Flow-Recreation Study Technical Report

Henry M. Jackson Hydroelectric Project FERC No. 2157

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July 2008

Executive Summary

Public Utility District No. 1 of Snohomish County (District) is applying for a new license for the Henry M. Jackson Hydroelectric Project, FERC No. 2157. It is conducting studies of Project effects on environmental resources, including whitewater boating in the 16.5 mile Sultan River from Culmback Dam to the Skykomish River. The study evaluates the effects of Project operations on whitewater recreation opportunities and identifies potential effects of providing whitewater boating flows on other recreation activities such as fishing and mining. Specific study objectives include: identify acceptable and optimal ranges, describe recreation-relevant hydrology of the current operating regime, describe feasibility and effect of providing scheduled releases for whitewater recreation, estimate whitewater use levels if releases were provided, describe existing and potential access issues, and identify potential impacts from whitewater flows on other recreation uses.

Information was organized by five river segments: (1) Culmback Dam to a river access trail; (2) River access trail to the Diversion Dam; (3) Diversion Dam to the Powerhouse; (4) Powerhouse to Trout Farm Road; and (5) Trout Farm Road to the confluence with the Skykomish River.

Methods

The study used a phased approach (Level 1-3); decisions about the level of information needed were developed in a study plan, then reviewed as components of the work were completed. Level 1 focused on "desk-top" methods that summarized existing information from guidebooks or resource documents.

Level 2 included more intensive existing information analysis, interviews with experienced recreation users, and limited fieldwork or "informal flow assessments." A total of 19 interviews were conducted with anglers, boaters, watershed patrol officers, and others familiar with recreation and impacts from flows.

Level 3 included a "controlled flow" assessment, where a panel of 14 "core team" and 46 "supplemental" kayakers assessed several flows on different segments over three days in October 2007. Between informal boating assessments, fieldwork, and the controlled flow study, 14 different flow-segment combinations were assessed between 185 and 1,400 cubic feet per second (cfs). "Close-out surveys" collected information about all of the flows boaters had assessed on Segments 2 and 3, flow preferences based on their history of use on Segment 4, seasonal preferences for potential whitewater flow releases, and comparisons of Sultan reaches with other regional rivers. Video/photographic documentation was conducted to show how major rapids or other river features change at different flows.

Recreation-relevant Hydrology

Project operations have altered the seasonal flow pattern in the Sultan River by storing winter and spring runoff for power generation, municipal water supply, instream flow augmentation for salmon and trout species, and flood control. Under "normal

operations," all but minimum fisheries flows (minimum of 20 cfs plus accretion) are removed from Segment 2, but very rare spills may provide higher flows. Higher base flows are provided in Segment 3 (95 to 175 cfs depending upon the season). Below the Powerhouse (Segments 4 and 5), outflows from power generation add additional water.

Study Findings

There are three general types of boating opportunities on Segments 2 through 4 of the Sultan River (the primary segments that were analyzed in this analysis): (1) technical boating focuses on lower flow trips that provide access to the canyon and some technical rapids, but lacks powerful hydraulics; (2) standard boating has more route options, stronger hydraulics, and larger waves; and (3) "big water" boating focuses on the powerful hydraulics available at much higher flows.

The whitewater difficulty of Segments 2 and 3 is generally Class III-IV, with one Class V rapid on Segment 3 (which can be portaged). Segment 4 is generally Class III with one Class IV rapid. The Sultan River is geologically active and heavily forested, so landslides or large woody debris introduced into the river may alter rapid difficulty.

Specified flow questions helped identify acceptable and optimal ranges for different types of opportunities, and findings for Segments 2 and 3 were similar. Boaters identified 300 cfs as a minimum to use the river for transportation, but these trips are lower quality. Flows about 450 to 500 cfs are required for acceptable technical trips in kayaks, but these would not be boatable for rafts (which require about 700 cfs). Standard trips occur from about 750 cfs and continue through 1,200 cfs (slightly less on Segment 2), but optimum standard trips start about 900 cfs, with better whitewater and more routes through rapids. Higher flows (over 1,200 cfs) provide "big water" opportunities. Findings for Segment 4 were similar to Segments 2 and 3, although boaters generally specified slightly higher flows on Segment 4 for each type of opportunity.

Boatable flows in Segments 1, 2, and 3 are affected by water supply and hydroelectric Project operations; effects can be quantified by integrating boating and hydrology information. On average, only about 4 days per year have boatable flows on these bypassed segments. Boatable flows in Segment 4 are also affected by Project operations. Water storage generally eliminates or mutes peak flows (only 8 spills in the past 23 years), but power generation frequently augments project minimum flows, which increases the number of boatable days. Higher quality boatable days are available about half of the year, although many provide technical or big water opportunities rather than standard trips.

Boaters rated their interest in whitewater releases by months of the year and days of the week. There was greater interest in August and September and distinctly lower interest from December through February. There was greater interest in weekend versus weekday releases.

Boaters generally preferred optimal over acceptable flows, even if releases would be of shorter duration or for fewer days. Because of the unique "plumbing" of the Project,

power generation losses could be minimized if less water were released from Culmback Dam and more, although limited, water was added at the Diversion Dam. Boaters were divided over this trade-off.

Boaters were asked to rate the Sultan River segments in comparison to other rivers. Segments 2 and 3 are highly regarded in the region and statewide (with Segment 3 receiving slightly higher ratings). Segment 4 had slightly lower ratings than Segments 2 and 3. Boaters identified outstanding features of the river, including fine scenery, remoteness, undeveloped character, length of the run, and quality of whitewater.

Whitewater releases could impact fishing and recreational mining that occurs on the bypassed reaches. Fishing on the Sultan River is primarily focused on steelhead, with the highest use probably occurring on Segment 3 (by wading anglers) and 5 (by boat-based anglers and to a lesser extent wading anglers). In general, lower flows provide more fishable water, improved access to fishable water, and better aesthetics. Most anglers appear sensitive to flows, but only a few were "calibrated" to a gage; most wading anglers prefer "base flows" on Segment 3 (under 200 cfs) and whitewater flows (over about 600 cfs) would substantially limit the amount of fishable water. Anglers suggest a wider fishable range exists on Segments 4 and 5, where more use is boat-based (and higher flows are typically present due to powerhouse outflows).

Recreational mining occurs in the Sultan River Basin on segments 1, 2, and 3 from March through October (but it is most common in July and August). "Base flows" of about 20 cfs on Segments 1 and 2 and under 100 cfs on Segment 3 allow good access for dredges and wading miners, cover target sediments in the bottom of the channel, and are clear. Any substantial increase in flows (e.g., over 600 cfs for whitewater) would be "un-mineable."

Boating advocates are interested in creating additional whitewater boating opportunities on the Sultan River. The report identifies considerations to help the District, agencies, and whitewater interests discuss the possibilities, including Project operations, liability, impacts on other recreation opportunities, impacts on water supply and other resources, cost of releases and boater interest in different flows and opportunities. Key findings include:

- In general, the District would prefer to release as little water as possible from the base of Culmback Dam; water released at the Diversion Dam produces some generation.
- Whitewater recreation flow releases in summer may affect biophysical resources (which are being addressed by other relicensing studies). Issues focus on timing releases to minimize effects on the displacement and disruption of rearing and spawning fish (fall for salmon, spring for steelhead).
- Most Seattle area-based boaters are likely to support one-day releases (two days are not needed to attract them to the area).
- Boaters would prefer weekends over weekdays, and Saturdays over Sundays.
- Boaters probably do not need Culmback Dam releases longer than 3 to 4 hours.

It is challenging to estimate use for whitewater boating on river segments where boatable flows are rarely available, but estimates range from about 40 to 200 paddlers, depending upon several factors. Higher use would occur if paddling clubs organize shuttles, releases are well-publicized, Diversion Dam access is offered, there are relatively few days of releases, or releases are available in summer or fall months. If whitewater boating releases are provided, there are some access challenges related to the Segment 2 hike-in and potential access to the Diversion Dam by vehicles.

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Acronyms and Abbreviations

AW	American Whitewater
BEEPS	Boeing Employees Everett Prospectors Society
BPA	Bonneville Power Authority
cfs	cubic feet per second
CRC	Confluence Research and Consulting
District	Public Utility District No. 1 of Snohomish County
FERC	Federal Energy Regulatory Commission
FR	Forest Road
MW	megawatts
NPS	National Park Service
PAD	Pre-Application Document
Project	Henry M. Jackson Hydroelectric Project
RM	River Mile
USFS	U.S.D.A. Forest Service
USGS	U.S. Geological Survey
WDOE	Washington Department of Ecology
WMPA	Washington Miners Prospectors Association

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Notice!

This report considers potential boating, scouting, and portaging options based upon on-land and on-river assessments conducted in April and October 2007. It does not identify or endorse specific boating, scouting, or portaging options for future boaters. All boaters need to make their own decisions about how to scout, run, and/or portage sections of the Sultan River during any on-river boating activities.

1.0 INTRODUCTION

Public Utility District No. 1 of Snohomish County (District) is applying to the Federal Energy Regulatory Commission (FERC) for a new license for the Henry M. Jackson Hydroelectric Project, FERC No. 2157 (Project). As part of that effort, the District is conducting studies to determine Project effects on environmental resources, including whitewater boating and other recreation activities in the 16.5 miles of the Sultan River from Culmback Dam to the confluence with the Skykomish River near the city of Sultan.

The Sultan River downstream of Culmback Dam flows through a deep gorge for nearly 14 miles before emerging onto an alluvial plain in its last 2.5 miles. There is limited access into or along this gorge, which has many rapids and cascades between sections of pools and riffles. The river offers fishing, recreational mining, and Class III/IV whitewater boating opportunities, all of which may be affected by Project-influenced flows.

The Diversion Dam at River Mile (RM) 9.7 historically (1930-1984) diverted some flow (an annual average of 113 cfs) from the river to Lake Chaplain, where domestic water supply was stored for the City of Everett. Stage II Project modifications in 1984 generally divert water from Culmback Dam to the Powerhouse (RM 4.3). At the Powerhouse, about 183 cfs is typically sent through Francis generation units and then to a division structure on the shore of Lake Chaplain, which returns supplementary flows back to the river at the Diversion Dam (between 75 and 155 cfs depending on time of year) and leaves the remainder in Lake Chaplain for water supply. An additional 200 to 1,200 cfs (depending upon the time of year and Spada Lake storage availability) is used for power generation through one or both Pelton generation units. The Project generates roughly 48 megawatts (MW) of power on average, and is capable of producing up to approximately 104 MW.

The Project also provides minimum instream flows from Culmback Dam to the Diversion Dam (20 cfs); from the Diversion Dam to the Powerhouse (95 to 175 cfs, depending upon the season); and below the Powerhouse (165 to 200 cfs, but flows are usually higher because they include generation outflow). These minimum flows are designed to protect existing salmon and trout fisheries, but they provide boatable flows upstream of the Powerhouse only in combination with relatively rare high runoff events, so boaters have limited information about which flows produce specific types of boating opportunities. Higher flows necessary to provide different types of whitewater boating may affect other recreation uses such as fishing and mining.

This report addresses these information gaps, identifying flow-dependent recreation opportunities, determining acceptable and optimum flow ranges for those opportunities, and describing Project effects on them. The report summarizes information from the Pre-Application Document (PAD) (Public Utility District No. 1 of Snohomish County and City of Everett, 2005), "desktop" analyses conducted for the study plan, fieldwork, interviews with experienced users, and a "controlled flow assessment" (where boaters evaluated several flows). The study design was developed in response to study requests of the Federal Energy Regulatory Commission (FERC), U.S.D.A. Forest Service (USFS), National Park Service (NPS), Washington Department of Ecology (WDOE), American Whitewater (AW), and other stakeholders, and approved by FERC in its Study Plan Determination dated October 12, 2006.

1.1 Study Purpose and Objectives

The overall purpose of the study was to evaluate the effects of Project operations on whitewater opportunities downstream of Culmback Dam and to identify potential measures to alleviate the effects of providing whitewater boating flows on other recreation such as fishing and mining. Specific objectives included:

- Identify recreation opportunities on different river segments, with a focus on whitewater boating, fishing, and recreational mining.
- Describe flow-quality relationships for each type of opportunity, and identify acceptable and optimal ranges for each.
- Describe recreation-relevant hydrology of current operating regime and potential future operating regimes (when available), and estimate the number of days per month that acceptable or optimal flows for whitewater, fishing, and mining would be available.
- Generally describe the operational feasibility and effect of providing scheduled releases for whitewater recreation or other flow-dependent recreational uses on power generation and water supply.
- Describe liability issues related to providing scheduled whitewater flows.
- Estimate whitewater use levels if scheduled releases were provided.
- Describe existing and potential access for boating, fishing, and mining activities, advantages and disadvantages of various options, and potential improvements that would address disadvantages or problems.
- Describe potential impacts on other recreation uses (e.g., fishing, swimming, mining) from providing scheduled whitewater flows.
- Share information about potential whitewater releases with researchers examining other resources (e.g., salmon and steelhead habitat) so their efforts can evaluate potential impacts on other biophysical or cultural resources.

- Describe potential effects of whitewater releases on other resources through integration of information with other resource studies.

1.2 Report Organization

The report begins with study methods and a description of the study area, and a summary of recreation-relevant hydrology. Study results follow, organized into sections for whitewater boating and other types of recreation.

The whitewater boating section focuses on the controlled flow assessment results for Segments 2 and 3 (the primary bypass reaches), and covers other segments based on interviews and other sources. The section on other recreation opportunities is primarily based on low flow fieldwork and interviews. A final section integrates information and discusses issues associated with providing potential boating flows.

Appendices provide lists of boating participants and interviewees, survey instruments, focus group notes, and additional information from the controlled flow assessment. Appendix 6.6 also provides an "illustrated summary" of the study (photos with extended captions), which is designed to serve as a stand-alone document.

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2.0 STUDY AREA

The study area includes the 16.5 miles of the Sultan River from Culmback Dam RM 16.5 to its confluence with the Skykomish River RM 0 (Figure 2-1). The river has been divided into five segments based on hydrological, operational, and recreation use characteristics, as described below.

2.1 River Segments

2.1.1 Segment 1: Culmback Dam to Forest Road 6122 River Trail

River Mile (RM) 16.5 to 15.7. This 0.8 mile segment is confined within a deep, narrow gorge. The reach has an overall gradient of about 120 feet per mile, but most of this occurs in nine distinct cascades; the largest of these contain individual near-vertical falls that range from 8 to 15 feet (Ruggerone 2006).

Access is challenging because there are no established trails. Although recreational miners have at least two claims in the reach, it is rarely visited by others. Mining access occurs from informal trails from the east off Forest Road (FR) 6122 on the south side of the Sultan River; miners either hike to the downstream end of the segment and walk/climb up the channel, or use technical climbing/rappelling gear to climb down to the river (Miller 2007). Travel on foot along the channel is only possible at low flows due to steep canyon walls and the force of water in the cascades (Bridge 2007). The reach may have been boated in the past, but reports are not certain (Williams 2007); it likely provides Class IV-V whitewater but may have unboatable rapids that require portaging.

Prior to September 2001, although possible to access the river channel by climbing down the face of the dam and then using a ladder near the release structure to reach the channel and travel downstream (by hiking or boating), this form of access was prohibited by the District to limit liability and protect facilities from damage. Since September 2001, security concerns have further prohibited public access to the dam vicinity.

2.1.2 Segment 2: FR 6122 River Access Trail to Diversion Dam

River Mile 15.7 to 9.7. This 6.0 mile reach is in a confined canyon, but has a less steep gradient than Segment 1, and a few areas with alluvial characteristics (evident at low flows). It has a gradient of about 70 feet per mile, with a mostly pool-drop character. The segment is accessed on the upstream end by a 1.5 mile informal USFS trail off FR 6122, which is a spur road off the Culmback Dam Road. The informal access trail was apparently built by miners, is not maintained by the licensee, and is located on USFS-managed land (see additional discussion of this trail in Section 4.4.2.1). Prior to the early 1990s, there was also access to a stringer bridge across the river (RM 14.3) that connected logging roads on the north and south sides of the Sultan River; those roads have deteriorated and a slide prevents vehicle access from FR 6122 on the south side. The segment ends at the Diversion Dam (RM 9.7) where there is a road (not accessible to public vehicle use). Segment 2 is generally considered a Class IV boating run.

2.1.3 Segment 3: Diversion Dam to Powerhouse (RM 9.7 to RM 4.3)

River Mile 9.7 to 4.3. The first 2.2 miles of this 5.4 mile reach is in a confined canyon, with a steeper gradient than Segment 2 (about 105 feet per mile). Most of the reach is pool-drop, but some rapids are linked and provide more continuous whitewater. Below Marsh Creek (RM 7.5) the river becomes wider and less steep (about 45 feet per mile), with a more open canyon.

The segment has five primary access points:

- Diversion Dam Road (RM 9.7). Two mile foot or bike access from Chaplain Lake Road (west side).
- Horseshoe Bend River Access (R.M 6.8). West side walk-in access on informal trail; primarily used by anglers.
- Horseshoe Bend River Access (R.M 6.8). East side walk-in access on informal trail; primarily used by anglers and miners.
- Old Gaging Station River Access (RM 4.8). West side walk-in access on informal trail; primarily used by anglers.
- Powerhouse area (RM 4.3). West side trail to the river and diversion dam; there are some informal trails heading upstream.

Locked gates limit public vehicle access to the west side trails and the Diversion Dam, although some anglers and hunters walk or bike into these areas. There are several recreational mining claims along the reach, each with specific walk-in access (most from the east side). Boaters occasionally use the reach in combination with Segment 2 during spills or intense winter storms, and a few may carry boats into the Horseshoe Bend Access Trail to increase the length of a Segment 4 trip. Segment 3 is generally considered a Class IV boating run, with one Class V rapid (Marsh Creek landslide); it is generally Class III below Marsh Creek.

2.1.4 Segment 4: Powerhouse to Trout Farm Road River Access

River Mile 4.3 to 2.5. This 1.8 mile reach goes though a short steep gorge before becoming more alluvial as it approaches the Skykomish River confluence. The gradient for the entire reach is about 65 feet per mile, most of which occurs in a series of rapids in the gorge area. Access is by road on both sides of a bridge near the Powerhouse, but east side gates to the Powerhouse are often closed after scheduled staff work hours (6:30 a.m. to 3:30 p.m.) and on weekends limiting public vehicle access to the east side. From the west side river recreationists can park on the Pipeline road and walk a quarter mile to the river access, just downstream of the bridge. The Pipeline road is open to traffic between 6 a.m. and 6 p.m., seven days a week. The area is primarily used by anglers (who generally fish upstream in Segment 3) and boaters (who boat Segment 4). The downstream end of the segment has a small parking lot and boat launch on Trout Farm Road (RM 2.5). A gate allows the District to control access to the property because of a long history of abuse by the public. People may still park along the road and walk the several hundred feet to the boat launch site or by requesting the gate combination may then gain access to the boat launch. There is also public access under the Bonneville

Power Administration (BPA) power lines located approximately one quarter mile to the north of the Trout Farm Road River Access property. The segment is generally considered Class III, with one Class IV rapid (Last Nasty).

2.1.5 Segment 5: Trout Farm Road River Access to Skykomish River

River Mile 2.5 to 0.0. This 2.5 mile reach is mostly alluvial in nature, with a few islands and braided channels; it has a gradient of under 20 feet per mile. The reach is accessed from Trout Farm Road River Access (RM 2.5) and provides opportunities for wading and boat-based fishing, recreational boating, and occasional swimming/wading at a small city park near the confluence with the Skykomish River. Boat-based fishing appears to be the most common use; anglers may link this short segment with additional fishing on the Skykomish River. There is little whitewater on this reach (Class I-II), but sweepers and a few sharp bends require some boating skill.

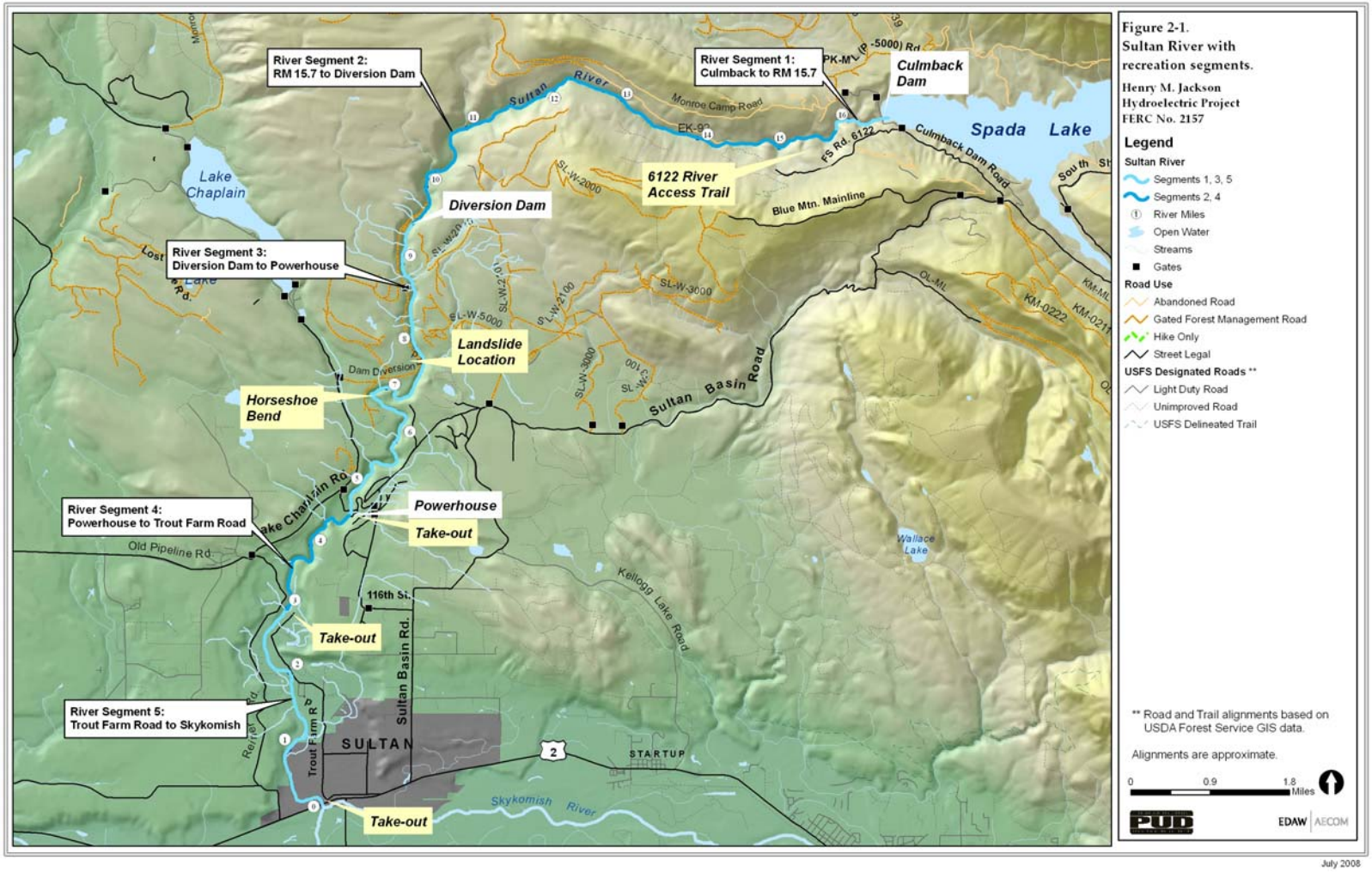

Figure 2-1. Map of Sultan River Indicating River Segments.

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3.0 METHODS

The study used a phased approach common in many relicensing assessments of flow-recreation issues (Gangemi 2004; Whittaker, Shelby, and Gangemi 2006); methods were also consistent with FERC study requirements under the Integrated Licensing Process (FERC 2004). Specific protocols follow accepted practices outlined in Whittaker et al. (1993) and (Whittaker et al. 2006). Three levels of study precision/intensity included:

- **Level 1** – initial information and integration studies. Level 1 used "desk-top" methods that rely on existing information and/or limited interviews about flows and recreation opportunities from people familiar with the river/reach.

- **Level 2** – limited reconnaissance studies. Level 2 used more intensive existing information analysis, more extensive interviews, and limited fieldwork.

- **Level 3** – intensive studies. Level 3 included fieldwork at multiple flows, flow comparison surveys, and a "controlled flow" assessment.

Decisions of the level of information needed were initially developed in the study plan (SP-14) (Public Utility District No. 1 of Snohomish County and City of Everett, 2006a), then reviewed as components of the work were completed. Decisions were made in consultation with stakeholders, and focused on four questions:

- Are there flow-dependent recreation opportunities on the river segments?
- Are flow-dependent opportunities affected by Project operations?
- Are flow-dependent recreational opportunities "important" relative to other resources, water supply or foregone power generation?
- Does Level 1 (and/or Level 2) information precisely define flow ranges and potential Project effects for each flow-dependent opportunity?

The phased approach provides multiple benefits, including streamlined costs and priorities, transparent and defensible records, early discussion of potential conflicts between resources, and improved efficiency of flow-based resource studies (e.g., recreation, fisheries, aesthetics, etc.). Descriptions of study "elements" follow.

3.1 Existing Information

3.1.1 Guidebooks, Web Pages, and Resource Documents

Whitewater guidebooks and web page information provided general descriptions of boating opportunities, access, rapids difficulty, and broad flow recommendations. Topographic maps, fish habitat surveys, fish passage assessments, aerial photographs, aerial video, and other information summarized in the PAD (Public Utility District No. 1 of Snohomish County and City of Everett, 2005) and initial study reports provided additional information on river characteristics. Recreation user surveys and associated reports (Public Utility District No. 1 of Snohomish County and City of Everett, 2006b)

also provided general information about recreation opportunities in the basin; these were supplemented with boaters' comments from previous proceedings related to the Project. A list of documents, guidebooks, and websites is provided in the references (Section 5.0).

3.1.2 Informal Boating Assessments

Boaters interested in potential whitewater releases conducted three informal flow assessments as relicensing study plans were being developed. These assessments capitalized on flow releases for maintenance or other relicensing studies.

- December 12 and 13, 2005. 650 cfs Culmback Dam release. The District notified boaters that maintenance needs would provide approximately two days of approximately 650 cfs from Culmback Dam (Segments 1 and 2); accretion increased this to about 670 cfs below the Diversion Dam (Segments 3 and 4). Thirty-four whitewater boaters paddled at least one of the accessible reaches (Segments 2, 3 or 4), and 31 completed a post-run questionnaire (developed by EDAW) that focused on the single flow seen during these releases.

- June 29, 2007. 300 cfs Culmback Dam release. The District notified boaters that other relicensing studies would provide approximately 300 cfs from Culmback Dam (Segments 1 and 2) for one day; the Diversion Dam gage fluctuated between 325 and 350 cfs during the period (due to inputs from tributaries on a rainy day). Two boaters (Andy Bridge and Leland Davis) conducted an in-channel hiking/swimming/climbing reconnaissance of Segment 1, traveling approximately 0.4 to 0.5 miles upstream (about half of the segment), before being blocked by an unswimmable rapid (later identified as Cascade 5 from the Ruggerone (2006) fish migration study). The reconnaissance focused on evaluating the difficulty of rapids in Segment 1 and options for on-land or on-water assessments during higher flow releases.

- July 13, 2007. 175 cfs Culmback Dam release, 400 cfs Diversion Dam release, and 600 cfs Powerhouse release. Co-licensees notified boaters that other relicensing studies would provide one day of approximately 175 cfs from Culmback Dam (Segments 1 and 2) and additional accretion and Diversion Dam input produced about 400 cfs in Segment 3 and 600 cfs in Segment 4. Five boaters paddled Segments 2 through 4 and four competed surveys with single flow and flow comparison questions.

3.1.3 Hydrology information

The PAD and other studies provide complete information about Project operations and hydrology in the basin. The present study summarizes recreation-relevant hydrology and operations information for reader convenience. Hydrology focuses on three locations:

- Flows below Culmback Dam (RM 16.5). Gage 12137300 records reservoir elevations (stage) and indirectly provides flow estimates for Segments 1 and 2 for minimum flow compliance purposes. This gage has been operational from 1965 through the present, but is not available to the public.

- Flows below the Diversion Dam (RM 9.7). USGS gage 12137800 provides flow estimates for Segment 3, although substantial tributary inputs may occur through the rest of the reach (particularly at Marsh Creek). This is a real-time gage available over the internet. It has been operational from May 1983 through the present.

- Flows below the Powerhouse (RM 4.3). USGS gage 12138160 provides flow estimates for Segments 4 and 5. This is a real-time gage available over the internet. It has been operational from July 1983 through the present.

Additional hydrology background information was reviewed from no-longer-active gages when relevant. These include USGS gage 12137500 at Start-up (just upstream from the Diversion Dam at RM 11.3; active from 1934 to 1971), USGS gage 12138000 at Sultan (downstream of Marsh Creek at RM 7.3, active from 1911 to 1931), and USGS gage 12138150 (just downstream of Chaplain Creek at RM 4.9; active from 1974 to 1984).

3.2 Preliminary Reconnaissance

An initial reconnaissance of the river was conducted in April 2007. Confluence Research Consulting (CRC) researchers and Andy Bridge (from AW) kayaked Segments 3 and 4 on April 17 at spring base flows (approximately 185 cfs in Segment 3 and 650 cfs in Segment 4). The reconnaissance evaluated boatability and fishability, and collected still and video footage within the "normal" range of operational flows.

On April 18, CRC accompanied District, City of Everett, and other consultant staff on a reconnaissance of the upper watershed, including Culmback Dam and the informal user trail from FR 6122 used for the Segment 2 boating put-in. This helped with schedule and logistics options for the controlled flow assessment.

3.3 Interviews with Experienced Users

CRC conducted interviews with anglers, boaters, watershed patrol officers, and others familiar with recreation use and potential impacts from flows. Interviews focused on several issues, including:

- History of whitewater boating on the river, with particular attention to Segment 1 (because there was greater documentation of Segment 2-4 use).

- Fishing use and fishability related to flows (primarily steelhead angling in Segments 3, 4, and 5). Questions were designed to assess how flows affect "angler habitat" and not focused on flow effects on the fishery (biological issues).

- Mining use and flow requirements for recreational mining activities.

A total of 19 interviews were conducted; interviewees included nine anglers, five boaters, two miners, two watershed patrol officers, and an official from the City of Sultan.

3.4 Controlled Flow Study

Controlled flow assessments are characterized by manipulation of the independent variable, flow (Whittaker et al. 1993). The idea is to release a series of known quantities of water in a short period of time to facilitate comparisons by a consistent panel of boaters (or other recreation users).

For this study, existing information and preliminary fieldwork (Levels 1 and 2 information) suggested a focus on whitewater boating on Segments 2 and 3. These two segments offer whitewater boating opportunities "important" enough relative to power generation, water supply, and other resources to merit further investigation. Whitewater boating on Segment 4 is also common and an "important" flow-dependent activity affected by the Project, but sufficient information about that segment was already available. More precise information about whitewater boating flows was also deemed unnecessary for Segment 1 (with access issues and steeper gradients and potentially unrunnable rapids) and Segment 5 (with its lower gradient and little whitewater). Finally, more precise information about flow requirements for fishing and mining were deemed unnecessary during the controlled flow assessment. These opportunities are flow-dependent and "important," but information from interviews was adequate to describe how current operations and potential whitewater releases would affect these activities.

Boaters ran each segment at three flows. They assessed the quality of boating opportunities, and estimated acceptable and optimal flow ranges. They provided quantitative ratings on survey forms and qualitative evaluations during focus group discussions. The study allowed evaluations of multiple flows over the three day period (Table 3-1). "Close-out surveys" conducted at the end of the study collected information about all of the flows boaters had assessed on Segments 2 and 3, flow preferences based on their history of use on Segment 4, seasonal preferences for potential whitewater flow releases, and comparisons of Sultan River reaches with other regional rivers.

3.4.1 Target and Actual Flows

Preliminary information from the literature review, interviews, informal boating assessments, and preliminary field work indicated that the study should focus on improved precision for the "acceptable" and "lower optimal" boating ranges. As discussed in the study plan, these are the flows most likely to be requested as "protection, mitigation, and enhancement" measures for projects with constrained water budgets.

The study was conducted on three consecutive days to increase continuity in the boating panel. Study dates and flows were chosen based on water availability, salmon flow requirements, previously assessed flows, operational considerations, likely-accretion hydrology, and to avoid colder temperatures and shorter days. Target flows were chosen in consultation with AW, and flows for the last day were revised based on discussions with participating boaters.

Target and actual flows are given in Table 3-1, which includes previously-assessed flows. Rain was generally constant (and occasionally heavy) during the assessment, so CRC has

included estimates of accretion (tributary and other basin inputs) by the end of each segment. When assessing flows, CRC asked boaters to focus on the flow that was released at the top of each segment (because that is the flow that can be provided).

Table 3-1. Pre-Study, Target, and Actual Flows for Flow-Recreation Study.

Date	Flow below Culmback Dam Segments 1 & 2			Flow below Diversion Dam Segment 3			Flow below Powerhouse Segments 4 & 5
	Target	Actual	With accretion[1]	Target	Actual	With accretion[1]	
Pre-study flows							
Dec 12, 2005		650			670		
Apr 22, 2007					185		630
Jun 29, 2007		300	330				
Jul 13, 2007		175			400		600
Controlled flow study							
Oct 19, 2007	400	325	365	575	540	690	
Oct 20, 2007	650	700	825	825	1,000	1,125	1,320
Oct 21, 2007	900	900	950	800	800	980	1,400

1. Flow with estimated tributary and basin accretion inputs by the end of the segment (if noticeably different from actual release).

Table 3-2. Summary of Flows for Entire Study (in ascending order).

Flow	Segment				Type of assessment and date
	1	2	3	4	
175		X			Pre-study boating flow (Jul 22)
185			X		Pre-study boating flow (Apr 22)
300	X				Pre-study on-land reconnaissance (Jun 29)
325		X			Study flow (Oct 19)
400			X		Pre-study boating flow (Jul 13)
540			X		Study flow (Oct 19)
630				X	Pre-study boating flow (Apr 22)
650		X	X		Pre-study boating flow (Dec 12, 2005)
700		X			Study flow (Oct 20)
800			X		Study flow (Oct 21)
900		X			Study flow (Oct 21)
1,000			X		Study flow (Oct 20)
1,320 / 1,400				X	Supplemental boaters only (Oct 20 & 21)

3.4.2 Participants

A "core team" for the three-day controlled flow study was selected with the assistance of AW. The goal was to have these boaters evaluate all reaches and flows. The core team consisted of 12 kayakers (not including the authors of this report, who boated in a hard shell kayak and 12 foot cataraft). All were highly skilled Class IV-V boaters. The core study team included Andy Bridge and Tom O'Keefe (AW representatives involved in study plan development and other Project relicensing meetings), as well as other boaters who had assessed the river during the December 2005 or July 2007 releases. Core team members boated Segments 2 and 3 at each flow, although one boater was unable to participate on the last day. The cataraft was only used on Segment 3 at the two higher flows.

Anticipating that other boaters would probably show up to boat one or more flows, "supplemental boaters" were asked to coordinate their logistics to minimize bottlenecks at put-ins or rapids. All boaters were also asked to complete a liability form (a District employee was located at Olney Pass to pass out and collect signed liability forms) and complete an on-line survey after their trip. In total, 46 boaters completed liability forms and 43 completed surveys (41 were hard shell kayakers and 2 were inflatable kayakers). Among the 43 that completed surveys, 41 boated one day (2 on Oct 19; 29 on Oct 20; 8 on Oct 21); and three boated two flows days. Five boated only one of the two target segments (four took out after boating Segment 2). Lists of core team and supplemental boaters are provided in Appendix 6.1

Several core team and supplemental boaters had substantial experience on Segment 4 (which is commonly boated because it has additional water from Powerhouse outflows). The close-out survey (for the core team) and the on-line survey (for supplemental boaters) included flow comparison questions about Segment 4. Results were developed for boaters who had boated the segment on ten or more occasions (n=21).

Angler stakeholder groups were notified of the flow assessment to provide an opportunity to evaluate specific flow releases, but no anglers appear to have done so. Interview information suggests that boating releases are primarily relevant for anglers using Segment 3, and that interview information sufficiently characterizes how fishability conditions change as flows increase. Researchers also conducted evaluations of Segment 3 for fishability during the controlled flow study.

3.4.3 Surveys and Focus Groups

During the flow assessment, core team boaters met in a maintenance building near the Powerhouse each day. Prior to the first day of boating, they completed a pre-study survey of their boating experience and preferences. Following each flow, they completed a "post-run survey" and participated in a short focus group discussion. On the last day, boaters also completed a "close-out survey" with questions evaluating the full range of flows on different segments. Supplemental boaters were asked to complete an abbreviated version of the close-out survey (to reduce response burden) following the study; it was available on an internet webpage. The surveys are provided in Appendix

6.2; the focus group questions and group responses are provided in Appendix 6.3; information about the core team and supplemental boaters from the surveys is provided in Appendix 6.4.

3.4.4 Video and Photography

Video/photographic documentation was conducted to show how major rapids or other river features change at different flows. Multiple "video stations" were established on the two primary study reaches, with additional footage from other locations.

Video footage has been edited into a short "technical documentation" (not "studio quality") video of the study. It is a stand-alone product that characterizes the study reaches and summarizes methods and findings. Still photos have been organized in an "illustrated summary" in Appendix 6.6.

3.4.5 Safety

Representatives from the District, City of Everett, AW, local boaters, and CRC worked cooperatively to provide a safe and efficient study. All participants signed liability waivers and took appropriate safety measures before getting on the river (including participating in a safety briefing). All core team boaters were Class IV boaters with commensurate self-rescue skills; supplemental boaters appeared to have similar skill levels. No injuries were reported during the study.

3.5 Recreation-relevant Hydrology

The hydrology of the Sultan River below Culmback Dam has been affected by the construction of Culmback Dam and Project operations. A complete review of current and proposed Project operations is available in the PAD and will be discussed further in other technical reports for relicensing. For reader convenience, we have summarized recreation-relevant hydrology:

3.5.1 Current Project Operations

Project operations have altered the seasonal flow pattern in the Sultan River by storing winter and spring runoff for various societal benefits. Besides incidental power generation, these include municipal water supply (for approximately 80% of Snohomish County citizens), instream flow augmentation during the drier summer months for several fishery species, and flood control. The Project is the only flood control structure on the Skykomish River and only one of two such structures on the Snohomish River. The specific storage and release pattern is complicated, but generally operates in one of two ways based on four possible reservoir "states."

- "Normal operations" occur when the reservoir is (1) being drawn down in preparation for anticipated high inflows; (2) has sufficient water to provide minimum instream flows, water supply, and power generation, or (3) has low inflows. Under "normal operations," all but minimum fisheries flows are removed from bypassed reaches

(Segments 1, 2 and 3) between Culmback Dam and the Powerhouse (see description below and Figure 3-2).

- "High inflow operations" occur when the reservoir (4) is full and inflows exceed the capacity of the power tunnel. In this situation, the Project spills into the bypassed reaches, and water supply flows are taken from the river at the Diversion Dam rather than from Spada Lake via the Powerhouse. This mimics the original operation of the Diversion Dam (prior to Stage II), but includes power generation (see details below and Figure 3-3).

3.5.1.1 Normal Operations (see Figure 3-2)

1. Most runoff for the basin above Culmback Dam is captured in Spada Lake during the fall, winter, and spring for water supply and power generation. Spills from Culmback Dam are avoided when possible.

2. Twenty cfs is released from Culmback Dam, which combines with accretion to provide flows for fish and aquatic habitat between Culmback Dam and the Diversion Dam. Accretion flows can range from 10 to 3,000 cfs.

3. The majority of the remaining outflow from Spada Lake is sent through the power tunnel to the Powerhouse.

4. At the Powerhouse, some flow is diverted for City of Everett water supply for county-wide use and minimum fish flows at the Diversion Dam. This water comes from Spada Lake via the power tunnel with sufficient pressure to operate two Francis-type turbines at the Powerhouse and then continue through a pipeline under the river and uphill to Lake Chaplain. A maximum of 390 cfs can be sent from Spada Lake to Lake Chaplain; the effective "head" from full pool in Spada Lake to Lake Chaplain is 675 feet.

5. The water arriving at Lake Chaplain is allocated in a division structure to flow two ways. An average of about 130 cfs flows into Lake Chaplain for water supply (via gravity), and 0 to 180 cfs (depending upon the time of year) flows to the river at the Diversion Dam (which is at a similar elevation). The conveyance system between Lake Chaplain and the Diversion Dam can transport water in either direction; the system capacity is 189 cfs to the Diversion Dam and 182 cfs from the Diversion Dam to Lake Chaplain.

6. Other water from Spada Lake via the power tunnel flows through two Pelton-type turbines at the Powerhouse, which has a capacity of about 1,400 cfs. The effective head between Spada Lake and these turbines is approximately 1,000 feet. This water is returned to the river at the Powerhouse, augmenting flows in Segments 4 and 5.

During normal operations, basin runoff is captured by Culmback Dam, so peak flows are substantially reduced in size and frequency. In addition, withdrawals for Snohomish County's municipal water supply are removed from the basin entirely (a pre-existing water right; not a Project impact).

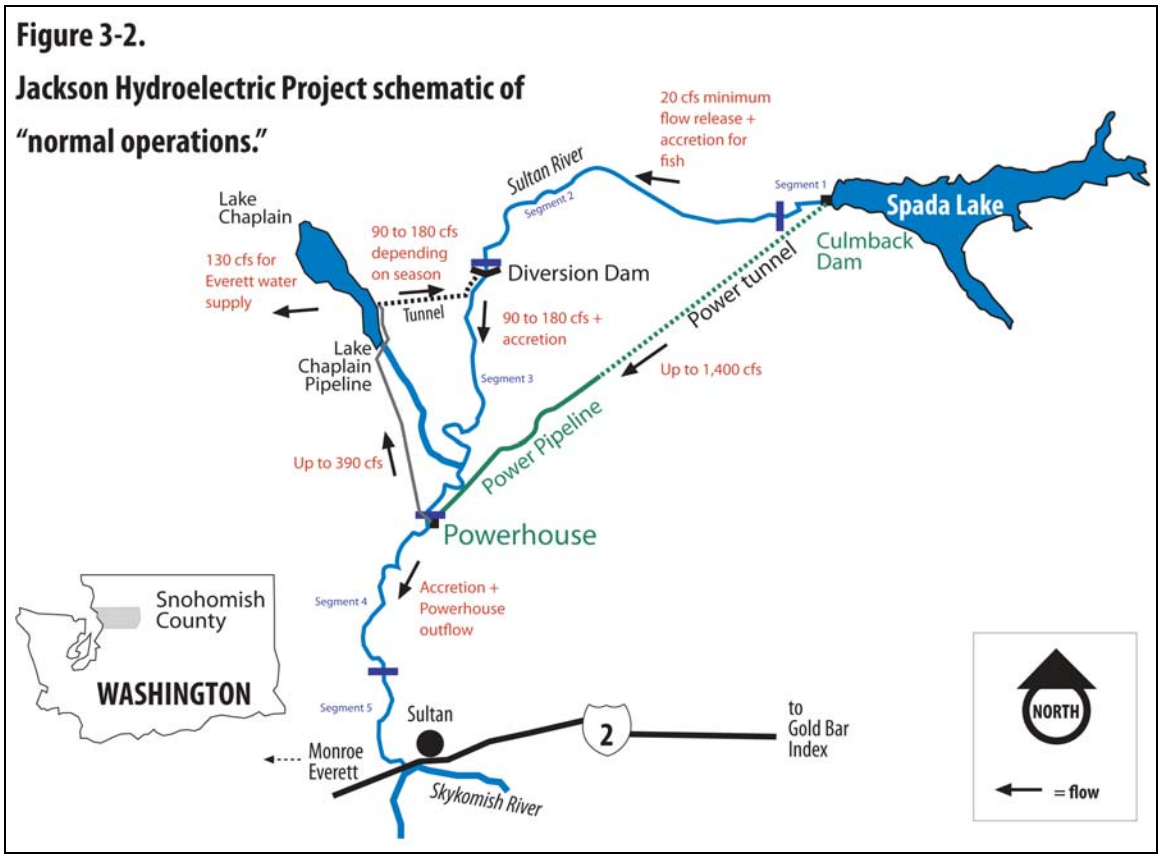

Figure 3-2. Schematic of "normal" Project operations

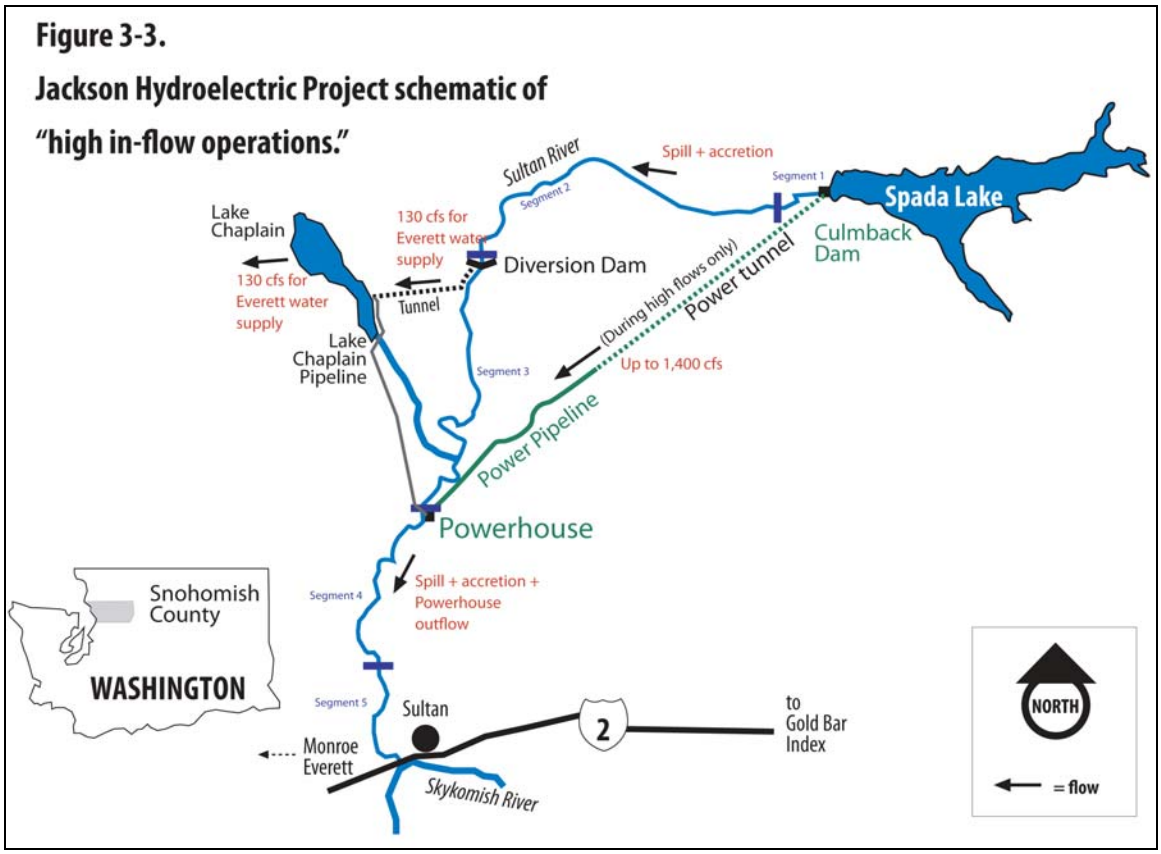

Figure 3-3. Schematic of "high inflow" Project operations.

3.5.1.2 High Inflow Operations (see Figure 3-3)

1. Spada Lake is full and inflows to the lake exceed the 1,400 cfs capacity of the power conduit to the Powerhouse.

2. The amount of spill at Culmback Dam equals inflows minus the capacity of the Powerhouse power conduit; the "morning glory" spillway can accommodate 57,750 cfs (the Maximum Probable Flood).

3. Valves at Culmback Dam can allow controlled releases as high as 2,500 cfs.

4. No water flows from the Powerhouse to Lake Chaplain through the Francis-type generators.

5. The City of Everett takes water supply from the river via the Diversion Dam (as long as river turbidity levels are acceptable). A maximum of 182 cfs may be removed

from the river at the Diversion Dam, but an average of 130 cfs is generally required to meet water demand.

During high inflow operations, tens of thousands of cfs flow is removed from the bypassed reaches (Segments 1, 2 and 3) compared to pre-Stage II conditions. Because of the "flashy" nature of the Sultan Basin (which averages 162 inches of annual rainfall), the Project has stabilized the flow regime and reduces the magnitude and frequency of the extreme high flow events that occurred before Culmback Dam was created in 1964 and expanded in 1983.

3.5.2 Segment Hydrology

Project operations produce a diversity of flows in specific segments, as described below:

3.5.2.1 Segments 1 & 2

During normal operations, these two bypassed reaches generally have 20 cfs minimum flow releases from Culmback Dam plus accretion from tributary inputs; the largest of these tributaries is Big Four Creek (river left at RM 0.7). Flows at the end of Segment 2 are typically less than 40 cfs during drier periods and rarely exceed 300 cfs during wetter periods. Fewer than 5% of days have accretion-only (non-spill) flows higher than 300 cfs at the end of Segment 2; these tend to occur for short durations during intense rain storms.

During high inflow operations, much higher flows can occur due to spills. However, this occurs infrequently. Less than 1% of all days in the period of record have had spills, an average of less than 4 days per year. These spill days have only occurred in 8 of the 23 years, and only one year (2006-07) since the winter of 1997-98.

3.5.2.2 Segment 3

This segment is below the Diversion Dam and combines Segment 2 flows with augmentation from the Powerhouse via the Diversion Dam tunnel from the division structure at Lake Chaplain during normal operations. Minimum flows range from 95 to 175 cfs depending upon the time of year (higher flows are required from January through mid-June and from mid-September through October). Accretion from tributaries can add flows; major tributaries include Habecker, Marsh, and Chaplain creeks. In general, this accretion is likely to add less than 50 cfs during drier periods and less than 200 cfs in wetter periods. Less than 5% of accretion-only (non-spill) days have flows exceeding 300 cfs at the top of the reach (the gage location).

During high inflow operations, Culmback Dam spills can substantially increase flows in this segment. This occurs infrequently (less than 1% of days, and not every year).

3.5.2.3 Segments 4 and 5

These segments are below the Powerhouse and thus combine Segment 3 flows with Powerhouse outflow. The reach has required minimum flows of 165 to 200 cfs depending on the time of year, but flows are often higher (exceeding 350 cfs about 75%

of the year and 700 cfs about 30% of the year). During spill events or intense winter storms, flows can reach several thousand cfs.

4.0 STUDY FINDINGS

4.1 Whitewater Boating

4.1.1. Boating Opportunities

Interviews, a literature review, fieldwork, and focus group discussions identified three general types of boating opportunities on the Sultan River below Culmback Dam. Similar labels and descriptions have helped distinguish opportunities on other whitewater rivers (Whittaker and Shelby, 2002).

- ***Technical whitewater boating.*** This opportunity focuses on lower flow trips. It provides access to the canyon and some technical whitewater rapids, but lacks powerful hydraulics. Some places present boatability problems which might require portages or preclude use by small rafts.

- ***Standard whitewater boating.*** This opportunity occurs at higher flows and has more route options, stronger hydraulics, and larger waves. It provides access to the entire run, provides few boatability problems, and is generally preferred over technical trips.

- ***"Big water" whitewater boating.*** This opportunity focuses on the powerful hydraulics and larger waves available at much higher flows. While higher flows may not increase the overall difficulty (class rating), the stronger hydraulics are more challenging for less-skilled boaters. Some higher skilled boaters prefer "big water" boating, or enjoy the diversity it offers.

4.1.2 Descriptions of Evaluated Flows

This section describes whitewater conditions for several flows based on fieldwork, interviews, focus groups, and post-run surveys. The section is organized by river segment (with observed flows ordered from lowest to highest, not necessarily the order in which they were evaluated).

4.1.2.1 Segment 1

<u>300 cfs</u>

Based on an ***on-land reconnaissance*** in June 2007 during an instream flow study release, there are five rapids on the lower half of this segment that offer constricted Class III and IV whitewater at this flow. The rapids were distinct and had pools/eddies between them, with drops about 6 to 8 feet in height; all appeared boatable in kayaks. However, the boaters were unable to travel far enough upstream to see the larger rapids (Cascades 6 and 7, as labeled by Ruggerone 2006) at this flow. It is unknown if those would provide boatable lines (or portage routes, if unrunnable). The canyon was extremely steep, with sheer cliff walls.

4.1.2.2 Segment 2

175 cfs

Based on a ***boating reconnaissance*** by five kayakers (four competed surveys) in July 2007, this flow was boatable in kayaks but very technical. There were many "pinning hazards" (places where boats could become stuck), but these were "manageable with proper scouting." In some rapids, boaters reported "sliding over lubricated rocks." Boaters portaged at least two logs that spanned the channel. The greatest boatability problems were in "boulder gardens" from about RM 11.5 to 10.0, where the channel widens. This is not a flow that whitewater boaters would seek, but it did provide access to the canyon. Boaters became "stopped" an average of seven times, and close-out surveys suggest that more than two stops per segment are unacceptable. All boaters classified this as a "technical opportunity" and preferred to see a "much higher" flow. Overall, post-run evaluations rated this flow "totally unacceptable."

325 cfs

Based on ***core team evaluations during the study*** (October 19, 2007), this flow is boatable, but remains a low water, technical opportunity for kayaks only. Providing access to the scenery and wilderness character of the upper river, it offered little "fun whitewater." Boaters noted pinning hazards, boatability problems, "wear and tear" on their equipment, and a slow rate of travel. However, the slow current and lack of power in the river provided easy scouting and preparation for rapids, and there was whitewater in a few rapids. Boaters became "stopped" between 2.0 and 5.0 times (median was 4.0), more than the median acceptable number (2.0) on this segment. No boater portaged any rapids. All boaters classified the flow as a "technical opportunity" and preferred to see a "slightly higher" (46%) or "much higher" (54%) flow. Overall post-run evaluations rated this flow "slightly unacceptable" (2.4 on a 5-point scale from "totally unacceptable" to "totally acceptable").

650 cfs

Based on an ***informal boating assessment*** by 34 kayakers in December 2005, this flow provided acceptable whitewater boating, but was probably a more technical than standard trip. Several boaters noted the flow was "low" and lacked the whitewater challenge that they expected on a Class III-IV reach. Others noted wood and pinning hazards. Converting overall evaluations to a 5-point scale (the 2005 assessment used a 7-point scale), boaters rated the flow "slightly acceptable" (3.7), although this referred to the entire run (Segments 2, 3, and 4).

700 cfs

Based on ***core team evaluations during the study*** (October 20, 2007), this flow provides markedly improved boatability and whitewater compared to 325 cfs. Rapids had fewer rocks, fewer pin hazards, larger waves, more powerful hydraulics, and more route options. However, there were still some rocky areas, log hazards, and hydraulics were less powerful than preferred. Only two boaters reported "stops" (at a single location), and there were no portages; both were less than the median number of stops and portages

(2.0) that boaters reported they would tolerate. Over half (64%) characterized this flow as a standard opportunity, but the remainder thought it was closer to the transition between technical and standard trips. About 55% preferred to see a "slightly higher" flow and the remainder thought this flow was close to optimal. Overall post-run evaluations rated this flow between "slightly acceptable" and "totally acceptable" (4.4 on the 5-point scale).

900 cfs

Based on ***core team evaluations during the study*** (October 21, 2007), this flow provides outstanding whitewater boating. There were many route options, few rocks, and no boatability problems. Hydraulics were powerful but "fluffy," holes were "filled in," and there were surfing and playboating opportunities. However, there were a few wood hazards, hydraulics were "pushier" for less skilled boaters, and there were fewer and smaller eddies than at lower flows. One boater had one stop, and another portaged one rapid. All but one boater characterized this as a standard opportunity (the other boater rated it the transition between standard and "big water" boating). Most (70%) thought this was close to an optimum flow, but one boater preferred slightly lower and two preferred slightly higher flows. Overall post-run evaluations rated it "totally acceptable" (4.9 on the 5-point scale).

4.1.2.3 Segment 3

185 cfs

Based on a ***boating reconnaissance*** in April 2007 (two kayaks and one inflatable kayak), this flow provided a sub-marginal but boatable technical opportunity. There were frequent contacts with rocks, limited route options, several pinning hazards, and little whitewater. Although the hard shell boaters had no "stops" and only portaged the landslide rapid, the inflatable kayaker had 11 stops and three in-channel portages (as well as the portage at the landslide). Close-out survey results suggest the median number of acceptable stops was 2.0. The greatest boatability problems were in the section between the Diversion Dam and the landslide, where rapids are steeper and more technical. Researcher evaluations suggested this flow was a "slightly unacceptable" (2.0 on the 5-point scale) technical trip, but a "totally unacceptable" standard trip.

400 cfs

Based on a ***boating reconnaissance*** by five kayakers (four competed surveys) in July 2007, this flow was boatable and distinctly better than 175 cfs observed on Segment 2 on the same day. Boaters characterized some rapids as "fun," with distinct route options and less "rock sliding" than Segment 2. All boaters portaged Landslide Rapid (although some thought it might be runnable with slightly higher water). More boatability issues were present below Horseshoe Bend at this flow. Two boaters had three stops while the rest reported none; this was less than the median number of acceptable stops. Boaters were split over whether the flow provided technical boating or a transition to standard boating. Three preferred a slightly higher flow, while the remaining boater thought it was close to optimal.

540 cfs

Based on ***core team evaluations during the study*** (October 19, 2007), this flow provides a technical opportunity for kayaks only. This segment has more challenging and frequent rapids than Segment 2, and several provided "whitewater action" at this level. Boaters who had run lower flows (185 cfs and 400 cfs) noted that this flow was dramatically improved. However, it still had many boatability problems and "boney" areas, particularly downstream of Horseshoe Bend. Some boaters became "stopped" as many as four times (median was 2.0), and half of the boaters portaged Landslide Rapid. Close-out survey results suggest that boaters would tolerate 2 stops and 2 portages on the reach. All but two boaters classified the flow as the transition between technical and standard boating, and all but one preferred "slightly higher" flow. Overall, post-run evaluations rated this flow "slightly acceptable" (3.8 on the 5-point scale).

670 cfs

Based on an ***informal boating assessment*** by 34 kayakers in December 2005, this flow provided acceptable whitewater boating. Several boaters noted that the flow was still "low" and lacked the whitewater challenge they expected on a Class IV reach, and others noted there were some wood and pinning hazards. Converting overall evaluations to a 5-point scale (the 2005 assessment used a 7-point scale), boaters rated the flow "slightly acceptable" (3.7), although this referred to the entire run (Segments 2, 3, and 4).

800 cfs

Based on ***core team evaluations during the study*** (October 21, 2007), this flow provided good boatability and whitewater challenge, and defined the start of standard boating for kayaks. It was also boatable in small rafts/catarafts, although it was a technical trip for these wider craft. Although there was good "structure" in rapids without being "pushy," rapids were steeper and had fewer route options compared to the higher flow (1,000 cfs) evaluated previously. Below Horseshoe Bend, the rapids had good definition for Class III boaters. Three kayakers became "stopped" one to two times (with the rest reporting none), and 64% portaged Landslide Rapid; these are less than close-out tolerances of 2 stops and 2 portages on the reach. Fifty-four percent characterized the flow as standard boating, with the remainder labeling it a transition between technical and standard. All but one preferred a flow that was "slightly higher." Overall post-run evaluations rated this flow "slightly acceptable" (4.2 on the 5-point scale).

1,000 cfs

Based on ***core team evaluations during the study*** (October 20, 2007), this flow provided excellent boatability and whitewater challenge, close to an "ideal" flow for standard trips. It was boatable in small rafts/catarafts, and much less technical than 800 cfs. Although there were still rocks in some preferred routes, most were "well-padded," hydraulics were "filled-in," and rapids were less steep (diminishing pinning hazards). Boaters noted that some hydraulics were "pushy," but easily manageable for Class IV boaters, with eddies plentiful and large enough for effective boat-based scouting. No kayakers became "stopped," and the catarafter was stopped just once (due to operator error). Most boaters (86%) portaged Landslide Rapid; two kayakers also portaged 1 or 2 other rapids.

Seventy-one percent classified the flow as a standard opportunity, with the remainder labeling it a transition between standard and big water boating. Seventy-nine percent thought the flow was near-optimal, with one preferring slightly lower and two preferring slightly higher flows. Overall post-run evaluations rated this flow "totally acceptable" (4.9 on the 5-point scale).

4.1.2.4 Segment 4

630 cfs

Based on a ***boating reconnaissance*** in April 2007 (two kayakers and one inflatable kayaker), this flow was near the transition between technical and standard boating. There were limited route options, but some power in the hydraulics, and a few playboating areas. Boaters had no stops or portages, and contact with rocks was rare. Researcher evaluations suggested this flow was "slightly acceptable" (4.0 on the 5-point scale), but more water would improve the whitewater.

1,320 cfs & 1,400 cfs

Based on comments from ***supplemental boaters during the study*** (October 20 and 21, 2007), these flows provided excellent whitewater opportunities. However, at least one playboating rapid ("Little Paradise," just downstream of "Last Nasty") was somewhat "washed-out" compared to lower levels (800 to 1,000 cfs).

4.1.3 Whitewater Difficulty

Core team boaters were asked to rate the whitewater difficulty of each segment (on the six class International Scale). Results are given in Table 4-1, which summarizes median responses. Among the "whitewater segments," Segments 2 and 4 are less challenging than Segment 3. On Segment 3, the reach above the Marsh Creek Landslide is clearly more challenging than the reach below the Landslide and Horseshoe Bend (which is Class III). Segment 1 is likely to be more challenging than Segment 3, but there is insufficient information to definitively classify all its rapids. Boaters generally thought whitewater difficulty did not substantially change at different flows, but Segment 2 was slightly less challenging at the lowest flow and Segment 3 was slightly more challenging at the highest flow.

The Sultan River has steep canyon walls and is heavily forested. As trees fall into the river, resulting large woody debris can change the character and difficulty rating of individual rapids. In addition, some parts of the canyon remain geologically active, as demonstrated by the 2004 landslide near Marsh Creek (which was videotaped by boaters in the area). The Marsh Creek Landslide rapid had substantial embedded woody debris when it was formed and was considered unboatable (Class VI). There appear to have been changes in the amount of debris, rock location, and sediment over time. Although the gradient of the rapid remains steep, it is now Class V and some boaters ran it at all three flows during the 2007 study. However, additional rockfall or downed trees may change the rapid again; boaters should not assume this (or any) rapid in the Sultan River will remain the same difficulty reported here.

Table 4-1. Whitewater Difficulty on Different Segments.

Segment	Overall	Hardest Rapid	Comments
1	IV to V?	VI?	Based on limited on-land reconnaissance.
2	III+ to IV	IV	III+ at lower flows (<500 cfs).
3	IV to IV+	V	IV+ at higher flows (>1,000 cfs). The one Class V rapid (Landslide) can be portaged.
4	III+	IV+	Class IV+ rapid ("Last Nasty") can be portaged.
5	II	II+	Based on Bennett (2005) and AW web page.

4.1.4 Flow Assessment Information for Segment 1

Based on core team discussion after a review of known information, this steep and constricted segment appears likely to be boatable at flows between about 300 and 1,000 cfs, but involves at least two difficult rapids that may be unrunnable. Taken together with the short length of the reach (less than a mile), difficult access (requiring a rappel-based put-in or substantial changes in security/access regulations at Culmback Dam), and the known value of the boating runs in Segments 2 and 3, boaters agreed that flow needs for Segment 1 probably should not "drive" potential flow releases for whitewater. In addition, boaters agreed it was unnecessary to develop further precision about flow needs for a reach that is unlikely to attract substantial use; as discussed in the methods, only "important" flow-dependent opportunities were targeted for Level 3 data collection. If boating flows were provided for Segments 2 and 3, they would also be available in Segment 1, and boaters thought an "expert team" could assess the segment at that time (with 300 to 600 cfs providing an initial estimate of the safest flow range for such an exploration).

4.1.5 Flow Assessment Information for Segments 2 and 3

Post-run evaluations help boaters focus on key attributes and the ways flows affect them. More detailed evaluation information from the close-out survey takes advantage of all study flows and previous boater experience, allowing consideration of the full range of other flows that might be available. Results help develop "flow evaluation curves" that relate flows and overall recreation quality, while "specified flow questions" help define acceptable and optimal ranges for specific opportunities.

4.1.5.1 Flow Evaluation Curves

Boaters rated a series of ten flows from 200 to 2,000 cfs using a seven-point acceptability scale (1=totally unacceptable, 4=marginal, and 7=totally acceptable) on Segments 2 and 3 (Figures 4-1 and 4-2, respectively). The figures show flow along the horizontal axis and average acceptability evaluations along the vertical axis; curves describe the relationship between flows and overall boating quality.

In general, the overall evaluation curves rise steeply at lower flows, reflecting the substantial improvement in quality as flows increase. The curves peak at optimal evaluations, and then decline more gradually. This is similar to findings from previous

studies (Whittaker & Shelby, 2002). Curves for technical trips rise more steeply and peak earlier than those for standard trips.

Curves for Segment 2 (Figure 4-1) show ***technical boating*** is unacceptable below 450 cfs, but small amounts of water substantially improve quality from 450 to 600 cfs (the highest rated technical flow). Above 600 cfs, ratings declined as technical trips transition into standard trips; by about 800 cfs (where the technical and standard curves cross), the transition is largely complete. ***Standard boating*** is unacceptable below 600 cfs, but improves with additional water from 600 to 1,000 cfs (the highest rated standard flow). Above 1,000 cfs, ratings decline gradually but remain acceptable through 2,000 cfs.

Curves for Segment 3 (Figure 4-2) show that ***technical boating*** is unacceptable below 450 cfs, but improves substantially until about 600 cfs, and is optimal between 600 and 800 cfs, when it transitions to standard trips. ***Standard boating*** is unacceptable below 600 cfs, but improves substantially from 600 to 1,000 cfs, and is optimal from 1,000 to 1,200 cfs. Above 1,200 cfs, ratings decline gradually, remaining acceptable through 2,000 cfs.

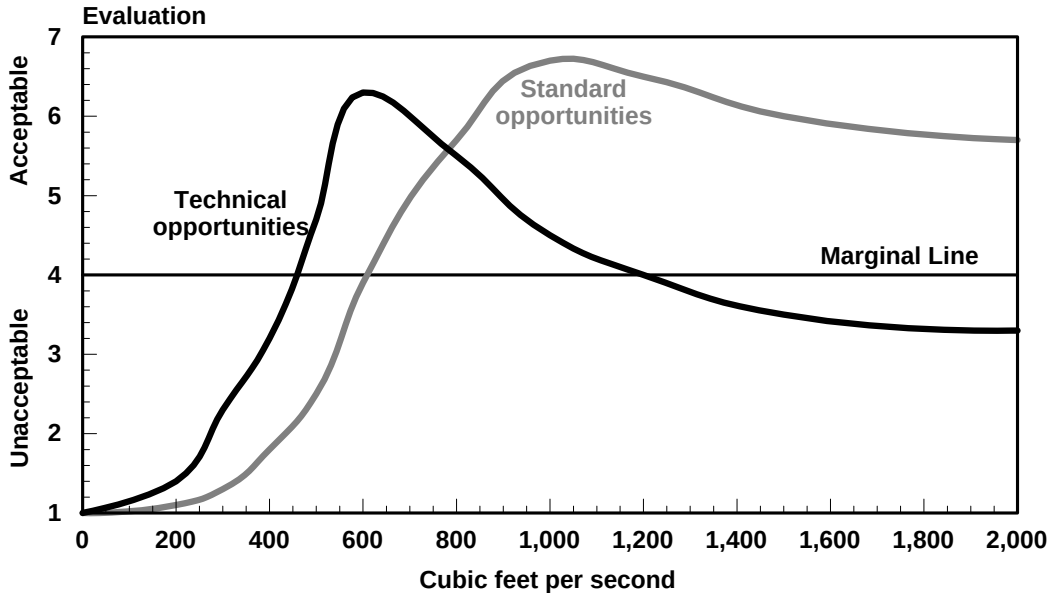

Figure 4-1. Flow Evaluation Curves for Segment 2.

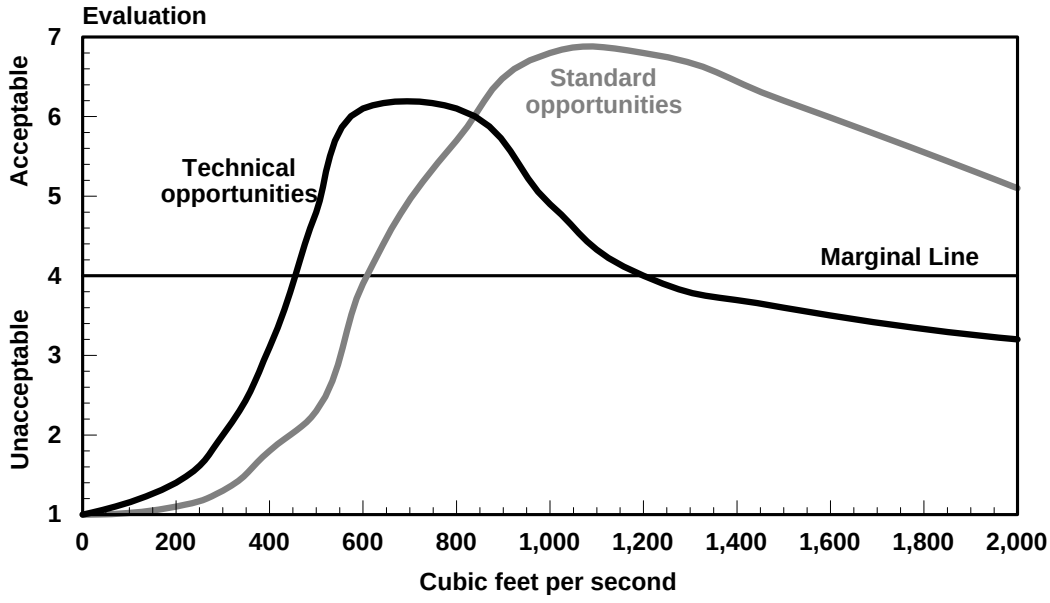

Figure 4-2. Flow Evaluation Curves for Segment 3.

4.1.5.2 Specified Flows

A series of "specified flow" questions asked boaters to identify flows that provide different boating opportunities. Specific questions are provided in Appendix 6.2. Table 4-2 shows medians, means, and "inter-quartile ranges" (the 25th and 75th percentile responses) for core team kayakers. Medians are the most useful measures of "central tendency" (because they are less susceptible to outlier distortion), while inter-quartile ranges help show the level of agreement. Figure 4-3 displays median responses to summarize opportunities.

- Findings for Segments 2 and 3 were similar. There are slight differences, but in general, flows provide similar opportunities on the two reaches.
- Boaters identified 300 cfs as a minimum to use the river for transportation, but trips are low quality at this level. Flows about 450 to 500 cfs are required for acceptable technical trips in kayaks, but these would not be boatable for rafts. Optimal ranges for technical trips start about 600 to 650 cfs.
- Boaters recognize differences between "technical" and "standard" trips, with flows about 750 cfs defining the transition.
- Standard opportunities become optimal about 900 to 950 cfs.
- Boaters recognize differences between "standard" and "big water" trips, with flows about 1,000 cfs (Segment 2) and 1,200 cfs (Segment 3) defining the transition.
- Differences between core team and supplemental boaters were not statistically significant (t-tests of means using $p<.05$), with two exceptions: supplemental boaters specified slightly lower flows for the lowest boatable flow and lowest acceptable technical flow. Only three of the supplemental boaters observed the lower flows that core team members evaluated, which probably explains the differences.
- For small rafts on Segment 3, the reach may be boatable at 700 cfs, but acceptable technical trips begin about 850 cfs. Standard trips start about 950 cfs and become optimal about 1,000 cfs. The transition to big water trips is about 1,200 cfs (same as for kayaks).
- When asked to specify a single flow that should be provided, most boaters preferred 1,000 cfs, which is in the middle of the optimal range for standard trips.
- When asked to specify two flows that should be provided, responses were more diverse. The lower flow ranged from 600 cfs to 1,200 cfs, and the median was 900 cfs. The higher flow ranged from 850 to 2,000 cfs, and the median was 1,200 cfs on Segment 2 and 1,100 cfs on Segment 3.

Table 4-2. "Specified Flows" for Segments 2 and 3.

Segment / specified flow	Median	Mean	Inter-quartile range
Segment 2			
Lowest boatable flow	300	291	250 to 300
Lowest acceptable technical trip	450	429	300 to 600
Lowest optimal technical trip	600	604	600 to 700
Transition between technical and standard trip	750	746	700 to 800
Lowest optimal standard trip	900	885	800 to 1,000
Transition between standard and big water boating	1,000	1,108	1,000 to 1,250
Lowest optimal big water boating	1,200	1,233	1,000 to 1,500
Highest safe flow	2,000	1,978	1,350 to 2,500
Single flow preference	1,000	1,023	900 to 1,150
Lowest of "two flow" preference	900	873	700 to 1,000
Highest of "two flow" preference	1,200	1,227	950 to 1,450
Segment 3			
Lowest boatable flow	300	329	300 to 400
Lowest acceptable technical trip	500	469	400 to 520
Lowest optimal technical trip	650	658	600 to 725
Transition between technical and standard trip	750	758	675 to 800
Lowest optimal standard trip	950	931	825 to 1,025
Transition between standard and big water boating	1,200	1,169	800 to 1,250
Lowest optimal big water boating	1,350	1,300	1,200 to 1,400
Highest safe flow	2,000	1,756	1,350 to 2,000
Single flow preference	1,000	1,023	800 to 1,200
Lowest of "two flow" preference	900	861	750 to 1,000
Highest of "two flow" preference	1,100	1,196	1,050 to 1,200

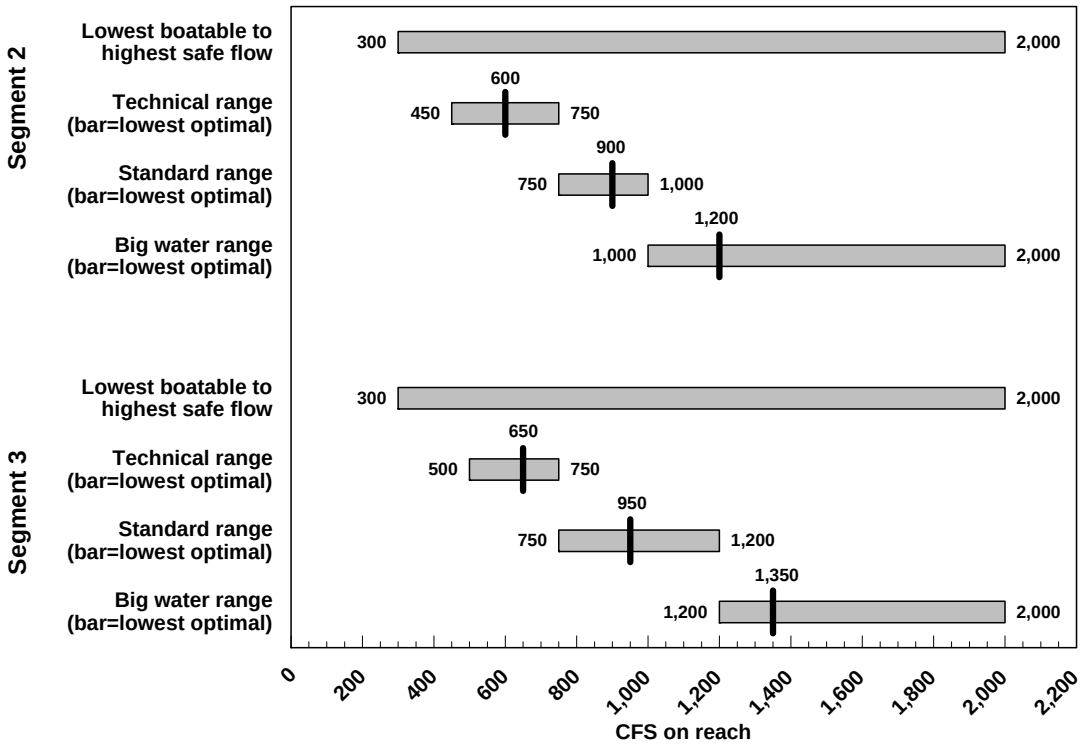

Figure 4-3. Summary of Flow Ranges Defined by Specified Flow Medians.

4.1.6 Flow Assessment Information for Segment 4

"Specified flow" questions were also asked for Segment 4; results were analyzed for the 21 core team and supplemental boaters who had taken more than ten trips on the segment. Table 4-3 shows medians, means, and "inter-quartile ranges" (the 25th and 75th percentile responses) for this panel.

- Findings for Segment 4 were similar to Segments 2 and 3, although boaters generally specified slightly higher flows on Segment 4 for each type of opportunity.
- The minimum boatable flow was 400 cfs, with 500 cfs for acceptable and 600 cfs for an optimal technical trip.
- Boaters recognize differences between "technical" and "standard" trips, with flows about 850 cfs defining the transition.
- Standard trips become optimal about 1,000 cfs (about 50 to 100 cfs higher than Segments 2 and 3).
- Boaters recognize differences between "standard" and "big water" trips, with flows about 1,150 cfs defining the transition; flows about 1,600 cfs provide optimal "big

water" boating. This transition was about same as Segments 2 and 3, but the optimal flow is notably higher.

- When asked to specify a single flow that should be provided, boaters preferred the start of optimal standard boating (1,000 cfs). When asked to specify two flows, boaters preferred 1,000 cfs and 1,400 cfs.

Table 4-3. "Specified Flows" for Segment 4.

Specified flow	Median	Mean	Inter-quartile range
Lowest boatable flow	400	418	300 to 500
Lowest acceptable technical trip	500	536	400 to 850
Lowest optimal technical trip	600	658	500 to 800
Transition between technical and standard trip	850	819	650 to 975
Lowest optimal standard trip	1,000	1,022	812 to 1,175
Transition between standard and big water boating	1,150	1,308	990 to 1,590
Lowest optimal big water boating	1,600	1,602	1,100 to 2,000
Highest safe flow	2,000	1,900	1,200 to 2,500
Single flow preference	1,000	1,118	912 to 1,350
Lowest of "two flow" preference	1,000	1,034	750 to 1,200
Highest of "two flow" preference	1,400	1,473	1,000 to 2,000

4.1.7 Project Effects on Whitewater Boating

Boatable flows in ***Segments 1, 2, and 3*** of the Sultan River are affected by water supply and hydroelectric Project operations. As discussed in the section on hydrology, water storage eliminates or mutes peak flows, and diversions to the Powerhouse and/or Lake Chaplain remove nearly all but minimum flows (plus accretion) during most of the year.

It is possible to quantify these effects on whitewater boating by integrating information about boating flows with hydrology data. Based on daily flow information from the gage below the Diversion Dam from 1990-2007 (after completion of Culmback Dam Stage II and refined operational procedures were implemented in November 1989), Figure 4-4 shows the average number of days per year when boating opportunities (using the ranges defined for Segment 3) are available under current operations. Through the period of record, an average of 17 days of boatable flows are available each year, but only about four provide higher quality boatable opportunities in the technical, standard, or big water ranges. In addition, these averages overestimate useable boatables days, as discussed below.

The number of higher quality boatable days (technical, standard, and big water boating only; it does not include "boatable but low quality days") are shown for specific years in Figure 4-5 since the completion of Culmback Dam Stage II in 1983. It shows that the

number of higher quality boating opportunities has occasionally exceeded ten days (particularly in the first two years after Culmback Dam Stage II was completed), but since current operations were implemented in 1990 it has ranged between 0 and 5 in most years.

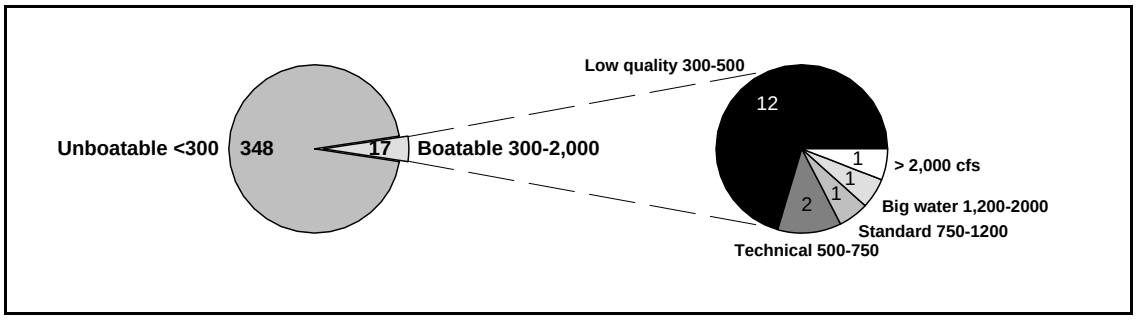

Figure 4-4. Average Number of Days of Boating Opportunities in Segment 3 per Year (1990-2007).

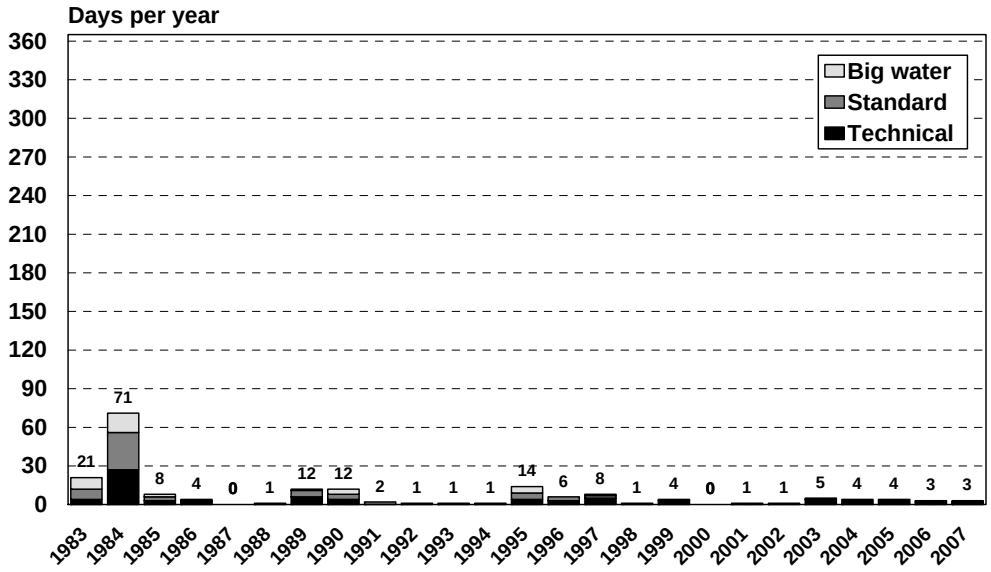

Figure 4-5. Number of Days of Higher Quality Boating Opportunities in Segment 3 in Specific Years (1983-2007).

Because flows for fisheries are generally added at the Diversion Dam, these estimates are most accurate for Segment 3. The number of days for Segment 2 would be slightly lower, because flows at the start of Segment 2 are usually lower than those below the Diversion Dam.

Because they are based on average daily flows, Figures 4-4 and 4-5 also probably over-estimate the "usable" number of boatable days. In many cases, flows spike for part of the

day, producing several hours of boatable flows but then dropping below those thresholds. Although boaters have access to instantaneous flows at the Diversion Dam gage, planning trips for short duration spike flows is challenging. Taken together, results indicate that higher quality whitewater opportunities occur a few days per year, and these few days are difficult for boaters to use.
Boatable flows in ***Segment 4*** are also affected by Project operations. Water storage generally eliminates or mutes peak flows, but power generation provides flow augmentations during summer and fall, which increases the number of boatable days.

It is possible to quantify these effects on whitewater boating by integrating information about boating flows with hydrology data. Based on daily flow information from the gage below the Powerhouse 1990-2007 (after completion of Stage II of Culmback Dam and rule curves and operational constraints were refined in November 1989), Figure 4-6 shows the average number of days per year when various opportunities (technical, standard, and big water, using the ranges defined for Segment 4) are available under current operations.

Results show that higher quality boatable days are available about half of the year, although many boatable days provide technical or big water opportunities rather than standard trips. In summer and fall (June through October), when fewer other rivers have good flows and boaters would be particularly interested in Segment 4 opportunities, about 26% of days have boatable flows (12% technical, 5% standard, and 9% big water).

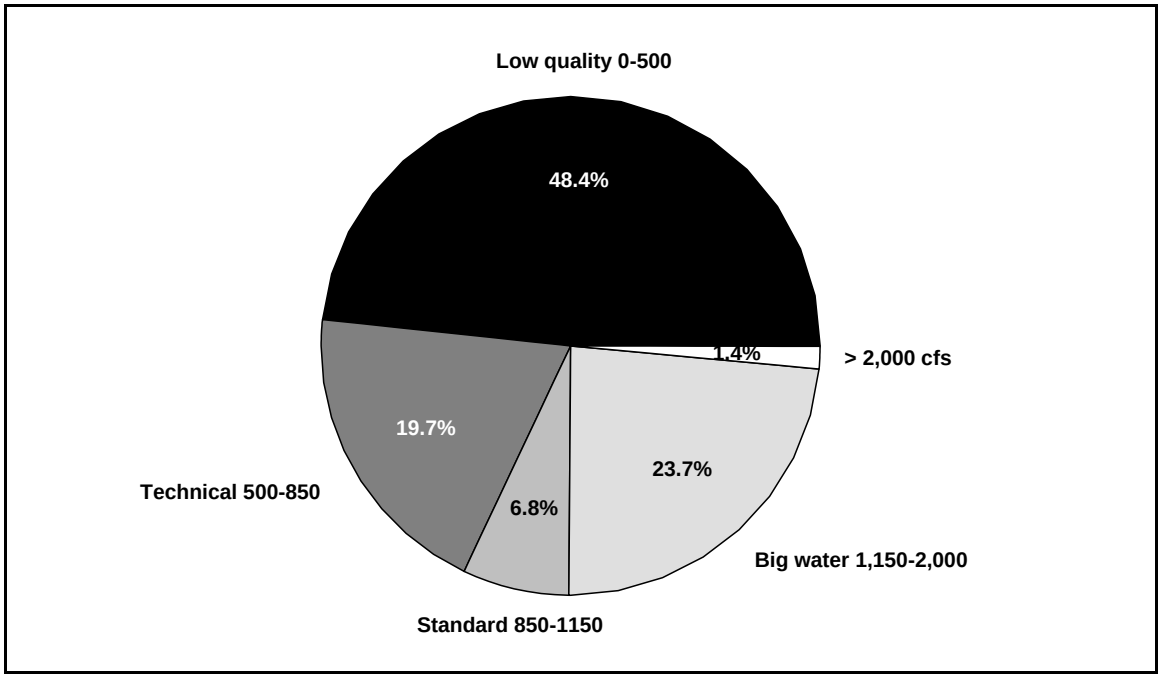

Figure 4-6. Percentage of Days of Boating Opportunities on Segment 4 Since 1990 (completion of Stage II Culmback Dam and refined operational procedures).

4.1.8 Comparisons to Other Rivers

Boaters were asked to rate the Sultan River segments below Culmback Dam in comparison to other rivers (within about two hours and the entire state of Washington). Responses were on a five point scale with the following points: "worse than average," "average," "better than average," "excellent," and "among the very best." Results are shown in Figure 4-7 for core team and supplemental boaters taken together (n=51).

Segments 2 and 3 are highly regarded in the region and statewide, with 64% to 83% rating them as "better than average," "excellent," or "among the best." Among these two reaches, Segment 3 received higher ratings. Segment 4, which is shorter but has boatable flows more often, had slightly lower ratings than Segments 2 and 3.

Focus group discussion identified the outstanding features of the run, including fine scenery, a remote and undeveloped character, and high quality Class III and IV whitewater. Boaters were also impressed by the length of the run and the amount of rapids. Combining segments produces a long (13.2 miles for all three segments) whitewater boating run that is scarce statewide.

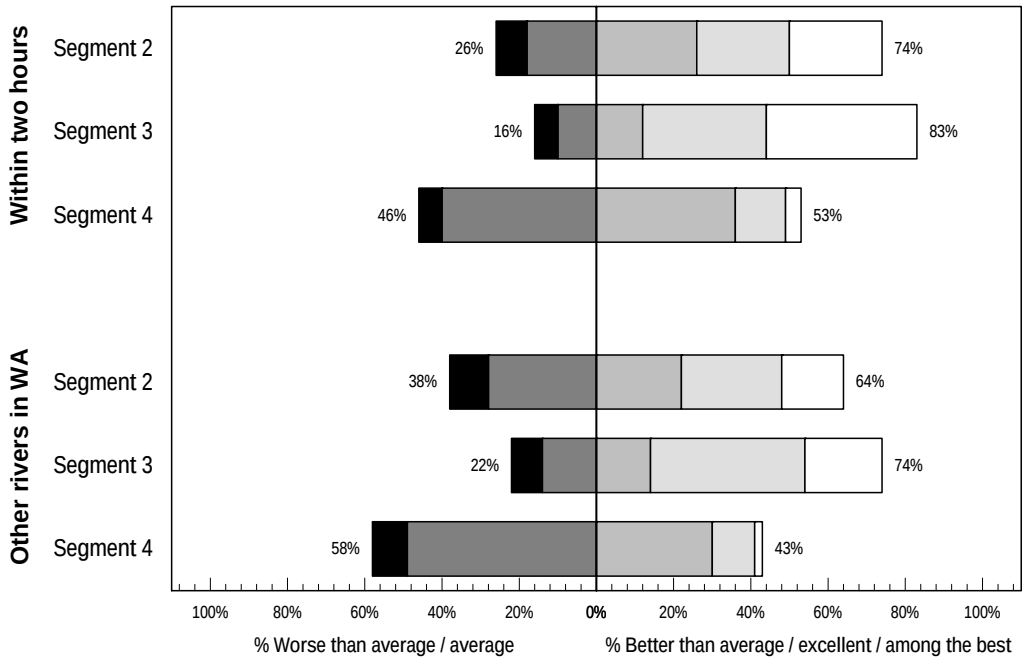

Figure 4-7. Boater Comparisons of Sultan River Segments to Others Within Two Hours and Statewide.

Boaters noted that many Puget Sound area rivers with Class III-IV whitewater are steeper and have more logs that require portages. Most rivers in the area are Class III (easier) or Class V (harder), with relatively few in between. When asked, boaters identified a few similar rivers (with caveats):

- Green River Gorge near Auburn, although it is generally easier, shorter, and has poor take-out access, with infrequent boatable flows (although more frequent than the Sultan).

- North Fork Skykomish, although it has only about one mile of comparable Class IV whitewater.

- Pilchuck Creek near Arlington, although it has more continuous (harder) whitewater and requires substantial rain to be boatable.

- North Fork Nooksack, although it has only about a mile of high quality whitewater.

4.1.8 Preferences for Flow Release Options

Anticipating boater interest (and recognizing operational constraints and power generation trade-offs), boaters were asked about their preferences for whitewater releases.

4.1.8.1 Timing of Flow Releases

Boaters were asked to rate their interest in months of the year and days of the week on a five point scale from "not at all interested" to "extremely interested." Mean responses are shown in Figure 4-8 for core team and supplemental boaters taken together.

Results show greatest interest in August and September (when few other whitewater rivers have boatable flows and weather is warmer). Interest was lower for December through February, the rainy season when many other rivers are running, and days are short and colder. There was greater interest in weekend versus weekday releases.

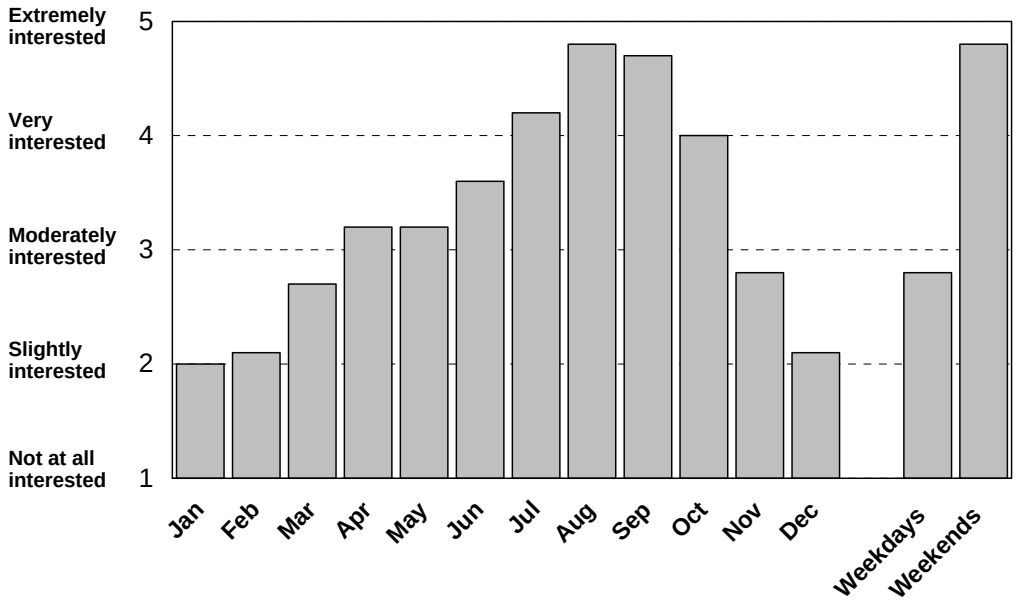

Figure 4-8. Average Interest in Flows for Specific Months and Days of the Week.

4.1.8.2 Length of Flow Releases

If boating flows were limited, boaters were asked about their preferences for optimal flows for one full day versus two consecutive days of releases with either 1) acceptable rather than optimal flows; or 2) optimal flows for fewer hours. Results are given in Table 4-4 for core team and supplemental boaters. They show a clear preference for optimal flows in general, with majority interest in two days of flows with fewer hours.

Table 4-4. Trade-offs in Lengths/Amounts of Flows.

If water for boating releases were limited, would you prefer…	Percent
…one day with an optimal flow all day	28
…two days with an acceptable but not optimal flows	15
…two days with optimal flows but for fewer hours	57

Discussion during focus groups provided additional information about these tradeoffs. First, having flows two days in a row is not a high priority. Given the length of the run, the relatively long hike-in access, and the proximity of the river to Seattle (where many boaters live), few boaters are likely to run the river two consecutive days and camp the night in between (especially if the releases occur in winter). Other rivers with such releases are farther from population centers, so two days of flows is important to make the trip worthwhile.

Second, the controlled flow study demonstrated that a full day of boating can be provided by a three to four hour release. On the first day, even at a low flow, the first boater group "caught up to" the front of the release after launching an hour after it began. Boaters never "ran out" of water, even taking out as late as 4:00 pm. With a release starting about 9 am, boaters that put-in before 11 am and make steady progress down river can take as long as 6 to 7 hours to the Powerhouse if necessary (less than two miles per hour). Even when the release is "turned off," flows decline relatively slowly (allowing extra time even if the opportunity changes to a lower quality level).

4.1.8.3 Quality Preferences on Different Segments

Because of the unique "plumbing" of the Jackson Project (which allows water to be added at the Diversion Dam), power generation losses could be minimized if less water were released from Culmback Dam and more water was added at the Diversion Dam. Boaters were asked about these trade-offs.

Results are given in Table 4-5 for core team and supplemental boaters. Boaters are divided over this trade-off, with equal numbers preferring the two options. Focus group discussion indicated that many boaters preferred the whitewater on Segment 3, but boating both segments was also very important. There was little interest in low quality technical boating on Segment 2 in trade for higher quality standard boating on Segment 3.

Table 4-5. Preferences for Optimal vs. Acceptable Flow Segment Trade-offs.

If water for boating releases were limited, would you prefer…	Percent
…acceptable but not optimal flows provided on Segments 2 and 3	50
…optimal flows provided only on Segment 3	50

4.1.8.4 Advance Notice of Whitewater Releases

Boaters were asked how far in advance they need to be notified of potential whitewater releases. Most required about 14 days (median) to plan such a trip, although several thought a week was sufficient.

4.2 Other River Recreation

4.2.1 Other Recreation Opportunities

4.2.1.1 Fishing

Fishing on the Sultan River is primarily focused on steelhead, although some anglers target trout and Dolly Varden (steelhead) (Robinson 2007; Torda 2007). There are winter and summer steelhead runs; the latter is weaker and neither is considered among the best in the region (Lowe 2007; Torda 2007; Bee 2007). The river has both hatchery and wild steelhead; some anglers are interested in more extensive steelhead stocking programs (Heirman 2007; Dalquist 2007), while others appear satisfied with the existing mix or prefer wild fish (Bee 2007; Dahl 2007).

Fish size averages about 6 to 10 pounds, but larger fish often reach 12 to 16 pounds (Lowe 2007; Heirman 2007). Steelhead season is from June 1 through February 28, with no lure restrictions. Although there are salmon runs, regulations prohibit salmon fishing. For more information about the fisheries in the Sultan River, refer to the PAD.

Anglers fish Segments 3, 4 and 5, with the highest use probably occurring on Segment 3 (from trails off the roads on the Lake Chaplain side) and Segment 5 (particularly from boats between Trout Farm Road and the Skykomish River confluence, or from the bank at Sportsmen's Park or Trout Farm Road boat launch in Sultan) (Dreimiller 2007; Schreiner 2007). Use levels are generally low, and some anglers value this relative lack of crowding (Bee 2007; Blankenship 2007; Dahl 2007). Most fish the river by themselves or with a partner, so group sizes are small. Watershed patrol officers report that there are sometimes as many as 10 vehicles at fishing access points on opening day or some weekends, but more common counts are 2 to 4 (Dreimiller 2007). Higher use levels occur in years when steelhead escapement is higher (Lowe 2007). Recreation survey work conducted for relicensing provides additional information about fishing use levels (Public Utility District No. 1 of Snohomish County and City of Everett, 2008).

Interviews suggests steelhead anglers use a variety of fishing methods, including fly fishing (usually while wading), spin fishing (wading or from the bank), and bait fishing

(often from a boat, but also from the bank). Most fly anglers use wet flies that mimic eggs, flesh, or insects (Bee 2007; Blankenship 2007) and fish Segment 3 off the Diversion Dam Road (Dreimiller 2007).

Common spinning lures include spoons and "pixies," while bait anglers use salmon eggs and shrimp (Harley 2007; Dahl 2007; Heirman 2007). Spin and bait fishing occurs on Segment 3 (near the Diversion Dam and just upstream from the Powerhouse), access points on Segment 5 (Trout Farm Road and Sportsmen's Park), or from boats launching from Trout Farm Road (Blankenship 2007; Bee 2007). Boating-based anglers may use drift boats, rafts, inflatable kayaks, and "belly-boats" (single person float tubes) (Lowe, 2007; Bee 2007; Blankenship 2007).

4.2.1.2 Recreational Mining

"Recreational" mining occurs in the Sultan Basin from Culmback Dam to the Powerhouse (Segments 1, 2, and 3). There are 17 claims; some are used by individuals and others by two mining associations (e.g., Washington Miners Prospectors Association [WMPA] with seven sites; Boeing Employees Everett Prospectors Society [BEEPS] with two sites). Some claims are disputed (Miller 2007).

The highest claim in the watershed is approximately 0.25 miles downstream from Culmback Dam in Segment 1, with several others between the start of Segment 2 and the Stringer Bridge (Miller 2007; Dunican 2007). The most popular Washington Prospectors claims (Miller 2007) are at Big Four Creek (Segment 2, RM 11.2) and near Horseshoe Bend area (Segment 3, RM 7.2).

Some mining claims have year-round permits, while others have seasonal restrictions (July 1 to August 31). Even for sites with a year-round permit, the "realistic" mining season, according to one miner, is from March through October because of weather (Miller 2007).

Miners haul some mining equipment into sites for the season, but some is left year-round (Miller 2007; Dunican 2007). Common equipment includes pontoon platforms, 2 to 5 inch dredges, generators, and sluicing / panning gear. Miners dredge gold from river sediments below the water surface (it is illegal to dredge above the waterline). Most gold is found in coarse sediments with median cobbles about 10 inches (Miller 2007).

Miners maintain their own informal trails into claims, with ropes on some steep sections (Miller 2007; Dunican 2007). Some sites have roads to trailheads, but vehicle access is generally limited by gates (miners or Associations have keys). Most mining is day use, although some camp over a weekend. Miners may work claims as individuals or in groups up to four. BEEPS sites are occasionally used by small groups of Boy Scouts to introduce the activity (Dunican 2007).

For association miners, Sultan mining is clearly recreational, although some members have made substantial equipment investments and expect financial returns (Miller 2007). Association miners consider the Sultan among the best close-by mining resources in the

Greater Seattle area; several claims are accessible within about an hour driving for members (Dunican 2007; Miller 2007).

4.2.1.3 Swimming and General River Recreation

There may be some swimming use at Sultan River Park near the mouth of the river, or from private residences along the lower river, but this use does not appear to be common (Dunn 2007; Dreimiller 2007; Schreiner 2007). More often these areas are used for "general river recreation" – picnicking or social gatherings – and opportunities are potentially enhanced by rather than dependent on river flows. When it occurs, swimming is generally done in Segment 5 in mid-summer (Dunn 2007).

4.2.2 Flow Requirements and Project Effects

4.2.2.1 Fishing

Flows affect fishability in several ways (Whittaker, Shelby, & Abrams, 2006). In general, lower flows are preferred by anglers because they provide (1) more fishable water, with current velocities and depths appropriate to preferred tackle and techniques; (2) improved access to fishable water due to improved wadeability; (3) the ability to use lighter tackle, which decreases the possibility of snagging rocks or vegetation in the channel; (4) fish concentrated in specific locations; and (5) better river aesthetics and possibly improved fishing success due to less turbid water.

Most anglers interviewed were sensitive to flows, but only a few were "calibrated" to a gage. Segment 3 flows do not vary substantially during the fishing season (with the exception of rare spill or high run-off during intense storms), so this is seldom a "variable" (Lowe 2007; Bee 2007; Robinson 2007). Flows on Segments 4 and 5 vary with Powerhouse outflows, but high peaks that would occur under a pre-Project regime are muted by Spada Lake storage.

Based on discussions with anglers, the best fishing in ***Segment 3*** is at "base flows" (Hartley 2007; Robinson 2007; Heirman 2007; Dalquist 2007) which typically range from 100 to 200 cfs during the fishing season. Anglers have fished higher flows (up to about 300 to 400 cfs), but these have reduced wadeability and sometimes increased turbidity (Dalquist 2007).

Overall, interview information suggests optimal fishing flows in Segment 3 are less than about 200 cfs, and flows as high as 400 cfs may be acceptable in some locations (although the river is probably not crossable above 400 cfs). Flows over 600 cfs offer limited fishable water and increased turbidity. Whitewater flows about 700 to 1,000 cfs do not offer high quality fishing on this reach. Researcher evaluations of fishability during the controlled flow study support this conclusion.

Anglers suggest a wider fishable range on ***Segments 4 and 5*** (Lowe 2007; Blankenship 2007; Torda 2007; Dahl 2007; Bee 2007)**.** This is probably related to three factors: 1) the river is more alluvial, has less gradient, and is generally wider, producing more fishable area; 2) anglers are more likely to fish from banks or boats, so additional water does not

decrease fishable area; and 3) higher flows occur more regularly and anglers have learned how to fish them.

In summer, flows below 400 cfs are too low for some watercraft (e.g., drift boats), requiring anglers to "walk around" some rapids, and occasionally becoming stopped in riffles (Bee 2007; Blankenship 2007; Dahl 2007). These low flows are rare during the winter run, and would be more frequent in the summer and early fall without the Project. At the high end, anglers fish Segment 5 in drift boats as high as 1,400 cfs (Bee 2007); higher flows are best for bait anglers fishing deeper pools.

Bank- or wading-based anglers on Segments 4 and 5 are less specific about flow ranges. Some report fishing from the bank is relatively unproductive, but some holes are probably accessible. Based on information for Segment 3 and other rivers, lower flows are easier to wade, and optimal whitewater flows will not provide optimal fishability flows for wading anglers.

Project operations generally appear beneficial for fishability (independent of biological effects on fish habitat) on ***Segment 3.*** These beneficial effects are particularly evident for winter run fishability, when Pre-Project base flows were higher and more variable.

Beneficial Project effects on fishability are smaller for Segments 4 and 5 due to Powerhouse outflows. The Project probably increases the number of boatable fishing days in summer and early fall by adding Powerhouse outflows, but it also adds them in winter, which may decrease fishable area for anglers that get out of their boats to fish. Although the Project also reduces the largest peak flows on these reaches, it does not provide the low base flows necessary for extensive wading-based use found on Segment 3. Most anglers still use boats to access Segment 5, and these opportunities can utilize a wider range of flows.

4.2.2.2 Recreational Mining

Based on interviews with miners (Dunican 2007; Miller 2007), flows can affect recreational mining in three major ways. First, miners need currents slow enough to maneuver their dredge platforms, and to swim or wade to target sediments. Second, because regulations only allow mining below the water line, flows need to cover target sediments. Third, the turbidity of high flows may limit the ability to find and mine target sediment pockets.

A few miners are calibrated to Sultan River gages, but most are not because the Project typically provides optimal mining flows during the primary mining season (July and August) in Segments 2 and 3 (Miller 2007). Flows rarely exceed 20 cfs plus accretion in Segment 2, and 100 cfs plus accretion in Segment 3. These flows allow good access for dredges and wading miners, cover target sediments in the bottom of the channel, and are clear. Any substantial increase in flows (e.g., over 500 cfs for whitewater) would be "un-mineable," and might jeopardize typical summer equipment storage locations (if miners were not informed about releases, and did not move their equipment to higher ground).

Some miners have additional concerns about whitewater boating. Although Association miners are not particularly concerned about loss of solitude or potential vandalism, at least one private miner has expressed strong opinions about this possibility to the District, USFS, City of Everett and FERC (Raether 2007). Association miners want to ensure that access trails used by the public are managed to handle to the volume of use, and when possible, public use is directed away from active mining areas with equipment (Miller 2007; Dunican 2007).

4.2.2.3 Swimming and General River Recreation

Previous studies show that different types of swimming areas respond differently to increased flows. For example, pool areas may be usable through a wide range of flows because current velocities do not change dramatically and substantial depths make these sites attractive. In contrast, higher gradient riffles and runs can change substantially with increased flows. At low flows, they may be stagnant and too shallow for certain types of swimming (e.g., "laps," or diving from the bank). At high flows, crossing may become difficult and stronger hydraulics can over-power less-skilled swimmers.

For the occasional wading and swimming that occurs on Segment 5 of the Sultan River, high quality opportunities are likely to be available through several hundred cfs. Whitewater releases might provide currents that are too fast in some riffles and runs, but pools and eddies near shore are likely to remain available. Whitewater releases in mid-summer may lower river temperature, but cool water already limits swimming. Similarly, there is also likely to be a distinct seasonal limitation on swimming. Before July and after early September, swimming is unlikely to occur regardless of the flow.

Many general recreation activities are enhanced by a river's aesthetics, which are in turn related to flows (Moore et al., 1990). Flows are one of several important factors in evaluations of scenic quality in a riverscape (topographic relief, vegetation, color, and weather conditions also play important roles), and recreation users can evaluate aesthetics of flow levels (Brown and Daniel, 1991). In general, aesthetic evaluations are high except when flows do not cover the bottom of the channel (Whittaker and Shelby, 2002). On Segment 5, where most riverside recreation is likely to occur, even low summer base flows are likely to provide acceptable aesthetics. Whitewater releases are unlikely to substantially diminish change this, and they might create more visual diversity by changing current speeds and rapids.

4.3 Whitewater Release Considerations

Boating advocates are interested in creating additional whitewater boating opportunities on the Sultan River. It is outside the scope of this report to recommend specific flow releases or the number of boating days that might address this interest, but it is possible to identify considerations that may help the District, agencies, and whitewater interests discuss the possibilities. Considerations include Project operations, District liability, impacts on other recreation opportunities, impacts on water supply and other resources, cost of releases and boater interest in different flows and opportunities.

4.3.1 Operational Considerations

From a utility perspective, two major operational considerations affect potential whitewater recreation releases. The first consideration is economic. Culmback Dam and Spada Lake store nearly all the water (aside from minimum fish habitat releases and occasional spill events) that is needed for the City of Everett's water supply used by Snohomish County residents and for a small portion of the District's expanding power generation needs for its service area, so additional flow releases erode the Project's ability to meet those two objectives. Although some hydroelectric projects must spill flows during part of the year, the Jackson Project has no such requirements. Unless coordinated with maintenance events, whitewater flow releases will diminish the Project's power generation and increase the District's power purchases. In general, the District would prefer to release as little water as possible from the base of Culmback Dam because the high head characteristics of the Project produce substantial power generation benefits. Releases at the Diversion Dam, while limited to roughly 180 cfs, do allow for a modest level of generation through the Project's Francis units but at reduced efficiency compared to releases from Spada Lake through the higher head (over 1000 ft) Pelton units. Releases at the Jackson Powerhouse into the Sultan River (up to 1,300 cfs) provide for maximum generation per unit of flow.

Quantifying the economic value associated with a release for whitewater recreation requires information on the location, magnitude, duration, frequency, and timing of the release. A brief discussion of these factors follows:

- Location – as outlined previously, releases from Culmback Dam into segments 1, 2, and 3 incur a greater cost than release from the Powerhouse into segments 4 and 5. Releases from the Diversion Dam are intermediate in cost but are limited in magnitude. Releases solely from the Diversion Dam do not provide a boatable flow.

- Magnitude – the volume of flow required to provide a particular whitewater experience in segments 2 and 3 ranges from 300 cfs to 2,000 cfs.

- Duration – in general, a 3 to 4 hour release appears sufficient to provide quality whitewater boating. However, this duration assumes a rapid opening and closing of the valves at Culmback Dam. The Operating Plan for the Jackson Project outlines specific downramping criteria that regulate the rate of stage reductions in the river for the protection of salmon and steelhead in the river. The criteria vary by season with the most liberal rates during the period when fry are least vulnerable (November through February). The net effect of the downramping criteria is that the actual duration of the release may be significantly longer than what is required for the recreational experience alone. The magnitude of the release also influences the duration of downramping.

- Frequency – the number of releases relates directly to economic costs.

- Timing – As previously mentioned, the timing of a release relates to fish protection requirements. The timing or season of a release relates to directly to power prices which can be highly variable.

These factors may act independently or in combination with one another. The District estimates costs associated with a one-day release may range between $15,000 and $75,000 depending on the magnitude and duration of the release and the replacement cost of power.

Second, there are practical considerations for flow releases. Valve-controlled releases of approximately 2,500 cfs are possible at Culmback Dam, so that is not a constraint (whitewater releases would be considerably less). However, the releases at the Diversion Dam are limited to about 180 cfs, providing an upper limit for adding water into Segment 3. In general, operators have the least flexibility to provide whitewater flows from July through September (particularly in dry years), when power values are high and they must carefully balance water supply and generation use with water availability and reservoir level goals for Spada Lake. There is also less flexibility in late spring (usually May), when filling Spada Lake for summer water use is critical (and the quantity of water to be produced from runoff and the last few spring storms may be more difficult to predict). In general, the times of greatest flexibility are from the start of fall rain storms (late October) through early spring (March), when there is usually higher runoff from storms and melting snow.

4.3.2 Liability

Potential District liability from providing whitewater flows is a concern. A legal analysis of liability issues is beyond the scope of this report, but the District has offered a summary review below:

Safety and liability concerns are common issues for whitewater boating, as FERC has recognized on several occasions. However, a FERC license containing a requirement to release "whitewater flows" may not be a shield to potential liability. The issue of liability for actions of a licensee is typically beyond the authority of the FERC, and appears to be a matter for resolution under state law.

It is unclear whether an injured whitewater boater could maintain a liability claim against a hydroelectric project licensee in Washington State. Washington's recreational immunity statute does not clearly provide a liability defense for whitewater boating below a hydroelectric facility, particularly if the activity occurs outside of a project's FERC boundary or on surrounding land not owned by the hydroelectric project licensee. With these uncertainties, potential common law liability claims remain a concern for project licensees.

Other electrical generating utilities in Washington State have approached state legislators and asked for legislative changes to clarify recreation immunity statutes. The District may determine that it needs to join in this effort.

Absent clear immunity conferred by statute to limit potential liability, a hydroelectric project licensee may need to set conditions on recreational boating activities (including whitewater boating) to help reduce exposure to liability claims. Example management actions could include: institution of a permitting system, requiring users to sign liability waivers, and requiring commercial rafters to have a permit and liability insurance. Appropriate signage posted at trail heads, with access limited to those areas, as well as other measures, may also be needed to limit the potential liability. These measures and conditions may also be required by any future statute conferring recreational immunity upon generating utilities in Washington State.

4.3.3 Impacts on Other Recreation

Whitewater boaters would prefer weekend whitewater releases in summer, but these are the same days that anglers and recreational miners use, and whitewater flows are likely to affect those activities. July and August weekends are particularly problematic for miners, because this is the "heart" of their mining season.

If summer boating releases were provided, they should be short (e.g., 3 to 4 hours) and well-publicized. This would allow miners to store their equipment above high water, and miners and anglers (boat and bank) could plan their activities accordingly. In general, miners and anglers would "lose" only part of a day during a whitewater flow release. For example, a summer whitewater flow release of 800 cfs from Culmback Dam from 10:00 am to 1:30 pm (with an additional 175 cfs from the Diversion Dam from about 1:00 pm to 4:00 pm) would probably prevent mining for a period of about 6 hours (in the morning at sites higher in Segment 2, in the late afternoon for sites near Horseshoe Bend in Segment 3). Similarly, anglers on Segment 2 would not be able to fish for about 6 hours starting around 12:00 noon.

4.3.4 Impacts on Other Resources

Whitewater recreation flows in summer may have impacts on biophysical resources, which are being addressed by other relicensing studies (to be integrated with results of this report as they are completed in 2008). Issues are likely to focus on timing releases to minimize potential effects on the behavior, including the potential displacement and disruption of rearing and spawning fish. Salmon and/or steelhead fry and juveniles are present throughout the summer months. Spawning of salmon occurs during the fall (September through January) whereas steelhead spawning occurs in the spring (March through June).

When integrating whitewater recreation flow information with ecological flow needs, some attention may focus on designing flow releases that mimic natural (unimpaired) high flow events and serve other ecological purposes (e.g., channel maintenance, gravel cleaning). However, these types of events historically occurred from mid-November through June and were much higher than whitewater recreation flow releases considered in this report. If whitewater recreation flow releases occur in wetter parts of the year when storms could have occurred under a pre-Project condition, they are likely to have less adverse effects. Monitoring may be needed to assess hypothesized impacts.

Stakeholders have expressed concern about potential impacts of whitewater boating on cultural resources in the canyon, particularly the Horseshoe Bend Placer Claim (~RM 7; listed on the National Register of Historic Places) and the Diversion Dam (recommended eligible for the National Register of Historic Places). Flows likely to be considered for whitewater recreation flow releases (probably lower than 1,200 cfs) are unlikely to have physical impacts on these two cultural resource areas because existing spill events are typically much larger (and appear to be having few effects, if any). However, providing boating releases would induce additional recreational use in the Sultan River canyon compared to current Project conditions (see managing boating use below, Section 4.4.3) and may increase the risk of vandalism to these historic resources.

4.3.5 Boater Interest in Different Opportunities

If there were no constraints, boaters would prefer optimal standard flows on weekends from mid-summer through early fall (see Section 4.1.8.1). However, boaters recognize that operational constraints, trade-offs with power generation, and concerns about impacts on other resources or recreation opportunities may limit the frequency or magnitude of augmented flows. Given this reality, the issue shifts from identifying boaters' "ideal" conditions to prioritizing the magnitude or timing of flows that provide the greatest benefit. The following summarizes likely boater priorities:

- In general, there is more interest in optimal standard boating than technical or lower quality standard boating, even if flows are provided fewer days per year or less time per day.

- Few boaters would argue for releases much higher than the low end of optimal boating (e.g., flows above 900 to 950 cfs) on Segments 2 or 3, respectively.

- If releases must occur after mid-October due to fish spawning issues, boaters would prefer them in October or early November (or wait until April); the goal is to avoid winter's shorter days and colder temperatures.

- Most Seattle area-based boaters are likely to support one-day releases (two days are not needed to attract them to the area). Paddling both reaches is a long day, and few boaters are interested in back-to-back long days.

- Boaters would prefer weekends over weekdays, and Saturdays over Sundays.

- Boaters probably do not need Culmback Dam releases longer than 3 to 4 hours. Boaters on other rivers (e.g., Youghiougheny, South Fork American, Upper Klamath, Ocoee) have learned to utilize whitewater releases of about this duration, which provide a two to three hour "put-in window" (as long as boaters move at the river's pace). During the controlled flow study, releases from about 9:00 am to 12:30 pm were clearly adequate. (Note: This assumes minimal ramping (as occurred during the study; attenuation through Segments 1 and 2 essentially created a "ramped" condition by the time water reached Segment 3 where substantial fish populations are resident.

- Some boaters would accept slightly lower quality standard or technical opportunities on Segment 2 in trade for higher quality opportunities on Segment 3 (or more releases per year). If access to the Diversion Dam were available during releases, a few boaters are likely to be interested in boating only Segment 3 (which has better whitewater). However, others appear interested in higher quality standard opportunities on Segment 2, or a single flow level on both reaches. There is no consensus over whether to use the Diversion Dam to add additional water to Segment 3. If this concept were used in planning releases, boaters would probably be more supportive if the flow on Segment 2 were at least 750 cfs (transition of technical/standard opportunity).

- Boaters prefer that information about planned releases be provided at least two weeks before the release.

4.4 Other Whitewater Boating Management Issues

4.4.1 Estimated Use Levels

It is challenging to estimate use for whitewater boating on river segments where boatable flows are rarely available. Boatable flows have not been reliably available on the Sultan River since Culmback Dam Stage II was completed in the early 1980s, and they were infrequently available during the early development of whitewater kayaking in the 1960s and 1970s. Kayaking demand has grown considerably since that time, with a major increase in the late 1990s. Aside from availability of flows and this general increase in kayaking demand, several other variables affect potential use levels on a specific river:

- proximity to population centers;
- quality of the run;
- difficulty of the run;
- type of opportunity (technical, standard, or big water boating);
- flow quality (optimal or acceptable levels);
- quality of scenery or other setting characteristics;
- length of shuttle;
- availability of facilities (e.g., nearby camping);
- difficulty of access;
- availability of other rivers during the same time period;
- crowding;
- permit requirements; and
- weather.

While it is outside the scope of this report to comprehensively examine these variables, it is possible to estimate potential ranges based on similar rivers, characteristics of the Sultan River, and professional judgment.

Scheduled releases on other Class III-IV whitewater rivers have attracted 200 to 500 kayakers on some days (e.g., Cheoah River, NC; Rock Creek / Cresta reaches on the

Upper North Fork Feather River, CA; Gauley River, WV). Popular runs on rivers with reliable and frequent boating releases (e.g., Lower Youghiogheny River, PA; South Fork American River, CA) may attract even higher kayaking use. Use on Segments 2 and 3 on the Sultan River is unlikely to reach those levels because: (1) the put-in to Segment 2 requires an hour-long hike; and (2) likely release times (due to potential impacts on fisheries and other recreation resources) may not be in summer when weather is better and fewer other rivers are available. Unless Sultan River releases were provided in July – September, an upper limit for a single-day release is likely to be about 150 to 200 boaters.

However, the Sultan River is close to a major metropolitan area with a robust kayaking population. A demand assessment for Portland, Oregon (Whittaker and Shelby, 2004) conservatively estimated over 1,000 avid Class III-V kayakers in that city, and the Seattle area (with about twice the population) probably has a larger number. Scheduled Sultan River releases when weather is "reasonable" (e.g., before November or after March) are likely to be well-attended. Fair weather weekend days might attract 80 to 120 boaters, particularly if releases are offered only a few days per year. On poor weather days, 40 to 80 boaters are more likely (there were 47 supplemental boaters on Saturday of the controlled flow study, with steady rain).

Numbers within these ranges are likely to be higher if paddling clubs organize shuttles, releases are well-publicized, and Diversion Dam access is offered (some boaters would run only Segment 3 to avoid the hike-in access or focus on the more challenging rapids; others might only boat Segment 2, which is easier). Numbers are likely to be lower if flows are more frequent (e.g., 10 or more days per year), releases occur in colder months, there are no organized shuttles, and the only access is hiking into Segment 2. The release in December 2005 attracted about 35 boaters even with snow on the ground.

4.4.2 Access Issues

For Segment 4, there is road access at the Powerhouse and Trout Farm Road (with a short carry to parking along the road). There are challenges related to the Segment 2 hike-in and potential access to the Diversion Dam by vehicles.

4.4.2.1 Hike-in Access from Forest Service Road 6122

The existing 1.1 mile informal trail from FR 6122 has been used by boaters for several years. This trail was originally developed by a miner who objects to its continued use by the public. Although the USFS has stated that the trail is not for exclusive use by any one party, they do not encourage use by the general public. Boaters who know the route have little trouble carrying boats to the river in less than an hour, but there are challenging sections: (1) downed trees and debris across a landslide; (2) several short steep pitches with awkward side-cuts and slippery soils; and (3) a steep drop to the river at trail's end (the miner uses a ladder that is off-limits to boaters).

The USFS assessed this trail and two alternatives (Forest Service 2007). They concluded that substantial work would be needed to bring the existing informal trail up to acceptable standards, and recommended development of an alternate route/trail to access the river. Considerations about whether to develop this new route/trail (and its location) may

include how often boatable flows are available and the number of boaters likely to use them.

Based on the USFS assessment, a potential alternate trail could start from the same FR 6122 turn-around before the landslide used with the existing route. However, the new 1.3 mile trail would traverse more gentle grades (generally less than 10%), and end at a put-in site far enough from the current put-in site to decrease potential conflicts (about 500 feet upstream of the end of the current trail).

The USFS did not recommend a third potential route to an old log stringer bridge because of the up-canyon landslide, encroaching vegetation in the old road bed, the likelihood of additional slides, and the greater distance to the river.

Boaters interested in running the Sultan River are typically fit and able to handle challenging hike-in access, but most would probably prefer a better trail (or vehicle access, if it could be provided). In the early 1980s, FR 6122 provided two-wheel drive access to the stinger bridge about 0.5 mile below the current put-in (Williams, 2007), an attractive access situation. Anything that decreases the effort involved in getting to the river would probably be supported by boaters, but they do not require a better trail, and many consider the existing trail satisfactory. From a resource perspective, scheduled releases are likely to increase the number of boaters using the trail, which appears to be among the major factors considered in the USFS recommendation. The USFS planned and budgeted to fix FR 6122 in 2005, but it postponed those efforts pending relicensing study results, which are expected to help identify recreation access needs with greater specificity.

4.4.2.2 Diversion Dam Access

Several boaters indicated that they might be interested in running either Segment 2 or 3 but not both. Public vehicles are currently not allowed access to the Diversion Dam road for security and safety reasons (it is gated at the run-off from Lake Chaplain Road), but the road and dam were accessible to District and researcher vehicles during the study (and they transported a few supplemental boaters). Arranging some form of access to these areas during flow releases would provide more flexibility for boaters, but might incur some management costs and liability exposure for the District.

Past the locked gate, the road is generally one lane with very limited parking near the Diversion Dam (or just downstream). If vehicle access is considered, a small number of organized shuttles could be conducted. One or two vehicles with a trailer could provide access for several dozen boaters.

4.4.3 Managing Use

On Saturday during the controlled flow study, over 50 boaters ran the river without substantial crowding or significant management issues. The District was able collect liability forms from all boaters, and no rescues were required.

However, the study required several District staff to monitor use, collect liability forms, and regulate flows. A few boaters also took advantage of District presence at the Diversion Dam to take-out or put-in at that location (some needed a ride out after deciding not to run Segment 3, while others were late to the put-in and were offered access to Segment 3).

There were also some "bottlenecks" at the put-in (the staging area, parts of the trail, at trail's end). If use levels approached 100 or more boaters, these might be exacerbated. However, they can be managed with relatively minor organization of use. Cooperative shuttles are probably the greatest need, and have been used successfully on other rivers (e.g., Lower Youghiogheny, Upper North Fork Feather). Trail improvements (if a new trail is developed) might also address these issues.

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6.0 APPENDICES

6.1 Flow Study Participant and Interview List

6.1.1 Flow Study Boaters

Core team

- Amy Brown
- Megi Morishita
- Will Robens
- Ryan Murray
- Andy Bridge
- Jennie Goldberg
- Hilary Neevel
- Thomas O'keefe
- Chris Tretwold
- Devin Smith
- Eric Mickelson
- Brian Zderic
- Bo Shelby (CRC consultant)
- Doug Whittaker (CRC consultant)

Supplemental boaters (that completed surveys)

- David Chatham
- Robert Mckibbin
- Charles Mellon
- Damon Matlon
- Jeff Bowman
- James Amandus
- Lisa Farin
- Todd Gillman
- Travis Lee
- Conor Sayres
- Stacy Karacostas
- Jon Almquist
- Gary Lewandowski
- Shane Robinson
- Bucky Klein
- Terry Lien
- Michael Harms
- Jonathan Ambrose
- Jonathan Dufay
- Joseph Mosquera
- Brock Gavery
- Christopher Lambiotte
- Rebecca Brown
- Brad Xanthopoulos
- Dave Moroles
- Christian Knight
- Steven Strong
- Jonathan Ambrose
- Dale Karacostas
- John Schier
- Kennet Belenky
- Abe Herrera
- Andrew Oberhardt
- Dave Evans
- Tim Holmberg
- Brian Vogt
- Dirk Fabian
- Scott Waidelich
- James Contos
- Dan Gavere
- Chris Fee
- Kyle Kovalik
- Tracy Clapp
- Nick Newhall

6.1.2 Interviewees

- Garry Blankenship, angler
- Ralph Dalquist, angler and member of Snohomish Sportsmen
- Vance Robinson, angler (also Filtration Plant maintenance)
- Sam Hartley, angler (also Filtration Plant operator)
- David Dahl, angler
- Gary Bee, angler, member of local chapter of Trout Unlimited
- Ron Torda, fly shop owner
- Bob Heirman, angler
- Larry Lowe, Washington Department of Fish and Game staff, angler
- Connie Dunn, City of Sultan (public works lead)
- Jim Miller, miner, Washington Prospectors
- Rick Williams, boater
- Jennie Goldberg, boater
- Brian Zderic, boater
- Joe Dreimiller, watershed patrol
- Patrick Schriener, watershed patrol
- Andy Bridge, boater, American Whitewater
- Tom O'Keefe, boater, American Whitewater

6.2 Flow Study Survey Instruments

SULTAN RIVER PRE-FIELDWORK INFORMATION FORM

Date: _____ / _____ / _____ Your name: _____

1. For the following types of whitewater craft, please indicate 1) the frequency you use each compared to other craft, 2) the years of experience you have with each, and 3) your skill level with that craft.

Craft	Frequency of use (circle one for each craft)				Years of experience	Skill level (circle one class)			
Hard shell kayak	No	Rare	Occasional	Frequent		II	III	IV	V
Inflatable kayak	No	Rare	Occasional	Frequent		II	III	IV	V
Raft/cataraft (length: ____)	No	Rare	Occasional	Frequent		II	III	IV	V
Other: _____	No	Rare	Occasional	Frequent		II	III	IV	V

2. In general, how many days per year do you spend whitewater boating? _____ days per year

3. What is your age? _____ years

4. Are you ❒ male or ❒ female?

5. Please estimate the number of trips you have taken on each reach of the Sultan River?

   _____ trips on Segment 2 (from Culmback Dam/6122 River Access site to Diversion Dam)

   _____ trips on Segment 3 (Diversion Dam to Powerhouse)

   _____ trips on Segment 4 (Powerhouse to Trout Farm Road)

   _____ trips on Segment 5 (Trout Farm Road to the Skykomish)

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

	Strongly disagree	Moderately disagree	Slightly disagree	No Opinion	Slightly agree	Moderately agree	Strongly agree
Running challenging whitewater is the most important part of my boating trips.	1	2	3	4	5	6	7
I am willing to tolerate difficult put-ins and portages in order to run interesting reaches of whitewater.	1	2	3	4	5	6	7
Good whitewater play areas are more important than challenging rapids.	1	2	3	4	5	6	7
I prefer boating steep, technical rivers.	1	2	3	4	5	6	7

SULTAN RIVER POST-RUN FORM

Date: _____ / _____ / _____ Your name: _____

1. What type of boat did you use today? ❑ Hard shell kayak ❑ Inflatable kayak ❑ Other _____

	Segment 2	Segment 3
2. Please check the reaches you boated today…	❑	❑
3. Please estimate the general class of whitewater on each reach (I to VI)		
4. Please estimate the class of the hardest rapid on this reach at this flow (I to VI)		
5. Please estimate the number of stops and portages you had on each reach.		
*Number of times I was **stopped** after hitting rocks*		
*Number of times I had to **portage** around unrunnable rapids/logs*		

6. Using the scale below, please rate the overall quality of the flow you boated for each reach *(Circle one number for each column).*

	Segment 2	Segment 3
Totally unacceptable	1	1
Slightly unacceptable	2	2
Marginal	3	3
Slightly acceptable	4	4
Totally acceptable	5	5

7. Please indicate the type of boating opportunity provided at this flow for each reach. *(Circle one number for each column).*

	Segment 2	Segment 3
***Technical boating:** Lower flow trips with technical routes through rapids, fewer route options, less powerful hydraulics, and occasional boatability problems (hitting or becoming stuck on rocks in the channel).*	1	1
*Transition between **technical** and **standard** boating.*	2	2
***Standard boating**: Medium flow trips with less technical whitewater, more route options, stronger hydraulics, larger waves, and infrequent boatability problems.*	3	3
*Transition between **standard** and **big water** boating.*	4	4
***Big water boating:** Higher flow trips with powerful hydraulics, larger waves, and no boatability problems.*	5	5

8. In general, would you prefer a flow that was higher, lower, or about the same as this flow? *(Circle one number for each column).*

	Segment 2	Segment 3
Much lower flow	1	1
Slightly lower flow	2	2
About the same; this was close to an optimum flow	3	3
Slightly higher flow	4	4
Much higher flow	5	5

SULTAN RIVER "CLOSE-OUT" FORM

Date: _____ / _____ / _____ Your name: _____

1. Given what you know about the quality of whitewater and other features on the Sultan River, please tell us maximum number of **stops** and **portages** that are tolerable for a high quality trip in your craft on each reach? *If you "don't care" about the number of stops and portages, place an X in the space provided.*

	Segment 2	Segment 3	Segment 4
*Number of **stops** I will tolerate after hitting rocks*			
*Number of **portages** I will tolerate around unrunnable rapids/logs*			

2. Compared to other rivers, how would you rate boating opportunities on these reaches? *(Circle one number for each; if you are unsure, leave that item blank).*

…other rivers in the area (within 2 hours)	*Worse than average*	1	1	1
	Average	2	2	2
	Better than average	3	3	3
	Excellent	4	4	4
	Among the very best	5	5	5
… other rivers in Washington	*Worse than average*	1	1	1
	Average	2	2	2
	Better than average	3	3	3
	Excellent	4	4	4
	Among the very best	5	5	5

3. Based on your boating trips on the Sultan River, please specify the flows that provide the following types of experiences. *(Note: If you are comfortable doing so, it is okay to specify flows you have not seen).*

	Segment 2	Segment 3	Segment 4
Think of the river as a ***waterway used for transportation***. What is the ***lowest flow*** you need to simply get down each reach in your craft?			
Some people are interested in a "technical" whitewater trip at lower flows. Think of this "**technical trip**" in your craft for each reach. *What is the **lowest flow** that provides an **acceptable** technical trip?*			
*What is the **lowest flow** that provides an **optimal** technical trip?*			
Some people are interested in taking trips at somewhat higher flows that feature stronger hydraulics but may offer less technical routes through rapids. Think of this "**standard trip**" in your craft for each reach. *What is the **lowest flow** that provides an **acceptable** standard trip?*			
*What is the **lowest flow** that provides an **optimal** standard trip?*			
What flow defines the ***transition between technical and standard trips?***			
Some people are interested in taking trips at much higher flows that feature more powerful hydraulics and large waves. Think of this "**big water trip**" in your craft. *What is the lowest flow that provides an **acceptable big water trip**?*			
*What is the lowest flow that provides an **optimal big water trip**?*			

	Segment 2	Segment 3	Segment 4
What flow defines the ***transition between standard and big water trips***?			
What is the ***highest safe flow*** for your craft and skill level?			
If only ***one*** flow was to be provided in a reach, what flow would you prefer?			
If ***two flows*** were to be provided in a reach on different days, what two flows would you prefer?			

4. Please rate your interest in boating flow releases in different months (assume optimal flows; consider each month as if flows would be provided only in that month).

	Not at all interested	Slightly interested	Moderately interested	Very interested	Extremely interested
Jan	1	2	3	4	5
Feb	1	2	3	4	5
Mar	1	2	3	4	5
Apr	1	2	3	4	5
May	1	2	3	4	5
Jun	1	2	3	4	5
Jul	1	2	3	4	5
Aug	1	2	3	4	5
Sep	1	2	3	4	5
Oct	1	2	3	4	5
Nov	1	2	3	4	5
Dec	1	2	3	4	5

4. Please rate your interest in boating flow releases on weekdays vs. weekends.

	Not at all interested	Slightly interested	Moderately interested	Very interested	Extremely interested
Weekdays	1	2	3	4	5
Weekends	1	2	3	4	5

5. If water for boating releases were limited, would you prefer… *(Circle one number)*
   1. …one day with an optimal flow all day.
   2. …two days with acceptable but not optimal flows.
   3. …two days with optimal flows but for fewer hours each day.

6. If water for boating releases were limited, would you prefer … *(Circle one number)*
   1. …acceptable but not optimal flows provided on both Segments 2 and 3.
   2. …optimal flows provided only on Segment 3 (below the Diversion Dam).

7. How far in advance do you need to know about releases in order to plan trips on Sultan River?

   About _____ days in advance or…

   About _____ weeks in advance, or…

   About _____ months in advance.

Please provide overall evaluations of flows for ***technical and standard trips*** on the two whitewater reaches above the powerhouse. Please consider all the flow-dependent characteristics that contribute to high quality trips (e.g., boatability, whitewater challenge, safety, availability of play areas, aesthetics, and rate of travel).
If you do not feel comfortable evaluating a flow you have not seen, don't circle a number for that flow.

	Totally unacceptable	Moderately unacceptable	Slightly unacceptable	Marginal	Slightly acceptable	Moderately acceptable	Totally acceptable
Segment 2: Technical trips							
200 cfs	1	2	3	4	5	6	7
300 cfs	1	2	3	4	5	6	7
400 cfs	1	2	3	4	5	6	7
500 cfs	1	2	3	4	5	6	7
600 cfs	1	2	3	4	5	6	7
800 cfs	1	2	3	4	5	6	7
1,000 cfs	1	2	3	4	5	6	7
1,200 cfs	1	2	3	4	5	6	7
1,500 cfs	1	2	3	4	5	6	7
2,000 cfs	1	2	3	4	5	6	7
Segment 2: Standard trips							
200 cfs	1	2	3	4	5	6	7
300 cfs	1	2	3	4	5	6	7
400 cfs	1	2	3	4	5	6	7
500 cfs	1	2	3	4	5	6	7
600 cfs	1	2	3	4	5	6	7
800 cfs	1	2	3	4	5	6	7
1,000 cfs	1	2	3	4	5	6	7
1,200 cfs	1	2	3	4	5	6	7
1,500 cfs	1	2	3	4	5	6	7
2,000 cfs	1	2	3	4	5	6	7

	Totally unacceptable	Moderately unacceptable	Slightly unacceptable	Marginal	Slightly acceptable	Moderately acceptable	Totally acceptable
Segment 3: Technical trips							
200 cfs	1	2	3	4	5	6	7
300 cfs	1	2	3	4	5	6	7
400 cfs	1	2	3	4	5	6	7
500 cfs	1	2	3	4	5	6	7
600 cfs	1	2	3	4	5	6	7
800 cfs	1	2	3	4	5	6	7
1,000 cfs	1	2	3	4	5	6	7
1,200 cfs	1	2	3	4	5	6	7
1,500 cfs	1	2	3	4	5	6	7
2,000 cfs	1	2	3	4	5	6	7
Segment 3: Standard trips							
200 cfs	1	2	3	4	5	6	7
300 cfs	1	2	3	4	5	6	7
400 cfs	1	2	3	4	5	6	7
500 cfs	1	2	3	4	5	6	7
600 cfs	1	2	3	4	5	6	7
800 cfs	1	2	3	4	5	6	7
1,000 cfs	1	2	3	4	5	6	7
1,200 cfs	1	2	3	4	5	6	7
1,500 cfs	1	2	3	4	5	6	7
2,000 cfs	1	2	3	4	5	6	7

6.3 Focus Group Notes

6.3.1 Pre-fieldwork Meeting Topics

- Introductions
- Study Objectives
- Pre-boating Forms
- Safety de-brief
- Photos and "sound bites"
- Logistics and food
- Group Photos
- Load-up
- Move cars

6.3.2 Post-run Meeting Topics / Agenda

- Eat and dry off.
- Complete post-run form (and close-out on the last day).
- Provide overall impressions.
- List advantages and disadvantages.
- What would it be like at higher and lower flows?
- Describe access issues.

6.3.3 Post-run Notes, Friday Oct 19

- Segment 2 was a low water very technical run. Good flow to access scenery and wilderness character of the upper basin, but not much whitewater.
- Segment 3 was also technical, but closer to the technical/standard transition.

Segment 2 Advantages	Segment 2 Disadvantages
"Cute" flow	Too low; way too low
Some good whitewater	Many stops
Spectacular scenery	Dangerous – pin potential
Slow – easy to scout, prep for rapids	Slow rate of travel
Pleasant	Less fun than Segment 3
Mellow	Lots of rocks
	Challenging to roll (shallow)
	Hard on boats, equipment

Segment 2: What about lower?	Segment 2: What about higher?
It would be a "boat hiking" trip	We'll see – should improve.
Hard to get down	
Not worth it	

I would not come back to run less	
Only usefulness is warm-up for Segment 3	
Segment 3 Advantages	**Segment 3 Disadvantages**
Great rapids	Horseshoe to Powerhouse was slow and boney
Best part of entire river is just below D-Dam	Safety concerns – pin potential
High quality rapids	Lots of rock banging/bashing
Big boulders	Still too low – but better than on Segment 2
More wood	
Good to see lower	
Continuous action below D-Dam	
Good visibility for scouting	
Log in rapid was easy to avoid today – may not be at next level	
Big improvement form 180 / 400 (Tom and Andy)	

Segment 3 What about lower?	Segment 3 What about higher?
Shouldn't go too much lower	Will improve – but one piece of wood might come into play.
It will get critical below Horseshoe first	

If flow is the same, are the two segments the same?

- Similar, but not the same.
- Might want a little more water in Segment 3 – it's a little wider, especially below Horseshoe.
- Also rapids are steeper and have more pinning hazards in the upper part of Segment 3 – needs more water to "clean-up".
- But overall, the two segments are comparable. Most feel that flows good on one should be good on the other.

Run timing:

	Group 1	Group 2
Start	10:30	11:10
Arrive Diversion Dam	12:20	1:10
Leave Diversion Dam	1:00	1:35
Arrive Powerhouse	3:00	4:00

Other craft notes:

- OK for an IK – similar flow needs to kayaks – and less pinning hazard.
- Small rafts (R2) might work on Segment 3. It would be a long haul in to Segment 2 and it is more constricted up there.
- Nothing larger than a 14 foot cataraft.

- Standard 6-pcak raft seems like the run craft – but maybe with paddlers.

Skill levels:
- Segment 2: Class III+ or IV.
- Segment 3: Solid Class IV except below Horseshoe.

6.3.4 Post-run Notes, Saturday Oct 20

- Today's flow: Segment 2 was transition between technical and standard.
- Segment 3 was low to middle part of standard.

Segment 2 Advantages	Segment 2 Disadvantages
Less rocky, fewer pin spots	Still some rocks
More fun	Still less powerful than preferred
Better waves	More wood is in play
More route options	Some new wood compared to yesterday's run
Close to ideal? (not for some)	
Good for first time creek / Segment 2 users	
A few play spots	
Fine level, but might be better at even higher	

Segment 2 What about lower?	Segment 2 What about higher?
Would be "bonier"	Would be faster and pushier
Still would be fun with slightly less	But likely to get better
Would have slower rate of travel	Rocks would be more covered
Less play	May get easier – straighter shots through constrictions
More pin hazards	Rate of travel would improve – shorten day
More boat/equipment damage	
One boater: I wouldn't come at lower flows	

Segment 3 Advantages	Segment 3 Disadvantages
Close to ideal	Some wood issues (especially first harder rapid)
Filled in several holes	Still some rocks in preferred routes – still a technical run
Some pushy hydraulics, but manageable	
Still good eddies	
Few rocks, most were "well-padded"	
Really fun level	
No really "nasty" hydraulics	

Segment 3 What about lower?	Segment 3 What about higher?
Still doable	Everything would "clean up"
Still have good challenge	Bigger holes
Would be more technical though	More challenging
	Fewer and smaller eddies
	More continuous
	Harder to collect gear/people in accident
	Swims would be more dangerous
	Lower skill boaters might be interested in access to Horseshoe Bend reach only – access issue

Run timing:

	Group 1	Group 2
Start	10:45	11:15
Arrive Diversion Dam	12:30	1:00
Leave Diversion Dam	1:00	1:25
Arrive Powerhouse	3:15	4:00

Skill level:
- Segment 2 was easier Class IV.
- Upper part of Segment 3 was solid Class IV (with one V).
- Lower part of Segment 3 was Class III.
- Preferences for last day flows:

Preferences for Sunday releases:
- Segment 2 "votes:" 1000, 950, 1050, 950, 1000, 1200, 1000, 900, 850, 850, and 900.
- Ending consensus was 900.
- Segment 3 "votes:" 1200, 1125, 900, 950, 1125, 900, 1400, 1250, 800, 850, 850, and 900.
- Ending consensus was 800.

Discussion about Segment 1 (after reviewing Ruggerione report photos):
- There are put-in options via rappel (or possibly via dam if security conditions change) above Cascades 6 & 7 (the crux difficult rapids).
- Flow requirements are not known, but estimates suggest slightly lower flows than optimal levels in Segment 2 will be best in Segment 1 (because crux rapids are steeper and there is more constriction).
- Best estimates of the lower cascades (1 to 5) that have been seen with 300 cfs: 600 to 700 cfs are likely to be optimal for an initial on-river reconnaissance of the run; higher flows might eliminate portage and scouting options from eddies.

- Cascades 6 and 7 (the bigger drops) may require less water, but no one is sure.
- Boaters are interested in investigating flows on their own -- a small group of adventurous boaters with high skill levels – if flows are provided for Segment 2/3.
- Use levels are likely to be very low – a small group once a year or so would be interested.
- Flow needs in this likely low use reach probably should not dictate potential releases in Segments 2/3.

6.3.5 Post-run Notes, Sunday Oct 21

Segment 2 Advantages	Segment 2 Disadvantages
"Fluffy"	More wood in play
Filled in holes and hydraulics	Pushier for less skilled boaters
More play features	Fewer, smaller eddies
Few rocks, well-padded	
Good boofs	
A few surf waves	
Many route options	
Faster rates of travel; good for long day	

Segment 2 What about lower?	Segment 2 What about higher?
See previous two day's comments	Wider lines in many route options
	Still a pool-drop river
	Faster lines
	A few things might start to wash out – at very higher flows (2,000 plus)

Segment 3 Advantages	Segment 3 Disadvantages
Good "structure" to rapids	Less filled in
Less pushy than Saturday	More rocks to hit
Some more technical character, but not pushy	Fewer route options
Below Horseshoe – good for Class III	Steeper drops, less friendly pin hazards
Below Horseshoe – good definition for less skilled	Harder than 1,000 (day before)
Landslide was good	

Segment 3 What about lower?	Segment 3 What about higher?
See Friday comments	See Saturday comments

6.3.6 Close-out Notes

Regional importance:

- Long run if both Segments 2 and 3 (and 4).
- Back country feel – low development.
- Unique characteristics for the area: most Puget Sound rivers are steeper, woodier, class 3-4. This has a consistent Class IV nature.
- Few runs in the area are so long.
- Fairly accessible – not challenging walk-in – just a little long.
- So much solid Class IV will attract boaters.
- There is really more Class III and Class V in the area – not much in between.
- Can stay in your boat for scouting most of the drops.

Substitutes:

- Green near Auburn (but the Green is easier, shorter, and has bad takeout and infrequent flows).
- North Fork Skykomish (but only about a mile is like Sultan).
- Pilchuck Creek near Arlington – but that needs lots of rain to be runnable, and it is more continuous and less pool-drop.
- NF Nooksack – but only a mile is as good as Sultan.

Release preferences:

- It's a long run, so it might be OK to offer a shorter release and have boaters say on the wave.
- Month of release is important – if summer, release could be later in day.
- People coming from far away, might only try to boat 1 day a weekend.
- Locals more likely to be interested in releases on both weekend days.

Access:

- Existing trail is "decent."
- Conflict with miner can be minimized with some rerouting at end.
- Diversion Dam access will be high priority for many boaters less interested in the long run, especially in winter.
- Consider Horseshoe segment access for less skilled boaters – who would attach it to Segment 4 run.

6.4 Additional Information from Study Boaters

	Core Team	Supplemental Boaters
Average days per year spent whitewater boating	66	67
Average previous trips on…		
Segment 2	2.4	1.5
Segment 3	2.8	1.5
Segment 4	14.7	9.8
Average age	37	35
Percent male	69%	93%
Average tolerance for "stops" on…		
Segment 2	1.9	2.9
Segment 3	2.2	2.9
Average tolerance for portages on…		
Segment 2	2.5	2.3
Segment 3	2.2	2.2
Average score on whitewater "preferences" items (1=strongly disagree to 7=strongly agree, 4=neutral)		
Running challenging whitewater is the most important part of my boating trips.	4.9	5.5
I am willing to tolerate difficult put-ins and portages in order to run interesting reaches of whitewater.	6.7	6.5
Good whitewater play areas are more important than challenging rapids.	3.1	3.0
I prefer boating steep, technical rivers.	5.6	5.8

Verbatim comments from supplemental boaters

Barry from SnoPUD was totally awesome. He drove us to the Diversion Dam after we learned that running the full river was not an option. There were eight of us and he was more than willing to help us out. Thanks to him, we were able to enjoy segment 3 and 4.

Well done on the release, it was well organized and an amazing weekend. Thanks.

I only boated one day; so it was difficult for me to estimate optimal and minimum acceptable flows. It was an amazing experience, and I hope that releases become more frequent. Thank you for asking of our input.

A whitewater park could be easily created from a modification of either diversion structure. This would greatly increase the desirability for this run.

If you are doing any releases for the Lower Stretch you should basically be looking to focus on two features primarily.

1. is Last Nasty. For the beginner looking to check out this run Last Nasty should be sought out in the 600-800 range. For the experienced 800-1600 is superb.

2. is Little Paradise. This is one of the better playspots in the greater Seattle area. It is 3 ledge systems below Last Nasty. At 750-800 the hole is friendly for wheels but rather shallow with the rock exposed. At 800-900 the hole moves into a prime zone deep enough for loops and "McNasties," retentive enough for linked up ends and has a very large eddy even as it flushes around 950 - 1000. Most people care more about Little Paradise than Last Nasty. BUT if you're a first timer to class IV and you want entrance to that play hole you have to run Last Nasty and at right around 800 it starts getting beefy, so that 900 prime, well it scares off new play boaters in the class III -III+ range.

It would be great if we could get access (into or out of the river) at the Diversion Dam so that people could run separate sections of the river. Section 2 alone would be excellent for an easy creek run, or access to section 3 alone would be a good, challenging run for someone who cannot or will not do the long hike in.

Awesome river, a real gem in Seattle. I wish it flowed every weekend. Hopefully we can all manage this resource to benefit all parties. Thanks for doing this study.

The question about: number of "stops" tolerated after hitting rocks" doesn't resonate with kayakers. We always hit - or scrape - rocks, sometimes on purpose. And thanks much for allowing us to participate in the flow survey.

Access to Segment 2 is very difficult. Some trail / foot-bed improvement would be necessary before a large # of boaters were to use it during wet, rainy weather.

I would be most interested in having direct access to put-in at the Diversion Dam, especially if flows are above 1,000 cfs.

I really liked the run on the Sultan but I wasn't able to boat at different water levels to get a better idea of what I liked the most. I also wanted to go down in a raft but after running it I was glad that I didn't due to the logs and tight slots. I would like to keep it as an option to raft from the Diversion Dam down to the fishing access for commercial runs. I think it will take bigger water and more runs to have an all conclusive answer on the commercial run idea. As of my run on Sat. I would say "No, I don't think it would be a river for guests to be on." Thank You.

The river seemed very user friendly. Shuttle was hard (biggest problem for me).

Great river, great run! Thanks for your efforts on behalf of the paddling community.

Just to say thank you for considering these releases, and I look forward to more boating opportunities on the Sultan River. I was unable to boat section 3 and I look forward to doing so in the future.

THANKS YALLS...

Boaters that want to boat rivers like the upper Sultan don't need anything more than what was there on the flow study dates. Bathroom, stairs, great trail, etc. are not needed. To me, part of the experience was the hike into the river and the remoteness. The only thing we need to add to the Upper Sultan is water.

Access at the diversion dam seems more reasonable and shorter trip down the river. It took us about 5 hours with a 1 hour hike in. That's a pretty long day.

Thanks so much to the American Whitewater guys who work so hard on our behalf. You guys are the true patriots. We love you.

Some of my answers regarding flows related to my only having boated the 2& 3 reaches at 650cfs (in 2005) and 900cfs (2007). I definitely preferred the 900 cfs level.

Thank you for the opportunity. This is a great run in that it has a nice pool/drop style which allows for excellent recovery after each rapid. This is more rare for Washington rivers/technical "creeking" runs. It makes it safer than some others of equal difficulty.

Good to have one more option to boat around the area. Thanks

Thanks for the opportunity. I'd be happy with the Sultan flowing at a medium-high flow at least three times a year. Weekends are very important as it's a long day. Also, late summer would be a good time as there is still plenty of sunlight and most of the natural runoff on other creeks is over with.

Thanks very much for the opportunity to boat the Upper Sultan. Regarding flow availability, I didn't see an answer that matches my preference. I would be happy with adequate but not optimal flow over more days rather than optimal flow only once, with the caveat that the days not be back to back. For example, I'd love to boat the Upper Sultan 2x a year, but would be less likely to do it two days back to back. I would be nice to get a window in September and a window in May. One other issue: ideally flows will be available when 2 conditions are met: first, daylight hours are long enough to allow safe passage (so not Nov - Feb) and second, flows would be available when other rivers are too low, so not May - end of June. Thanks again!

With better access and flow opportunities, this run provides two unique opportunities. Segment 2 (Culmback to Diversion Dam) is a great Class IV training ground. There are few river reaches that provide such good quality Class IV- with a few more challenging drops on which people can develop their skills. The opportunity to access the river at the Diversion Dam would make for an outstanding Class IV run w/ 1 Class V (Landslide) and some IV+. I have always thought the lower Sultan run (Powerhouse down) was too short to be really "worth it." Adding the Diversion Dam section would create a run that would be one of the best in the state. It would be a destination both recreationally and commercially. This is also one of the most scenic sections of water I have had the chance to paddle. It is simply an amazing natural resource that more people should have the chance to see. Thanks to Tom and AW and all the "official" flow study people!

I have been running rivers in this state and others for over 18 years. This is one of the finest whitewater runs I have ever paddled. What a great recreational resource we have in our backyard.

Open it up during dry months of late summer. Get community involved to build a decent access trail to put-in.

I'd like to thank all of the friendly PUD workers, watershed patrols, and surveyors that made a positive reflection of the relationships we have made. They truly made the boating experience that much more incredible. The Sultan River is one of the best whitewater rivers in Washington and I look forward to running it again soon! Thanks again!

PUD and AW: Thank you for doing this! Let's get some boatable flows for as many days as we can during the re-licensing.

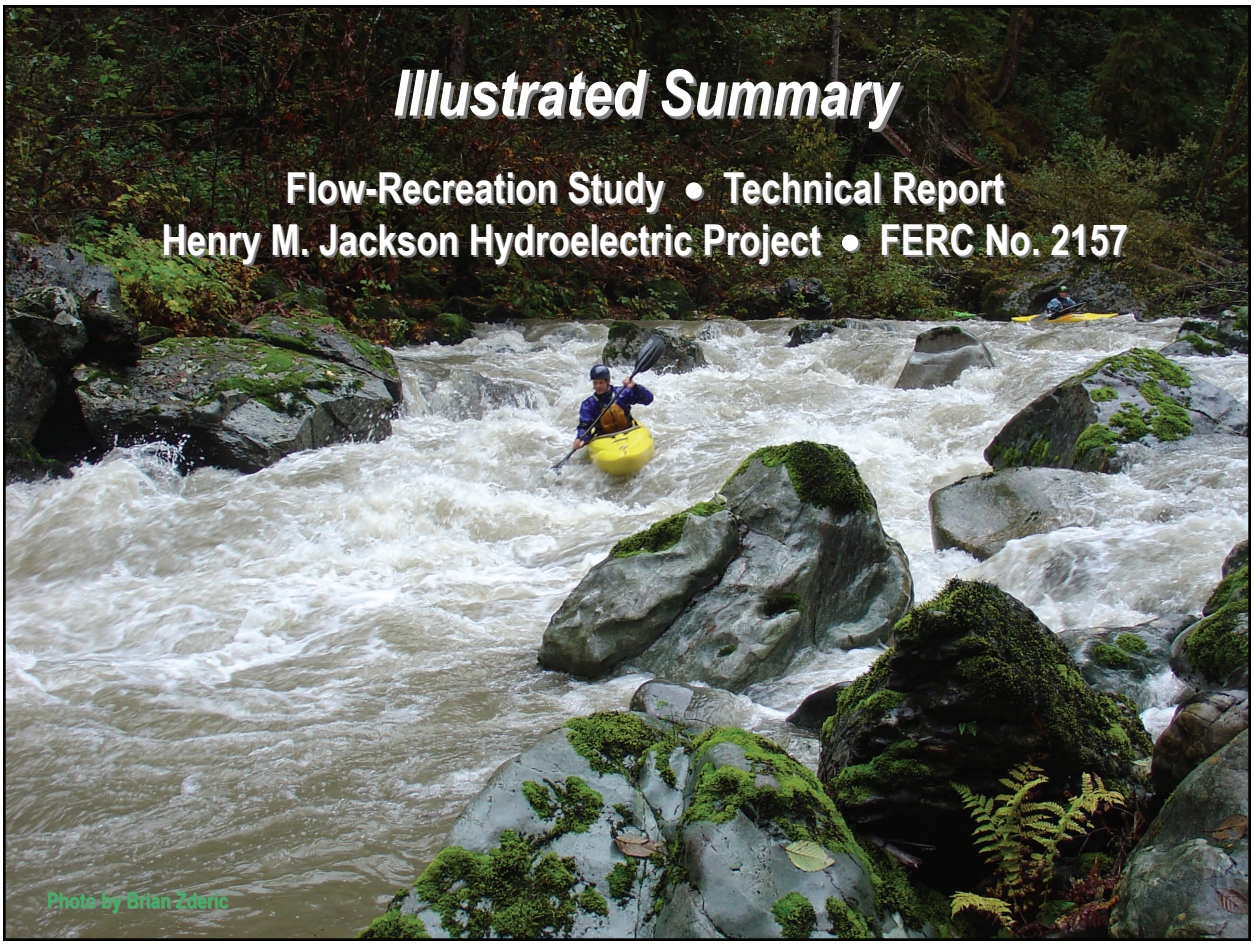
Great trip, wonderful day, hike in a bit mucky. Would love to see summer flows for warm weather boating.

It would be great to offer access at the Diversion Dam. The reach above the diversion is class 3-4 and an excellent stretch of challenging water for class 3-4 boaters. However, the reach below the diversion dam is a little beyond the skill of the class 3 boater. Having access to takeout at the diversion for these boaters would make this reach a great resource. Using the diversion dam as a put in for the reaches below would provide the class 4-5 boater with a great stretch of whitewater and thus shortening the time on the water and maybe potential release time as well. Thanks for the opportunity to boat this river, my experience with everyone involved on the day I paddled was excellent.

6.5 Additional Information From Angler Interviews

Ten interviewees provided information about their fishing use. They reported an average of 21 years fishing in the Sultan River basin (range was from 5 to 60 years) and 11.3 days per year (range from 2 to 30 days per year). Eight of 10 reported fishing Segment 3, six of 10 reported fishing Segment 5, and only two of ten reported fishing Segment 4. Four of the six reported using fly fishing gear, six of ten reported using bait, and eight of 10 reported using spinning tackle.

Appendix 6.6



Public Utility District No. 1 of Snohomish County, Washington is applying for a new license for the Henry M. Jackson Hydroelectric Project, FERC No. 2157. The PUD is conducting studies of Project effects on resources in the 16.5 mile reach of the Sultan River from Culmback Dam to the Skykomish River. The flow-recreation study evaluates the effects of Project operations on whitewater boating opportunities and identifies impacts of potential boating flows on other recreation resources such as fishing and mining.

This illustrated summary presents major findings from the study (most captions are abbreviated from the report). Those interested in more detail should consult the full report.

Prepared by...
Doug Whittaker Ph.D. and Bo Shelby, Ph. D.

Confluence Research and Consulting

Prepared for...
Public Utility District No. 1 of Snohomish County

May 2008

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

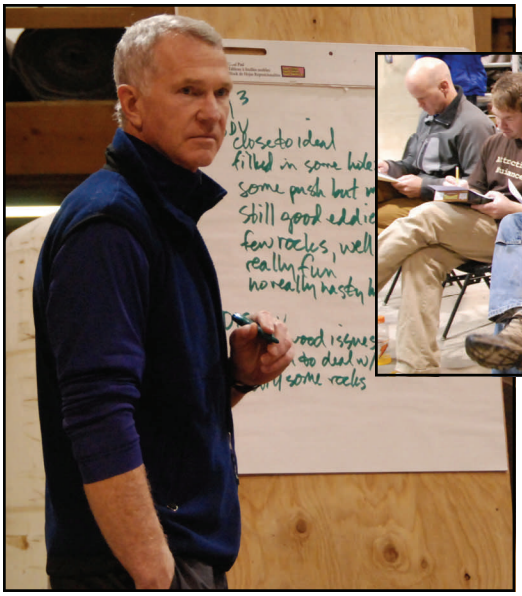
Study Area and Methods

The Project stores water in Spada Lake (this photo) for flood control, but also sends water through a powerhouse (top right) for power generation and municipal water supply. About 12 miles of the Sultan River are bypassed by Project diversions, although minimum flows are provided for salmon and steelhead. A Diversion Dam in the middle of the reach (bottom right) can further regulate flows. The river was divided into five segments based on access and flow characteristics; the study focused on Segments 2 and 3, from a mile below Culmback Dam to the Powerhouse.

The study used a phased approach that included summaries of existing information, interviews with experienced recreation users, and informal boating assessments of 650 cfs in December 2005 (left), 185 cfs in April 2007 (above), and 175 cfs in July 2007.

A "controlled flow assessment" was conducted in October 2007. A panel of 14 "core team" and 46 "supplemental" boaters assessed flows between 325 and 1,400 cfs over three days. Segment 2 is accessed by a road over Olney Pass (above) and a rough one-mile trail to the river.

A Class IV rapid on Segment 3 at 1,000 cfs (left). Study participants were Class IV-V boaters, who volunteered their time to help with the study.



Focus groups were conducted each day to discuss advantages and disadvantages of study flows. "Close-out surveys" evaluated all of the study flows, other flows based on previous use, timing preferences for potential whitewater releases, and comparisons of the Sultan with other regional rivers.

Segment 2 at 175 cfs was marginally boatable, but there were many "pinning hazards" and in some rapids boaters reported "sliding over lubricated rocks." Boaters portaged at least two logs that spanned the channel. The greatest boatability problems were in wider channel "boulder gardens" from about RM 11.5 to 10.0.

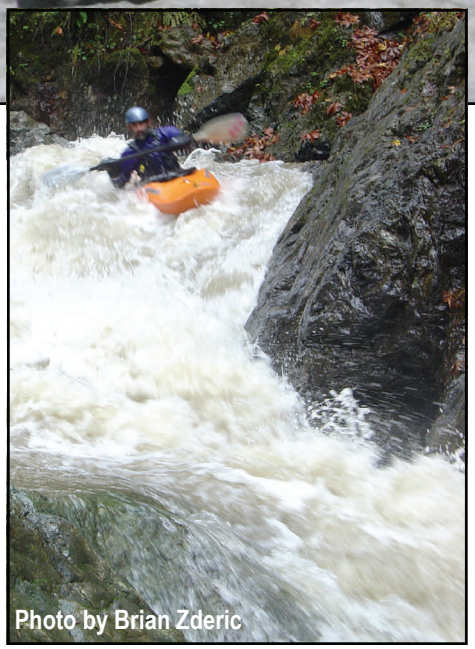
Segment 3 at 185 cfs was marginally boatable, limited route options, several pinning hazards, with frequent contact with rocks, and little whitewater. Although hard shell kayakers had no "stops" and only portaged one rapid, the inflatable kayaker had 11 stops and three in-channel portages.

Segment 3 at 800 cfs. This flow provided improved boatability and whitewater quality compared to 325 cfs, defining the start of standard boating for kayaks. It was also boatable in small rafts / catarafts, although it was a technical trip for these larger craft. Rapids were steeper and had fewer route options compared to 1,000 cfs. At higher flows, hydraulics were bigger and more "pushy," but boat scouting was still possible for Class IV paddlers.

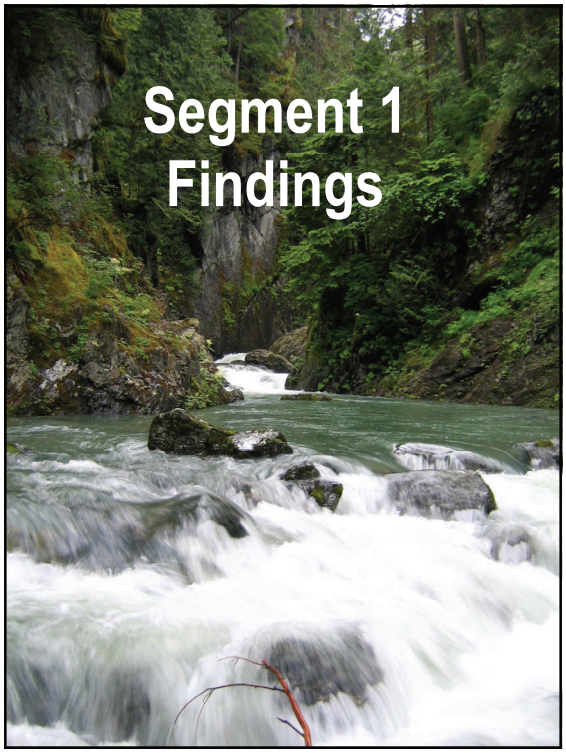
A rapid on Segment 3 at 400 cfs (top) and 800 cfs (bottom). The lower flow provides "technical" boating, with more exposed rocks and fewer route options; the higher flow provides "standard" boating with larger waves and hydraulics that increase whitewater quality.

Segment 2 is about six miles long and has Class III-IV rapids. The reach is boatable at 300 cfs, but these trips are low quality (top, at 400 cfs). Flows about 450 cfs are required for acceptable technical trips in kayaks (inset below, at 650 cfs). Standard whitewater trips occur between 750 and 1,000 cfs (main photo below, at 800 cfs), with optimum standard trips starting about 900 cfs. Higher flows (over 1,200 cfs) provide "big water" boating. Since 1990, Project operations have provided higher quality boating opportunities about four days per year (on average) during intense rain storms or rare releases from Culmback Dam.

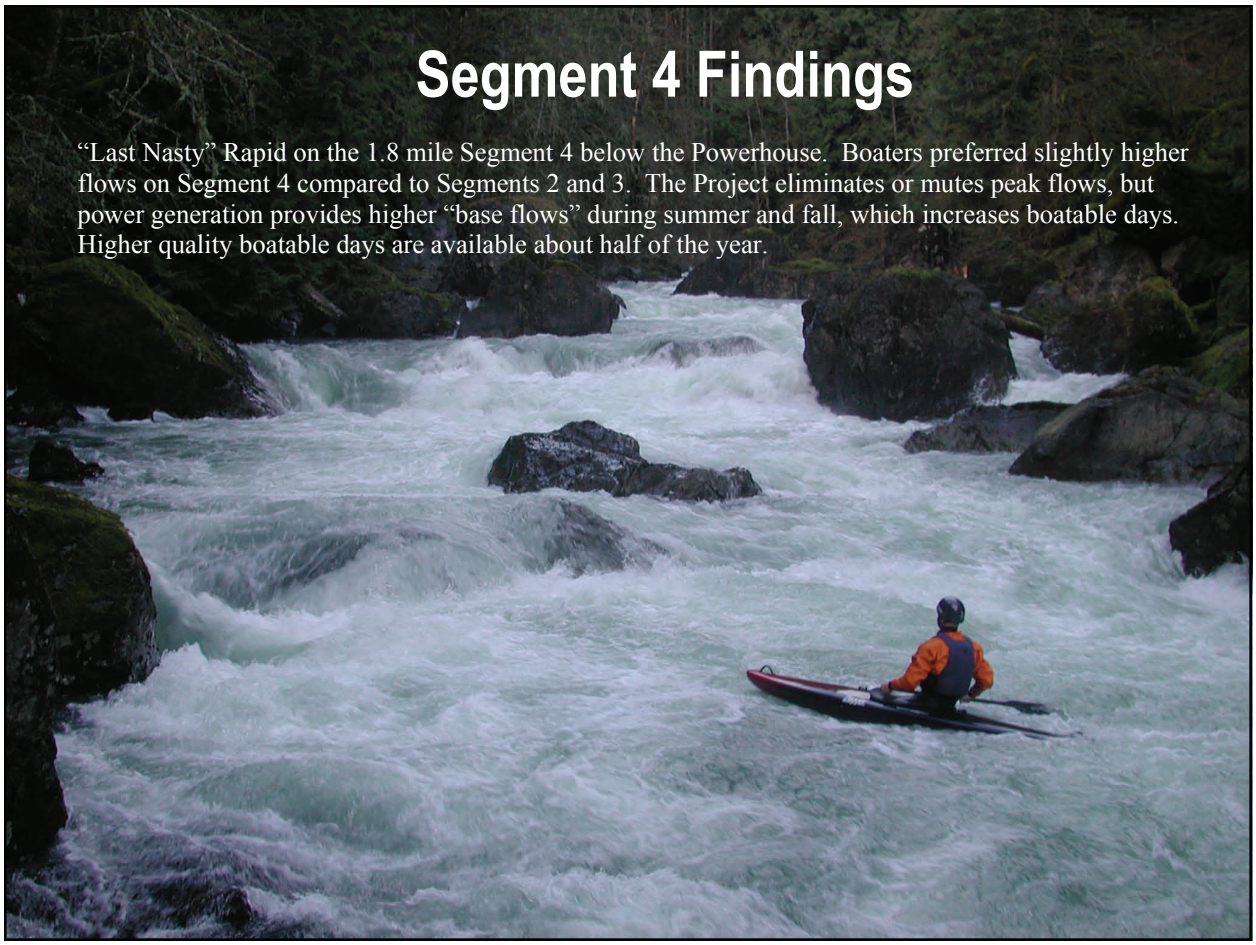
Segment 3 is about five miles long and has more difficult Class IV rapids than Segment 2, plus one Class V rapid (below), which can be portaged. Although it is possible to boat the reach at lower flows, acceptable technical trips in kayaks start about 500 cfs (700 cfs for small rafts). Standard trips occur from about 750 cfs to 1,200 cfs, with optimum standard trips starting about 900 cfs (above). Higher flows provide "big water" boating. As with Segment 2, current Project operations provide about 4 days of boatable flows per year.

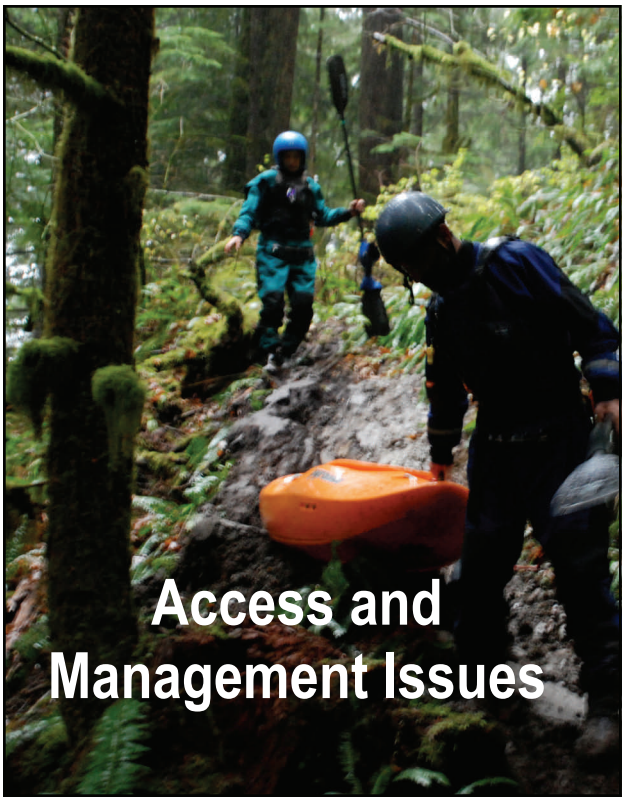


Class V Landslide Rapid on Segment 3 at 540 cfs (top) and 800 cfs (middle). This rapid was created in 2004 following an intense rain event; coincidentally, kayakers boating the higher flows from the same storm videotaped the slide as it occurred. At all three study flows, the rapid was boated by some kayakers (bottom) and portaged by others.



Segment 1 at about 300 cfs. This reach is in a steep, constricted gorge. It may be boatable between 300 and 1,000 cfs, but access requires a rappel-based put-in or changes in Culmback Dam access regulations and some rapids may require portages. Given its short length, difficult access, and the greater attraction of Segments 2 and 3, boaters agreed that flow needs for Segment 1 should not "drive" potential releases for whitewater.





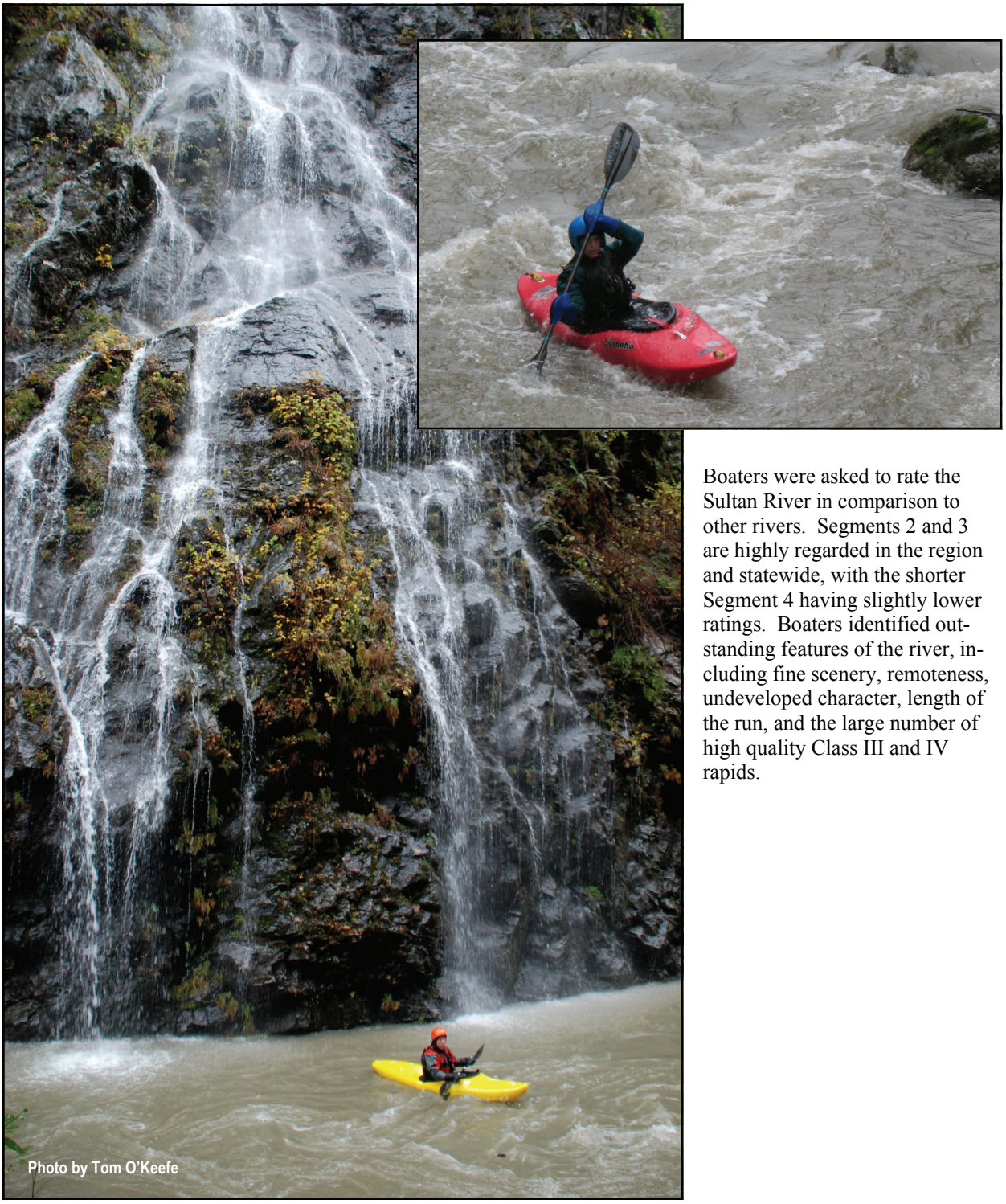
Forest Service Road 6122 provides access to Segment 2 from a trailhead (above) down a rough 1.1 mile trail. The trail has challenging sections (left) and some resource impacts. The Forest Service has assessed trail conditions and considered alternative routes; the importance of developing new access may depend on the frequency of potential boating releases and the number of boaters that use them. It is challenging to estimate potential boating use levels, but about 80 to 120 boaters might use the river per day (if they occur on weekends, during favorable weather, and when other rivers have lower flows).

Currently there is no public vehicle access to the Diversion Dam (end of Segment 2 and start of Segment 3) for security and watershed protection purposes. If boating releases are provided, arranging limited access to this area could provide more flexibility for boaters, but might involve management issues for the District.

Whitewater recreation flow releases would diminish power generation and may affect biophysical resources (which are being addressed by other relicensing studies). Biophysical issues focus on timing releases to minimize the disruption of rearing and spawning fish (fall for salmon, spring for steelhead). Boating releases may also affect other recreation opportunities on the river, including fishing and mining.

Most fishing on the Sultan River targets steelhead, with higher use on Segments 3 and 5. Most anglers appear sensitive to flows, but few are "calibrated" to a gage. Most wading anglers prefer "base flows" on Segment 2, and whitewater flows would substantially limit the amount of fishable water. There is a wider fishable range on Segments 4 and 5, where more use is boat-based and higher flows are common due to powerhouse outflows.

Recreational mining occurs in the Sultan River Basin, with highest use in summer. "Base flows" provide good visibility, cover target sediments in the bottom of the channel, and allow access for dredges and wading miners. Whitewater releases would probably be "un-mineable."



Boaters were asked to rate the Sultan River in comparison to other rivers. Segments 2 and 3 are highly regarded in the region and statewide, with the shorter Segment 4 having slightly lower ratings. Boaters identified outstanding features of the river, including fine scenery, remoteness, undeveloped character, length of the run, and the large number of high quality Class III and IV rapids.

Boating advocates are interested in creating whitewater boating opportunities on the Sultan River. The report identifies considerations, including Project operations and power generation, liability, impacts on other recreation resources, impacts on non-recreation resources, cost of releases, and boater interest in specific flows and types of opportunities.

Appendix 6.7

Responses to Draft Report Comments

STAKEHOLDER COMMENT – SUPPLY ANALYSIS	LICENSEE RESPONSE
Tom Davis – US Forest Service – Email dated 6/17/2008	
Section 4.4.2.1 Hike-in Access from FSR 6122 1st sentence: The nonsystem access route improved by a miner is located on National Forest Systems lands. The public can use the route, but use is not encouraged. The route is not shown on Forest Service maps nor maintained by the Forest Service for public use.	Point noted. We will modify the language to reflect that trail use is not encouraged.
Section 4.4.2.1 Hike-in Access from FSR 6122 3rd paragraph: in addition, the recommended FS trail route would minimize maintenance and resource damage (erosion) due to the reduced grade and standard trail design. The put-in site is still located on a mining claim but does avoid the access route ("trail") utilized by the miner and some of the miner's equipment such as the ladder.	We will revise the language to reflect that the alternate put-in site avoids the trail and mining equipment exposure to conflict inherent in the current situation.
Section 4.4.3 Managing Use 2nd paragraph: Additional sanitation facilities (restrooms, trash cans) may also be necessary dependant on the amount of use expected. Improvements to the proposed trailhead site on FSR 6122 would also be needed such as grading, surfacing, delineation of parking spaces, signage, and seeding of disturbed areas with approved native seed mix.	Options for location of a trailhead are currently being explored. The requirements for each are essential to a determination of the best location. It is unlikely that the amount of use anticipated for boating will warrant the type and level of trailhead development suggested.
Tom O'Keefe – American Whitewater – Email dated 6/19/2007	
Page ii, paragraph 4 This paragraph notes that on average, only about 4 days per year have boatable flows on these bypassed segments. It would be helpful to add the statement that spills have occurred in only 8 of the last 23 years to clarify that 4 days per year is a statistical average and not indicative of a "typical year".	Statistic added to text to reflect that 4 days per year is an average..

STAKEHOLDER COMMENT – SUPPLY ANALYSIS	LICENSEE RESPONSE
Page iii, paragraph 3 "…most wading anglers prefer "base flows" on Segment 2 (under 200 cfs)…" This statement is confusing given that angler use, while present, appears to be limited for segment 2 and "base flow" is 20 cfs not 200 cfs for this reach.	This is a typo: it should read Segment 3
Page 5, section 2.1.2 The report states that access to the diversion dam has "not [been] accessible to public vehicle use since September 2001." To our knowledge access was not available to the public prior to that.	The reference to "September 2001" has been removed.
Page 7, section 2.1.4 Page 7 and 10 could be combined onto one page.	We concur. Thank you for this edit.
Figure 2-1 The map indicates that the Blue Mountain Mainline is not gated but a gate has been recently installed. There is also a gate at the take-out for segment 4 that is not indicated on the map.	We concur. The map will be updated. EDAW can reproduce the map with the correct information.
Page 21, section 3.5.1.2 Section heading mislabeled as 5.3.1.2	Thank you. This typo has been corrected.
Page 35, section 4.1.7 The statement is made that 17 days of boatable flows are generally available with 4 days of higher quality boating opportunities. These statements are misleading given the following qualifiers provided in the next paragraphs: boatable flows can occur during hours of darkness and significant year-to-year variability exists with decreasing likelihood of spills in recent years.	Flow statistics are based on average daily values and therefore reflect the average flow values for boatability for an entire 24 hour period. The text will be revised as follows: Through the period of record, an average of 17 days of boatable flows are available each year, but only about four provide higher quality boatable opportunities in the technical, standard, or big water ranges. In addition, these averages overestimate useable boatable days, as discussed below.

STAKEHOLDER COMMENT – SUPPLY ANALYSIS	LICENSEE RESPONSE
Page 47 The statement is made that estimated cost of a one-day release is $15,000 to $75,000 but no information is provided on specific assumptions used to derive this estimate. The original study plan noted that this report would describe, "the operational feasibility and cost of providing scheduled releases for whitewater boating and other flow-dependent recreational uses at the project.".[1] Is this range based strictly on power replacement costs or are personnel costs also included? What specific durations and ramping rates are considered? What range of cost estimates for replacement power are being used? As we examine different potential operational scenarios in more detail a greater understanding of these assumptions will be essential to an informed discussion.	The details of how this range of costs was calculated will be shared with the Aquatic Resources Working Group when the results of the study are discussed in the context of PM&E development.
Page 47, section 4.3.2 The section states that "safety and liability concerns are common issues for whitewater boating, as FERC has recognized on several occasions." In fact the Commission has consistently stated in recent license orders, that risk associated with whitewater boating "has not precluded the Commission from requiring whitewater access and flow releases" at other projects across the country..[2] While it is true that other utilities have raised this issue, the majority of accident reports for FERC-licensed projects are not associated with whitewater boating.	Point noted. However, the exposure of the utility to legal action from an injury suffered during the course of whitewater boat related to hydroelectric operations remains the same without a specific legal determination to the contrary. While liability concerns may not be in and of themselves reasons to refrain from a particular action, they are a valid factor to be weighed in deciding whether and to what extent a particular PM&E is adopted.
The Washington State Recreational Use statute, RCW 4.24.210, specifically provides immunity for both "boating" and "water sports". Further protection under this statue can be achieved by providing appropriate warning signs and public notification of	The limited protection that RCW 4.24.210 affords does not clearly extend to a hydroelectric operator such as the District, particularly for the release of flows sufficient to allow whitewater boating. The possibility for signage and public notification does not alleviate the

[1] Study Plan 14, Whitewater Recreation Conrolled Flow Study, Section 14.8, FERC eLibrary Accession Number 20060515-5094.
[2] *Public Utility District No. 1 of Chelan County* 117 FERC ¶62,129 (2006); *See also, e.g., Northern States Power Company*, 79 FERC ¶62,170 (1997) and *Georgia Power Company*, 77 FERC ¶62,002 (1996).

STAKEHOLDER COMMENT – SUPPLY ANALYSIS	LICENSEE RESPONSE
project operations. Most importantly, however a number of legal doctrines protect federal agencies (including FERC) under "sovereign immunity". Dams with federal licenses have are covered by the discretionary function exemption 28 U.S.C.A. S2680(a) providing a much stronger protection than just the state statutes. Finally, we have observed that many utilities have attempted to use liability and "safety" as an argument for restricting free public access to rivers, an approach we find inconsistent with the Federal Power Act.	concern that RCW 4.24.210 may not protect the District from a subsequent lawsuit. The “sovereign immunity” doctrines cited apply only to a federal agency or employee of the federal government, not to an entity such as the District. The discussion of the District’s liability concerns is intended to illuminate a serious potential detriment of providing recreational whitewater flows, and to ensure that all relevant information is available when determining the appropriate timing, duration, and level of these flows, if any. Ensuring that all relevant information is considered in the context of PM&E development is entirely consistent with the Federal Power Act.