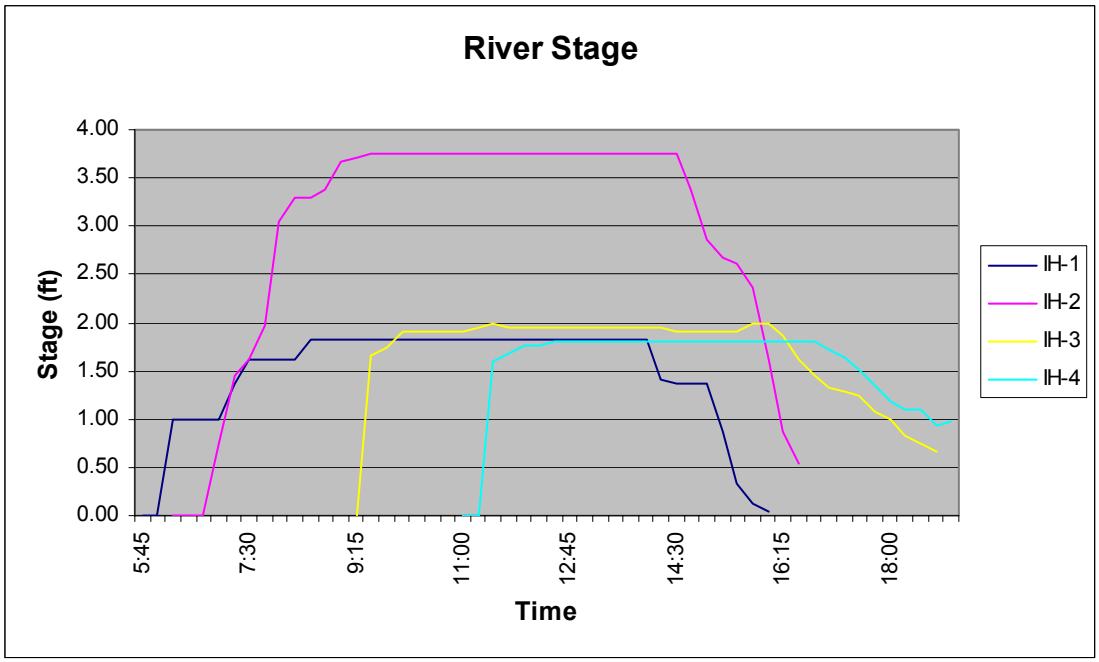

Figure I4.1-3. 15min river stage data recorded during the whitewater boating flow study.

I4.2 Temperature

During the Whitewater Boating Flow study the *in situ* data loggers recorded a sharp initial decrease in temperature at IH-2, IH-3 and IH-4 during the increased flows through the respective sample sites (Figure I4.2-1). As the flows stabilized the temperature began to rise slowly at each site as the exposure to sunlight heated the water throughout the day. IH-1 did not experience this initial decrease in temperature with increased flows due to its location (0.2 miles from Ice House Dam).

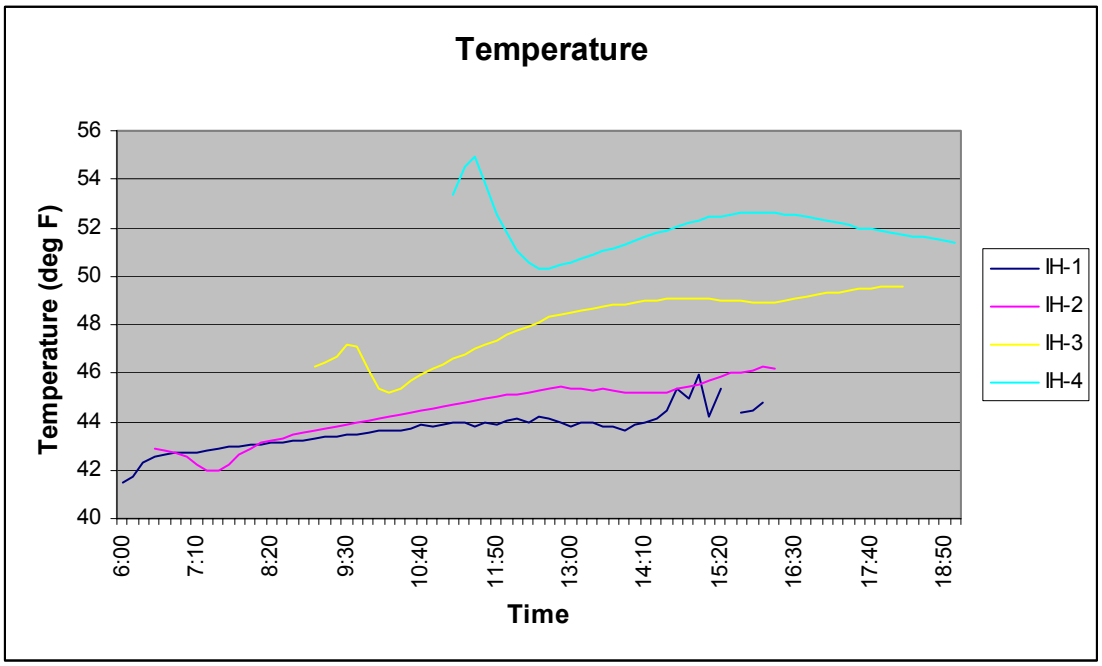

Figure I4.2-1. Temperature results recorded during the whitewater boating flow study

I4.3 Turbidity and TSS

During the whitewater boating flow releases the turbidity and TSS increased at each of the four sample sites. This increase in turbidity and TSS can be attributed to the increased flows through the reach resulting in the transport of particulates (e.g., organic detritus and sediment) downstream.

The large initial turbidity spikes at each location coincide with the sudden rise in flows at the respective sites. Table I4.3-1 shows the timing of the initial turbidity spike compared to the onset of the increased flows at each sample site.

Table I4.3-1. Comparison of initial turbidity increase relative to the onset of flow increase at each sample site.

Location	Timing of initial turbidity spike[1]	Beginning of flow increase[1]
IH-1	06:20	06:15
IH-2	08:20	07:00
IH-3	09:30	09:30
IH-4	11:30	11:30

[1] **Times indicated above are based on a 24-hour clock.**

Figure I4.3-1 below shows the turbidity concentrations at each site throughout the day. The initial spikes are visible however IH-2 and IH-3 have subsequent spikes in turbidity concentrations throughout the day. These subsequent spikes may be related to many unknown

variables such as placement of the *in situ* data logger or large objects (e.g., large woody debris) becoming dislodged during the elevated flows.

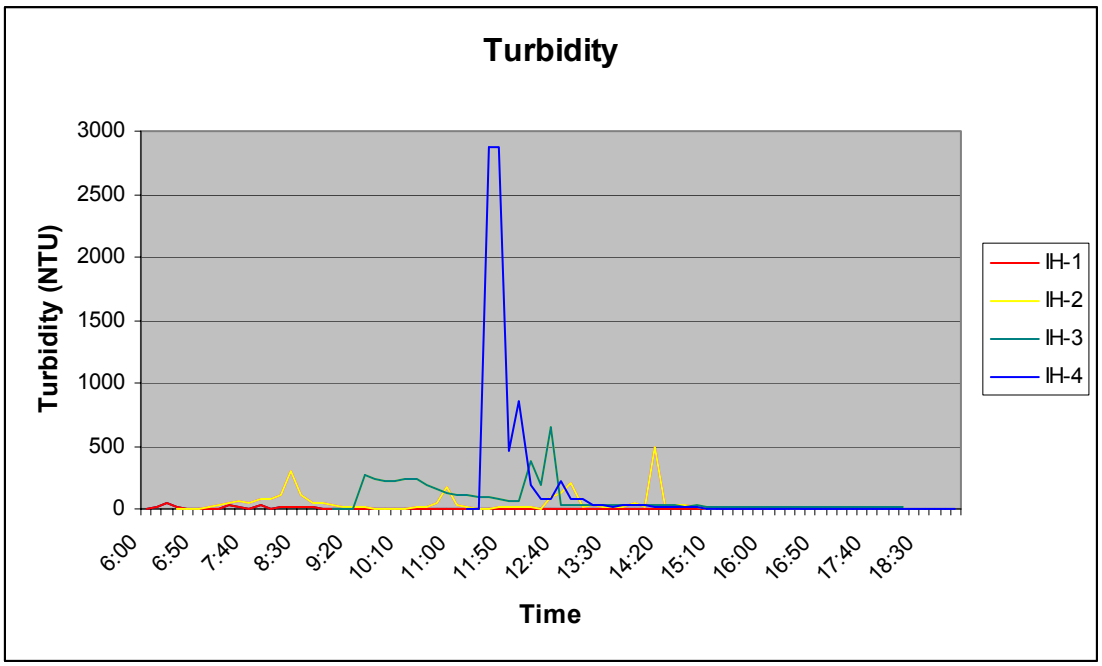

Figure I4.3-1. Turbidity results recorded during the whitewater boating flow study

ATTACHMENT I1

SITE PHOTOGRAPHS

(Provided on CD)

SITE PHOTOGRAPHS INDEX

BASELINE PHOTOGRAPHS

- IH-1A
- IH-1D
- IH-1U
- IH-2A
- IH-2D
- IH-2U
- IH-3A
- IH-3D
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SITE PHOTOGRAPHS INDEX

FLOW PHOTOGRAPHS

IH-1	IH-2	IH-3	IH-4
0610 A	0615 1U	1400 A	1230 D
0610 D	0615 2A	1400 D	1330 A
0610 U	0615 3D	1400 U	1330 D
0645 A	0700 4U	1430 A	1330 U
0645 D	0700 5A	1430 D	1430 A
0645 U	0700 6D	1430 U	1430 D
0715 A	0730 7U	1500 A	1430 U
0715 D	0730 8A	1500 D	1515 A
0715 U	0730 9D	1500 U	1515 D
0745 A	0800 10U	1530 A	1515 U
0745 D	0800 11A	1530 D	1600 A
0745 U	0800 12D	1530 U	1600 D
0815 A	1000 13U	1600 A	1600 U
0815 D	1000 14A	1600 D	1700 A
0815 U	1000 15D	1600 U	1700 D
0845 A	1600 16U	1630 A	1700 U
0845 D	1600 17A	1630 D	1800 A
0845 U	1600 18D	1630 U	1800 D
1010 A	1630 19U	1700 A	1800 U
1010 D	1630 20A	1700 D	1900 A
1010 U	1630 21D	1700 U	1900 D
1545 A		1730 A	1900 U
1545 D		1730 D	
1545 U		1730 U	
		1800 A	
		1800 D	
		1800 U	

ATTACHMENT I2

RAW DATA

(Provided on CD by Request)