Consultative Committee Report

July 2003

Prepared on behalf of:

The Consultative Committee for the Falls River Water Use Plan

Prepared by:

BC Hydro

Falls River Water Use Plan

A Project of BC Hydro

National Library of Canada Cataloguing in Publication Data
Falls River Water Use Plan Consultative Committee (Canada)
Consultative committee report : Falls River water use plan

"A project of BC Hydro."
Includes bibliographical references: p.
ISBN 0-7726-5053-5

1. Water use - British Columbia - Big Falls Creek. 2. Water use - British Columbia - Prince Rupert Region - Planning. 3. Water resources development - British Columbia - Big Falls Creek. 4. Hydroelectric power plants - British Columbia - Prince Rupert Region. 5. Dams - Environmental aspects - British Columbia - Big Falls Creek. I. B.C. Hydro. II. Title. III. Title: Falls River water use plan.

TD227.B7F34 2003 333.91'009711'1 C2003-960209-5

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This report was prepared for and by the Falls River Water Use Plan Consultative Committee, in accordance with the provincial government's *Water Use Plan Guidelines.*

The report expresses the interests, values and recommendations of the Committee and is a supporting document to BC Hydro's Falls River Water Use Plan that will be submitted to the Comptroller of Water Rights for review under the *Water Act*.

The technical data contained within the Report was gathered solely for the purposes of developing the aforementioned recommendations and should not be relied upon other than for the purposes intended.

EXECUTIVE SUMMARY

A Water Use Plan (WUP) is a technical document that, once reviewed by provincial and federal agencies and accepted by the provincial Comptroller of Water Rights, defines how water control facilities will be operated. The purpose of a water use planning process is to develop recommendations defining a preferred operating strategy using a multi-stakeholder consultative process.

The Falls River water use planning Consultative Committee process was initiated in May 2002 and completed in May 2003. The consultative process followed the steps outlined in the 1998 provincial government's *Water Use Plan Guidelines*.

This report summarizes the consultative process and records the areas of agreement and disagreement arrived at by the Falls River Water Use Plan Consultative Committee. It is the basis for the Falls River Draft Water Use Plan. Both the Falls River Consultative Committee Report and the Falls River Draft Water Use Plan will be submitted to the Comptroller of Water Rights.

Falls River Hydroelectric Project

The Falls River hydroelectric project is located approximately 50 kilometres southeast of Prince Rupert on Falls River above its confluence with the Ecstall River. A short section of the Falls River is located below the spillway and flows into the Ecstall River, a tributary of the Skeena River.

The Falls River project has a single reservoir. Water flows from intakes from the Big Falls Reservoir through two penstocks to the two generating turbines in the powerhouse. Water from the turbines is discharged into the Falls River via a tailrace downstream of the facility.

Consultative Committee Process

The Falls River Water Use Plan Consultative Committee consisted of seven representatives and their designated alternates (where applicable). Key interests included fish, wildlife, First Nations' traditional use and hydroelectric power. The representatives included BC Hydro, provincial and federal agencies, the Lax Kw'alaams Band, the Allied Tsimshian Tribes Association (ATTA), community fisheries organizations and industry.

The main Consultative Committee and its Fish and Wildlife Subcommittee held a total of seven meetings, ultimately reaching unanimous acceptance of a preferred operating alternative for the Falls River hydroelectric facility, and a specified monitoring program.

The Consultative Committee explored issues and interests affected by the operations of BC Hydro's Falls River hydroelectric facilities and agreed to the following objectives for the Falls River Water Use Plan:

- Cultural and Traditional Use: Minimize impacts on traditional use by maximizing the abundance and diversity of fish and wildlife around the Falls River facility.
- Fish in the Big Falls Reservoir: Maximize littoral productivity; maximize access (migration) to spawning and rearing habitats in tributaries; minimize back-watering of spawning and incubation habitats; minimize de-watering and stranding of fish; minimize sediment erosion and suspension (mobilization).
- Fish in the Falls River: Maximize available habitat (quality and quantity); minimize total gas pressure (TGP); minimize impacts of potentially acidic discharges on incubating eggs; minimize fine sediment releases into the river; minimize stranding of fish and de-watering of eggs; optimize flows for fish at all life stages.
- Greenhouse Gas (GHG) Emissions: Minimize the provincial greenhouse gas impacts associated with changes to generation at the Falls River facility.
- Power: Maximize the financial value of the power produced at the Falls River facility.
- Recreation: Maximize the recreational attraction of the river and reservoir by maximizing the abundance and diversity of fish and wildlife around the Falls River facility.
- Wildlife using the Reservoir: Maximize riparian habitat (sedge grass community); minimize stranding and/or inundation of nests and dens; maximize migratory access.

Agreement on a preferred operating alternative

The Consultative Committee identified seven main water use objectives (see above) and 18 sub-objectives. Performance measures (indicators) were developed based on these objectives. In all cases, performance measures were modelled quantitatively. Operating alternatives were then developed to address the various objectives.

In total, 15 operating alternatives were run through BC Hydro’s operations model and the consequences for each objective were discussed by the Consultative Committee based on the agreed-to performance measures.

Of those alternatives, two received acceptance from all members and one was chosen as the preferred alternative, on the condition that specified monitoring programs would also be implemented. The Committee reached this decision at their final meeting on 22–23 May 2003.

The Consultative Committee recommends the Falls River hydroelectric facility be operated as designed subject to a set of operating constraints (see Table 1).

Table 1: Recommended Operating Constraints for the Falls River Hydroelectric Facility

Area	Operating Variable	Constraint	When	Comment on Intent
River	Minimum discharge	2.6 m^3/s when reservoir is at or above elevation of 88.4 metres. 1.3 m^3/s when reservoir is at or below elevation of 88.4 metres.	Year round	Maximize habitat for fish in the river.
River	Minimum discharge	6.5 m^3/s when reservoir is at or above elevation of 88.4 metres.	1 August-15 October	Maximize fall spawning habitat for fish in the river.
River	Generation curtailment	Curtail turbine discharge to 1.3 m^3/s when reservoir is at or below elevation of 88.4 metres.	Year round	Increase reliability of minimum discharge.
River	Minimum discharge	Return to applicable minimum discharge as soon as possible.	Unplanned outages	Increase reliability of minimum discharge.
River	Minimum discharge	Ensure applicable minimum discharge is being provided through the sluice gates before shutting down turbines.	Planned outage of generation units (turbines).	Increase reliability of minimum discharge.
River	Ramping rate when ramping up (unit ramping)	Maximum rate of increase of 1.3 m^3/s over 10 minutes for discharges between 1.3 and 6.5 m^3/s.	15 February-15 March	Minimize impacts on alevin below tailrace.
River	Ramping rate when ramping down (total discharge)	Maximum rate of decrease of 1.3 m^3/s over 10 minutes for discharges between 1.3 and 6.5 m^3/s.	1 November-15 April	Minimize stranding of fish in the tailpond.
Reservoir	Flashboard Installation	Install annually.	Between 15 February and 15 March, the sooner the better.	Maximize sedge grass community maintenance.
Reservoir	Flashboard Removal	Remove annually.	Between 1 May and 15 May, the later the better.	Maximize sedge grass community maintenance.
Reservoir	Reservoir Elevation	Minimum elevation of 92.0 metres with potential incursions above 92.0 metres.	From 1 April to the removal of the flashboards.	Minimize backwatering of cutthroat tributary spawning habitat.
Other	Timing of Annual Maintenance	Preferably between March 1 and 28.	March	Maintain safety and reliability of facility.
Other	Operation of Undersluice	BC Hydro will consult with interested parties (provincial and federal agencies, First Nations and community fishery groups) before operating the undersluice.		Minimize impacts to fish related to fine sediment releases into the river.

Consequences of the preferred alternative

The expected outcomes of the final recommended operating alternative are summarized in Table 2. The annual cost of implementing the operating alternative is expected to be $50,000 in lost revenue.

The main benefits over the reference case[1] include: an increase (by a factor of three) in available spawning and incubation habitat for cutthroat trout in the Falls River Reservoir and an increase (by a factor of 10) in the area of sedge grass community maintained (valuable riparian wildlife habitat).

Table 2: Expected Consequences of Recommended Alternative Compared to Reference Case

Water Use Interest	Consequences
Fish in Falls River	o Neutral – No significant increase is expected in the area of fish habitat available for coho, chum and chinook spawning and rearing. However, the recommended operating constraints for minimum discharge and ramping are expected to minimize impacts on these fish during key life stages and in the event of planned and unplanned outages.
Fish in Big Falls Reservoir	o Neutral – No significant change to tributary access for cutthroat trout or Dolly Varden. o Neutral – No significant change is expected in the area of tributary spawning habitat in the drawdown zone for Dolly Varden. + Significant decrease (by a factor of 10) in the amount of tributary spawning habitat lost through back-watering in the drawdown zone. + Increase of 50% in expected area of effective littoral habitat.
Wildlife in Big Falls Reservoir	? Decrease of 25% in expected area of available shoreline habitat for nesting and denning wildlife. + Increase (by a factor of three) in the area of sedge community maintained.
Power Generation	? Decrease in power revenue of $50,000 per year on average (approximately 2%) over reference case.
Greenhouse Gas (GHG) Emissions	? Increase in GHG emissions for BC Hydro's integrated generation system.

Due to the uncertainty surrounding the presence and use of Dolly Varden spawning habitat in the lower portion of Falls River Reservoir tributaries, the Consultative Committee chose an operating alternative option that maximized other ecological benefits and annual revenues from the Falls River hydroelectric project.

[1] Historic operations could not be used as the base case or reference case for the Falls River Water Use Plan because the outcome of a concurrent dam safety review process was a change in the allowable timing for a key operating variable (flashboard installation). Instead, a reference case was developed to reflect the operations BC Hydro would undertake moving forward in the absence of recommendations from the Falls River Water Use Plan Consultative Committee.

The Committee was willing to make this trade-off given: 1) the high degree of uncertainty regarding the presence and use of Dolly Varden fish habitat in the reservoir drawdown zone; and 2) the preferred operating alternative still provides a reduction in the impact on potential Dolly Varden habitat as compared to historic operations.

The results of the monitoring program designed to address the uncertainty about this issue and objective will allow future decision-makers to revisit this trade-off if necessary.

Monitoring Program

The Consultative Committee discussed sources of uncertainty associated with implementing the preferred operating alternative. Through the water use planning process and trade-off discussions, the Committee reviewed a number of monitoring programs to address these uncertainties. Of these, six were thought to satisfy the eligibility criteria for monitoring studies under the Water Use Plan Program. The committee's recommended monitoring program is summarized in Table 3.

Table 3: Summary of Recommended Falls River Monitoring Program Studies

#	Monitoring Interest	Description	Cost	Schedule
	RIVER			
1	Presence and Timing of Steelhead and Salmon Spawning	Monitor timing of adult presence in Falls River below the dam and in the tailpond for March, April, August, September & October.	$12,000/year for up to 5 years (up to $60,000 total)	5 years
2	Fish Spawning Habitat	Monitor egg-fry survival. Place egg boxes and measure habitat at site. Evaluate effect of operation on survival.	$20,000/year for up to 5 years (up to $100,000 total)	5 years
	RESERVOIR			
3	Tributary Access and Potential Stranding	Survey location of barriers within drawdown zone in three tributaries and identify location and size of potential areas of stranding along the shore in the drawdown zone.	$5,000 Potential to combine with Study #5 for cost savings	In 1st year
4	Sedge Habitat Maintenance	Aerial overflight to identify extent of sedge habitat. Detailed assessment of species composition and density of vegetation in sedge habitat community.	$15,000 in year one; $15,000 in follow up year ($30,000 total)	In 1st year and in follow up year, 3–5 years later
5	Tributary Back-watering	Survey for redds in drawdown zone of three tributaries or, if necessary, sampling for adult spawners by netting, angling, or direct observation by snorkelling. Deploy temperature monitors and collect life history data.	$6,000 to $20,000 Potential to combine with Study #3 for cost savings	In 1st year
6	Wildlife Shoreline Habitat	Survey drawdown zone for dens and nests established by birds and mammals. Map locations and measure elevation.	$15,000/year ($30,000 total)	In 1st and 2nd years
	Total	**Implement all studies**	**$245,000**	**Over 5 years**

Once the implementation of the operational changes approved under the final Falls River Water Use Plan has begun, then BC Hydro will: 1) develop detailed terms of reference for the monitoring program; and 2) start monitoring program study, data collection, analysis and reporting. The Consultative Committee recommended that the detailed terms of reference be developed in consultation with appropriate government agencies, First Nations, and interested parties.

The results of approved monitoring programs will be sent to all interested members of the Consultative Committee as they become available.

Review Period

The Falls River Consultative Committee recommends that five years after the implementation of the Falls River Water Use Plan (or as soon as the results of all the approved monitoring program studies are available), a technical review of monitoring studies be undertaken by BC Hydro, appropriate government agencies, First Nations and interested parties. If scientific data and significant new risks are identified that could lead to a change in operations, a formal review of the Water Use Plan could be requested at that time.

If a review is not recommended during the five-year technical review of monitoring results, then the next review of the Falls River Water Use Plan will be conducted 10 years after the implementation of the Falls River Water Use Plan.

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1 INTRODUCTION

Water use planning was introduced by the Minister of Employment and Investment (MEI)[1] and the Minister of Environment, Lands and Parks (MELP)[2] as an approach to ensure provincial water management decisions reflect changing public values and environmental priorities. The purpose of water use planning is to understand public values and to develop a preferred operating strategy through a multi-stakeholder consultative process.

A Water Use Plan is a technical document that, following review by provincial and federal agencies and approval by the provincial Comptroller of Water Rights, defines how water control facilities will be operated. The process for developing a Water Use Plan is described in the provincial *Water Use Plan Guidelines* (British Columbia, 1998).

The Water Use Plan is intended to accommodate other water use interests through incremental changes in how existing water control facilities store and release water. While there may be opportunities to undertake physical works as a substitute for changes in flow, water use planning focuses primarily on a better use of water at facilities as they exist today.

Water Use Plans are not intended to be comprehensive watershed management plans or to deal with water management issues associated with other activities in the watershed such as forestry or mining. First Nations rights and title issues and historic grievances arising from the initial construction of the facilities are specifically excluded from Water Use Plans but can be considered as part of other processes (British Columbia, 2000).

The Falls River Water Use Plan Consultative Committee process was initiated in May 2002 and completed May 2003. The purpose of this report is to document the consultative process and present the recommendations of the Falls River Water Use Plan Consultative Committee. The interests and values expressed in this report will be used by BC Hydro to prepare a draft Water Use Plan for the Falls River hydroelectric project.

This Consultative Committee Report is a record of the water use issues and interests discussed and the trade-offs between different operating alternatives to meet stakeholder objectives. Both the *Falls River Water Use Plan Consultative*

[1] The Ministry of Employment and Investment responsible for electricity policy at the inception of the Water Use Plan program is now part of the Ministry of Energy and Mines.

[2] The Ministry of Environment, Lands, and Parks was reorganized in 2001 into the Ministry of Water, Land and Air Protection and the Ministry of Sustainable Resource Management.

Committee Report and BC Hydro's draft Water Use Plan for the Falls River project will be submitted to the Comptroller of Water Rights.

2 DESCRIPTION OF THE FALLS RIVER PROJECT

This section describes: 1) the location of the Falls River hydroelectric project and its physical structures; 2) the hydrology of the Falls River basin; and 3) the historical operation of the project.

2.1 Location and Physical Structures

BC Hydro's Falls River hydroelectric project is located within the Regional District of Skeena/Queen Charlotte Islands, approximately 50 kilometres southeast of Prince Rupert on Big Falls River above its confluence with the Ecstall River. A short section of the Falls River is located below the spillway and flows into Ecstall River, which is a tributary of the Skeena River. A map of the general area of the Falls River project is provided in Figure 2-1.

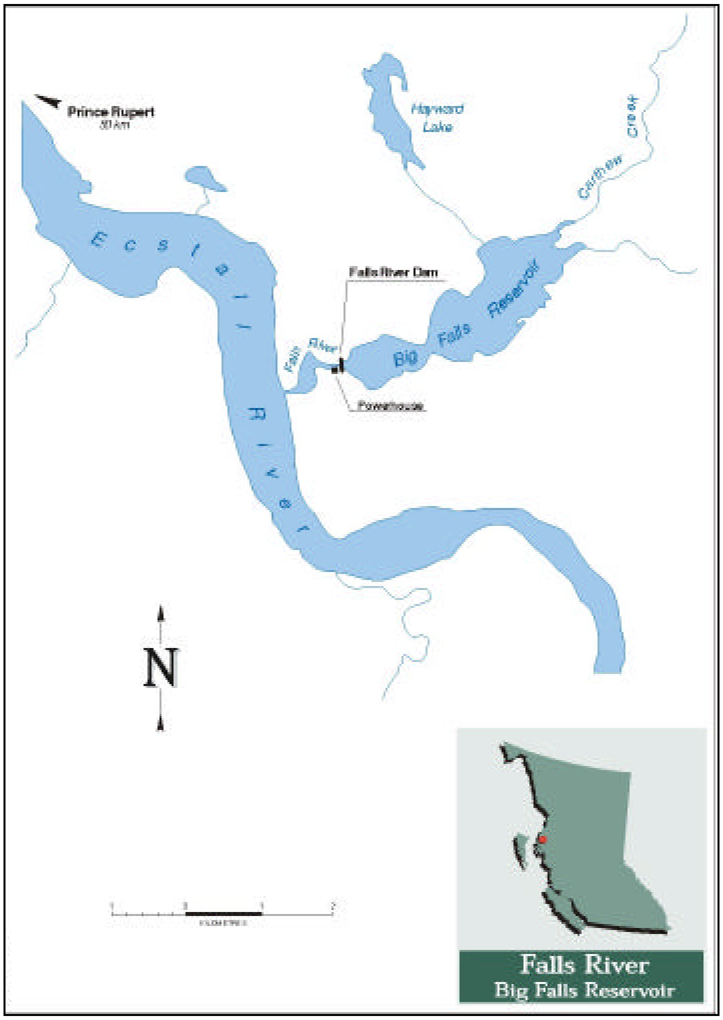

Figure 2-1: Location of Falls River Hydroelectric Project and Big Falls Reservoir

Access to the reservoir is by air or water only and floatplanes must land in the Ecstall River. There is an access road leading from the powerhouse to the reservoir. There is minimal four-wheel drive access during some parts of the year, via a network of active and abandoned logging roads. BC Hydro land encompasses the generating facilities. Land around the reservoir is Crown. In recent years, there has been active logging in the Falls River area at the eastern end of the reservoir.

The current physical structures comprising the Falls River hydroelectric project include the following components (also see Figure 2-2):

- **Big Falls Reservoir:** The water surface area created by the dam is 340 hectares when the reservoir is at an elevation of 92.40 metres. In recent years, the typical operating range for the reservoir has been from as high as 92.40 metres (with flashboards installed) down to 88.40 metres (the threshold for a discretionary reduction in unit load to meet minimum discharge levels for fish downstream). The live storage capacity of the reservoir (the volume of water between the elevations of 88.40 metres and 92.40 metres) is 8.8 million cubic metres (m^3) or 102 cubic metres per second days (m^3/s-days).

- **Concrete Gravity Dam:** The dam is approximately 154 metres in length and the maximum height of the dam (top of concrete) is 12 metres at an elevation is 92.96 metres[1].

- **Free Overflow Spillway:** The crest of the free overflow spillway is approximately 77 metres in length, at an elevation of 90.3 metres. When timber flashboards are installed, the crest is at an elevation of 92.4 metres.

- **Sluiceways or Sluice Gates:** There is a concrete crest at elevation 83.82 metres with permanent sill logs extending up to the sluice gate sills at elevation 87.17 metres. There are two functioning sluice gates – each measuring 6.1 x 6.1 metres – that are programmed to open for spill control when the reservoir exceeds a set elevation. These gates are operated automatically by a Programmable Logic Controller (PLC) when the reservoir level is above the sill elevation (87.20 metres). The minimum gate opening in the remote control mode is 0.3 metres, releasing approximately 7 m^3/s (also measured as cubic metres per second or cms). When the reservoir elevation is at full pool (92.96 metres), the combined discharge capacity of the two sluice gates is 317 m^3/s.

[1] Note: All elevations noted in this report are referenced to a local datum, 21.3 metres. Source: Government Survey of Canada datum (in metres).

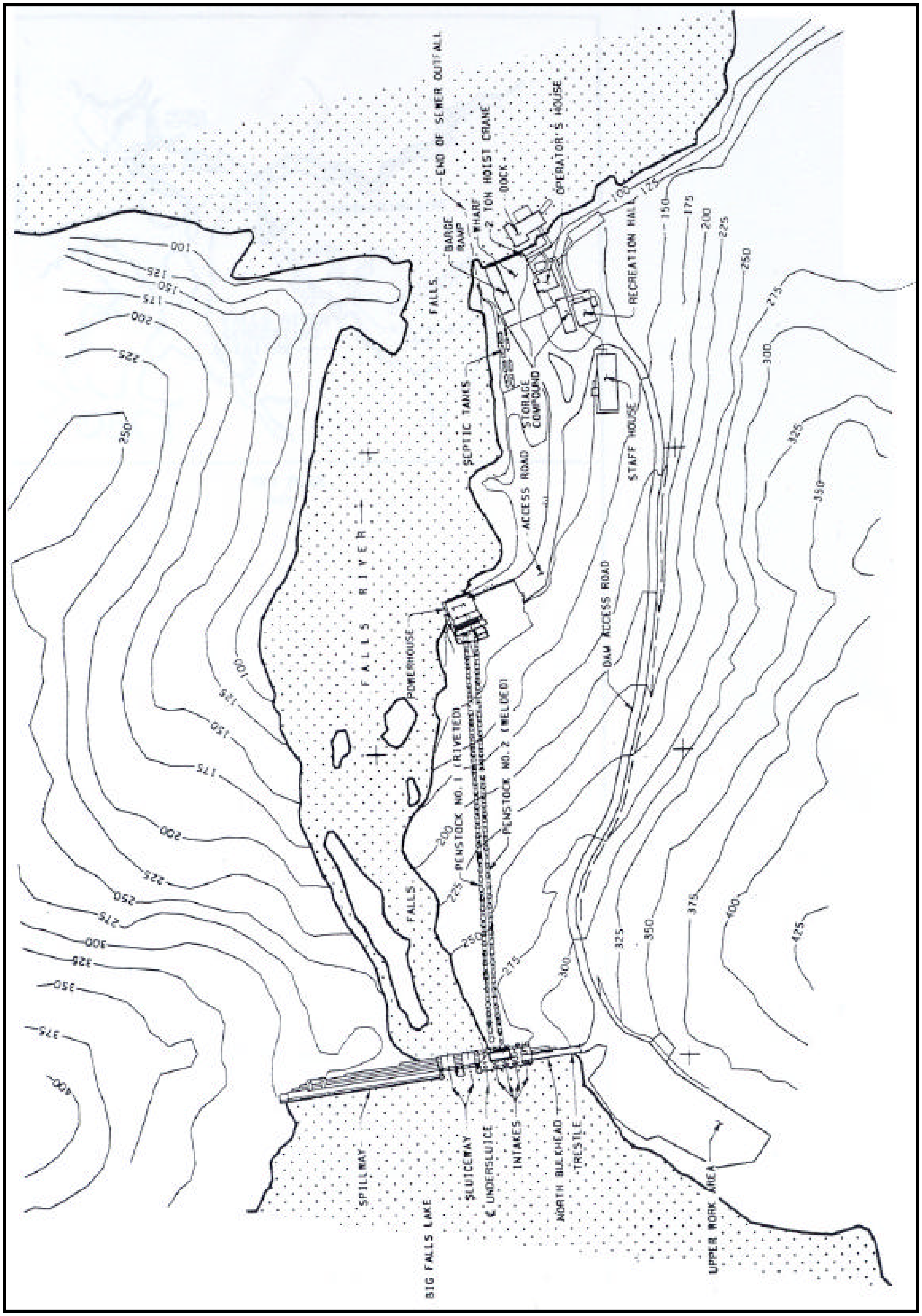

Figure 2-2: Falls River Hydroelectric Project

- **Undersluice:** There is an undersluice below the sluice gates. Its dimensions are 1.5 by 1.5 metres and it has a sill elevation (inlet invert level) of 81.86 metres. The undersluice can only be operated by local manual control and is not currently used for normal operation.

- **Falls below Dam and Spillway:** A 50-metre high falls is located just below the dam and spillway. At any given time, water flows from the Big Falls Reservoir into the Falls River in one or more of three ways: 1) over the spillway and falls, 2) through the sluice gates or 3) through one or both of the two penstocks that feed into the generating units and then discharge to the tailpond.

- **Penstocks:** These two steel pipes (each 1.83 metres in diameter) carry water from the intake reservoir to the powerhouse. Penstock #1 is 233 metres in length and Penstock #2 is 235 metres in length. These are the pipes seen on the very left hand side of Photo 2-1.

- **Powerhouse:** Photo 2-1 shows a picture of the Falls River powerhouse that holds two Francis generating turbine units with a normal combined maximum output of 7 megawatts (MW). Generating Unit #1 (G1) and Generating Unit #2 (G2) have maximum discharge capacities of 6.5 m^3/s and 7.1 m^3/s, respectively, for a combined maximum discharge of 13.6 m^3/s. Water from both units is released via a tailrace downstream of the dam below the falls.

Photo 2-1: Falls River powerhouse and tailpond

- **Tailpond and Lower Falls:** At the bottom of the falls is a 180-metre long tailpond that provides the majority of the fish habitat downstream of the dam. At the end of the tailpond is a cascade that presents a barrier up to 4.5 metres high at low tide (see Photo 2-2). Falls River flows about 1.4 kilometres (km) below the dam before it joins the Ecstall River.

Photo 2-2: Lower falls at end of tailpond where Falls River flows into Ecstall River

2.2 Hydrology of the Falls River Basin

The Big Falls River drainage basin has an area of approximately 246 square kilometres (km^2) draining west into the Ecstall River estuary. The basin is bounded by mountain peaks rising as high as 1966 metres on the eastern side. Several small glaciers are present in the southeast corner of the basin.

The climate of the northern coastal area is influenced predominantly by the flow of warm moist air masses from the Pacific Ocean, although cold dry air masses occasionally extend south and west in the area. The wettest season is winter, as evidenced by a mean monthly precipitation at the Falls River Generating Station of between 430 and 550 millimetres (mm) monthly for October to January, compared with mean monthly values between 110 and 160 mm for May to August.

The maritime nature of the climate is indicated by air temperature records at Prince Rupert. Mean daily air temperatures range from approximately 2°C in January to 14°C in August with maximum and minimum temperatures of 32°C and -21°C.

The Falls River Basin experiences snowmelt from May through August with annual peaks during this period typically ranging from 80 to 150 m^3/s. The highest annual inflows are during the winter storm season when daily inflows can reach over 500 m^3/s. During periods of high inflow, the limited storage capacity of the Big Falls Reservoir cannot capture all the incoming water resulting in spilling over the dam and falls (see Photo 2-3).

Photo 2-3: Falls River powerhouse with spill over falls during high inflows

2.3 Description of Historic Plant Operations

During the consultative process for the Falls River Water Use Plan (2002/2003), a parallel Dam Safety Review process was also under way. During the Falls River Water Use Plan process, a set of initial operating alternatives was modelled that might accommodate the key interests: fish, wildlife and power.

While modelling these exploratory alternatives, the timing of the installation of the flashboards was questioned. As a result, BC Hydro sought direction from its Director of Dam Safety to ensure all the alternatives explored through the Falls River Water Use Plan consultative process met BC Hydro's Dam Safety requirements. The Project Team supporting the consultative process worked closely with dam safety personnel to understand what the dam safety requirements would be moving forward.

This section describes the operation of the Falls River project in the years leading up to the initiation of the Falls River water use planning process and parallel dam safety review process in 2002.

- **Reservoir Operating Constraints:** A minimum reservoir operating elevation of 83.84 metres is required to maintain adequate domestic water supply. The minimum reservoir operating elevation for Generating Unit #2 (G2) is 86.60 metres; for Generation Unit #1 (G1), it is 85.50 metres.

- **Minimum Discharge (Flow):** In the early 1990's, BC Hydro adopted a minimum discharge of 1.3 m^3/s. This minimum flow is intended to maintain suitable fisheries habitat downstream. When both generating units are shut down (e.g., for maintenance or during an unplanned outage), the Programmable Logic Controller (PLC) is programmed to open a sluice gate to provide this discharge. In April 2002 (before the Falls River Water Use Plan process began), BC Hydro adopted a practice of curtailing generation when the reservoir reached 88.40 metres to maintain the minimum discharge from the plant of 1.3 m^3/s even under low inflow conditions.

- **Flashboard Installation and Removal:** Under historic operations, timber flashboards were installed annually at the facility on or around 15 November, and removed on or around 15 May. Flashboards are used on the free overflow spillway to surcharge the reservoir for generation purposes.

  - **Normal seasonal operations with flashboards out (15 May to 15 November):** During this period, there are no timber flashboards installed at the facility; the maximum normal reservoir elevation is 90.3 metres. When the water level exceeds this maximum, the water begins to flow over the spillway. When the reservoir elevation exceeds 91.65 metres, the sluice gates are opened automatically to control further rise of the reservoir.

  - **Normal seasonal operations with flashboards in (15 November to 15 May):** With the timber flashboards installed, the maximum normal reservoir elevation is 92.4 metres. When the reservoir exceeds this maximum, water will begin to spill over the flashboards. When the reservoir level exceeds 92.5 metres, the sluice gates are opened automatically to control further rise of the reservoir.

A key outcome of the concurrent Dam Safety Review of the Falls River project was ***direction from BC Hydro's Director of Dam Safety that moving forward, flashboards could be installed no sooner than 15 February and removed no later than 15 May.*** The Project Team ensured all options explored during

Falls River Water Use Plan process met this requirement. The main implication of this direction on dam safety requirements was that the Committee could not consider historical operations as a viable alternative for recommendation.

3 CONSULTATIVE PROCESS

The Falls River Water Use Plan consultative process followed the steps outlined in the provincial government's *Water Use Plan Guidelines* (Province of British Columbia, 1998). These steps outlined in Table 3-1 provide the framework for a structured approach to decision-making. The Consultative Committee is responsible for working through Steps 3 to 8.

Table 3-1: Water Use Planning Process

Step	Components of Water Use Planning Process
1	Initiate Water Use Plan
2	Scope water use issues and interests
3	Determine consultative process
4	Confirm issues and interests of specific water use objectives
5	Gather additional information
6	Create operating alternatives for regulating water use to meet different interests
7	Assess trade-offs between operating alternatives
8	Determine and document areas of consensus and disagreement
9	Prepare a draft Water Use Plan and submit for regulatory review
10	Review the draft Water Use Plan and issue a provincial decision
11	Authorize Water Use Plan and issue federal decision
12	Monitor compliance with the authorized Water Use Plan
13	Review the plan on periodic and ongoing basis

3.1 Initiation and Issues Scoping

In May 2002, BC Hydro began the Initiation Stage for the Falls River Water Use Plan (Step 1 in Table 3-1). Reference material was gathered to undertake a review of existing fish, wildlife and recreation information. Federal, provincial and local government agencies were also invited to identify representatives to participate in the Falls River Water Use Plan.

Between May and September 2002, BC Hydro contacted known stakeholders and other potentially interested parties in the area by telephone. This included First Nations, government representatives from municipal, regional, provincial and federal agencies, environmental groups, industries and community associations. During these calls, BC Hydro documented issues and interests associated with the operations of the project, determined the general use of the Falls River area, solicited the names of other stakeholders in the area and discussed the interest in participating in the Falls River Water Use Plan consultation process.

On 18 July 2002, a letter was sent to a broad list of potentially interested stakeholders (representing approximately 30 organizations[1]) advising them of the project initiation and inviting them to fill out a questionnaire describing their related issues and interests.

On 1 August 2002, a letter was sent to the Comptroller of Water Rights formally initiating the Falls River Water Use Plan.

In August 2002, First Nations and provincial and federal government agency representatives were invited to participate in a preliminary site visit to the Falls River facility and Big Falls Reservoir.

BC Hydro summarized the identified stakeholder interests/issues and submitted a summary report *Preliminary Issues Identification Report: Falls River Water Use Plan*, BC Hydro, 2002) to the Comptroller of Water Rights. This report completed Step 2 of the provincial *Water Use Plans Guidelines* (Table 3-1). The key interests identified were:

- Power
- Fish
- Wildlife
- First Nations Traditional Use
- Recreation

A news release was sent out 23 September 2002 announcing the start of the process and the first Consultative Committee meeting. Advertisements for the first meeting were also placed in the *Terrace Standard* on 14 and 28 September 2002 and in the *Prince Rupert Daily News* on 13 and 27 September 2002.

3.2 Consultative Committee Structure and Process

The Falls River Water Use Plan Consultative Committee consisted of main table members, alternates and observers (see Appendix A). Where possible, each member had a designated alternate who could assume the member's role in the event they could not attend a given meeting.

Observers attended on a drop-in basis and provided input but did not participate in decision-making. Seven members (and their designated alternates) actively completed the Falls River water use planning process over a series of three Consultative Committee meetings (see Table 3-2).

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[1] See Appendix A.

In addition to the Consultative Committee, participants formed a Fish and Wildlife Subcommittee (see Appendix A) to focus on specific fish and wildlife issues and to provide technical advice to the Consultative Committee. This Subcommittee met four times during the consultation process (Table 3-2).

Table 3-2: Falls River Water Use Plan Consultative Committee and Subcommittee Meeting Dates

Group	Meeting Dates
Consultative Committee	2–3 October 2002
	11–12 February 2002
	21–22 May 2003
Fish and Wildlife Subcommittee	4 December 2002
	7 January 2003 (by conference call)
	4 February 2003 (by conference call)
	15 April 2003

In October 2002, at their first meeting, the Consultative Committee adopted a Terms of Reference (see Appendix B) and a consultation work plan. Both the Terms of Reference and the work plan were included in the *Proposed Consultative Process Report: Falls River Water Use Plan* (BC Hydro, 2002) and submitted to the Comptroller of Water Rights to fulfil Step 3 of the provincial *Water Use Plan Guidelines*.

The Consultative Committee and Subcommittees met between October 2002 and May 2003 to complete the water use planning process. A site tour of the Falls River hydroelectric facility was held on 22 August 2002. The consultative process included three Consultative Committee meetings and four Fish and Wildlife Subcommittee meetings (some of which were held by conference call).

Detailed meeting notes recorded the discussions and decisions made at all these meetings, including conference calls. See Appendix C for a list of documents, including meeting notes, produced during the water use planning process.

Table 3-3 documents the progress made by the Falls River Water Use Plan Consultative Committee, Fish and Wildlife Subcommittee, and Project Team (which provided process and technical support to the Committee and Subcommittee) in completing the first nine Steps (or tasks) outlined in the provincial *Water Use Plan Guidelines*.

Table 3-3: Falls River Water Use Plan Consultation Process Schedule

Step	Components of Water Use Plan Process	Timeframe for Falls River WUP Consultation
1	Initiate Water Use Plan.	May–August 2002
2	Scope water use issues and interests.	June–September 2002
3	Determine consultative process.	October 2002
4	Confirm issues and interests of specific water use objectives.	October 2002
5	Gather additional information.	October 2002–April 2003
6	Create operating alternatives for regulating water use to meet different interests.	December 2002–May 2003
7	Assess trade-offs between operating alternatives.	February–May 2003
8	Determine and document areas of consensus and disagreement.	May–June 2003
9	Prepare a draft Water Use Plan and submit to Comptroller of Water Rights for review.	June–July 2003

3.3 First Nations Involvement

The Falls River project lies in the traditional territory of the Lax Kw'alaams Indian Band. The Allied Tsimshian Tribes Association (ATTA) represents the nine tribal groups that form the Lax Kw'alaams Band: Gitsiis, Ginaxangiik, Gitnadoiks, Gitzaxlaal, Gitando, Gitwylgiots, Gitlan, Gilutsau and Gispaxlo'ats. One of these groups' traditional territories encompasses the Falls River area.

Lax Kw'alaams Chief and Council were first notified about the upcoming Water Use Plan for Falls River by letter in May 2002 with a follow up phone call and letter in July. They were advised of the initiation of the Falls River Water Use Plan consultation process and invited to participate. BC Hydro requested a meeting with the community to present information about the water use planning process.

In August 2002, Lax Kw'alaams determined that ATTA was the body to represent its interests. BC Hydro invited representatives from both ATTA and Lax Kw'alaams to attend a preliminary site visit to the facility along with provincial and federal agency representatives on 22 August 2002. Although interested, both representatives were unable to attend. A presentation meeting for Lax Kw'alaams and ATTA was then arranged for 10 September 2002 in Port Simpson.

Subsequently, the 10 September 2002 meeting was deferred until 1 October 2002 when BC Hydro staff and representatives of Lax Kw'alaams and ATTA met to discuss the water use planning process and ATTA issues related to the Falls River facilities. At that time, both the ATTA and Lax Kw'alaams decided to attend the first Consultative Committee meeting on 2 and 3 October 2002 as observers. They also requested another community meeting to determine whether

ATTA would continue to participate at the Falls River Water Use Plan Consultative Committee table.

That next community meeting took place on 3 December 2002. Lax Kw'alaams and ATTA each designated a representative for the Consultative Committee, and funding arrangements to support their participation at the Water Use Plan table were discussed. Both representatives participated in all the Consultative Committee meetings and most of the Fish and Wildlife Subcommittee meetings throughout the remainder of the Falls River Water Use Plan consultative process.

3.4 Community Awareness and Communication

During the Falls River water use planning process, BC Hydro mailed two update memos to its list of interested stakeholders to inform them about development in the process (December 2002 and April 2003).

The BC Hydro Water Use Plan web site also provided information to those interested in the Falls River plan as well as those interested in other Water Use Plans for other BC Hydro facilities in the province.

The Aboriginal Relations Task Manager on the Falls River Water Use Plan Project Team worked to ensure information was provided to First Nations in a timely manner and to assist them, when requested, to interpret the information provided.

4 ISSUES, OBJECTIVES AND PERFORMANCE MEASURES

As per Step 4 of the provincial *Water Use Plan Guidelines*, the Consultative Committee stated specific **objectives** for the desired outcomes in dealing with water use issues. In defining the objectives, the participants articulated what they sought to achieve through incremental changes in BC Hydro operations (e.g., maximize the abundance of fish populations).

For each water use objective, the Consultative Committee defined one or more **performance measures** (indicators) to quantify how the objective would be measured (e.g., square metres of fish habitat). The Committee then used these performance measures to compare the benefits and trade-offs between different operating alternatives for the Falls River hydroelectric project.

This section of the report provides a summary of the interests, objectives and performance measures for the Falls River Water Use Plan. It also summarizes any studies undertaken to inform the development of objectives and performance measures. The presentation order of issues here does not imply any priority or relative importance among the issues.

For each issue below, we provide descriptive context for the issue followed by the objectives and performance measures. The performance measure column specifies how the performance measure will be calculated (e.g., number of days the reservoir is below 88.4 metres). Some performance measures have additional information such as the location where the performance measure is calculated (e.g., the area of the drawdown zone of the reservoir between specified elevations) or the relevant time of year (e.g., 1 April to 31 October for growing season for sedge grass wildlife habitat).

This section of the report also describes studies the Consultative Committee undertook to better understand the relationship between BC Hydro operations and the resource values of concern to the table. See Appendix C for a list of documents generated by the Falls River water use planning process.

4.1 Power Generation

The Falls River hydroelectric project is part of BC Hydro's provincial integrated generation system. Although connected to the integrated generation system, the Falls River project is a remote facility that also plays an important role in the reliability of local electricity supply.

The Falls River project is classified as a coastal hydrology system with high winter inflows from seasonal rainstorms and spring and summer inflows resulting from snowmelt. As a result, generation at the facility varies daily and seasonally with the demand for electricity and the availability of water.

BC Hydro uses all of the available inflow, within the storage and generation limits of the facilities. Spills occur when inflows exceed generation or storage capacity.

The Falls River powerhouse currently generates approximately 52 gigawatt-hours (GWh) annually providing electricity to BC Hydro's provincial integrated energy supply system. The output from the facility can supply the equivalent of approximately 5000 homes and its estimated value is $2.5 million per year.

4.1.1 Issues – Power Generation

There are two main issues associated with power generation at the Falls River project:

- **Reliability**: Industrial consumers want reliable power. The Falls River project only generates about one per cent of the province's total generation. If Prince Rupert is separated from the provincial integrated energy supply system (e.g., in the event of a transmission failure), then industry is reliant on Falls River and the Prince Rupert Gas Turbine Station for back-up power supply.
- **Flexibility of Operations:** The value of energy changes depending on the time of day, week and year based on peaks in demand. The flexibility to start and stop operations to take advantage of these changing values is important to BC Hydro since it allows them to maximize the value of energy produced at the facility. The issue is whether water is available for generation when needed, or does a particular operating alternative cause it to be used inefficiently from an operating point of view (e.g., spilled unnecessarily at a time when it is economically valuable).

4.1.2 Objectives and Performance Measures – Power Generation

The Consultative Committee developed one **objective** and two sub-objectives related to power (see Table 4-1). The main objective is to **maximize value of power produced at Falls River**. The two sub-objectives are to:

1. **Maximize the flexibility of operations** (the ability to stop and start in response to changes in demand).
2. **Maximize the availability of water for power generation**.

The **performance measure** used to score each alternative for the main power objective is **dollars of electricity revenue per year** (adjusted for the cost of flashboard installations and the cost of revenue lost due to reduced generation capacity during planned annual maintenance). Those representing the power interest on the Committee chose not to develop performance measures for the two sub-objectives. For more detailed information on the methodology, assumptions and uncertainties related to the performance measures for power generation, see Appendix D.

Table 4-1: Objectives and Performance Measures – Power Generation

Objectives	Performance Measures	Location
Maximize the value of electricity to BC Hydro and the province	Annual Revenue - Dollar value of average annual energy production	Falls River Generating Station

4.1.3 Studies – Power Generation

A key precursor to calculating performance measures for power and other interests was to have data on inflows into the reservoir. Historic inflows have not consistently been recorded directly by instruments on site at the Big Falls Reservoir. As a result, the inflow records used for modelling performance measures during the Falls River water use planning process came from the following sources:

- **Synthetic Data:** Synthetic data was developed based on correlations between Falls River inflows and those in nearby watersheds where measurements have been collected with water gauges by the Water Survey of Canada. The years for which synthetic inflow data were used are 1967–1969, and 1977–1994 (for a total of 21 years of the 33 years of inflow records used in the process).
- **Observed Data:** This data is calculated using historic records of reservoir elevation and generation for the years from 1970–1976 and 1995–1999 (for the remaining 12 years out of the 33 years of inflow records used in the process).

4.2 Reservoir Wildlife

There are two distinct areas of riparian and nearshore habitat used by wildlife in the area: 1) Big Falls Reservoir and tributary streams; and 2) the Falls River downstream of the reservoir. There is little information about wildlife use of the Falls River downstream of the reservoir and no specific issues or concerns were identified for this area by the Consultative Committee. The focus throughout the consultative process was on wildlife values around the reservoir.

The reservoir shoreline is characterized by forested steep rock slopes except on the northeast shore where the Hayward and Carthew creeks drain into the lake through shallow valleys. The forest extends about 500 metres from the lake and disappears as it reaches the alpine[1]. The lake lies in the Coastal Western

[1] Bradley, R.M. April 1983. *Falls River redevelopment environmental review of reservoir clearing options.*

Hemlock, wet marine biogeoclimatic zone. Western red cedar, yellow-cedar, western hemlock, Pacific silver fir, and Sitka spruce, are the dominant species.

In July 1982, a biologist studied the area for potential nesting bird habitat[1]. No nest cavities were found in trees surveyed in the lake. Bird habitat values were low due to diminished habitat resources. The birds observed included Canada Geese grazing on mudflats for a spring staging area and a common merganser raising a brood in Big Falls Creek. Local residents have also observed white swans feeding and breeding around the reservoir[2].

Breeding waterfowl included common merganser on Big Falls Creek, a common loon pair, and breeding osprey. Other birds observed were swallows and bald eagles. Around the eastern shore, tracks and other sign of black bear and grizzly bear, wolf, moose and deer were found. The area is located within the grizzly bear range mapped as "moderate".

4.2.1 Issues Not Pursued by Consultative Committee – Reservoir Wildlife

There were a few wildlife issues raised by members of the Committee that were not pursued because they fell outside the scope of the water use planning process. In particular, these issues were related to grievances arising from the initial construction of the facilities. These types of concerns are specifically excluded from Water Use Plans (Province of British Columbia, 2000). The issues and concerns in question are noted below, along with a brief explanation as to why they were not considered in the remainder of the Falls River Water Use Plan process:

- **Loss of Beaver Habitat:** First Nations observed a permanent migration of beavers out of the area after the dam was built. The beavers moved up to other lakes in the watershed, meaning they were no longer available for hunting and trapping (traditional use). Unfortunately, there are no incremental changes to operations that could address this concern.
- **Potential for Mercury Contamination of Wildlife:** First Nations raised a concern regarding the potential for mercury contamination of wildlife consuming fish from the reservoir. This issue is dealt with in more detail in Section 4.3.1.

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[1] Bradley, R.M. April 1983. *Falls River redevelopment environmental review of reservoir clearing options.*

[2] Barry Drees, fax communication (23 July 2003).

4.2.2 Issues Pursued by Consultative Committee – Reservoir Wildlife

There were four key issues raised by the Committee related to the impacts of operations on wildlife:

- **Nesting and Denning Wildlife:** Shoreline nesting birds or denning animals could be impacted by reservoir level fluctuations occurring at key life stages. In particular, the Committee was concerned about the extent to which operations contributed to the stranding or flooding of both nests and dens.

- **Habitat Access and Migration:** A lot of wildlife use the area for habitat (moose, mountain goats, mink, osprey, otters, eagles, wolves and bears). The Committee expressed concern about the impacts of operations – specifically reservoir fluctuation – on stranding or other impacts on wildlife movement and migration.

- **Quality and Quantity of Riparian Habitat:** The background literature review conducted during the initiation of the process and the site visit in August 2002 provided the Committee with an understanding of the importance of the sedge grass community in providing riparian habitat for wildlife using the area. The issue of concern is the impact of operations on the quality and quantity of sedge habitat in and around the drawdown zone of the reservoir.

- **Indirect Impacts on Fish-Eating Wildlife:** There are number of wildlife species in the area who consume fish as a key portion of their diet. The concern is the negative impacts of operations on fish abundance could also have negative impact on fish-eating wildlife. The Committee agreed this issue would be addressed under the discussion of fish issues, the idea being that any improvements to fish and fish habitat would benefit wildlife that eat fish.

4.2.3 Objectives and Performance Measures – Reservoir Wildlife

The main objective in considering alternative operations is to **maximize the abundance and diversity of wildlife that use the area around the reservoir**. The Committee also identified four key sub-objectives that helped to qualify the main objective and develop useful performance measures, described below (see Table 4-2):

- **Maximize riparian habitat:** The performance measure for this objective is **sedge community maintenance measured in hectare-days**. Based on our present understanding of the Falls River reservoir, it appears the band of sedge vegetation in the drawdown zone of the reservoir is maintained by annual flooding that kills trees and other species not tolerant of periodic inundation. Since both the extent and duration of the flooding are important, this performance measure is the product of time and area (hectare-days).

Also important is the amount of time during the remainder of the growing season that the sedge community is not flooded so it can grow. Based on available scientific literature and in the absence of site specific data, the Committee selected a value of four-weeks (28 days) as the period of inundation necessary to prevent succession (intrusion by shrubs and other non-wetland vegetation) and maintain the sedge habitat.

This performance measure is the amount of area that has been inundated a minimum of 28 days over the growing season to avoid intrusion of shrubs.

- **Minimize stranding and/or flooding of bird nests and wildlife dens in the drawdown zone of reservoir:** There are two performance measures for this sub-objective. The first is **shoreline habitat measured in hectare-days**. The product of the number of hectares available for denning and nesting times the number of days they are dry consecutively (must meet a minimum threshold of 30 days) summed up over the potential period of nesting and denning. The second is **water level stability measured as the standard deviation of the reservoir level.** This performance measure was developed based on the assumption that more stable water levels during the growing season increases survival and foraging success for wildlife using shoreline and riparian habitats.

- **Maximize access to migratory corridors:** The Consultative Committee agreed to proceed without a specific performance measure for this sub–objective given the lack of specific information about reservoir elevations that would present potential barriers to wildlife migration.

Table 4-2: Objectives and Performance Measures – Wildlife Using Falls River Reservoir

Objectives	Performance Measures	Location
Maximize riparian habitat.	Sedge Community Maintenance – Sum of hectare-days that are flooded for a minimum of 28 days during the growing season (1 April–31 October).	Reservoir drawdown zone (from 90.3 metres to 92.4 metres in elevation)
Minimize stranding and/or flooding of nest and dens.	Shoreline Habitat – Sum of hectare-days of available habitat for nesting and denning that remains dry for a minimum of 30 days during the growing season (1 April–31 October).	Same as above
Minimize stranding and/or flooding of nest and dens.	Water Level Stability – Standard deviation of reservoir levels.	Same as above

For more detailed information on the methodology, assumptions and uncertainties related to the performance measures for wildlife, see Appendix E.

4.2.4 Studies – Reservoir Wildlife

The Consultative Committee commissioned one study related to the maintenance of the sedge grass community that provides valuable riparian habitat for wildlife. The study[1] was designed to solicit an expert opinion on:

- The minimum duration and frequency of inundation that will be required to maintain the existing sedge grass community around the reservoir

- The design of a monitoring program that could be implemented following the Water Use Plan to test the effectiveness of a new operating regime chosen by the Consultative Committee.

Based on the limited information available about the sedge grass community in the Falls River Reservoir, Anne Moody was unable to assess the duration and frequency of flooding required to maintain the sedge community. She did, however, offer specific suggestions regarding the design of an effectiveness monitoring program.

4.3 Reservoir Fish

The Big Falls Reservoir was created in 1930 from the damming of the Falls River. No lake was present prior to the impoundment of the Falls River. When the reservoir was created, the existing forest was not logged and the lake was left with standing dead timber. Based on a mean annual inflow of 26 cubic metres per second (m^3/s), the reservoir requires less than a day to drain if the facility is running at full capacity. The lake has large areas of shallow shoal, with an average depth of seven metres. The main tributaries are Big Falls Creek, Hayward Creek and Carthew Creek. Visibility (light penetration) is estimated to an average depth of six metres. Fish species present are Dolly Varden[2] and cutthroat trout.

4.3.1 Issues Investigated but Not Pursued by Consultative Committee – Reservoir Fish

The Consultative Committee and Fish and Wildlife Technical Subcommittee discussed a few issues in their earlier meetings that were not pursued any further for reasons outlined below:

- **Pelagic productivity:** Pelagic productivity refers to the annual production of aquatic organisms living in the open water – the pelagic

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[1] Moody, Anne. 2003. *Falls River Water Use Plan: Vegetation Commentary for the Falls River Reservoir* (Anne Moody, 2003). Consultant's report commissioned by Falls River Water Use Plan Consultative Committee.

[2] At this point, the continued presence of Dolly Varden in the reservoir cannot be confirmed. The Consultative Committee has recommended the implementation of a monitoring program designed to address this uncertainty.

zone of the reservoir. These organisms are an important source of food for fish. Based on an average depth in the reservoir of seven metres, a drawdown of three metres (the annual average maximum drawdown observed during the growing season from 1995 to 2002) would reduce the total volume of the reservoir by up to 50 per cent.

This appears to be a significant and harmful reduction in living space for these organisms. However, data collected by Larratt (1983) show that plankton (pelagic organisms) account for less than one percent of primary production in the Big Falls Reservoir. The Consultative Committee agreed that while they valued pelagic productivity, it was unlikely impacts of operations on pelagic organisms would lead to significant impacts on fish in the reservoir.

- **Water Quality and Temperature:** The Fish and Wildlife Technical Subcommittee agreed that these two factors are not likely to be issues in the reservoir, but are unknown. As a result, the Consultative Committee included monitoring of water quality and temperature in the design of monitoring programs developed to address uncertainty related to other issues in the reservoir.

- **Potential for Mercury Contamination in the Reservoir:** Representatives of the Lax Kw'alaams Band and the Allied Tsimshian Tribe Association (ATTA) expressed concern about the potential for mercury contamination of fish in the reservoir and wildlife further up the food chain (e.g., birds, mink, osprey, eagles, wolves, bears) who consume the fish.

  Mercury contamination in hydroelectric reservoirs is typically associated with the original flooding of the area. However, no one on the Committee or the supporting Project Team was able to conclusively answer the following question with certainty: *Is there an incremental operational change that could be made to address contamination if it is an issue?*

  The Committee agreed more information was needed before they could make a decision about whether the issue could or could not be considered under the scope of the water use planning process. The Corporate Representative for BC Hydro on the Committee offered to hire a consultant to collect some fish from the reservoir and have them tested for mercury contamination.

  The results of this testing (conducted in October 2002) were interpreted and presented at the second Consultative Committee meeting

(February 2002) by Randy Baker[1], an aquatic ecologist specializing in mercury contamination. At that meeting, Randy Baker indicated that mercury levels present in the cutthroat trout that were tested are among the lowest reported in British Columbia.

In his opinion, mercury concentrations of cutthroat trout from Falls River Reservoir are so low there is an extremely low health risk to humans from consuming this species. Similarly, wildlife eating these cutthroat trout would also not be expected to be at risk of accumulation of mercury in their tissues. Accordingly, in Randy Baker's estimation, no further monitoring of cutthroat trout is required.

In the absence of mercury data for bull trout from the reservoir, Randy Baker was unable to say if there is a different level of risk associated with consuming this species since bull trout typically have higher mercury concentrations than most other species. However, any risk of adverse health impacts to humans or to wildlife associated with bull trout would require consumption on a very regular basis for a period of years. Accordingly, Randy Baker suggested that if bull trout are present in the reservoir and are being consumed by First Nations' people, mercury testing of a sample of bull trout should be conducted on an opportunistic basis.

Returning then to the two key questions: *1) Is mercury contamination of fish and wildlife an issue in the Big Falls reservoir? 2) If so, is there an incremental operational change that could be made to address contamination if it is an issue?*

Based on Randy Baker's interpretation of the results for cutthroat trout, and pending the testing of bull trout in the reservoir (if they are present), the answer to question one is that mercury contamination does not appear to present any significant risk of adverse health impacts for humans or wildlife consuming the fish in Big Falls Reservoir.

In response to question two, Randy Baker indicated the annual fluctuation of reservoir levels (even extreme rainfall and inflow events) does not increase mercury concentrations. The only time significant increases in mercury might be expected is if the area of the reservoir is permanently expanded; for example, if the surface area were to be increased by at least 30 to 40 per cent of its current maximum.

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[1] Randy Baker, Azimuth Consulting Group Inc. Randy Baker is an expert in the field of mercury toxicology. He has studied the issue of mercury in the environment, especially the relationship between mercury and reservoir creation, since 1979. He is currently on contract to the United Nations to co-author a book on mercury with specific focus on mercury in aquatic biota, especially fish.

Annual drawdowns and increases in reservoir level from inflows – even if newly vegetated area at the edge of the drawdown zone are being flooded – would not cause a noticeable increase in fish mercury concentrations. ***In other words, the issue of potential mercury contamination falls outside the scope of water use planning because there are no incremental operating changes that can significantly increase or decrease the risk.***

At the final Consultative Committee meeting (May 2002), the representative of the Allied Tsimshian Tribe Association (ATTA) indicated that he would like to see continued monitoring of mercury levels in reservoir fish (particularly bull trout) over the next five years. As this issue falls outside the scope of the water use planning, BC Hydro and the ATTA agreed to discuss the ATTA's request outside the Falls River Water Use Plan process. After the final meeting of the Falls River Water Use Plan Consultative Committee, representatives of both First Nations organizations formally reiterated their request for additional mercury monitoring studies (see Appendix F).

4.3.2 Issues Pursued by the Consultative Committee – Reservoir Fish

The Consultative Committee pursued a number of issues related to resident fish in the Big Falls Reservoir:

- **Backwatering of spawning and incubation habitats in the tributaries in the drawdown zone:** Studies of fish in other reservoirs have shown high and rapid mortality to incubating eggs that are back-watered by rising reservoir levels. Therefore, the Consultative Committee focused on managing reservoir levels so as to encourage spawning of cutthroat trout and Dolly Varden further up the tributaries, and avoid backwatering of incubation habitats in the drawdown zone.

- **De-watering of fish eggs or stranding of fish during drawdowns:** Depending on the shape of the reservoir bed and shore and the drawdown rate, changing reservoir levels can leave fish and/or fish eggs stranded. The Fish and Wildlife Technical Subcommittee identified this as an unknown risk in the Big Falls Reservoir. Therefore, the Consultative Committee focused on developing a monitoring program to assess the risk of stranding in the reservoir.

- **Littoral Productivity:** Littoral productivity refers to the annual production of organisms that are growing on or near the reservoir shoreline within the area illuminated and therefore capable of primary production. These littoral organisms, such as algae and macrophytes (weeds) are an important source of food for fish. The littoral zone in Big Falls Reservoir is extensive as most of the reservoir bottom may be lit by sunlight during part of the year. However, decreases in reservoir elevation are expected to de-water extensive areas of habitat. In turn, this could lead to the death of littoral organisms through dessication (drying), freezing, and predation. The Consultative Committee focused on managing one of the key factors that limits littoral productivity: the timing and level of reservoir drawdowns.

- **Access to tributaries:** The location of spawning and rearing habitat for resident fish (cutthroat trout and Dolly Varden) in the Big Falls Reservoir are unknown. However, if fish are spawning in the area, it is reasonable to expect that these fish would spawn in tributaries, upstream of the reservoir. Studies on other reservoirs in the province have shown that barriers to adult and juvenile migration may emerge during drawdown conditions. The risk associated with this potential issue is unknown for the Big Falls Reservoir, and became a candidate topic for a monitoring program.

- **Species at risk:** Previous studies have identified Dolly Varden (a species at risk) in the watershed; however, this region supports the blue-listed bull trout, which is easily mistaken as Dolly Varden. Cutthroat trout are also present and they are also blue-listed. This issue relates to both the issue of tributary access (potential barriers to migration) and backwatering of tributary spawning habitats in the drawdown zone (both described above).

- **Sediment erosion and suspension:** The drawdown of the reservoir may allow deposits of fine sediment to be eroded and suspended in the water column, in turn causing adverse effects to aquatic organisms (pelagic and littoral). This could include interference with light penetration, and therefore primary productivity, resulting is less food for fish.

4.3.3 Objectives and Performance Measures – Reservoir Fish

There is one main objective and four sub-objectives for managing fish in Big Falls Reservoir (Table 4-3). The main objective is to **maximize the abundance and diversity of fish in the reservoir.** The sub-objectives clarify what means might be used to achieve this fundamental objective and address the Committee's specific concerns about potential impacts of operations on fish (described in the previous section). Each of the sub-objectives and the performance measures used to track it across alternatives are described below and summarized in Table 4-3.

- **Maximize quantity and quality of littoral habitat:** As described earlier, littoral organisms are an important source of food for fish. Annual littoral production is maximized when the reservoir is relatively stable and littoral ecology can develop undisturbed from year-to-year. When water levels fluctuate because of reservoir operations, the ability for algae, macrophytes and associated aquatic communities to establish is limited by the duration that zone is wetted and receives sufficient sunlight. In the Big Falls Reservoir, the average depth in the reservoir is still shallow enough for light penetration, but decreases in water levels (exposure and dessication) will limit littoral production. The littoral zone performance measure is **hectare-days of effective littoral zone (ELZ)**.

- **Maximize tributary access for spawning and rearing:** The spawning and rearing habitats for resident fish in Big Falls Reservoir are partly known from fish inventory studies in the watershed. However, the distribution of spawning is not understood through the system. It is unclear what portion of the spawning population uses the lower reaches of the three-key tributaries. Studies on other reservoirs in the province have shown the barriers to adult and juvenile migration may emerge during drawdown conditions. Based on aerial photographs of the Big Falls Reservoir, the gradient of the tributary streams is low (0.5 to 1 per cent), suggesting that barriers will not be an issue. There is some evidence from bathymetry of steeper topography at reservoir elevations of four-to-five metres below full pool (88.4 metres) that may create a barrier to upstream migrating adults. The performance measure for the access objective is **tributary access days**, **for both cutthroat trout and Dolly Varden**.

- **Minimize back-watering of spawning and incubation habitats:** It is unclear what portion of the spawning population uses the lower reaches of the three-key tributaries feeding into the reservoir. During a site visit of the facility and reservoir conducted in August 2002, sand and silt substrate was observed in tributary stream channels in the drawdown zone, suggesting that spawning habitat may be poor. This could not be confirmed within the available time frame of the Falls River Water Use Plan consultative process. In the absence of more information, the Consultative Committee assumed some spawning habitat is present. The Committee also assumed any back-watering of spawning habitat results in egg mortality. The performance measure for this objective is **square metres of tributary spawning habitat lost, for both cutthroat trout and Dolly Varden**. This lost habitat estimates the area originally available for spawning and subsequently back-watered later in the spawning period or during incubation.

- **Minimize de-watering or stranding of fish:** Studies of other reservoirs in the province have demonstrated the potential for stranding of fish in the event of rapid drawdowns of the reservoir, depending on the bathymetry of the reservoir. The Consultative Committee agreed to proceed without a performance measure for this objective since there was insufficient information available to develop a realistic and useful measure. Data collection on this objective would require a detailed bathymetric survey of the reservoir and field observation during drawdowns. The time and resources were not available to do during the Falls River Water Use Plan consultative process. The Committee agreed to revisit this issue during their discussion of monitoring needs.

- **Minimize impacts on Species at Risk:** The Consultative Committee agreed since the main species at risk are Dolly Varden and bull trout, the **Tributary Access and Tributary Spawning Habitat Lost Performance Measures** (see above) would address this objective.

- **Minimize erosion and suspension (mobilization) of sediment:** Operations may influence deposition and erosion by altering water velocity within the reservoir and the area of exposed sediment. The high rate of reservoir turnover and glacial silt input from tributaries suggests that operations cannot control erosion and deposition. However, rates of erosion will be higher at lower reservoir elevations because of the increased velocity in the reservoir and deposition will be less. Erosion and sedimentation are also of greatest concern during the growing season when turbidity caused by increased suspended sediment can reduce light penetration, lowering littoral productivity. All of these factors suggest that concerns for erosion and sedimentation are of greatest concern at lower reservoir levels during the growing season. The performance measure for this objective is the **Sediment Exposure and Velocity Index measured in days**.

Table 4-3: Objectives and Performance Measures – Fish in Big Falls Reservoir

Reservoir Fish Objectives	Performance Measures	Location/Timing
Maximize littoral habitat	Effective Littoral Habitat – sum of hectare-days that are wetted and receive sufficient light during the growing season.	Measured over entire reservoir from 1 April–31 October.
Maximize tributary access	Tributary Access Days – number of days the reservoir elevation is above 88.4 metres (threshold for potential barrier to migration) during the spawning seasons for cutthroat trout and Dolly Varden.	Measured over entire reservoir. 1 April–15 May for cutthroat trout. 1 September–31 October for Dolly Varden.
Minimize the loss of tributary spawning habitat	Tributary Spawning Habitat Lost – the area (in square metres) of spawning habitat in tributary streams within the drawdown zone that has water flowing over it during the spawning period and is back-watered during the incubation period, for cutthroat trout and Dolly Varden.	Measured for tributary spawning habitat in drawdown zone between 90.3 and 92.4 metres in elevation. 1 April–15 July for cutthroat trout. 1 September–15 March for Dolly Varden.
Minimize erosion and sediment suspension	Sediment Exposure and Velocity Index – Number of days the reservoir is below 90.3 metres in elevation during the growing season.	Measure for entire reservoir from 1 April–31 October.

For more detailed information on the methodology, assumptions and uncertainties related to the performance measures for fish in Big Falls Reservoir, see Appendix G.

4.3.4 Studies – Reservoir Fish

During the Falls River Water Use Plan consultative process, there were no site-specific studies conducted on operational impacts affecting fish in the Big Falls Reservoir, with the exception of the mercury contamination testing of cutthroat trout, described in Section 4.4.1. The decision not to conduct any other studies was based on the limited budget and timeline for the consultative process. Instead, later in the process, the Consultative Committee developed and recommended a monitoring program which included information gathering to address the uncertainty relating to operational impacts on fish in the reservoir (Section 7).

4.4 River Fish

A 50-metre high falls is located just below the dam and spillway. At any given time, water flows from the Big Falls Reservoir into the Falls River in one or more of three ways: 1) over the spillway and falls; 2) through the sluice gates; or 3) through one or both of the two penstocks that feed into the generating units and then discharge to the tailpond. The 180-metre-long tailpond provides the majority of the fish habitat downstream of the dam. At the end of the tailpond is a cascade that presents a barrier up to 4.5 metres high at low tide. Falls River flows about 1.4 kilometres (km) below the dam before it joins the Ecstall River.

Chinook, coho, chum, pink salmon, cutthroat trout, rainbow trout and Dolly Varden (or bull trout[1]) are present in the Falls River downstream of the dam (FISS, 2000). Fisheries and Oceans Canada escapement records indicate that chinook, chum and pink salmon populations have all declined from highs several decades earlier; however, the accuracy of these records is questionable.

The Ecstall River is used by five species of Pacific salmon (FISS, 2000). Spawning, rearing and holding areas are plentiful. Other fish species reported include cutthroat trout, steelhead, Dolly Varden, eulachon, mountain whitefish and non-game fish (FISS, 2000).

The Consultative Committee's choice of operating alternative would affect the amount and timing of water to be released for fish downstream of the facility. Water released from the reservoir into the Falls River feeds into the Ecstall River at their confluence. For the purposes of the Falls River Water Use plan, the scope of fish issues in the Falls River extends from the Falls River dam downstream to the confluence with the Ecstall River.

[1] Past observations of Dolly Varden may actually have been of bull trout.

4.4.1 Issues Investigated but Not Pursued by Consultative Committee – River Fish

The Consultative Committee and Fish and Wildlife Technical Subcommittee discussed a few issues in their earlier meetings that were not pursued any further for reasons outlined below:

- **Temperature:** Given the same air temperatures, slow moving reservoirs can experience greater changes in water temperature over a season than a fast moving river. This is especially true if water is kept in the reservoir long enough to absorb and store heat, and potentially stratify into thermal layers. In turn, this creates the opportunity to heat and cool on a daily and annual basis, possibly leading to unnatural temperature regimes that may fall outside the optimal range for fish adapted to original conditions in the river before it was impounded. The Subcommittee agreed this was not likely to be an issue at Falls River given the location of the facility in a region where warm temperatures are usually not an issue for fish. Nonetheless, the Committee suggested that temperature monitoring might be useful.

- **Decline of Salmon Populations:** Since the initial construction of the Falls River dam and power facilities, salmon populations in the Falls River have declined. The Fish and Wildlife Technical Committee discussed stocking the area as a potential solution; however, stocking programs fall outside the scope of the Water Use Plan program. Instead, the Consultative Committee agreed to look at other ways to improve conditions for fish in the river by managing the way water is released from the facility to improve flow conditions (see Section 4.4.2).

- **Impact of water acidity on egg loss:** The subcommittee noted that if the acidity (pH) of the water flowing into the river downstream is not in the right range (too acidic) during incubation, fish egg shells can become so soft that they are not able to survive. This is called soft shell egg loss. The acidic pH downstream would be the result of more acid conditions in the reservoir, that in turn are caused by the ongoing decay of flooded vegetation and standing trees. The Consultative Committee could not identify an operational change that could address this issue. Instead, they focused on ensuring monitoring programs for the reservoir included monitoring of water quality (pH) data.

- **Gravel recruitment for spawning habitat:** Gravel provides important habitat for fish spawning. Before the dam was in place, gravel would have been carried over the Falls River falls on an ongoing basis. This is an example of an impact related to the original construction of the facility and therefore does not fall within the scope of the water use planning process. This impact cannot be addressed by changing the way water is stored or released. Even a large (flushing) release from the dam would not carry gravel over since the bottom of the sluice gate is still several metres higher than the bottom of the reservoir. Although this issue could not be addressed under the Falls River Water Use Plan process, the BC Hydro representative did indicate that BC Hydro would be willing to stockpile large woody debris collected from the reservoir during regular maintenance. This debris would be made available for use in restoration projects at or near the Falls River site (e.g., in the tailpond).

- **Natural recruitment of debris:** Large woody debris can be an important component of fish habitat downstream of the dam. With the creation of the reservoir, there is far less debris being recruited from the reservoir and carried downstream. Since this is an impact of the original construction of the dam, the Consultative Committee agreed it does not fall in the scope of the water use planning process.

- **Flow impacts on projects by the Bridge Coastal Restoration Program (BCRP):** BCRP plans to fund a habitat restoration project in the river downstream of the dam using gravel beds. Although the loss of natural gravel recruitment is outside the scope of the water use planning process (it is an impact of original construction of the dam), there may be opportunities to alter flows from the facility to support that project. The Consultative Committee agreed this would be covered under the general discussion of managing flows for spawning and fish rearing habitats downstream.

- **General effects of Falls River operations on fish and habitat in Ecstall River:** Sockeye salmon and eulachon are present in the Ecstall River and concerns in these habitats may be different than those in the Falls River. Inflow from the Falls River into the Ecstall contributes 22.7 per cent at the Falls/Ecstall confluence. Assuming identical run-off per unit area, the median flow of the Ecstall during the low flow period (November through March) would decrease from approximately 10 m^3/s to 7.5 m^3/s during a powerhouse shutdown (worse case scenario).

  Although this appears to be an important potential effect, the Ecstall River is intertidal downstream of the confluence with the Falls River, with a tidal range of approximately six metres. Stage change of this magnitude would dominate the hydraulics of the Ecstall River and minimize the influence of inflows from Falls River. Based on these realities, the subcommittee agreed it is unlikely that operations at the Falls River project have a significant effect on fish and habitat in the Ecstall River.

4.4.2 Issues Pursued by Consultative Committee – River Fish

There were a number of issues pursued by the Consultative Committee related to fish using the Falls River downstream of the facility:

- **Discharges from the facility to the river:** The key interest was managing discharges into the Falls River to improve the quantity and quality of fish habitat. In the early 1990's, BC Hydro adopted the practice or curtailing generation when the reservoir is below 88.4 metres in order to maintain a discharge from the facility of 1.3 m^3/s.

  This amount is equivalent to 5 per cent of the mean annual discharge (MAD) in Falls River. The specific optimal flows for spawning, rearing and migration in the Falls River are unknown. Both spawning and rearing habitat may be affected by the intertidal nature of flows in the tailpond below the facility, with daily stage changes of up to 3 metres per day during each of the two tidal cycles each day (two high tides and two low tides every 24 hours).

  The Fish and Wildlife Technical Subcommittee compared the life stages of the main species potentially present (chinook, coho, chum, steelhead, trout and Dolly Varden) with the patterns of discharges from the Falls River facility. The comparison showed that under low tide conditions (when operations have a greater influence on flows downstream of the facility), rearing habitats were most at risk during the dry winter months (January to March). The comparison also showed that during low inflow years, spawning habitats might be at risk during the fall (August to October) under low tide conditions. Therefore, the Consultative Committee focused on managing flows during critical periods for salmon spawning (August to October), incubation (November and December) and rearing (January to March).

- **Risk of fish stranding:** The subcommittee also noted the risk for fish stranding in the event of a rapid decrease in discharge under low tide conditions; for example, in the event of an outage without any discharge through the sluice gates. Therefore, the Consultative Committee focused on managing ramping rates and developing protocols for the provision of minimum flows in the event of outages.

- **Total Gas Pressure (TGP):** In areas below a waterfall or below a dam that is spilling, the force of the water carries air with it to depth. This can cause large increases in the amount of oxygen in the water and is harmful to fish, causing death in extreme cases. No studies of TGP have been done at the Falls River hydroelectric project. However, based on experience at similar facilities in the province, the Fish and Wildlife Technical Subcommittee agreed the risk of TGP being an issue for fish using the Falls River tailpond was low.

- **Timing of sediment discharge through sluiceways:** Sluicing of sediment past dams can create impacts if large quantities are released or if the release is improperly timed (e.g., if the release coincides with spawning or incubation). The issue was identified initially under the assumption that the undersluice at the base of the dam was operational. However, the undersluice has not been operated for decades and is not currently operational[1].

4.4.3 Objectives and Performance Measures – River Fish

There is one main objective and four sub-objectives for managing fish in the Falls River (Table 4-4). The main objective is to **maximize the abundance and diversity of fish in the river.** The sub-objectives clarify what means might be used to achieve this fundamental objective and address the Committee's specific concerns about potential impacts of operations on fish in the river (described in the previous section). Each of the sub-objectives and the performance measures used to track it across alternatives are described below and summarized in Table 4-4.

The two main sub-objectives that have accompanying performance measures are **optimize flows for fish at all life stages** (spawning, incubation, rearing and migration) and **maximize quantity and quality of habitat**. These both reflect the committee's concern for fish using the Falls River downstream of the dam. In total, there were nine performance measures developed to accompany these objectives: **Winter Rearing Habitat, Summer Rearing Habitat**, and **Spawning Habitat**, each calculated for chum, coho and chinook. Recognizing the magnitude of the influence of tidal conditions on the Falls River below the dam, all performance measures were developed assuming low (0) tide conditions, when discharges from the Falls River dam would have the greatest influence on velocity and depth downstream of the facility.

As described below, the remainder of the sub-objectives do not have performance measures associated with them:

- **Minimize fine sediment releases into the river:** Large releases of fine sediment from the Big Falls Reservoir into the Falls River occur primarily when the undersluice is operated. The undersluice has not been used by BC Hydro for some time, and may not be used again until some time in the future. Rather than develop a performance measure, the Consultative Committee agreed to recommend that BC Hydro consult with interested parties (provincial and federal agencies, First Nations, and community fisheries groups) before operating the undersluice in the future[2].

- **Minimize Total Gas Pressure (TGP):** The Fish and Wildlife Technical Subcommittee did not develop a performance measure for the Total Gas

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[1] If the undersluice were to be operated in the future, the major concern would be the potential negative impacts of a sediment release during fish spawning or incubation.

[2] The Ministry of Environment, Lands, and Parks was reorganized in 2001 into the Ministry of Water, Land and Air Protection and the Ministry of Sustainable Resource Management.

Pressure (TGP) objective since insufficient information was available to design one. Fisheries and Oceans Canada reported that some TGP measurements were taken at the Falls River site downstream of the dam during some field research undertaken in November 2002. All the readings were within an acceptable range. The subcommittee agreed to revisit this issue during discussions of monitoring needs.

- **Minimize water quality impacts on incubating eggs:** The Fish and Wildlife Technical Subcommittee did not develop a performance measure for this objective since there was insufficient information available to confirm: 1) whether this is an issue at Falls River (i.e., whether the water discharged from the Falls River dam is acidic enough at key incubation times to have an impact and 2) whether there is an operational change that could address this objective if it is an issue. The subcommittee agreed to revisit this topic during discussions of monitoring needs.

- **Minimize stranding of fish or de-watering of incubating eggs:** Under BC Hydro's current operating practices, during an unplanned outage, there is of lag of 10 to 15 minutes between a stop in discharge from the generation turbine(s) and the provision of the minimum discharge through the sluice gates. This lag is intentional as it provides time for anyone in the spill channel to evacuate prior to spilling. This lag means there could be zero discharges from the facility during an outage; in turn, this could result in the mortality of incubating eggs if it happens during low tide conditions. The Fish and Wildlife Subcommittee agreed to proceed without a performance measure for this objective since the solution to this issue is likely to be a set of operating protocols that could be adopted no matter which operating alternative is chosen, rather than an operating alternative per se. The Consultative Committee focused on designing protocols for planned and unplanned outages and constraints on ramping rates.

Table 4-4: Objectives and Performances – Falls River Fish

River Fish Objectives	Performance Measures	Location
Maximize spawning and rearing habitat. Optimize flows for fish at life stages (spawning, incubation, rearing, migration).	Winter Rearing Habitat, Summer Rearing Habitat, and Spawning Habitat, each for coho, chinook, and chum (9 Performance Measures in total). Calculated as the Weighted Useable Area (WUA) of habitat that is suitable for use by rearing juveniles or spawning adults of each species.	Falls River below the falls downstream to the end of the tailpond. 1 November–31 March for Winter Rearing. 1 April–31 October for Summer Rearing. 1 August–30 April for Spawning (and incubation).

For more detailed information on the methodology, assumptions and uncertainties related to the performance measures for fish in the Big Falls Reservoir, see Appendix G.

4.4.4 Studies – River Fish

In October 2002, during the Falls River Water Use Plan consultative process, some studies were conducted to assess factors influencing the amount of useable habitat for various species of salmon. This included mapping of the location of potential substrate for spawning and an assessment of the quality of that substrate. It also involved the verification of some of the velocity and depth estimates at key points in the tailpond that would later be used for environmental modelling of performance measures for rearing and spawning habitat.

In addition, later in the process, the Consultative Committee developed and recommended a monitoring program which included information gathering to address the uncertainty relating to operational impacts on fish in the river (Section 7).

4.5 Cultural and Traditional Use by First Nations

The Falls River project lies in the traditional territory of the Lax Kw'alaams Band. The Allied Tsimshian Tribes Association (ATTA) represents the nine tribal groups that form the Lax Kw'alaams Band: Gitsiis, Ginaxangiik, Gitnadoiks, Gitzaxlaal, Gitando, Gitwylgiots, Gitlan, Gilutsau and Gispaxlo'ats.

Asserting their aboriginal rights and title within their traditional territory, Allied Tsimshian Tribes and Lax Kw'alaams Band members will continue their cultural and traditional use of the area.

4.5.1 Issues – Cultural and Traditional Use

During the consultative process, Lax Kw'alaams and ATTA raised potential issues related to the cultural resources and traditional use of the area surrounding the Falls River project:

- **Possible presence of Culturally Modified Trees (CMT):** Early in the consultative process, the Lax Kw'alaams representative indicated there are Culturally Modified Trees (CMTs) in the Falls River watershed. ATTA and Lax Kw'alaams have trained people who can identify these trees. They later confirmed that based on their records and current knowledge, there are no CMTs in the drawdown zone that could potentially be impacted by ongoing reservoir operations.

- **Possible presence of former traditional campsites:** Early in the consultative process, the Lax Kw'alaams representative indicated there are traditional campsites in the Falls River watershed and some of these might be impacted by operations at the Falls River project. They later confirmed, based on their records and current knowledge, there are no campsites in the drawdown zone that could potentially be impacted by ongoing reservoir operations.

- **Standing trees in the reservoir:** The Allied Tsimshian Tribes Association representative expressed concern about the aesthetic appearance of the standing timber in the reservoir as well as the navigational hazard associated with the stumps. While the reservoir is a traditionally used area, it is not currently used for boating because of the navigational safety issue. However, even the most extreme change in current operations (keeping the reservoir could be kept at a very high level) would not address the problem. Therefore, the Consultative Committee agreed it was outside the scope of the water use planning process. While acknowledging the safety concern, the representative of the Ministry of Water Land and Air Protection noted that standing timber can also be viewed as a valuable resource: the trees in the reservoir would contribute to primary productivity and provide valuable habitat (i.e., cover) for reservoir fish.

- **Potential mercury contamination of fish and wildlife in the reservoir:** Early in the consultative process, the Lax Kw'alaams and ATTA representatives expressed concern regarding the potential for mercury contamination of fish in the reservoir, and wildlife consuming those fish. This issue is covered in more detail in Section 4.4.1. In addition, representatives of both First Nations organizations reiterated their concern in a letter documenting their feedback on a draft version of this report (see Appendix F).

- **Potential impacts of minimum downstream flows for fish in the river:** Later in the process, both the Lax Kw'alaams and ATTA representatives stated their interest in understanding the impacts of operations on salmon stocks in the Falls River downstream of the dam. Their interest was shared by other members of the Committee. More detail on this issue is provided in Section 4.4.2. Representatives of both First Nations organizations reiterated their concern in a letter documenting their feedback on a draft version of this report (see Appendix F).

4.5.2 Objectives and Performance Measures – Cultural and Traditional Use

Since none of the potential issues raised above were pursued by the Consultative Committee within the scope of the Falls River Water Use Plan, no specific cultural and traditional use objectives or performance measures were developed. However, the ATTA and Lax Kw'alaams representatives indicated their support of the fish and wildlife objectives given that an important part of their traditional use of the area was hunting and fishing, and they currently maintain wildlife traplines in the vicinity of the reservoir. They also expressed an interest in fishing in the reservoir again once the issue of mercury contamination can be resolved (see Section 4.4.1).

4.5.3 Studies – Cultural and Traditional Use

During the Falls River Water Use Plan consultative process, there were no studies conducted on operational impacts affecting cultural and traditional use of the area in and around the Falls River and Big Falls Reservoir, with the exception of the mercury contamination testing of cutthroat trout in the reservoir, described in Section 4.4.1.

4.6 Recreation

There are two distinct geographical areas to consider in terms of recreation issues:

- **Big Falls Reservoir:** Lack of access limits recreational use of the reservoir. The reservoir shoreline beside the dam is accessible via an access road from the powerhouse. This is the only access point as steep bluffs and thickly treed banks bound the reservoir. When the reservoir was created in 1930, the existing forest was not logged. Except in the forebay area (immediately behind the dam), standing stumps and floating debris cover the reservoir surface. As this is both an aesthetic issue and a navigational hazard, there is no fly-in fishing; however, some outfitters and guides take boats up the Falls River to the dam and carry light-weight boats (e.g., kayaks) up to the reservoir for paddling. These users have adapted to the reservoir as it currently exists. Some limited angling (fishing) does occasionally occur in the reservoir[1].

- **Falls River:** The Ecstall River (downstream of the Falls River) is a tidal river and small boats can travel upriver as far as the powerhouse during high tide conditions. A small amount of fishing occurs in the Falls River in pools below the powerhouse and spillway. Because the facility has limited storage and is operated as run-of-river during high inflow events, spilling is common (60 per cent of the year). Rapid spilling at the dam can be a hazard to public use of the river, although warning signs and audible alarms have been posted. There may be hunting in the area during the fall. A number of fishing guides operate in the area.

Some stakeholders have suggested there is an untapped potential for recreational development in the area. Although the area is scenic, BC Hydro currently has no intent to pursue recreational development.

Ultimately, recreation was not pursued as a Falls River water use planning issue given that: 1) there are no opportunities to directly advance any recreation objectives, either on the reservoir or on the river, using incremental operational

[1] As reported by Jim Hellman of the Prince Rupert Salmonid Enhancement Society at the first meeting of the Falls River Water Use Plan Consultative Committee on 2-3 October 2002.

changes at the Falls River project, 2) there was no one representing this interest on the Consultative Committee and 3) the Consultative Committee assumed that their efforts to address issues for fish and wildlife would benefit recreational users whose main interest in the area is hunting and fishing.

4.7 Greenhouse Gas (GHG) Emissions

Since the Falls River project is part of BC Hydro's integrated electricity system, it will be necessary to compensate for a decrease in generation at the facility through other generation resources.

4.7.1 Issues – Greenhouse Gas (GHG) Emissions

Based on BC Hydro's current *Integrated Energy Plan* (BC Hydro, 2000), the sources used to compensate for lost generation at the Falls River project will include a mix of 90 per cent gas-fired and 10 per cent renewable generation. Gas-fired generation leads to the emission of greenhouse gases (GHGs) such as carbon dioxide (CO_2) and methane (CH_4). On the other hand, any operational changes that increase the amount of power produced at Falls River will avoid the need to use other resources (including 90 per cent gas-fired generation) and therefore avoid emitting more greenhouse gases.

4.7.2 Objectives and Performance Measures – Greenhouse Gas (GHG) Emissions

In light of the reality above, the Consultative Committee agreed the related objective for the Falls River Water Use Plan is to **minimize the provincial greenhouse gas (GHG) impacts of operations by maximizing the amount of non-GHG power generated at the facility**. The performance measure designed to track this objective is **Change in Greenhouse Gas Emissions** described in Table 4-5 below.

Table 4-5: Objectives and Performance Measures – Greenhouse Gas (GHG) Emissions

Objectives	Performance Measures	Location/Timing
Minimize provincial greenhouse gas (GHG) impacts of changes to Falls River operations	Change in Greenhouse Gas (GHG) Emissions – This number is the estimated amount that emissions will change with a change in operating constraints at the Falls River project compared to the reference case alternative. A positive score indicates an increase in provincial emissions (negative environmental impact), while a negative score indicates a reduction in provincial emissions (an environmental benefit).	Measured based on annual power generation from the Falls River project.

For more detailed information on the methodology, assumptions and uncertainties related to the performance measure for changes in greenhouse gas emissions for the Falls River project, see Appendix H.

4.7.3 Studies – Greenhouse Gas (GHG) Emissions

There were no studies related to this issue conducted during the Falls River Water Use Plan (WUP) consultative process. There was, however, a study commissioned by the Water Use Planning Management Committee, the interagency committee that oversees the water use planning process, and its Resource Valuation Advisory Team (RVAT). The aim of the study was to shed light on the climate change or greenhouse (GHG) issue as it relates to water use planning at BC Hydro's individual hydroelectric facilities. The final report explores ways to estimate GHG impacts that could result from changes in facility operations that might be proposed in the water use planning process (MWA Consultants, 2001). The information from this study was used to developed the GHG performance measure used during the Falls River Water Use Plan consultative process.

4.8 Flood Management

Flood management has not historically been a concern at the Falls River facility. Since the facility has limited storage capacity in the reservoir and is operated as a run-of-river facility during periods of high inflows (60 per cent of the year), its operation does not significantly change the risk of flooding downstream. For the same reasons, the opportunities to modify operations to meet flood management objectives are limited.

5 OPERATING ALTERNATIVES

In Step 6 of the water use planning process outlined in the *Water Use Plan Guidelines* (see Table 3-1), the Consultative Committee created and evaluated various operating alternatives for satisfying the water use planning objectives described in Section 4. The BC Hydro Project Team (providing process and technical support to the Consultative Committee) simulated these operating alternatives using computer models of the Falls River hydroelectric project. The Committee used the modelling results and performance measures to compare how well each alternative performed in satisfying the water use planning objectives. This section describes the specifications of the Falls River water use operating alternatives and the water use modelling process.

5.1 Specifying Water Use Operating Alternatives

In general, the specifications for the Falls River operating alternatives were relatively simple, requiring minimum releases into the Falls River and desired elevations for Big Falls Reservoir at different times of the year.

- **Discharge into the Falls River:** Since the Falls River project has limited ability to store and control higher water flows, the Water Use Plan could only address low flow conditions. As a result, the Consultative Committee focused on maintaining and/or increasing minimum flows into the Falls River. BC Hydro can control releases while the reservoir elevation is at or below 90.3 metres when the timber surcharge flashboards are not installed and 92.4 metres when they are installed.

  When the reservoir surcharges above these levels, water begins to spill over the free crest spillway and assuming constant power generation, there is no control over the rate of release into the Falls River. This is the upper limit of the reservoir elevation range where BC Hydro has the ability to control flows downstream.

  The lower limit of BC Hydro's ability to reduce flows into Falls River is at a reservoir elevation of 85.5 metres if a generating unit is being used to maintain minimum flow, or at an elevation of 87.2 metres if the sluice gates are being used. There are certain times of year when BC Hydro's ability to provide discharges to the river is limited by the inflows to the reservoir.

- **Desired Reservoir Elevations:** BC Hydro has three main operating options it can use to achieve desired elevations in the reservoir at certain times of year to meet various Committee objectives: 1) installing and removing the timber flashboards used to surcharge the reservoir, 2) using the sluice gates to release water and 3) varying the output (and water discharges) from the generating units in the powerhouse. There are, however, certain times of year when BC Hydro's ability to use these options to maintain the desired elevations is limited by the inflows to the reservoir.

- **Flashboard Installation:** During the 2002/2003 consultative process for the Falls River Water Use Plan, a parallel Dam Safety Review process was also under way. During the Falls River water use planning process, a set of preliminary operating alternatives was modelled that might accommodate the key interests – fish, wildlife and power. While modelling these exploratory alternatives, the timing of the installation of the flashboards was brought into question.

  As a result, BC Hydro sought direction from its Director of Dam Safety to ensure all the alternatives explored through the Falls River Water Use Plan consultative process met BC Hydro's Dam Safety requirements. It was determined that the maximum window for safe annual installation was 15 February to 15 May (in contrast to the historical period of 15 November to 15 May).

5.2 Round One – Trial Alternatives

As a first round, the Consultative Committee developed five Trial Alternatives. The Trial Alternatives demonstrated how the Falls River hydroelectric project responded when certain target flows in the Falls River or elevations in the Big Falls Reservoir were imposed. The Trial Alternatives also demonstrated to the Consultative Committee the process of specifying operating alternatives and interpreting the resulting model outputs and performance measures.

Some of the five Trial Alternatives (Table 5-1) maximized a single water use objective. For instance, Alternative 4 maximized power generation and Alternative 5 specified a desired increase in downstream minimum flows for fish, to the exclusion of other interests. By contrast, other alternatives tried to maximize several water use objectives at once. For instance, Alternatives 1 and 2 specified desired reservoir elevations at certain times of year to maintain the sedge habitat community (riparian habitat for wildlife), minimize impacts to shoreline wildlife habitat and minimize impacts to reservoir tributary spawning habitat. These Trial Alternatives were not proposed as recommended operating regimes, but rather to serve an instructional purpose and suggest approaches for more realistic and optimal alternatives to satisfy multiple water use objectives.

Table 5-1: Specifications for Five Falls River Water Use Plan Trial Alternatives

Alternative #	1	2	3	4	5
Objective	Maximize abundance and diversity of wildlife in the reservoir.	Maximize abundance and diversity of wildlife in the reservoir.	Maximize abundance and diversity of wildlife in the reservoir.	Maximize annual revenue from power generation.	Maximize fish habitat in the river.
Reservoir Constraints					
Flashboards Installed	1 April–15 May	1 April–15 May	None	1 April–15 May	1 April–15 May
Target elevation for spring spawning	Above 91.75 m 1 April–15 May	Above 91.75 m 1 April–15 May	Above 90.3 m 1 April–15 May	None	None
Target elevation for spring incubation	None	None	Below 89.3 m	None	None
Target elevation for fall spawning	Above 90.3 m 1 September–15 October	Above 90.3 m 1 September–15 October	Above 90.3 m 1 September–15 October	None	None
Target elevation for fall incubation	Below 90.3 m 16 October–31 March	Below 90.3 m 16 October–31 March	Below 90.3 m 16 October–31 March	None	None
River Constraints					
Minimum discharge year round	1.3 m^3/s	1.3 m^3/s	1.3 m^3/s	1.3 m^3/s	2.6 m^3/s
*Generation curtailment starts at reservoir elevation**	88.4 m	89.3 m	88.4 m	88.4 m	88.4 m

* This is to prevent “0” minimum flow events downstream, based on the following logic. By limiting discharge from the facility to 1.3 m^3/s when the reservoir reaches a critical elevation, there would still be enough water in the reservoir at a high enough elevation to be release through the sluice gates (threshold of 87.2 metres for lower sill of gates) to meet the minimum downstream flow requirements) if the generating units were to malfunction.

5.2.1 Lessons from Trial Alternatives

There were several lessons from the modelling results for the first five Trial Alternatives:

- **Ability to meet increased minimum discharge requirements:** BC Hydro’s ability to meet an increased minimum discharge requirement of 2.6 m^3/s to the river is limited in some years by the inflows to the reservoir. This led the group to speculate about BC Hydro’s ability to meet requirements for increased minimum discharge and desired reservoir elevations for other objectives simultaneously. This also led the group to explore a two-tiered minimum discharge requirement to address limiting inflow conditions.

- **Time lag for reaching target reservoir elevations:** There is a one to two week time lag involved in reaching target reservoir elevations for spring spawning after installation of the flashboards. In order to be truly effective in minimizing impacts on reservoir tributary spawning habitat in the drawdown zone, the flashboards would need to be installed at least two weeks in advance of the anticipated start of spring spawning.

- **Reference Case:** Since the historic operating regime could not be used as a base or reference case for the Falls River Water Use Plan (see note about flashboard installation in Section 5.1), the Committee needed to generate a realistic reference case. Alternative 4 was intended to be the reference case, since it was designed to maximize power generation while still meeting required and voluntary historic requirements. It was anticipated that the annual installation of the flashboards (which allow surcharging of the reservoir) would lead to an increase in annual revenue. As it turned out, in many years, the cost of installing and removing flashboards were not offset by increased power generation. This led to development a revised reference case in Round Two.

- **Maintenance Outage:** None of the Round One Alternatives were modelled to take into account the requirement for annual maintenance on the generating turbines. This led to the modelling of a conservative month-long maintenance period in later alternatives to make them more realistic.

5.3 Round Two – Refined Alternatives

Based on the learning experience of the Trial Alternatives, the Consultative Committee developed and evaluated more realistic and optimal alternatives to seek a balance between competing water use objectives. All Round Two operating alternatives described below were subsequently carried into Round Three with new labels. The link between Round Two and Round Three alternatives is shown in Table 5-2. This also clarifies references to labels in other Falls River Water Use Plan documents such as Consultative Committee meeting notes.

Table 5-2: Link between Round Two and Round Three Alternatives

Description	Round Two Alternatives	Corresponding Round Three Alternatives
Historical operations	6	6
Constraints for fish and wildlife in reservoir, and increased minimum discharges for fish downstream	7A	7A
Similar to 7A but with more stable reservoir	7B	7B
Based on 7A, with addition of higher minimum discharge during fall spawning in the river	-	7C
Based on 7B, with addition of higher minimum discharge during fall spawning	-	7D

Table 5-2: Link between Round Two and Round Three Alternatives (cont'd)

Description	Round Two Alternatives	Corresponding Round Three Alternatives
Installing flashboards only 1 in every 3 years	8	8A
Based on 8A, with addition of higher minimum discharge during fall spawning	-	8B
Revised Reference Case	9A	9A
Revised Reference Case modelled without a maintenance outage to allow for comparison with Round One Trial Alternatives	9B	9B

5.4 Round Three – Final Alternatives

The Consultative Committee developed and evaluated a total of 15 operating Alternatives, including Rounds One, Two and Three (Table 5-3). Each alternative was a combination of one or more constraints on operating the Falls River hydroelectric facility to achieve a suite of water use objectives described in Section 4. Each alternative specified up to eight constraints, including:

- Timing of flashboard installation to maintain the sedge grass community around the reservoir (riparian habitat for wildlife).
- Up to two desired fish flows in the Falls River, including minimum discharge requirements for: 1) the whole year and 2) the fall salmonid spawning period from 1 August to 15 October.
- Reservoir elevation level at which generation curtailment would start in order to ensure the provision of minimum discharges under low inflow conditions.
- Up to four desired elevations for fish in the Big Falls Reservoir, including targets for: 1) spring spawning, 2) spring incubation, 3) fall spawning and 4) fall incubation.

Note is also made of whether the alternatives were modelled with or without provision for a month-long maintenance period in March, as is the case for Round Two and Three Alternatives, but not Round One.

Table 5-3: Specification of Operating Constraints for Falls River Water Use Plan Alternatives

	ALTERNATIVES														
	1	**2**	**3**	**4**	**5**	**6**	**7A**	**7B**	**7C**	**7D**	**8A**	**8B**	**9A**	**9B**	**10**
OPERATING CONSTRAINTS FOR RIVER OBJECTIVES															
Minimum discharge - year round	1.3 m^3/s	1.3 m^3/s	1.3 m^3/s	1.3 m^3/s	2.6 m^3/s	1.3 m^3/s	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	1.3 m^3/s	1.3 m^3/s	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m
Generation curtailment* starts below reservoir elevation:	88.4 m	89.3 m	88.4 m	88.4 m	88.4 m	86.5 m	89.3 m	88.4 m	89.3 m	88.4 m	88.4 m	88.4 m	88.4m	88.4m	88.4 m
Minimum discharge for fall spawning (Aug 1 - Oct 14)	same as year round	same as year round	same as year round	same as year round	same as year round	same as year round	same as year round	same as year round	6.5 m^3/s	6.5 m^3/s	same as year round	6.5 m^3/s	same as year round	same as year round	6.5 m^3/s
OPERATING CONSTRAINTS FOR RESERVOIR OBJECTIVES															
Flashboard (FB) installation	1 April – 15 May	1 April – 15 May	none	1 April – 15 May	1 April – 15 May	15 Nov – 15 May	15 Mar – 15 May	15 Mar – 15 May	15 Mar – 15 May	15 Mar – 15 May	Once every 3 years, 15 Mar – 15 May	Once every 3 years, 15 Mar – 15 May	none	none	15 Mar – 15 May
Spring Spawning Target (March/April – 15 May)**	Above 91.75 m	Above 91.75 m	Above 90.3 m	none	none	none	92.0 to 92.5 m	92.0 to 92.5 m	92.0 to 92.5 m	92.0 to 92.5 m	Above 90.3 m in non-FB years 92.0 to 92.5 m in FB years	Above 90.3 m in non-FB years 92.0 to 92.5 m in FB years	none	none	92.0 to 92.5 m
Spring incubation Target (15 May – 1 September)	none	none	Below 89.3 m	none	none	none	none	none	none	none	none	none	none	none	none
Fall Spawning Target (1 September – 15 October)	Above 90.3 m	Above 90.3 m	Above 90.3m	none	none	none	Above 90.3 m	Above 90.3 m	Above 90.3 m	Above 90.3 m	none	none	none	none	none
Fall Incubation Target (15 October – March/April)**	Below 90.3 m	Below 90.3 m	Below 90.3 m	none	none	none	Below 90.3 m	Below 90.3 m	Below 90.3 m	Below 90.3 m	none	none	none	none	none
OTHER OPERATING CONSTRAINTS															
Maintenance Outage (assuming only one unit out at a time)	none	none	none	none	none	1 - 28 March	1 - 28 March	1 - 28 March	1 - 28 March	1 - 28 March	1 - 28 March	1 - 28 March	1 - 28 March	none	1 - 28 March

*This is to prevent "0" minimum flow events downstream. By reducing power generation to 1 megawatt when the reservoir reaches a critical elevation, this attempt to ensure that if either the generating units were to malfunction, there would still be enough water in the reservoir at a high enough elevation to be released through the sluice gates to meet the minimum downstream flow requirements.

**The beginning of the spring spawning season (or the beginning of the fall incubation period) is defined as 1 April for Alterntives 1 to 5, and 15 March for Alternatives 6 to 9.

5.4.1 Rationale for Water Use Alternatives

Each of the operating alternatives was designed with a specific objective or set of objectives in mind.

Table 5-4 helps to clarify the rationale for each alternative.

Table 5-4: Rationale for Falls River Water Use Plan Alternatives

#	Description of Alternative	Rationale: What objectives is this alternative designed to meet?
1	Reservoir Fish and Wildlife Friendly	Minimize backwatering of cutthroat and Dolly Varden eggs in reservoir drawdown zone during incubation. Maximize maintenance of sedge habitat around reservoir.
2	Fish and Wildlife Friendly with More Stable Reservoir	Same as for Alternative 1, plus, maximize reservoir shoreline habitat for wildlife (by targeting a narrower operating range).
3	No Flashboards	Same as for Alternative 1, but accomplished *without installing flashboards*.
4	Reference Case	Maximize power generation while mimicking existing/historic operating constraints but with new flashboard schedule.
5	Increased Minimum Flow for Fish in River	Optimize downstream flows for fish at all life stages (spawning, incubation, rearing). Maximize power generation.
6	Historic Operations	This alternative will show how BC Hydro operated in the past. While water use planning is a forward-looking process, the Committee requested this alternative so they could see the impact of historic operations on performance measure values. It was modelled for comparison purposes only, and cannot be considered for recommendation by the Committee since it includes the old flashboard schedule that no longer meets dam safety requirements.
7A	Improved Stable Reservoir	This alternative shares the same objectives as Alternative 7B, and also maximizes reservoir shoreline habitat for wildlife (by targeting a narrower operating range).
7B	Improved Fish and Wildlife Friendly	This alternative shares the same objectives as Alternative 1, but is designed to improve on it by: Installing the flashboards earlier (15 March instead of 1 April) to try and get reservoir levels up before spring spawning begins in April. Keeping the range of elevations during spring spawning (and flashboard installation) narrower to prevent backwatering during incubation. Providing increased minimum downstream flows for fish at all life stages (spawning, incubation, rearing).
7C	Improved Stable Reservoir plus Falls Spawning	This alternative is based on 7A, but adds one operating constraint: a minimum discharge of 6.5 m^3/s from 1 August to 14 October to minimize impact of flow changes on fall spawning fish in the river.
7D	Improved Fish and Wildlife Friendly plus Fall Spawning	This alternative is based on 7B, but adds one operating constraint: a minimum discharge of 6.5 m^3/s from 1 August to 14 October to minimize impact of flow changes on fall spawning fish in the river.

Table 5-4: Rationale for Falls River Water Use Plan Alternatives (cont'd)

#	Description of Alternative	Rationale: What objectives is this alternative designed to meet?
8A	Flashboards Every 3 Years	This alternative is designed to see if most of the fish and wildlife objectives for Alternative 7B can be met if flashboards are only installed once every 3 years to maintain sedge habitat and if the reservoir is not altered for fall/winter spawning and rearing: • In 1 in 3 years when flashboards are installed, operations will be similar to those under Alternative 7B, except that this alternative does not include measures to avoid backwatering of Dolly Varden. • In the 2 out 3 years when the flashboards are not installed, operations will be similar to those for Alternative 9A but with higher minimum flows for fish downstream, and it includes a target minimum elevation in the spring to minimize backwatering of cutthroat.
8B	Flashboards Every 3 Years plus Falls Spawning	This alternative is based on 8A but adds one additional operating constraint: a minimum discharge 6.5 m^3/s from 1 August to 14 October to minimize the impact of flow changes on fall spawning fish in the river.
9A	Revised Reference Case	This alternative shows how BC Hydro would operate in the future in the absence of any input from the Water Use Plan Committee. This is a revision of the original Reference Case (Alternative 4) based on the realisation that BC Hydro would not install the flashboards since it involves an annual installation cost for very little power benefit.
9B	Reference with No Maintenance Outage	This alternative is a variation on Alternative 9A, but without a scheduled maintenance outage in the month of March. This alternative was modelled to help isolate the cost and impacts of including a maintenance outage, and will allow for better comparison between Alternatives modelled with and without an outage (i.e., Alternatives 6-9 versus Alternatives 1-5).
10	Hybrid	This alternative is a "hybrid" or combination of Alternatives 7D and 8B. It was developed at the final meeting of the Consultative Committee during trade-off discussions as a way of trying to capture the benefits of two different alternatives. It is based on Alternative 7D, but does not include the operating constraints on the reservoir from September through March to try to prevent the backwatering of potential Dolly Varden tributary spawning habitat in the drawdown zone (like Alternative 8B).

5.4.2 Progressions of Alternatives

As noted earlier, some of the alternatives from Round One were carried into Rounds Two and Three. This section describes the progressions from Rounds One to Three for three sets of alternatives.

- **Fish and Wildlife in the Reservoir:** Both ***Alternatives 1 and 2*** were developed to try and meet all the fish and wildlife objectives for the reservoir simultaneously. Alternative 2 differed from Alternative 1 only in the level at which generation curtailment begins (to ensure minimum discharge under low inflow conditions). In Alternative 2, curtailment begins at a reservoir elevation of 89.3 m – nearly a metre higher than in Alternative 1 at 88.4 metres.

Alternatives 7B and 7A are variations of Alternatives 1 and 2, respectively. The improvements to Alternatives 1 and 2 attempted in the design of Alternatives 7B and 7A are: the installation of the flashboards two weeks earlier to account for the lag time required to meet target elevations for spring spawning in the reservoir; a two-tiered minimum discharge which increases minimum discharge for fish downstream from 1.3 to 2.6 m^3/s when the reservoir is above 88.4 metres; and the inclusion of a 28-day annual maintenance outage.

Once the Committee reviewed Alternatives 7A and 7B, they reviewed the need for further increases to minimum discharge for salmonid spawning in the river in the fall months. Both ***Alternatives 7C and 7D*** include this additional constraint as an improvement over 7A and 7B respectively. The progression through improvements to original alternatives can be represented as follows:

Alternative 1 ➜ Alternative 7B ➜ ***Alternative 7D*** *for fish and wildlife*

Alternative 2 ➜ Alternative 7A ➜ ***Alternative 7C*** *for fish and wildlife*

- **Reference Case:** As noted earlier, the historic operating regime could not be used as the base or reference case for the Falls River Water Use Plan (see note about flashboard installation in Section 5.1 above). ***Alternative 4*** was the Committee's first attempt at developing reference case. However, modelling showed that the installation of flashboards did not benefit annual revenue to the extent expected (i.e., installation costs were not justified by the expected incremental increase in revenue).

  As a result, ***Alternative 9A*** was developed as a more realistic reference case and was used as such for the remainder of the process. So in the case, the progression was from:

  Alternative 4 ➜ ***Alternative 9A as the Reference Case***

5.5 Modelling Operating Alternatives

Modelling the operating alternatives involved a number of steps and computer programs. First the modellers used the BC Hydro Power Optimization Model[1] to simulate operating the hydroelectric facility according to the specifications of the operating alternative. The power model optimized power generation subject to operating constraints specified by the Consultative Committee such as preferred

[1] The Power Optimization Model was sometimes referred to as the "AMPL model" during the Water Use Plan process as the model was developed using "**A** **M**athematical **P**rogramming **L**anguage".

minimum discharges and target reservoir levels. The modellers also considered the physical operating characteristics of the system such as reservoir storage volume and the discharge capacities of the generating turbines and the sluice gates.

The power model simulates the operation of the Falls River hydroelectric project under each operating alternative. The simulations are based on 33 years (1967 to 1999) of historic and synthetic Big Falls Reservoir inflow data. These historic inflows are then routed through the Falls River hydroelectric project in accordance with physical capacities and with consideration for the Consultative Committee's preferred discharges to the Falls River downstream and desired elevations in the Big Falls Reservoir.

For each operating alternative, the model provided the daily reservoir elevation, daily spill discharge, daily turbine discharge and daily generation output files over 33 years of simulated operation. These outputs from the power model served as inputs to two other types of models: 1) environmental simulation models to calculate the performance measures for each operating alternative, and 2) a model used to calculate the value of energy (VOE) produced in each of the 33 years. The Consultative Committee used the resulting performance measures to compare the relative performance and trade-offs between the operating alternatives.

5.6 Hydrographs for Operating Alternatives

The hydrographs for the river and reservoir for each of the operating alternatives considered by the Falls River Water Use Plan Consultative Committee are shown in Appendix I.

6 TRADE-OFF ANALYSIS

In the trade-off process, the Consultative Committee compared the merits of the 15 operating alternatives for the Falls River hydroelectric project. The Consultative Committee sought the alternative that best satisfied their suite of water use objectives. The alternatives considered in the trade-off discussion varied in the benefits they provided.

Natural rates of inflow and reservoir storage capacity impose limits on how much water is available to satisfy the range of water use objectives. Necessarily, there are trade-offs on what can be achieved with a finite supply of water. For instance, maintaining high flows for fish habitat in the river means under some conditions, there may be less water available for generation or for meeting elevation targets to minimize backwatering of Dolly Varden incubation habitats in the reservoir drawdown zone.

The trade-off process involved discussions of the relative value among water use objectives: gaining more of some values in exchange for less of others. This section documents the trade-off process and values that Consultative Committee members placed on different water use objectives.

The Consultative Committee used the performance measure scores to compare the 15 operating alternatives. Selection of the preferred operating alternatives involved four steps:

1. Identify key performance measures.
2. Assess trade-offs among operating alternatives and narrow down to better performing alternatives.
3. Assess degree of Consultative Committee consensus on remaining alternatives.
4. Select preferred operating alternative and specify operating constraints.

The outcomes of each step are described below.

6.1 Step 1 – Identify Key Performance Measures

Initially, the Consultative Committee developed 12 different performance measures. Some of these were calculated for multiple species of fish, for a total of 20 performance measures (see Section 4). At the beginning of the trade-off process, the Committee agreed that a number of the performance measures were not helpful in identifying better performing alternatives for one of two reasons:

1) they showed no significant differences across alternatives or 2) there was too much uncertainty about how to interpret the scores (i.e., the Committee was not confident that the scores provided a true reflection of the impact of operations on key objectives).

Based on the original list of 20 performance measures, the Committee agreed to reduce the list to seven key performance measures (see Table 6-1).

Table 6-1: Summary of Key Performance Measures Considered in Final Trade-off Discussions

Interest/Area	Performance Measure (units)	Description	Used in Final Trade-off Discussions? YES	NO
Fish/River	Summer Rearing Habitat (square metres)	Weighted Useable Area (WUA) of habitat available for rearing (juveniles) in the river from 1 April–31 October for three species: chinook, chum and coho.		✗
Fish/River	Winter Rearing Habitat (square metres)	Weighted Useable Area (WUA) of habitat available for rearing (juveniles) in the river from 1 November–31 March for three species: chinook, chum and coho.		✗
Fish/River	Spawning Habitat (square metres)	Weighted Useable Area (WUA) of habitat available for spawning in the river during the spawning periods for three species: chinook, chum and coho.		✗
Fish/ Reservoir	Tributary Access (days)	Number of days that the reservoir stays above 88.4 metres in tributaries in the drawdown zone during the spawning season for two species: cutthroat trout (1 April–15 May) and Dolly Varden (1 September–31 October).		✗
Fish/ Reservoir	Sediment Exposure and Velocity Index	Number of days during the year that the reservoir is below 90.3 metres in elevation.		✗
Fish/ Reservoir	Tributary Spawning Habitat Lost (square metres)	Reflects the area of spawning habitat in tributaries in the drawdown zone that has flowing water during the spawning period and is back-watered during the incubation period. For two species: cutthroat trout and Dolly Varden.	✓	
Fish/ Reservoir	Littoral Habitat (square metres)	The area of Effective Littoral Zone (ELZ) or productive shallow water habitat on the margin of the reservoir where light penetrates.	✓	
Wildlife/ Reservoir	Shoreline Habitat (hectare-days)	The sum of hectare-days of habitat in the drawdown zone that is available for nesting and denning that stays dry for at least 30 consecutive days from 1 April–31 October.	✓	

Table 6-1: Summary of Key Performance Measures Considered in Final Trade-off Discussions (cont'd)

Interest/Area	Performance Measure (units)	Description	Used in Final Trade-off Discussions? YES	NO
Wildlife/ Reservoir	Sedge Community Maintenance (hectare-days)	The sum of hectare-days of sedge grass habitat in the drawdown zone that is flooded for at least 28 days during the growing season (1 April–31 October). The longer those same hectares remain dry during the rest of the season, the higher the score.	✓	
Wildlife/ Reservoir	Water Level Stability (standard deviation)	A measure of how constant the water level in the reservoir remains during the growing season (1 April–31 October).		✗
Power	Annual Revenue ($ million)	Total value of the power generated that the province would receive from the generation of the Falls River hydroelectric plant.	✓	
Greenhouse Gas (GHG)	Change in GHG emissions (tonnes of CO_2 equivalent)	Amount that GHG emissions in the province will change compared to emissions under the Reference Case (Alternative 9A).	✓	

Note that although the performance measure for Greenhouse Gas (GHG) Emissions did remain in the set of key performance measures considered during trade-off discussions, there was discussion among Committee members as to the priority or weight that should be placed on it. Some members disregarded the GHG performance measure in developing their level of support for alternatives; others did consider it.

6.2 Step 2 – Trade-offs Between Operating Alternatives and Identifying Better Performing Alternatives

The Consultative Committee used three key tools to assist them to interpret the performance measure results for the operating alternatives they had developed: 1) the concept of Minimum Significant Incremental Change (MSIC) to guide the determination of whether two performance measure scores were significantly different, 2) a set of box plots to provide a visual comparison of the performance measures and 3) an interactive colour-coded Excel spreadsheet to identify trade-offs between alternatives. Each of these tools is described below. Section 6.2.3 outlines the Committee's process for eliminating less desirable alternatives using these tools.

6.2.1 Minimum Significant Incremental Change for Performance Measures

The Minimum Significant Incremental Change (MSIC) is the amount by which two alternatives must differ on a performance measure score before one alternative can be considered to perform significantly better (or worse) than the other. A difference between the two scores that is equal to or less than the MSIC means the two alternatives perform equally well on that objective.

For instance, consider two fictitious operating use alternatives: Alternative X provides $10.0 million in power revenue and Alternative Y provides $10.1 million. Based on the power revenue performance measure, it would appear that Alternative Y provides a gain of $100,000 in revenue. However, there is variation in the amount of electricity generated depending on differences from year-to-year in weather and inflows.

Furthermore, the market price of electricity is based on estimates and assumptions. Based on these variations and uncertainties, professional judgement determines that the error or MSIC associated with the power revenue performance measure is ± 2 per cent or ± $200,000. So, in the case of Alternatives X and Y where the difference between their scores ($10.1 m - 10.0 m = $100,000) is less than the MSIC, the Committee should consider the two operating alternatives to provide the same power revenue.

The measure of a significant difference is determined through professional judgement, based on the following sources of uncertainty:

- Statistical variation arising from annual fluctuations in inflows.
- Modelling error in calculating discharge from the reservoir and reservoir elevations.
- Modelling error in the calculation of performance measures.
- Uncertainty in the link between the performance measure and the fundamental objective (the interest that underlies it).
- Measurement error.

The MSIC values for each performance measure are shown in Table 6-2.

Table 6-2: Minimum Significant Incremental Change (MSIC) Values for Performance Measures

Interest/Area	Performance Measure (units)	Minimum Significant Incremental Change
Fish/River	Summer Rearing Habitat (square metres).	± 20%
	Winter Rearing Habitat (square metres).	± 20%
	Spawning Habitat (square metres).	± 20%

Table 6-2: Minimum Significant Incremental Change (MSIC) Values for Performance Measures (cont'd)

Interest/Area	Performance Measure (units)	Minimum Significant Incremental Change
Fish/Reservoir	Tributary Access (days).	± 20%
	Sediment Exposure and Velocity Index.	± 40%
	Tributary Spawning Habitat Lost (square metres).	± 20%
	Littoral Habitat (square metres).	± 25%
Wildlife/Reservoir	Shoreline Habitat (hectare-days).	± 10%
	Sedge Community Maintenance (hectare-days).	± 25%
	Water Level Stability (standard deviation).	± 10%
Power	Annual Revenue ($ million).	± 1%
Greenhouse Gas (GHG)	Change in GHG emissions (tonnes of CO_2 equivalent).	± 1%

6.2.2 Box Plots for Performance Measures

The other tool used by the Consultative Committee were box plots of the performance measures (see Appendix J). These plots graphically showed the variation in scores for each performance measure across the simulated operating alternatives described in Section 5. While the consequence table of performance measures showed median (50^{th} percentile) values (see Figure 6-1), the box plots also show the 10^{th} and 90^{th} percentile values and allow for easier visual comparison.

6.2.3 Explanation of Interactive Colour-Coded Consequence Table

The Consultative Committee used an interactive colour-coded Excel spreadsheet to help compare and interpret the scores for the nine key performance measures (for example, see Figure 6-1). Each of the 15 columns represents one operating alternative while each of the seven rows represents one performance measure (and underlying water use objective). The cell at the intersection of a column and a row holds the score for a given performance measure for that alternative. In some cases, higher scores indicated better performance; in other cases, it is the reverse. The colour-coding takes this into account.

The colour-coding of the table indicates how the scores of all performance measures for the various alternatives compare to the scores for a particular alternative of interest. The column for the alternative of interest is shown in white, while the scores for all the other alternatives are shown either in green, yellow or red. Scores shown in green indicate better performance that the selected alternative of interest; yellow indicates no significant difference in performance; red indicates poorer performance.

The colour-coding is based on the Minimum Significant Incremental Change (MSIC) for each performance measure (discussed above in Section 6.2.1). This is the minimum difference between two performance measure scores required in order for them to be considered different from one another (better or worse). In the case of Figure 6-1, it is the Revised Reference Case (Alternative 9A) that is shown as the alternative of interest: all other colour-coded scores are shown in reference to it.

As an example of the colour-coding, in Figure 6-1, Alternative 9A (the Revised Reference Case) is highlighted as the selected alternative for comparison. Choosing the performance measure for Shoreline Habitat, we can see the score for Alternative 9A is 24,564 hectare-days. That is, Alternative 9A provides 24,564 hectare-days of nesting and denning habitat for wildlife along the shoreline of the reservoir. One column to the left, Alternative 8B scores 23,803 but is within ± 5,393 hectare-days MSIC[1] of the score for Alternative 9A.

To indicate there is no significant difference from Alternative 9A, the cell for the Shoreline Habitat Performance Measure under Alternative 8B is coloured *yellow*.

In contrast, the same performance measure for Shoreline Habitat shows Alternative 3 provides 31,899 hectare-days of available habitat and the cell is coloured *green*.

The green indicates that the score of 31,899 hectare-days is significantly more than the 24,564 hectare-days score for Alternative 9A. Finally, when compared to Alternative 9A, Alternative 7D scores 18,991 for the Shoreline Habitat Performance Measure and the cell is coloured *red*, indicating that Alternative 7D provides significantly fewer days of available habitat for nesting and denning wildlife.

In summary, the colour-coding relative to the highlighted (white) operating alternative is:

- **Red:** <u>Significantly worse</u> than the highlighted operating alternative
- **Yellow:** <u>Not significantly different</u> from the highlighted alternative.
- **Green:** <u>Significantly better</u> than the highlighted operating alternative.

Note that in the colour-coded matrices that follow in this report, the red, yellow and green colour-coding patterns may change if comparisons are being made against a different highlighted operating alternative. As different alternatives are highlighted, the colour-coding changes to reflect relative gains, losses and equalities.

[1] See Section 4 in this report for a description of MSIC (Minimum Significant Incremental Change).

FALLS RIVER WUP COLOUR-CODED CONSEQUENCE TABLE

Legend
PM is SAME
PM IS WORSE
PM is BETTER

Alternative of Interest → REF ALT 9A

PERFORMANCE MEASURE	SPECIES	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	HIST ALT 6	ALT 7A	ALT 7B	ALT 7C	ALT 7D	ALT 8A	ALT 8B	REF ALT 9A	ALT 9B	ALT 10
FISH in the RIVER																
Winter Rearing Habitat	Chinook	5,530	5,516	5,507	5,712	5,708	5,776	5,642	5,657	5,642	5,657	5,675	5,675	5,736	5,714	5,657
	Coho	6,878	6,890	6,903	7,058	7,069	7,032	7,021	7,021	7,021	7,021	7,027	7,027	7,040	7,044	7,021
	Bull Trout	1,047	1,047	1,045	1,086	1,086	1,082	1,068	1,066	1,068	1,066	1,078	1,078	1,085	1,085	1,066
Summer Rearing Habitat	Chinook	4,328	4,156	4,328	4,430	4,462	4,630	4,128	4,188	4,128	4,188	4,377	4,377	4,335	4,430	4,188
	Coho	6,936	6,939	6,987	7,031	7,438	7,224	7,412	7,288	7,412	7,288	7,294	7,294	7,131	7,031	7,288
	Bull Trout	1,154	1,129	1,154	1,159	1,256	1,207	1,242	1,235	1,242	1,235	1,230	1,230	1,161	1,159	1,235
Spawning Habitat	Chinook	381	381	381	381	381	384	386	386	386	386	382	382	381	381	386
	Chum	16	14	16	15	16	19	17	16	17	16	15	15	15	15	16
	Coho	75	73	75	73	74	90	73	73	73	73	73	73	73	73	73
FISH in the RESERVOIR																
Tributary Access	Dolly	61	61	61	61	61	61	61	61	61	61	61	61	61	61	61
	Cutthroat	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
Sediment Exposure & Velocity Index	-	104	99	212	119	119	68	86	90	86	90	98	98	121	126	-
Tributary Spawning Habitat Lost	Bull Trout	4,438	4,777	4,467	8,108	8,108	17,101	5,750	5,646	5,750	5,646	8,108	8,108	8,108	8,108	8,698
	Cutthroat	2,371	2,105	2,780	5,743	5,702	2,821	736	736	736	736	3,740	3,740	7,358	7,746	736
Littoral Habitat (ELZ)	-	29,424	29,506	19,093	17,377	17,377	20,980	29,427	29,427	29,427	29,427	26,450	26,450	17,223	17,205	26,449
WILDLIFE																
Shoreline Habitat (nesting & denning)	-	19,441	19,441	31,899	19,670	19,670	19,193	18,991	18,991	18,991	18,991	23,803	23,803	24,564	24,564	18,672
Sedge Community Habitat	-	3,550	3,628	409	2,350	2,350	2,563	4,010	4,010	4,010	4,010	2,381	2,381	1,413	1,413	4,095
Water Level Stability	-	0.72	0.71	0.63	0.73	0.73	0.76	0.75	0.77	0.75	0.77	0.37	0.37	0.47	0.49	-
POWER																
Annual Revenue	-	2.47	2.44	2.48	2.53	2.53	2.62	2.45	2.47	2.45	2.47	2.51	2.51	2.55	2.60	2.50
GREENHOUSE GAS (GHG)																
Change in GHG Emissions	-	-7	181	129	-366	-366	-658	440	262	440	262	172	172	0	-315	107

Figure 6-1: Colour-Coded Consequence Table Comparing Falls River Water Use Plan Operating Alternatives. Colour-coding shown in reference to Alternative 9A.

In making choices, the Consultative Committee members sought alternatives that offered more green cells (gains) and fewer red cells (losses) than the highlighted alternative under consideration. Using the spreadsheet, Committee members could highlight any one of the 15 alternatives and compare its performance to the other 14 alternatives.

The colour-coding would automatically adjust to show the gains and losses relative to the particular alternative under scrutiny. Projected onto a screen, the Consultative Committee could collectively review the comparisons and discuss the trade-offs in gains and losses.

6.2.4 Elimination of Less Desirable Operating Alternatives

Through the trade-off process, the Consultative Committee reduced the number of operating alternatives to two top choices (Alternatives 7D and Alternative 10) from the field of 15. Eliminating the other 13 alternatives was not a straightforward process as each alternative had important merits not offered by other alternatives. In order to eliminate an alternative, Committee members had to agree to trading off one water use objective for another. A summary of the Consultative Committee's rationale for eliminating alternatives and the trade-offs involved are summarized in Table 6-3.

Table 6-3: Summary of Consultative Committee Process for Eliminating Operating Alternatives

Alternative Eliminated	Reason for Elimination
6 **Historical Operations**	Alternative 6, which models Historic Operations, could not be considered for recommendation by the Consultative Committee due to changes in dam safety requirements for the timing of flashboard installation. Historic operations were modelled for comparative purposes only.
9B **Revised Reference Case modelled without maintenance**	Alternative 9B is a variation on Alternative 9A; the only difference is that 9B is modelled without a maintenance outage. This alternative was modelled for comparative purposes only: to help isolate the impact of the month-long maintenance outage in March by comparing 9A and 9B. This in turn allowed for a better comparison of Alternatives 1-5 (modelled without the outage) with Alternatives 6-9A (modelled with the outage). This alternative was never intended for potential recommendation since it does not allow for annual maintenance requirements.
1 **Fish and Wildlife in Reservoir**	Alternatives 7B and 7D are both improvements on Alternative 1; they both perform the same or better than Alternative 1 across all remaining performance measures.
2 **Fish and Wildlife with more stable Reservoir**	Alternatives 7A and 7C are both improvements on Alternative 2; they both perform the same or better than 2 across all remaining performance measures.
5 **Increased minimum discharge**	The minimum flow requirement of 2.6 m3/s year round for the river conflicts with operations to minimize backwatering of Dolly Varden by maintaining higher reservoir elevations during September and early October. The Committee did not want maintain a minimum flow at the expense of another interest.

Table 6-3: Summary of Consultative Committee Process for Eliminating Operating Alternatives (cont'd)

Alternative Eliminated	Reason for Elimination
8A **Flashboards one in three years**	Although the key performance measures scores are the same for 8A and 8B, 8B is considered an improvement over 8A because it includes a minimum flow requirement of 6.5 m^3/s for 1 August–14 October to maximize fall salmonid spawning in the river (that requirement is the only difference between 8B and 8A).
9A **Revised Reference Case**	Alternative 9A is the Revised Reference Case for the Falls River Water Use Plan. Alternative 4 equalled or outperformed 9A on all key performance measures.
7A **Reservoir Fish and Wildlife and Increased Discharge**	Although the key performance measure scores are the same for 7A and 7C, the Committee preferred 7C because it includes a minimum flow requirement of 6.5 m^3/s for 1 August–14 October to maximize fall salmonid spawning in the river (that requirement is the only difference between 7C and 7A).
7B **Stable Reservoir and Increased Discharge**	Although the remaining performance measures are the same for 7B and 7D, the Committee preferred 7D because it includes a minimum flow requirement of 6.5 m^3/s for 1 August–14 October to maximize fall salmonid spawning in the river (that requirement is the only difference between 7D and 7B).
7C **Improved 7A**	The Committee agreed to eliminate Alternative 7C because the key performance measure scores for Alternative 7D equalled or exceeded those for 7C.
3 **Reservoir Fish and Wildlife without flashboards**	The Committee agreed to eliminate Alternative 3 because it had such a low value for sedge habitat. Maintenance of the sedge community is a key priority for the Consultative Committee, so even if some of the key performance measure scores for other objectives were high for this alternative, the Committee was not willing to risk the impact to sedge for the sake of those other interests.
4 **Initial Reference Case**	Although Alternative 4 performs well for some objectives, it was eliminated because its operating constraints do not include the increased minimum flows for fish downstream.
8B **Improved 8A (Flashboards one in three years)**	Although there were clear power (financial) benefits associated with Alternative 8B, several key fish and wildlife performance measures performed significantly worse under this alternative, namely: Tributary Spawning Habitat Lost (for both cutthroat trout and Dolly Varden), and Sedge Community Maintenance. There were a number of Committee members that could not support this alternative because of the uncertainty surrounding the impacts of installing the flashboards only one in every three years, rather than annually. More specifically, there was concern that the tri-yearly installation of the flashboards might: 1) not be sufficient to maintain the aerial extent and species composition of the sedge grass community; 2) result in a high level of mortality in the years the flashboards were installed if wildlife had adapted to lower reservoir levels during the other two non-flashboard years (i.e., nests and dens that had been established at lower reservoir levels in years 1 and 2 might get flooded out in year 3 when flashboards are installed).

After this elimination process, the Consultative Committee was left considering only Alternative 7D. While this suggested Alternative 7D was the preferred alternative, the Committee was not fully satisfied with this alternative. During the discussion of the trade-offs between Alternatives 7D and 8B (see last row in Table 6-3), the Committee did identify significant financial (power) benefits associated with Alternative 8B. Although the Committee could not accept all the consequences of Alternative 8B, they expressed an interest in exploring variations of Alternative 7D with the intent of improving the financial performance of the alternative.

The result was the development of a new "hybrid" Alternative 10. This new alternative maintains the benefits of Alternative 7D with one exception: Alternative 10 does not prevent backwatering of stream channels in the lower reaches of tributaries (in the drawdown zone) that may be spawning habitat for Dolly Varden[1]. The financial benefit of Alternative 10 compared to Alternative 7D is an additional $25,000 per year.

The elimination of less desirable alternatives and the creation of Alternative 10 left the Committee considering two viable operating alternatives. Figure 6-2 outlines the remaining trade-off choices between Alternatives 7D and 10. In this case, Alternative 7D is chosen as the comparison point for the colour-coding. For example, the red colouring for the Dolly Varden (bull trout) Tributary Spawning Habitat Lost Performance Measure for Alternative 10 means more habitat is lost (greater negative impact on fish) than under Alternative 7D.

COLOUR-CODED RESULTS FOR KEY PERFORMANCE MEASURES

PM is SAME (yellow)
PM IS WORSE (red)
PM is BETTER (green)

PERFORMANCE MEASURE	SPECIES	7D	10 Hybrid
FISH in the RESERVOIR			
Tributary Spawning Habitat Lost	Bull Trout	5,646	8,698 [worse]
	Cutthroat	736	736 [better]
Littoral Habitat (ELZ)	-	29,427	26,449 [better]
WILDLIFE			
Shoreline Habitat (nesting & denning)	-	18,991	18,672 [better]
Sedge Community Habitat	-	4,010	4,095 [better]
POWER			
Annual Revenue	-	2.47	2.50 [better]
GREENHOUSE GAS (GHG)			
Change in GHG Emissions	-	262	107 [same]

Figure 6-2: Trade-offs Among Key Performance Measures for Alternatives 7D and 10

Colour-coding shown in reference to Alternative 7D

[1] Monitoring is required to determine whether the lower reaches of the reservoir tributaries provide suitable spawning habitat, and if so, whether these areas are being used for spawning.

6.3 Step 3 – Assess Degree of Consensus on Alternatives 7D and 10

The facilitator requested that each of the Consultative Committee members verbally state their degree of support for **Alternatives 7D and 10**. Possible declarations were:

- **Endorse –** "I fully support this alternative without any conditions."
- **Accept –** "I can live with it with conditions for monitoring programs as described in Section 7 later in this report."
- **Block –** "I cannot live with it."

The results (Table 6-4) show Alternatives 7D and 10 *both* received unanimous acceptance by the Consultative Committee on condition of the concurrent implementation of specified monitoring programs.

Table 6-4: Preference for Falls River Water Use Plan Operating Alternatives

Consultative Committee Representative	**Operating Alternative**	
	Alt 7D	**Alt 10**
Allied Tsimshian Tribe Association (ATTA)	A	A
BC Hydro	A	E
Fisheries and Oceans Canada	E	E
Lax Kw'alaams Band	A	A
Ministry of Water, Land and Air Protection	E	A
Prince Rupert Salmonid Enhancement Society	A	A
Ridley Terminals (Industry)	A	A
Total Endorsing or Accepting out of 7	**7**	**7**

Note: *(A = Accept with Conditions, B = Block, E = Endorse)*

Consultative Committee members also provided supporting rationale for their level of support for each alternative, summarized in Table 6-5.

Table 6-5: Summary of Consultative Committee Members' Support for Alternatives 7D and 10

Committee Member	Rationale for Support Alternative 7D	Rationale for Support Alternative 10
Allied Tsimshian Tribe Association (ATTA)	Accept – Seems to be the best of all the alternatives being considered. Strongly feel that there is a need to monitor both in the reservoir and in the river. Need to balance what is happening in the reservoir with what is happening in the river. Feel that it is time we have an opportunity to study and better understand what is going on in this river system.	Accept – Accept for now but cannot endorse until we can review the monitoring results and understand what is going on for Dolly Varden. Would not be willing to select #10 as the preferred operating alternative and default to #7D automatically in 1 or 2 years from now if the monitoring showed negative impacts on Dolly Varden habitat. Would not want to limit the options under consideration once the monitoring results are available – wants to review and discuss monitoring results first, and explore other options.
BC Hydro	Accept – Accept because there are some benefits to reservoir tributary habitat, littoral productivity, and sedge community under this alternative. Concerned about the high maintenance costs associated with Alternative 7D since it requires heavy use of the sluice gates from September through March each year to meet the operating constraints for Dolly Varden and prevent backwatering of incubating eggs. This is likely to cause more wear and tear on the equipment and ultimately result in higher maintenance costs that are not accounted for in the power performance measure.	Endorse – Prefer Alternative 10 over 7D because it is less costly. Also, 10 avoids the heavy use of the sluice gates during the fall and winter each year to meet the operating constraints for Dolly Varden. Also, under 10, there is a greater chance of consistently meeting or exceeding the minimum flow Would be willing to select Alternative 10 as the preferred operating alternative, but default to 7D automatically in 1 or 2 years if the monitoring showed negative impacts on Dolly Varden habitat.
Fisheries and Oceans Canada	Endorse – Uncertain about fish usage in the lower river, and potential for improvement through operations – until we have more information from monitoring, it seems like there are greater gains to be made for fish in the reservoir. Value the sedge community in the reservoir, and this alternative performs well for sedge. Would not want to sacrifice other values to try to bring about improvement in tributary habitat for Dolly Varden given the uncertainty about usage.	Endorse – Would be willing to select Alternative 10 as the preferred operating alternative, but default to 7D automatically in 1 or 2 years if the monitoring showed negative impacts on Dolly Varden habitat. Would want to know that the value to Dolly Varden habitat would justify the cost of returning to Alternative 7D.
Lax Kw'alaams Band	Accept – Support ATTA response (see above). There is still tributary spawning habitat lost but it is a lot less in this alternative, and less impact on the sedge community. There is a lot of uncertainty but with the monitoring I hope that we will have more information. I would be uncomfortable making a decision without that opportunity to monitor. The littoral productivity is also greater under this alternative. I am still uneasy with this lack of information but look forward to getting more information in the future.	Accept – Accept for now but cannot endorse until we can review the monitoring results and understand what is going on for Dolly Varden. Would not be willing to select #10 as the preferred operating alternative and default to #7D automatically in 1 or 2 years from now if the monitoring showed negative impacts on Dolly Varden. Does not want to limit the options under consideration once the monitoring results are available – wants to review and discuss monitoring results first, and explore other options.

Table 6-5: Summary of Consultative Committee Members' Support for Alternatives 7D and 10 (cont'd)

Committee Member	Rationale for Support Alternative 7D	Rationale for Support Alternative 10
Ministry of Water, Land and Air Protection	Endorse – The province values char (Dolly Varden) habitat in the lower reaches of the tributaries entering the reservoir, as well as sedge grass habitat for wildlife. This alternative performs well for both these interests.	Accept/Endorse – Accept pending the results of monitoring study of reservoir tributary habitat. Endorse if monitoring shows there is no Dolly Varden habitat in the areas of the tributaries exposed to backwatering. Would be willing to select Alternative 10 as the preferred operating alternative, but default to 7D automatically in 1 or 2 years if the monitoring showed negative impacts on Dolly Varden habitat.
Prince Rupert Salmonid Enhancement Society	Accept – Habitat losses for fish and wildlife seem to be less under this alternative. Value the minimum flow for the lower river and particularly like the increase in the minimum flow for the fall period.	Accept – Would be willing to select Alternative 10 as the preferred operating alternative, but default to 7D automatically in 1 or 2 years if the monitoring showed negative impacts on Dolly Varden habitat.
Ridley Terminals (Industry)	Accept – My primary interest was to ensure cheap and reliable energy. Don't see the loss of cheap reliable energy in either of these alternatives however I do acknowledge the power lost. I can accept this alternative but would ultimately like to see what we could get for the lower cost of Alternative 10. Am not anti-environment but would want to know that there is value in terms of benefits achieved with the costs we are looking at.	Accept – Like the idea that there is less power lost under Alternative 10, but am concerned that until we know whether or not there are impacts on Dolly Varden, the 7D alternative may be more appropriate. Would be willing to select Alternative 10 as the preferred operating alternative, but default to 7D automatically in 1 or 2 years from now if the monitoring showed negative impacts on Dolly Varden habitat.

6.4 Select preferred operating alternative

Modelling the operating alternatives demonstrated that the finite supply of water in the Falls River could not optimally satisfy all the water use objectives. This became apparent during the final comparison of Alternatives 7D and 10. Gains in fish and wildlife resources in the reservoir conflicted with losses to financial revenue from power generation and were also expected to result in minor increases in greenhouse gas (GHG) emissions on a provincial scale.

Ultimately, in choosing between Alternatives 7D and 10, the Committee had to decide which of these competing benefits was more important. In the end, it came down to choosing between: 1) uncertain benefits for Dolly Varden (bull trout) tributary spawning habitat (minimizing the loss of available habitat) and 2) certain benefits for power (maximizing revenue from generation at the facility) and greenhouse gas (minimizing increases in greenhouse gas emissions).

As noted in the Consultative Committee members' rationales for supporting Alternative 10 (see Table 6-5 above), the Committee discussed the possibility of taking an adaptive approach to selecting a preferred operating alternative. This would involve selecting Alternative 10 as the preferred operating alternative for the first year or two, and monitoring the impact of those operations on reservoir tributary habitat for Dolly Varden. If the results of the monitoring showed there minimal impacts on Dolly Varden, then Alternative 10 would remain the preferred operating alternative. If, on the other hand, the monitoring results did reveal negative impacts of operations on Dolly Varden, then operations would automatically revert to those specified under Alternative 7D.

Several Committee members felt this proposal had merit and would have been willing to adopt it. However, some disagreed on the grounds that they did not want to commit to Alternative 7D as the default operating alternative before reviewing the monitoring results. They suggested that the monitoring might lead to additional insight about the reservoir, and would want the opportunity to explore other options in response the results.

In the end, the Ministry of Water Land and Air Protection (MWLAP) suggested that they would be willing to proceed with Alternative 10 even though it has the potential to result in reduced Dolly Varden spawning habitat in the reservoir given:

- The high level of uncertainty surrounding the availability and use of Dolly Varden habitat in the reservoir drawdown zone.
- The operations under Alternative 10 will still result in an improvement in Dolly Varden spawning habitat compared with historic operations (Alternative 6).

The Consultative Committee agreed to recommend Alternative 10 as the preferred operating alternative.

6.5 Specify operating constraints

The Falls River Water Use Plan Consultative Committee recommends the Falls River hydroelectric project be operated as designed subject to the operating constraints shown in Table 6-6. These constraints include those reflecting the design of the modelled Alternative 10, as well as some additional operating constraints recommended by the Consultative Committee to better address certain key objectives (without impacting on existing benefits for other objectives).

Some constraints apply to operations affecting the river (minimum discharge) while others apply to the regulation of reservoir levels. The constraints relating to the river are described first:

- **Minimum discharge levels to provide minimum flow for fish in the river**: The Committee recommended a two-tiered minimum discharge constraint. This means that when reservoir levels are higher (at or above 88.4 metres), a higher level of minimum discharge is released to the river (2.6 m^3/s); when the reservoir falls below a threshold (below 88.4 metres), the level of minimum discharge is lowered (1.3 m^3/s). This ensures the provision of a minimum discharge (albeit lower) even when the reservoir is affected by low inflow conditions. This two-tiered minimum discharge constraints applies year round, except in the fall (1 August to 14 October) when a much higher level of minimum discharge (6.5 m^3/s) is specified to improve spawning conditions when the reservoir is at or above 88.4 metres.

- **Protocols for minimum discharges for fish during outages:** In order to minimize fish stranding along the river during *planned* and *unplanned* outages, the Consultative Committee agreed to recommend that BC Hydro: 1) establish the required minimum discharge through the sluice gates before shutting down both generating units during *planned* outages and 2) restore the required minimum flow as soon as possible by opening the sluice gates during any *unplanned* outages.

- **Restrictions on Ramping rates:** The Consultative Committee discussed two different restrictions on ramping rates to address fish objectives: 1) *limits on ramping rates when ramping up* to minimize the siphoning away of newly hatched fish fry (alevin) that may have moved to the surface of gravel beds below the tailrace during lower flows and 2) *limits on ramping rates when ramping down* to minimize stranding of juvenile or adult fish in the tailpond portion of the Falls River downstream of the facility. See Table 6-6 for the specific rates recommended.

The constraints relating to the regulation of reservoir levels are described here:

- **Flashboard Installation:** In order to maintain the sedge grass community, the Committee recommends that the flashboards be installed annually sometime between 15 February and 15 March **(**the earlier the better) and removed between 1 May and 15 May (the later the better). This means that for a period of at least six weeks – and up to 12 weeks – each year the sedge grass habitat is flooded. Theoretically, during this time, other plants, shrubs and trees that do not tolerate flooding will die off, thereby maintaining the sedge community as a riparian or wetland habitat (rather than having it gradually develop into a forest).

- **Regulation of reservoir elevations during spring spawning:** The Committee recommends keeping the reservoir elevation at or above 92.0 metres (a half-metre below the top of the flashboards) during cutthroat spawning (1 April–15 May). The intent is to encourage the cutthroat to spawn further up the tributaries so that incubating eggs will not be back-watered after the flashboards are removed. The Committee recognizes that there is still a risk that during this time frame, eggs may spawn in areas at elevations at or below 92.0 metres and be back-watered before the flashboards are removed.

The Committee also made two other recommendations that apply to the system more generally:

- **Timing of annual maintenance:** BC Hydro must perform annual maintenance on the facility and typically schedules it during the month of March. The Committee recommended that BC Hydro continue to schedule maintenance during the period to minimize interference with meeting all the other operating constraints discussed above.
- **Operation of the undersluice:** There is an undersluice below the sluice gates at a sill elevation of 81.86 metres. The undersluice can only be operated manually and is not currently used for normal operations. The Committee expressed concern about the potential impacts on fish in the river if the undersluice were opened and fine sediment from the reservoir were washed into the river. The Committee recommended that BC Hydro consult with interested parties (provincial and federal agencies, First Nations and community fishery groups) before operating the undersluice in the future.

Table 6-6: Recommended Operating Constraints for the Falls River Hydroelectric Project

Area	Operating Variable	Constraint	When	Objective
River	Minimum discharge	2.6 m^3/s when reservoir is at or above 88.4 metres in elevation. 1.3 m^3/s when reservoir is below 88.4 metres in elevation.	Year round	Maximize habitat for fish in the river.
River	Minimum discharge	6.5 m^3/s when reservoir is at or above 88.4 metres in elevation.	1 August–15 October	Maximize fall spawning habitat for fish in the river.
River	Generation curtailment	Curtail turbine discharge to 1.3 m^3/s when reservoir is below 88.4 metres in elevation.	Year round	Ensure provision of minimum discharge.
River	Minimum discharge	Return to applicable minimum discharge as soon as possible.	Unplanned outages	Ensure provision of minimum discharge.
River	Minimum discharge	Ensure applicable minimum discharge is being provided through the sluice gates before shutting down generation units.	Planned outage of generation units.	Ensure provision of minimum discharge.
River	Ramping rate when ramping up (unit ramping)	Maximum rate of increase of 1.3 m^3/s over 10 minutes for discharges between 1.3 and 6.5 m^3/s.	15 February–15 March	Minimize impacts on alevin below tailrace.

Table 6-6: Recommended Operating Constraints for the Falls River Hydroelectric Project (cont'd)

Area	Operating Variable	Constraint	When	Objective
River	Ramping rate when ramping down (total discharge)	Maximum rate of decrease of 1.3 m^3/s over 10 minutes for discharges between 1.3 and 6.5 m^3/s.	1 November–15 April	Minimize stranding of fish in the tailpond.
Reservoir	Flashboard Installation	Install annually.	Between 15 February and 15 March, the sooner the better.	Maximize sedge grass community maintenance.
Reservoir	Flashboard Removal	Remove annually.	Between 1 May and 15 May, the later the better.	Maximize sedge grass community maintenance.
Reservoir	Reservoir Elevation	Minimum elevation of 92.0 metres with potential incursions above 92.0 metres.	From 1 April to the removal of the flashboards.	Minimize backwatering of cutthroat tributary spawning habitat.
Other	Timing of Annual Maintenance	Preferably between 1 March and 28 March.	March	Maintain safety and reliability of facility.
Other	Operation of Undersluice	BC Hydro will consult with interested parties (provincial and federal agencies, First Nations and community fishery groups) before operating the undersluice.		Minimize impacts to fish related to fine sediment releases into the river.

6.5.1 Implementation of Operating Constraints and Interim Procedures

During the discussion of operating constraints, BC Hydro agreed to begin immediate implementation of the new, year round, two-tiered minimum discharge levels to provide minimum flow for fish in the river. This means that when reservoir levels are higher (at or above 88.4 metres), a higher level of minimum discharge is released to the river (2.6 m^3/s); when the reservoir falls below a threshold (below 88.4 metres), the level of minimum discharge is lowered (1.3 m^3/s). BC Hydro's interim adoption of this operating constraint is voluntary and does not change the reference point for the calculation of water rental remissions.

With the exception of BC Hydro adopting this one recommended operating constraint, interim operations will follow those described under Alternative 9A, the Revised Reference Case. The implementation of the other operating constraints will begin once the Comptroller of Water Rights has reviewed the Water Use Plan and provides direction to BC Hydro.

6.5.2 Expected Consequences of Recommended Operating Alternative

Alternative 10 is expected to provide numerous benefits (and some losses) over the revised Reference Case (Alternative 9A) shown in Table 6-7. The consequences of Alternative 10 are described as "neutral (o)" if they were not significantly different from those of the reference case; a "increase (+)" if there is a benefit or improvement over the reference case; and a "decrease (?)" if there a relative loss.

Consequences in the neutral category include: fish habitat in Falls River, fish tributary access in the reservoir, and tributary spawning habitat for Dolly Varden in the reservoir.

Benefits are expected in the reservoir for cutthroat tributary spawning habitat, littoral habitat, and the maintenance of the sedge community.

Losses are anticipated for revenues from power generation, provincial greenhouse gas emissions, and reservoir shoreline habitat for nesting and denning wildlife.

The expected consequences outlined in the table are described in relative terms: these are the consequences of the recommended alternative (10) in comparison to the Revised Reference Case alternative (9A). Magnitude of losses and benefits remains to be confirmed post-implementation based on the results of recommended monitoring studies (see Section 7).

Table 6-7: Expected Consequences of Falls River Water Use Recommended Alternative

Water Use Interest	Consequences
Fish in Falls River	o Neutral – No significant increase is expected in the area of fish habitat available for coho, chum and chinook spawning and rearing. However, the recommended operating constraints for minimum discharge and ramping are expected to minimize impacts on these fish during key life stages and in the event of planned and unplanned outages (see Table 6-4).
Fish in Big Falls Reservoir	o Neutral – No significant change to tributary access for cutthroat trout or Dolly Varden. o Neutral – No significant change is expected in the area of tributary spawning habitat in the drawdown zone for Dolly Varden. + Significant decrease (by a factor of 10) in the amount of tributary spawning habitat lost through backwatering in the drawdown zone. + Increase of 50% in expected area of effective littoral habitat.
Wildlife in Big Falls Reservoir	? Decrease of 25% in expected area of available shoreline habitat for nesting and denning wildlife. + Increase (by a factor of 3) in the area of sedge community maintained.
Power Generation	? Decrease in power revenue of $50,000 per year on average (approximately 2%) over reference case.
Greenhouse Gas (GHG) Emissions	? Increase in GHG emissions for BC Hydro's integrated generation system.

6.5.3 Hydrographs for River and Reservoir under the Recommended Operating Alternative

The recommended operating alternative (Alternative 10) will impose a modified hydrograph onto the Falls River and a modified regime of reservoir elevations on Big Falls Reservoir compared to historical operations (Alternative 6) and operations under the Revised Reference Case (Alternative 9A).

The hydrographs for the river and reservoir under Alternative 10 are shown on the next page in Figure 6-3 and Figure 6-4.

The hydrographs for the river and reservoir for all of the operating alternatives considered by the Falls River Water Use Plan Consultative Committee are shown in Appendix I.

Note: In the following hydrographs cms = m^3/s

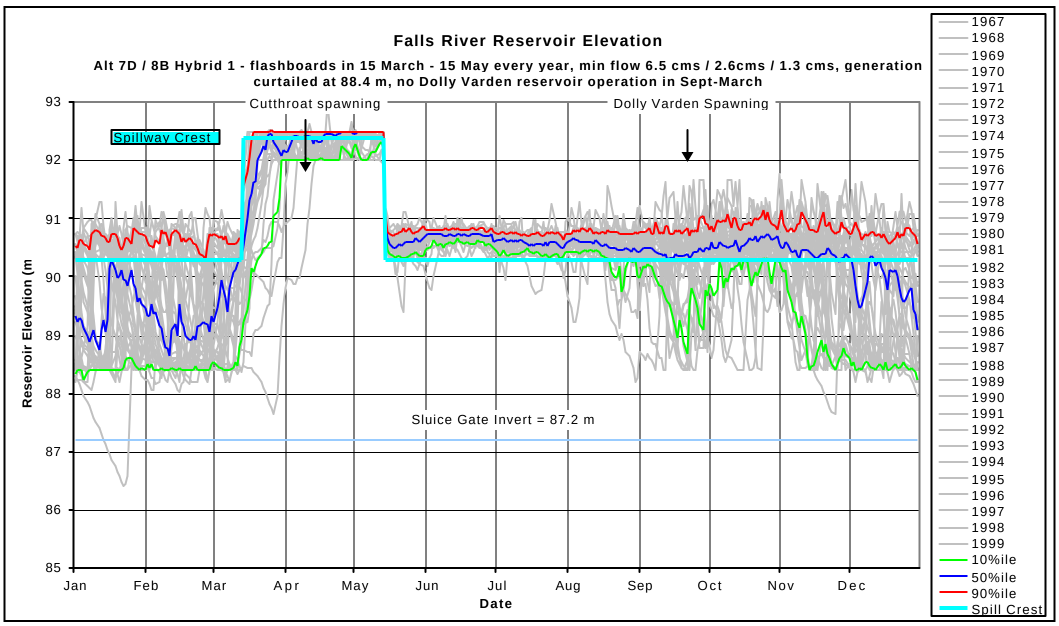

Figure 6-3: Hydrograph of Big Falls Reservoir Elevations for Preferred Operating Alternative 10

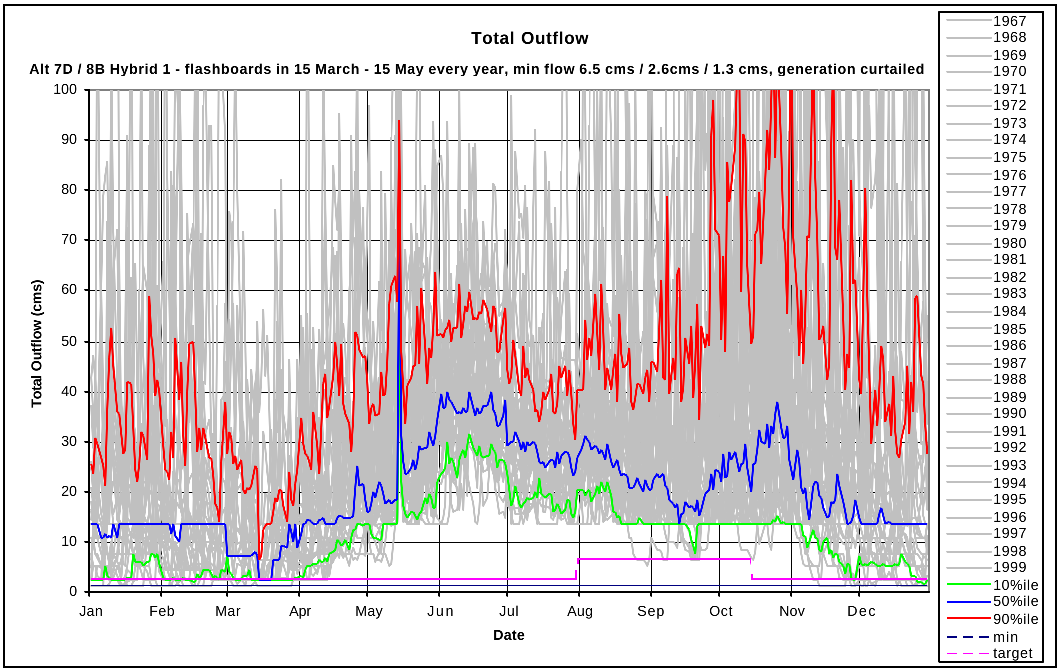

Figure 6-4: Hydrograph of Total Discharge (Outflow) from Falls River facility into Falls River for Preferred Operating Alternative 10

7 MONITORING PROGRAMS

In addition to recommending a preferred operating alternative for the Falls River hydroelectric project (Section 6.3), the Consultative Committee recommended an associated monitoring program designed to address key uncertainties and answer specific questions that may change future decisions on operations.

In the Falls River water use planning process, the Consultative Committee chose their preferred operating alternative based on the available information about fish, wildlife and vegetation. On most issues, there was very little scientific information available. As a result, the Committee had to make some assumptions in order to move ahead with their decision making.

For example, there was no site-specific information about the minimum duration and frequency of flooding required to maintain the sedge community habitat. Alternative 10 provides annual flooding of the sedge grass habitat in the drawdown zone for at least six weeks every spring. This is expected to ensure the maintenance of the extent and composition of the sedge grass community. A monitoring program provides the opportunity to assess how well the preferred operating alternative (Alternative 10) achieves the desired fundamental objective of maximizing the abundance and diversity of wildlife using the reservoir drawdown zone. The results of the monitoring program can provide better data for future decision making and reduce the uncertainty around the biological response to changes in operations.

This section describes the criteria used to evaluate monitoring programs under the Water Use Plan, and the Falls River Water Use Plan monitoring program recommended by the Consultative Committee.

7.1 Criteria for Water Use Monitoring Studies

The Water Use Plan Management Committee developed principles and criteria for screening monitoring programs and the component studies. In the face of uncertainty about the relationship between changes in operation and biological response in the Falls River system, ***a monitoring program is intended to assess the effectiveness of the operational changes for the Falls River hydroelectric project relative to water use objectives.***

The Water Use Plan Eligibility Criteria state that a monitoring program should:

1. Provide information that will help in deciding the best use of water *(i.e., provide results that could change the way decision makers choose to use water at the Falls River project).*

2. Distinguish between competing hypotheses *(i.e., if the Committee's recommendations are based on more than one possible hypothesis or set of assumptions, the monitoring program should isolate the impact of each hypothesis or assumption).*

3. Show results in a timely manner *(i.e., deliver results in time to assist in decision making during the next review of the Falls River Water Use Plan).*

4. Be cost effective *(i.e., be the least expensive way to generate that level of learning both within the Falls River Water Use Plan and across all Water Use Plan monitoring programs for other facilities).*

The criteria can summed up as: 1) *efficacy*, 2) *sensitivity*, 3) *timeliness* and 4) *cost effectiveness*. Monitoring programs that meet these criteria are eligible under the Falls River Water Use Plan.

7.2 Falls River Water Use Plan Monitoring Program

During their second and third meetings, the Consultative Committee discussed a variety of potential monitoring studies. The Consultative Committee evaluated all these studies for eligibility under the Falls River Water Use Plan using the Eligibility Criteria for Water Use Plan Monitoring Studies (see Sections 7.1 and 7.2 above or Appendix K). For a more detailed record of the broad set of monitoring studies considered and their evaluation by the Committee, see Appendix L. Based on their evaluation, the Consultative Committee recommended a monitoring program including six monitoring studies:

- **Presence and Timing of Steelhead and Salmon Spawning in the River:** Assess the presence and timing of steelhead and salmon spawning in the Falls River downstream of the facility.

- **Fish Spawning Habitat in the River:** Assess the impact of operations on fish spawning habitat and egg-fry survival in the Falls River downstream of the facility.

- **Tributary Access and Potential Stranding in the Reservoir:** Check for barriers to tributary access and assess the potential for stranding of fish in the reservoir.

- **Sedge Habitat Maintenance in the Reservoir:** Assess the impact of operations on maintenance of sedge grass community (riparian habitat for wildlife) around the reservoir.

- **Tributary Backwatering in the Reservoir:** Assess the presence and use of tributary spawning habitat for cutthroat and Dolly Varden in the drawdown zone of the reservoir.

- **Wildlife Shoreline Habitat around the Reservoir:** Assess the impact of operations on wildlife shoreline habitat (dens and nests established by birds and mammals).

Table 7-1 summarizes the recommended scope, costs and schedules for each of the six monitoring program studies. See Appendix M for more detailed discussion of the recommended studies.

Table 7-1: Summary of Recommended Falls River Water Use Plan Monitoring Program Studies

#	Monitoring Interest	Description	Cost	Schedule
	River			
1	Presence and Timing of Steelhead and Salmon Spawning	Monitor timing of adult presence in Falls River below the dam and in the tailpond for March, April, August, September and October.	$12,000/year for up to 5 years (up to $60,000 total)	5 years
2	Fish Spawning Habitat	Monitor egg-fry survival. Place egg boxes and measure habitat at site. Evaluate effect of operation on survival.	$20,000/year for up to 5 years (up to $100,000 total)	5 years
	Reservoir			
3	Tributary Access and Potential Stranding	Survey location of barriers within drawdown zone in three tributaries and identify location and size of potential areas of stranding along the shore in the drawdown zone.	$5,000 Potential to combine with Study #5 for cost savings	In 1st year
4	Sedge Habitat Maintenance	Aerial overflight to identify extent of sedge habitat. Detailed assessment of species composition and density of vegetation in sedge habitat community.	$15,000 in year one; $15,000 in follow up year ($30,000 total)	In 1st year and in follow up year, 3–5 years later
5	Tributary Back-watering	Survey for redds in drawdown zone of three tributaries or, if necessary, sampling for adult spawners by netting, angling, or direct observation by snorkelling. Deploy temperature monitors and collect life history data.	$6,000 to $20,000 Potential to combine with #3 for cost savings	In 1st year
6	Wildlife Shoreline Habitat	Survey drawdown zone for dens and nests established by birds and mammals. Map locations and measure elevation.	$15,000/year ($30,000 total)	In 1st and 2nd years
	Total	**Implement all studies**	**$245,000**	**Over 5 years**

Typically, a monitoring program is designed to provide a before and after comparison of alternative operating regimes. There would be a period of data collection to establish a baseline condition. Then the new operating regime is adopted and the effects are monitored for a period. The before and after comparison would demonstrate whether the new operating regime performed better than the old.

There are two potentially complicating factors affecting the quality of the "before" or baseline data that will be collected under the monitoring program for the Falls River hydroelectric project. First, the Consultative Committee recommended that Alternative 10 be implemented immediately with no period for baseline data collection. However, this is not a significant concern as the only study requiring baseline data collection requirement is Study 4 for Sedge Community Maintenance. Since changes in vegetation occur gradually (over a number of years), data collected during or after the first year of implementing the new operating constraints will still be valid.

Secondly, operations for 2002/2003 have already differed from historical operations (Alternative 6) significantly in that the flashboards were not installed at all this year while the dam safety review of flashboard operations was being conducted. Again, for the monitoring studies being recommended, this will not be a significant concern.

7.3 Development of Detailed Terms of Reference for Monitoring Studies

Once the implementation of the operational changes approved under the final Falls River Water Use Plan has begun, BC Hydro will: 1) develop detailed terms of reference for the monitoring program; and 2) start monitoring program study, data collection, analysis and reporting. The Consultative Committee recommended that the detailed terms of reference be developed in consultation with appropriate government agencies, First Nations, and interested parties.

7.4 Communication of Monitoring Program Results

The Consultative Committee recommended that results of all the monitoring program studies be sent to all interested members of the Committee by BC Hydro as those results become available.

7.5 Request for Additional Monitoring Studies after Completion of Consultative Process

After the final meeting of the Falls River Water Use Plan Consultative Committee, representatives of the Allied Tsimshian Tribes Association and the Lax Kw'alaams Band jointly requested that additional monitoring studies be performed. The scope of these studies is outlined in a record of their review of a draft of this report (see Appendix F).

8 IMPLEMENTATION OF RECOMMENDATIONS

BC Hydro agreed to begin immediate implementation of the new, year round, two-tiered minimum discharge levels to provide minimum flow for fish in the river. This means that when reservoir levels are higher (at or above 88.4 metres), a higher level of minimum discharge is released to the river (2.6 m^3/s); when the reservoir falls below a threshold (below 88.4 metres), the level of minimum discharge is lowered (1.3 m^3/s). BC Hydro's interim adoption of this operating constraint is voluntary and does not change the reference point for the calculation of water rental remissions.

With the exception of BC Hydro adopting this one recommended operating constraint, interim operations will follow those described under Alternative 9A, the Revised Reference Case. The implementation of the other operational changes and monitoring program recommended and signed off by the Falls River Consultative Committee will be implemented once the Comptroller of Water Rights and government approve the Falls River Water Use Plan (see Appendix N). This will happen in the following sequence:

- **Approval of the Water Use Plan:** As described in Step 10 of the *Water Use Plan Guidelines*, the Comptroller of Water Rights will review and issue a decision on the Falls River Water Use Plan under provisions of the *Water Act*. This process involves referring the draft plan for review and comment by Fisheries and Oceans Canada, other provincial agencies, First Nations, and holders of water licences who might be affected by the changes.

  As part of the review, the Comptroller may require modifications to the draft plan. The Comptroller and BC Hydro will work together on any changes and Consultative Committee members and other interested parties will be kept informed of them. The outcome of the review process will be a plan authorized by the Comptroller.

- **Implement Operational Changes:** Once the Comptroller of Water Rights has approved the Falls River Water Use Plan and provided BC Hydro with direction, BC Hydro will begin to implement the approved operational changes immediately.

- **Initiate Monitoring Program:** Once the implementation of the operational changes approved under the final Falls River Water Use Plan has begun, then BC Hydro will: 1) develop detailed terms of reference for the monitoring program; and 2) start monitoring program study, data collection, analysis and reporting. The detailed terms of reference will be developed in consultation with appropriate government agencies, First Nations, and interested parties.

9 REVIEW PERIOD

The Falls River Consultative Committee recommends that five years after the implementation of the Falls River Water Use Plan (or as soon as the results of all the approved monitoring program studies are available), a technical review of monitoring studies be undertaken by BC Hydro, appropriate government agencies, First Nations and interested parties. If scientific data and significant new risks are identified that could lead to a change in operations, a formal review of the Water Use Plan could be requested at that time.

If a review is not recommended during the five-year technical review of monitoring results, then the next review of the Falls River Water Use Plan will be conducted ten years after the implementation of the plan.

10 REFERENCES

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11 ACRONYMS AND ABBREVIATIONS

ATTA	Allied Tsimshian Tribe Association
cm	centimetre
cms	cubic metres per second (also abbreviated as m^3/s)
DFO	Fisheries and Oceans Canada
FWTC	Fish and Wildlife Technical Subcommittee
GHG	Greenhouse Gas
GWh	Gigawatt-hour (of energy)
ha	area in hectares (1 ha = 10 000 m^2)
K$	thousands of dollars
km	kilometre
km^2	square kilometre
m	metre
m^2	square metre
m^3/s	discharge or flow rate in cubic metres per second (also abbreviated as cms)
Mm^3	millions of cubic metres (volume of water)
MSIC	Minimum Significant Incremental Change
MWLAP	Ministry of Water Land and Air Protection
PM	Performance Measure
t CO_2e	tonnes of carbon dioxide equivalent (unit for greenhouse gas emissions)
WUP	Water Use Plan

APPENDIX A: FALLS RIVER WATER USE PLAN CONSULTATIVE COMMITTEE, OBSERVERS AND SUBCOMMITTEES

Table A-1: Falls River Water Use Plan Consultative Committee

Member	Affiliation	Notes
Dana Atagi	Ministry of Water, Land and Air Protection	Alternate for Jeff Lough
Eugene Bryant	LaxKw'alaams Band	
James Bryant	Allied Tsimshian Tribes Association (ATTA)	
Stephanie Carroll	Fisheries and Oceans Canada (Vancouver)	
Barry Drees	Prince Rupert Salmonid Enhancement Society	
Jim Hellman	Prince Rupert Salmonid Enhancement Society	Alternate for Barry Drees
Larry Keene	Ridley Terminals	
Jeff Lough	Ministry of Water, Land and Air Protection	
Lana Miller	Fisheries and Oceans Canada (Prince Rupert)	Alternate for Stephanie Carroll
Terry Molstad	BC Hydro Corporate Representative	
Laurie Ryan	Allied Tsimshian Tribes Association (ATTA)	Alternate for James Bryant

Table A-2: Falls River Water Use Plan Observers

Observer	Affiliation
Joy Hillier	Fisheries and Oceans Canada (Prince Rupert)
Don Hjorth	Fisheries and Oceans Canada (Prince Rupert)
Jack Rudolph	City of Prince Rupert (Councillor)
Ed Wampler	District of Port Edward (Mayor)
Wade Balbirnie	International Forest Products Ltd. (Interfor)
Dennis Oddson	Resident, Prince Rupert
Scott Allen	Community Fisheries Development Centre
Larry Golden	Prince Rupert Environmental Society
Christian Shears	BC Ministry of Forests
Maria Parks	Skeena–Queen Charlotte Islands Regional District

Table A-3: Falls River Water Use Plan Fish and Wildlife Subcommittee

Member	Affiliation
Dana Atagi	Ministry of Water, Land and Air Protection
Eugene Bryant	LaxKw'alaams Band
James Bryant	Allied Tsimshian Tribes Association (ATTA)
Stephanie Carroll	Fisheries and Oceans (Vancouver)
Barry Drees	Prince Rupert Salmonid Enhancement Society
Jeff Lough	Ministry of Water, Land and Air Protection
Lana Miller	Fisheries and Oceans (Prince Rupert)
Terry Molstad	BC Hydro Corporate Representative
Laurie Ryan	Allied Tsimshian Tribes Association (ATTA)

LIST OF STAKEHOLDERS CONTACTED PRIOR TO FIRST CONSULTATIVE COMMITTEE MEETING

The following organizations and members of the public were contacted either by mailout on 18 July 2002 or by phone during the months of June to September 2002 prior to the first meeting of the Falls River Water Use Plan Consultative Committee on 2–3 October 2002.

Affiliation	**Individuals**
City of Prince Rupert	Don Scott (Mayor) and Bill Smith (CEO)
Community Fisheries Development Centre and North Coast Fisheries Renewal Council	Scott Allen
District of Port Edward	Ed Wampler (Mayor) and Ron Bedard (CAO)
Ecstall Guides	Stan Doll, Harald Kossler, Dustin Kovacvich
EPCOR Generation Inc., Brown Lake Generating Station	Ken Warren
Fisheries and Oceans Canada	Stephanie Carroll, Steve Macfarlane and Mitch Drewes
Guideoutfitter Association	Kevin Wiley
Inland Air Charters	Trevor Pearce
International Forest Products	Peter Scharf and Wade Balbirnie
Milligan Outfitting Co.	Bob Milligan
Ministry of Forests	Brian Wesleyson
Ministry of Sustainable Resource Management	Sarma Lipins
Ministry of Water, Land and Air Protection	Dana Atagi and Jeff Lough
MLA (North Coast)	Bill Belsey
MLA (Skeena)	Roger Harris
Member of Parliament (Federal)	Andy Burton
Prince Rupert Chamber of Commerce	Maureen Macarenko and Jan Palmer
Prince Rupert Development Commission	Don Allan
Prince Rupert Grain	General
Prince Rupert Port Authority	General
Prince Rupert Rod and Gun Club	Wally Robinson
Prince Rupert Salmonid Enhancement Society (Oldfield Creek Hatchery)	Barry Dress and Jim Hellman
Prince Rupert Yacht and Rowing Club	Jim Simmons
Rave On Charters	Vicki Campbell
Regional District of Skeena-Queen Charlotte	Vic Peterson and Bill Beldessi
Ridley Terminals Inc.	Larry Keene
Skeena–Cellulose	Randy Young
Sunchaser Charters	General
Terrace Area Angling Guide	Tom Protheroe and Jim Culp

APPENDIX B: CONSULTATIVE COMMITTEE TERMS OF REFERENCE

The following Terms of Reference were adopted by the Falls River Water Use Plan Consultative Committee at their first meeting on 2–3 October 2002.

INTRODUCTION

The purpose of the Terms of Reference is to ensure that participants of the Falls River Water Use Plan (WUP) process have a clear understanding of their purpose and responsibilities, to provide assurance that public values will be integrated into resource management decisions, and enhance the smooth functioning of the Committee work.

CONSULTATIVE COMMITTEE PURPOSE

The broad consultative purpose is to integrate First Nations' and public values into water flow management decisions related to BC Hydro operations. The specific Committee purpose is to provide clearly documented value based recommendations for consideration by BC Hydro when preparing their Water Use Plan (WUP) for the Falls River facilities. The objective of the Committee will be to recommend:

- A preferred operating regime (or range of regimes) for the facilities, considering allocation of water to different water uses (e.g., flood control, fisheries, power generation, traditional use, aquatic ecosystem 'health', recreation, etc.);
- Criteria for a monitoring and assessment program; and
- Timing for periodic review of the Falls River Water Use Plan.

Consensus is a goal, but not a requirement of the Water Use Planning process. Consensus is defined in the *Water Use Plan Guidelines* as a decision in which the participants can accept, without having to agree to all the details of the operating regime. Where the process identifies a preferred operating alternative (consensus), documentation will include areas of agreement, as well as areas of contention, and the underlying trade-offs between alternative water uses. Where no preferred operating alternative is identified (non-consensus), documentation will record that agreement was not reached, and indicate differences of opinion and reasons for disagreement.

CODE OF CONDUCT

All participants of the Falls River Water Use Plan will endeavor to:

- Support an open and inclusive process
- Treat others with courtesy and respect
- Listen attentively with an aim to understand
- Be concise in making your point
- Speak in terms of interests instead of positions

- Be open to outcomes, not attached to outcomes
- Challenge ideas, not people
- Let opposing views co-exist
- Avoid disruption of meetings (e.g., cell phones, caucusing at the table, etc.)
- Aim to achieve consensus on issues being addressed.

The facilitator will ensure that the code of conduct is followed by Consultative Committee members.

PROCESS

Committee Tasks

The Committee will achieve its purpose by undertaking Steps 4 to 8 of the *Water Use Plan Guidelines*. In summary these include:

- Confirm issues and interests in terms of specific water use objectives along with quantitative and/or descriptive measures for assessing their achievement.
- Identify existing information and information gaps related to the impacts of water flows, and their timing, on each objective.
- Create alternative operating regimes to compare impacts on water use objectives.
- Assess the trade-offs between alternative operating regimes in terms of objectives.
- Determine and document areas of agreement and disagreement

Procedure in the Event of Disagreement

The following interest-based negotiation steps will be used as a tool for resolving issues:

- Define the issue
- Identify interests
- Brainstorm options
- Evaluate options
- Choose an option

Interests are defined as the needs, wants, fears and concerns that are connected to an issue. Positions are defined as a predetermined solution to a problem without consideration for the interests of others.

DELIVERABLE

A ***Consultation Report***, signed off by the participants, documenting the overall process; water use interests, objectives and performance measures; information collected, operating alternatives reviewed, trade-off assessment, and areas of final agreement and disagreement.

The target date for the delivery of this report is Spring/Summer 2003.

WATER USE PLAN PREPARATION, REVIEW, AND APPROVAL

Recommendations in the *Consultation Report* will be fully considered by BC Hydro as they prepare the Draft Water Use Plan for the Falls River facilities. A copy of the draft Water Use Plan, prepared by BC Hydro, will be distributed to the Consultative Committee.

The Draft Water Use Plan and the Consultative Report will be submitted to the BC Comptroller of Water Rights. The Comptroller will co-ordinate a final regulatory review and approval as outlined in the Water Use Plan Guidelines.

The target date for the delivery of this report is Spring/Summer 2003.

MEMBERSHIP

Committee Membership

The Falls River WUP Consultative Committee has been established in accordance with Steps 2 and 3 of the WUP Guidelines. Committee Members represent a broad range of interests affected by the operations of the Falls River facilities.

Alternates

Committee Members can designate Alternates (either a non-Committee Member or another Committee Member) to represent them when they are unable to attend a meeting or on issues where an Alternate has more relevant knowledge or experience.

Members should ensure that their Alternate is familiar with these Terms of Reference, the *Water Use Plan Guidelines* and is up-to-date on issues being discussed. Alternates who attend meetings should ensure that the Committee Member is updated on all issues that were discussed.

New Members

Individuals or organizations may apply to become Committee Members by:

- Submitting a request for Committee Membership to the BC Hydro process co-ordinator. The process co-ordinator will then schedule the membership request as an agenda topic for the next Committee meeting.
- Applicants must be present at the meeting where the application is considered and be prepared to describe the interests they represent and the

reasons why they believe those interests are not adequately represented in the process.

- Committee Members will consider new applications based on the principle of a fair, open and inclusive process.

New Committee Members will be required to:

- Abide by the Terms of Reference.
- Become familiar with past work completed by the Committee.
- Accept agreements previously made by the Committee.

Observers and Guests

WUP Observers are included in the Communications distribution list, receiving all communications including meeting notices, information packages, agendas and minutes. Water Use Plan Observers are not full Committee Members and thus do not participate fully in discussions, do not sit at the main table, and do not participate in the trade-off and decision activities. Observers may, by decision of the Committee, be given opportunity to provide input into the discussions of the Committee.

Guests may be invited to attend meetings to provide a technical presentation or respond to questions on a subject that is relevant to the development of the Falls River Water Use Plan. Such presentations must be pre-arranged as an agenda item with the Facilitator and/or the BC Hydro Communications representative.

Observers and guests will not participate in making Committee decisions.

ROLES AND RESPONSIBILITIES

Committee Members

In addition to following the code of conduct, participants of the Falls River WUP are responsible for:

- Attending and openly participating in Falls River Consultative Committee meetings;
- Ensuring continuity in representation, through the use of a designated Alternate and/or provision of advance comments or information to the facilitator in the event of an expected absence;
- Articulating their interests with respect to water use;
- Reviewing relevant information and coming to meetings prepared;
- Making recommendations concerning study/research work;
- Exploring the implications of a range of operating alternatives;
- Seeking areas of agreement;

- Being accountable to constituents, other Committee Members and the general public;
- Keeping constituents current on progress and decisions of the Committee; and
- Signing off on the final Consultation Report provided is a true and accurate record of the Falls River Water Use Plan Committee process, documenting decisions and all areas of agreement and disagreement.

Facilitator

In addition to following the code of conduct, the Facilitator of the Falls River Water Use Plan is responsible for:

- Aiding the Consultative Committee in achieving its purpose and associated tasks (i.e., undertaking Steps 4 to 8 of the Water Use Plan Guidelines);
- Making every endeavour to ensure that all parties are heard and that all differences are resolved fairly, without unnecessary delay or expense;
- Making every endeavour to be, and remain, completely impartial between the parties, according equal attention and courtesy to all persons involved; and
- Producing the *Consultation Report* for review and sign off by the Consultative Committee

BC Hydro Project Team

A BC Hydro Project Team has been established to assist with the work of the Consultative Committee. In addition to following the code of conduct, the BC Hydro Project Team is responsible for assisting and taking the lead role in technical support for the Committee. This includes working with the entire Committee, internal BC Hydro resources and external resources including the regulatory agencies, local resources and experts in:

- Managing and resourcing the process to maintain an acceptable time schedule;
- Compiling and providing existing data and information;
- Establishing the scope, limits and boundaries for proposed studies; and
- Arranging and managing studies for collection of new data and information.

The BC Hydro Project Team is also responsible for assisting with administrative tasks, which include:

- Arranging meetings;
- Preparing and distributing the meeting minutes of Committee meetings or any sub-committee, working table or technical work group meetings. Meeting minutes shall focus on content, not people. All such notes will be

distributed directly to each Committee Member, designated Alternates and observers and guests. Committee Members may distribute minutes and materials to their constituents;

- Arranging for facilitation services (as necessary);
- Maintaining a database of interested parties who are to receive copies of meeting notes and other written materials;
- Distributing meeting notes and supporting materials;
- Developing and maintaining communication links with interested parties;
- Producing and issuing all communications materials;
- Supporting report and document preparation and copying;
- Assisting with preparation and presentation of the *Consultation Report*; and
- Presenting the Draft Water Use Plan to the Consultative Committee.

Working Groups (Subgroups)

To expedite the completion of tasks identified by the Committee, Working Groups may be established to undertake work between Committee meetings.

Working groups will:

- Be open to all Members, who will be notified in advance of any meeting;
- Schedule meetings to optimize opportunities for attendance;
- Offer opportunity for input from Members who cannot make a scheduled meeting;
- Include non-Committee Members, such as technical or scientific experts, as appropriate;
- Include a facilitator as required; and
- Prepare options and/or recommendations for consideration by the Committee.

Working groups will not make decisions on behalf of the Committee.

PUBLIC COMMUNICATION

The following procedure will be followed with respect to public communication:

- Committee meetings will be open to the public and the media;
- Newsletters, press releases or media updates describing the Water Use Planning process and its progress will be prepared on a periodic basis by BC Hydro;
- Committee Members will describe their points of view as interests rather than positions and will not criticize or discredit the process or the views of others when communicating with the broader public with respect to the process; and

- Where needed, the Committee will select an appropriate spokesperson, such as the facilitator or BC Hydro communications, to represent the Committee.

APPENDIX C: DOCUMENTS GENERATED DURING THE FALLS RIVER WATER USE PLANNING PROCESS

This appendix summarizes the documents prepared or used in the 2002–2003 Falls River water use planning process. The format of the document is as indicated, either bound paper or as digital files.

Pre-Reading Packages and Meeting Notes

Pre-reading packages include materials distributed to the Consultative Committee or the Fish and Wildlife Technical Committee in preparation for upcoming meetings. Meeting notes summarize presentations, discussions and agreements at Falls River Water Use Plan Consultative Committee and Subcommittee Meetings. In most cases, draft meeting notes were circulated for review followed by notes marked "final". In other cases, any amendments to the previous meeting notes were recorded in the meeting notes for the following meeting. Meeting notes were distributed as digital files with attachments where applicable.

Committee or Subcommittee	Meeting Number	Date	Digital File Names for Pre-Reading Packages and Meeting Notes
Consultative Committee (CC)	CC #1	2–3 October 2002	FLS WUP – CC #1 – Pre-Reading.zip FLS WUP – CC #1 – Minutes.zip
Fish and Wildlife Technical Subcommittee (FWTC)	FWTC #1	4 December 2002	FLS WUP – FWTC #1 – Pre-Reading.zip FLS WUP – FWTC #1 – Minutes.zip
Fish and Wildlife Subcommittee	FWTC #2	7 January 2003	FLS WUP – FWTC #2 – Pre-Reading.zip FLS WUP – FWTC #2 – Minutes.zip
Fish and Wildlife Subcommittee	FWTC #3	4 February 2003	FLS WUP – FWTC #3 – Pre-Reading.zip FLS WUP – FWTC #3 – Minutes.zip
Consultative Committee	CC #2	11–12 February 2003	FLS WUP – CC #2 – Pre-Reading.zip FLS WUP – CC #2 – Minutes.zip
Fish and Wildlife Subcommittee	FWTC #4	15 April 2003	FLS WUP – FWTC #4 – Pre-Reading.zip FLS WUP – FWTC #4 – Minutes.zip
Consultative Committee	CC #3 (final)	21–22 May 2003	FLS WUP – CC #3 – Pre-Reading.zip FLS WUP – CC #3 – Minutes.zip

Falls River Water Use Plan – BC Hydro Interim Reports

These reports are in digital formats.

BC Hydro. (2002). *Issues Identification Report: Falls River Water Use Plan.* September 2002. Submitted to the Comptroller of Water Rights.

BC Hydro: (2002). *Proposed Consultation Process Report: Falls River Water Use Plan.* October 2002. Submitted to the Comptroller of Water Rights.

Reports, literature reviews, and memos generated during the Falls River water use planning process

These reports exist in various forms, either as bound publications or in digital MS-Word or Adobe Acrobat PDF form.

Lewis, Adam. (2002a*). Falls River Water Use Planning: Information and Quick Reference Sheets*. Prepared by Ecofish Research Ltd. For BC Hydro, 26 November 2002. 5p. Digital MS-Word "Falls River Info Sheets v4.doc"

Moody, Anne. (2003). *Falls River Water Use Plan: Vegetation Commentary for the Big River Reservoir.* Prepared by AIM Ecological Consultants Ltd. For BC Hydro, April 2003. 13p. Digital Adobe Acrobat "Big Falls Reservoir – Vegetation Assessment.pdf" or MS-Word "Falls River – Vegetation Assessment – April 2003.doc".

MWA Consultants. August 2001. *Characterization of Greenhouse Gas (GHG) Emissions Related to water use planning at BC Hydro Hydroelectric facilities.* Consultant's report prepared for Water Use Planning (WUP) Interagency Management Committee (MC) and Resource Valuation Advisory Team (RVAT).

APPENDIX D: INFORMATION SHEET ON POWER GENERATION PERFORMANCE MEASURES

What is the performance measure for power generation at Falls River?

The performance measure for power generation at the Falls River hydroelectric project is average annual revenue. This is the total financial value (revenue) that the province would receive from the generation of the Falls River hydroelectric plant on an annual basis under each proposed operating alternative.

For what locations and timing is this performance measure relevant?

This performance measure is measured for the Falls River hydroelectric project on an annual basis.

Why is it important?

The Falls River hydroelectric project is part of BC Hydro's provincial integrated generation system. The value of energy produced at the project changes depending on the time of day, week and year based on peaks in demand. The flexibility to start and stop operations to take advantage of these changing values is important to BC Hydro since it allows them to maximize the value of energy produced at the project.

How does it affect the objective?

The power objective for the Falls River Water Use Plan is to maximize the value of power produced. This performance measure provides a direct indicator of the impact on the financial value of power from the project under each proposed operating alternative on the financial value of the project.

How can it be affected by operational changes?

The Annual Revenue performance measure will show higher scores under operating scenarios that: 1) maximize the amount of water available for power generation on an annual basis; and 2) maximize the flexibility of operation (ability to stop and start to take advantage of changes in the market value of energy).

What are the key assumptions and uncertainties associated with the impact that this performance measure addresses?

The key assumption is that a change in operation at the Falls River project is not expected to have an impact on the overall BC Hydro system.

The key uncertainty is the ongoing change in the price (value) of electricity. For the purpose of comparing different operating alternatives during the Falls River Water Use Plan consultative process, the same set of Value of Energy (VOE) values was applied for all alternatives evaluated.

How is this performance measure calculated?

Since the market price of electricity varies hourly, daily and seasonally, the value of electricity varies with the amount generated, the timing of generation, and the flexibility of the plant.

BC Hydro values the power produced by a generation facility using the methodology developed in the Value of Electricity (VOE) Report. The VOE Report provides long term time-of-generation energy values/prices with adjustments to reflect plant flexibility and transmission losses[1]. The VOE Report contains commercially sensitive information and is confidential. However, use of this methodology was reviewed and accepted by the Water Use Planning Inter-Agency Management Committee.

To calculate the value of electricity, the model output for each operating alternative that is modelled to include the daily generation associated with the alternative. This is then converted to an annual average revenue performance measure value using the Value of Energy (VOE) methodology. As noted above in the discussion of uncertainties, the same set of Value of Energy (VOE) values was applied for all alternatives evaluated to allow for fair comparison.

Is there adequate information available to calculate this performance measure?

Calculating this performance measure requires two key sets of data associated with each proposed operating alternative:

- daily turbine discharge, measured in cubic metres per second (m^3/s)
- corresponding daily generation, measured in megawatt-hours (MWh).

Both sets of data are available.

References

BC Hydro. (1999). *1999 Value of Electricity Report: Price Forecast and Valuation Methodology for Wholesale Electricity in B.C.* Confidential internal document produced by Doug A. Robinson, Resource Management, BC Hydro. October 1999 with price forecast updates in August 2000, January 2001, August 2001, March 2002.

[1] In the case of the Falls River project, transmission losses are minimal because the site is located adjacent to the load centre.

APPENDIX E: INFORMATION SHEET ON RESERVOIR WILDLIFE PERFORMANCE MEASURES

There were three performance measures developed by the Falls River Water Use Plan Consultative Committee to assess the impact of various operating alternatives on key wildlife objectives. These are:

- Shoreline Habitat Performance Measure for nesting and denning wildlife using the shoreline area around the reservoir.
- Sedge Community Maintenance Performance Measure for the riparian wildlife habitat around the reservoir.
- Water Level Stability Performance Measure for wildlife using the reservoir.

Each of these performance measures is described in greater detail in the following pages, starting below.

SHORELINE HABITAT PERFORMANCE MEASURE

What is this performance measure?

The Shoreline Habitat performance measure calculates the area available for nesting and denning over the growing season, measured in hectare-days. Habitats must be stable (dry) over a consecutive 30-day period to provide nesting and denning value.

For what locations and timing is this performance measure relevant?

The Shoreline Habitat performance measure applies to the area of potential wildlife nesting and denning habitat surrounding the Big Falls Reservoir at elevations between 90.3 metres and 92.4 metres (drawdown zone). It is calculated over the growing season, from 1 April to 31 October.

Why is this measure important? How can it be affected by operational changes?

Shoreline nesting birds or denning animals could be impacted by reservoir level fluctuations occurring at key life stages. In particular, the Committee was concerned about the potential for stranding or flooding of both nests and dens in the drawdown zone. A more stable reservoir could promote the productivity of nesting and denning wildlife using the area.

The relationship between habitat area and reservoir elevations in Big Falls Reservoir is summarized in the following area-elevation graph Figure E-1 used in the calculation of the Shoreline Habitat performance measure.

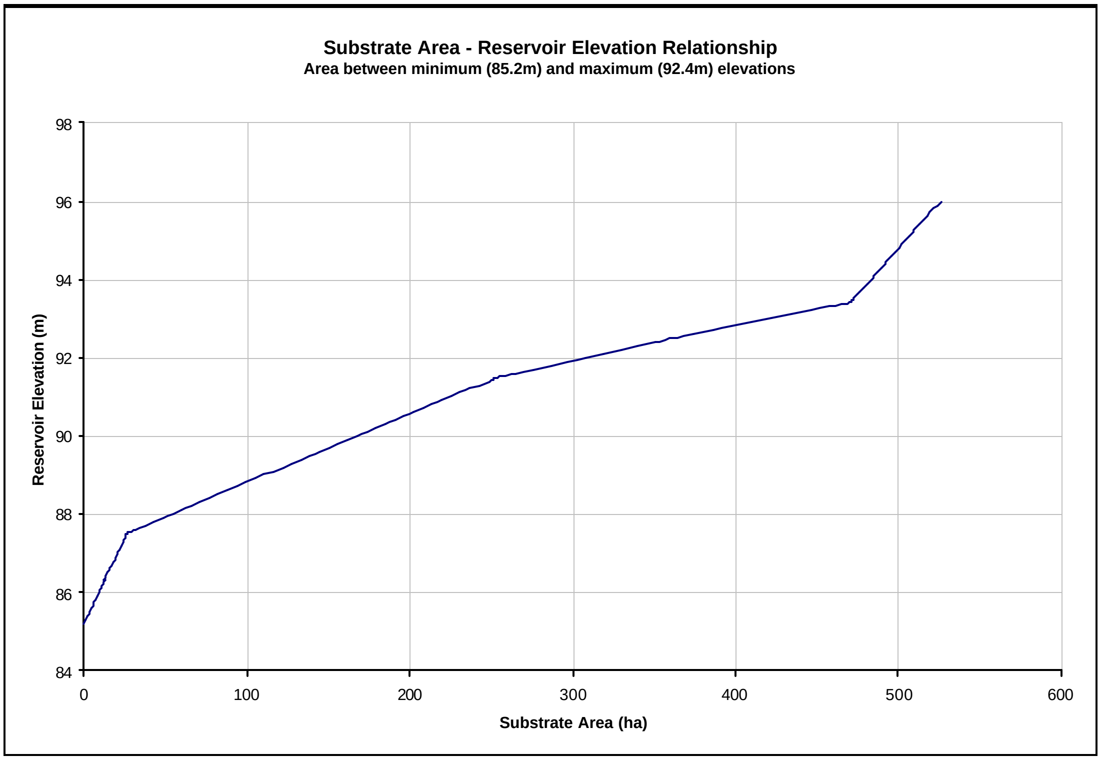

Figure E-1: Relationship between wildlife habitat area (substrate area) and elevation for the Big Falls Reservoir

How does this performance measure relate to the Committee's objectives?

One of the Falls River Water Use Plan Consultative Committee's fundamental objectives in developing operating alternatives was to *maximize the abundance and diversity of wildlife using the area around the Big Falls Reservoir*. The Committee also developed a more specific objective to *minimize stranding and/or flooding of bird nests and wildlife dens in the drawdown zone of reservoir*.

How is the Shoreline Habitat performance measure calculated?

The minimum dry area within the drawdown zone available over each 30-day period is the area of stable nesting and denning habitat. Each day in the growing season is assessed (minus 30 days), and the average is summarized for each year. The 10^{th} percentile, median (50^{th} percentile), and 90^{th} percentile values over the range of yearly averages are tabulated for each alternative using the formula:

$$NA_j = \min_{x=j \to j+30}(A_x)$$

where NA_j is the nesting/denning area and A_x is the area within the drawdown zone.

What are the key assumptions and uncertainties associated with the impact of reservoir operations on shoreline habitat?

The Falls River Water Use Plan Fish and Wildlife Technical Subcommittee (FWTC) identified several key assumptions associated with the Shoreline Habitat performance measure for wildlife, related to the suitability and extent of the habitat:

- <u>Suitability of habitat</u>: It is assumed that in order to provide suitable habitat for nesting or denning, an area must remain dry for a period of at least 30 consecutive days. This is based on work in the Campbell River WUP where a 40-day threshold period was assumed necessary for young-of-the-year to reach a mobile stage, and not require a next or den for immediate survival). In the absence of such detailed information for wildlife in the Big Falls Reservoir, this assumption was assumed to apply there as well.
- <u>Extent of potentially suitable habitat</u>: An aspect of the performance measure calculation for the Campbell River Water Use Plan (which was used to develop the Shoreline Habitat performance measure for the Falls River Water Use Plan) was the integration of two factors: 1) the suitability of a given habitat type for reproduction related activities; and 2) timing of habitat use. Such detailed information is not available for the Big Falls Reservoir and so this aspect of the original performance measure was ignored. Instead, it is assumed that all habitats between 90.3 metres and 92.4 metres are equal in quality and comprise the extent of useable habitats for nesting and denning.

Is there adequate information available to calculate this performance measure?

The assumptions described above limit the confidence in the model, but the data are adequate for the purpose of this performance measure. The only data required for its calculation are the expected daily reservoir elevation in Big Falls Reservoir and the relationship between reservoir elevation and area.

The Consultative Committee was informed of the limitations of the input data before using Shoreline Habitat performance measure results to make recommendations on operating alternatives.

References

None.

SEDGE COMMUNITY MAINTENANCE PERFORMANCE MEASURE

What is this performance measure?

The Sedge Community Maintenance performance measure calculates the area of sedge habitat in the drawdown zone that is maintained and not colonized and succeeded by shrubs or trees. Habitats must be inundated for at least 28 days to ensure the sedge grass vegetation is not colonized by shrubs or trees.

For what locations and timing is this performance measure relevant?

The Sedge Community Maintenance performance measure applies to the drawdown zone of the Big Falls Reservoir at elevations between 90.3 metres and 92.4 metres and is calculated over the growing season, from 1 April to 31 October. The existing sedge community lies between these two elevations.

Why is this measure important? How can it be affected by operational changes?

The sedge grass community in and around the drawdown zone of the Big Falls Reservoir provides valuable riparian habitat for birds and wildlife is closely linked to aquatic habitats and likely increases reservoir productivity. Based on our current understanding of the sedge community, it appears that the annual inundation of the area under historical operations has maintained this habitat. The sedge community is maintained by annual flooding that prevents succession by killing off flood-intolerant shrubs and trees that could succeed if the habitat were to remain dry year-round.

The relationship between potential sedge grass habitat area and reservoir elevations in Big Falls Reservoir is summarized in the area-elevation graph (Figure E-2) used in the calculation of the Sedge Community Maintenance performance measure.

How does this performance measure relate to the Committee's objectives?

One of the Falls River Water Use Plan Consultative Committee's fundamental objectives in developing operating alternatives was to *maximize the abundance and diversity of wildlife using the area around the Big Falls Reservoir*. The Committee also developed a more specific sub-objective to *maximize riparian (sedge) habitat for wildlife using the drawdown zone*.

How is the Sedge Community Maintenance performance measure calculated?

This is the amount of area that has been inundated for a minimum of 28 days during the growing season. The total area above 85.2 metres that is inundated for a minimum of 28 days is summarized for each year. The 10th percentile, 50th percentile (median), and 90th percentile values are tabulated for each operating alternative over the range of yearly areas using the formula:

$$CA_{yr} = \sum_{z=85.2}^{92.4} A_{z*}, \quad \text{where} \quad A_{z*} = \min(\underset{x=j}{\overset{j+28}{A_z}} \le A_x)$$

where CA_{yr} is the community area yearly value, A_{z*} si the area inundate for at least 28 days over the growing period, and A_z is the area at any elevation z.

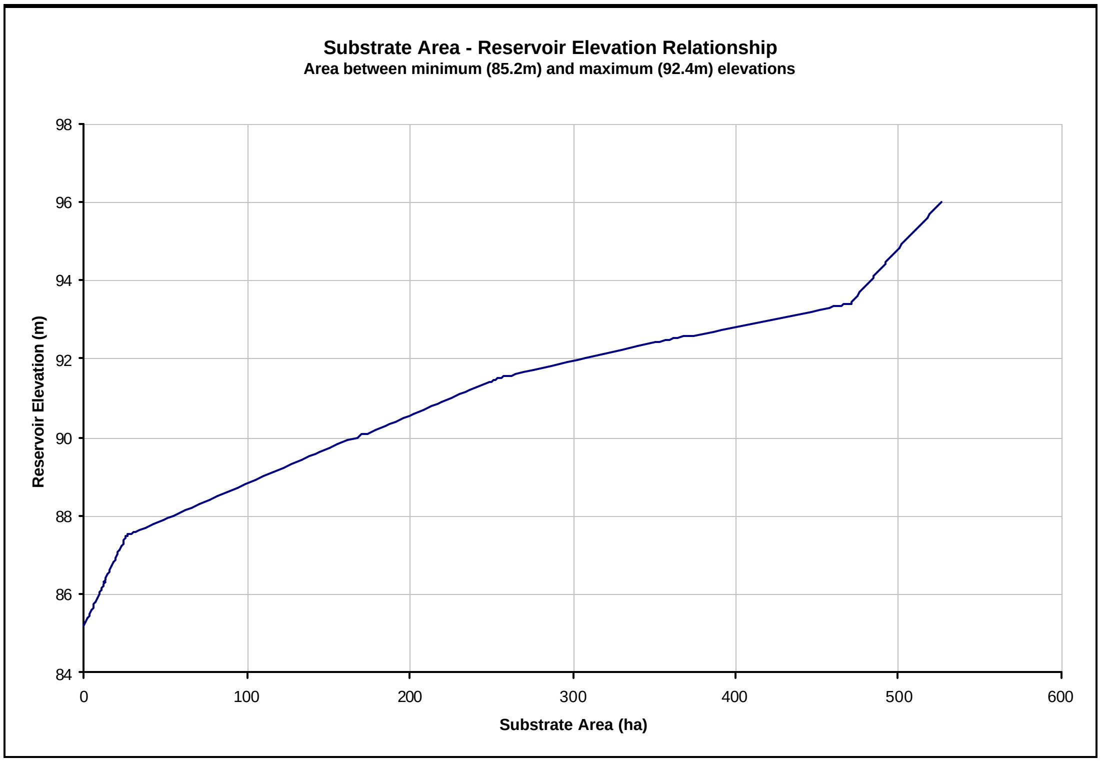

Figure E-2: Relationship between sedge habitat area (substrate area) and elevation for the Big Falls Reservoir

What are the key assumptions and uncertainties associated with the impact of reservoir operations on shoreline habitat?

The Falls River Water Use Plan Fish and Wildlife Technical Subcommittee (FWTC) identified one key set of assumptions associated with the Sedge Community Maintenance performance measure:

- Minimum Flooding Requirements: Based on present understanding of the Big Falls Reservoir, it is assumed the band of sedge vegetation in the drawdown zone between 90.3 metres and 92.4 metres of elevation is maintained by the annual flooding that kills trees and other species not tolerant of periodic inundation. The exact elevation, timing, duration and frequency of flooding necessary to maintain the existing structure of the shoreline community are unknown. For the purpose of the Falls River Water Use Plan consultative process, it was assumed that an annual inundation lasting at least four weeks (28 days) in the spring (between February and May) would prevent succession and maintain the sedge habitat.

A vegetation assessment (Moody, 2003) commissioned by the Falls River Water Use Plan Consultative Committee concluded that there is insufficient information available to make any assumptions about the elevation, timing, duration and frequency of flooding required for maintenance. However this performance measure was still used by the Consultative Committee because it accurately represents the best available information on how operations influence sedge community persistence. The performance measure allowed the Consultative Committee to evaluation how much different operating alternatives deviated from the current regime, and therefore evaluate the potential response of the sedge community.

Is there adequate information available to calculate this performance measure?

The only data required for its calculation are the expected daily reservoir elevation in Big Falls Reservoir and the relationship between reservoir elevation and area. Both are available. As noted, the assumptions described above limit the confidence in the model, but the data are adequate for the purpose of this performance measure.

The Consultative Committee was informed of the limitations of the input data before using Sedge Community Maintenance performance measure results to make recommendations on operating alternatives.

References

Moody, Anne. (2003). *Falls River Water Use Plan: Vegetation Commentary for the Big River Reservoir.* Prepared by AIM Ecological Consultants Ltd. for BC Hydro, April 2003.

WATER LEVEL STABILITY

What is this performance measure?

The Water Level Stability performance measure provides an index of reservoir stability over the growing season. Standard deviation is a common measure of variation that was used to calculate this index, described on a scale from 0 to 1.

For what location and timing is this performance measure relevant?

This performance measure is measured for the Big Falls Reservoir from 1 April to 31 October.

Why is it important? How can this performance measure be affected by operational changes?

This performance measure complements the Shoreline Habitat performance measure (which measures how much of the shoreline stays dry), in that it measures how constant the water level remains. The Water Level Stability performance measure is based on the assumption that more stable water levels during the growing season increase survival and foraging success for wildlife and birds that use shoreline habitats.

How does this performance measure affect the Committee's objectives?

One of the Falls River Water Use Plan Consultative Committee's fundamental objectives in developing operating alternatives was to *maximize the abundance and diversity of wildlife using the area around the Big Falls Reservoir*. This performance measure relates to that larger objective, as well as to the specific sub-objective *to minimize the stranding and inundation of wildlife nests and dens around the drawdown zone*.

How is this performance measure calculated?

The Water Level Stability index is simply the standard deviation of reservoir elevations over the growing season (1 April to 31 October).

What are the key assumptions and uncertainties associated with the impact this performance addresses?

The only assumption associated with the Water Level Stability is the postulated link with wildlife productivity. While stability is known to be beneficial to littoral productivity, there are no studies conducted under the Water Use Planning program that formally link a decrease in reservoir level fluctuations with an increase in survival and foraging success for wildlife and birds that use shoreline habitats.

Is there adequate available information to calculate this performance measure?

The only data required for its calculation are the expected daily reservoir elevation in Big Falls Reservoir, and is available. As noted, the assumptions described above limit the confidence in the model, but the data are adequate for the purpose of this performance measure.

The Consultative Committee was informed of the limitations of the input data before using Sedge Community Maintenance performance measure results to make recommendations on operating alternatives.

References

None.

APPENDIX F: CORRESPONDENCE BETWEEN FIRST NATIONS AND BC HYDRO REGARDING THE DRAFT FALLS RIVER WATER USE PLAN CONSULTATIVE COMMITTEE REPORT

On 23 July 2003 the Allied Tsimshian Tribes Association (ATTA) and the Lax Kw'alaams representatives sent a letter to the BC Hydro Project Team as a record of their comments on the draft Falls River Water Use Plan Consultative Committee Report.

The letter is included here in its entirety, starting on the next page. Note that specific references to pages may have changed between the draft and final version of the report, but that references to specific sections still apply.

BC Hydro's letter of response (18 August 2003) is also included later in this appendix.

Allied Tsimshian Tribes Association

8 Munroe Street
Lax Kw' alaams, BC, V0V 1H0
Ph: (250) 625-3297 Fax: (250) 625-3376
E-mail: atta@citytel.net

July 23, 2003

To: Kristann Boudreau

Facilitator: Falls River Water Use Plan

We the Allied Tsimshian Tribes and the Lax Kw'alaams Band Consultative Committee members have reviewed the Falls River Water Use Plan Draft Report and have the following concerns.

Our biggest concern was the mercury content and testing of fish and wildlife within the Big Falls River reservoir and below the dam.

We would like to have the mercury testing done twice a year for our peace of mind and safety. Testing should be done in the spring time when there is a big water urn off and in the fall time there is also a big run off.

The survey done in June of 2003 for chinook salmon states the chinook are not longer spawning in this are as they once have done, this has a reflection on the other salmon species as the cohoe, pinks and chum salmon in this area.

We recommend that a similar study be done on these other salmon species as was done on the Chinook, we have the same concerns as stated on page 33, section 4.4.2, page 35 paragraph 2, page 36 section 4.5.1 paragraph 5.

On page 36 section 4.5 Cultural and Traditional Use by Allied Tsimshian Tribes and Lax Kw'alaams band members, will continue in Big Falls River area asserting our Aboriginal Rights and Title within our traditional territory.

After first year of study in lower Falls River area, we cannot agree with consultative committee's report until more studies are done on all species of salmon within the Big Falls River area starting from last week in August to first week in October.

We required definite statement if salmon are spawning in area of the dam or not.

This area should be monitored in early spring time for survival of salmon, then can we be able to determine what the water level should be so that the salmon can survive.

Only then can we agree that the proper Water Use Plan be implemented.

We further request that the Falls River salmon species have some programs or partnerships to restore river to historical levels of salmon, as it once had before the dam was installed. This is vital to all fish and wildlife in the Falls River and area.

Signed by:

Eugene Bryant	Lax Kw'alaams Band Council Representative
James Bryant	Allied Tsimshian Tribes, Representative
Laurie Ryan	Allied Tsimshian Tribes, Alternate

Signatures dated: July 23, 2003

Councillor Eugene Bryant
Lax Kw'alaams Band
206 Shashaak Street
Lax Kw'alaams, BC

18 August 2003

James Bryant, President
& Laurie Ryan
Allied Tsimshian Tribes Association
8 Munroe Street
Lax Kw'alaams, BC V0V 1H0

Dear James, Eugene and Laurie:

Re: Comments on *Draft* Falls River Water Use Plan Committee Report

Thank you for taking the time to review and comment on the *Draft Falls River Water Use Plan Consultative Committee Report* and for getting your comments to Kristann Boudreau in the requested timeframe. We recognize your community is involved in many important processes and we appreciate that you set other items aside to document your issues and concerns regarding the Falls River project.

Your letter dated 23 July 2003 documents a number of concerns that have been raised during the Falls River Water Use Plan (WUP) process. In some cases, these issues have been dealt with in part, while others you note require the collection of information over time through the monitoring program to answer your questions and meet your objectives to restore salmon populations. I would like to take this opportunity to respond to the points you have raised and propose ways in which they may be addressed.

<u>Mercury Testing</u>

During the Falls River Water Use Planning process, you expressed concern regarding the potential for the occurrence of mercury in Big Falls Reservoir. You noted signs posted in an adjacent watershed had raised questions regarding the safety of Big Falls Reservoir and articulated how important it is to your communities to have peace of mind when using the Big Falls Reservoir for traditional hunting and fishing activities.

In response to your concerns, BC Hydro conducted testing of fish in the reservoir in the fall of 2002 and the results of the tests were presented to the Falls River Water Use Plan Committee on 11 February 2003. As you will recall, Randy Baker, an internationally respected expert on mercury, reviewed the results of laboratory tests for mercury in 5 cutthroat trout caught in Big Falls Reservoir. The results of the testing indicated that there were very low levels of mercury in the fish tested – between 0.02 and 0.05 parts per million (ppm) or ten times less than the guidelines for human consumption of 0.5 ppm which are set jointly by Agriculture Canada and Health Canada. Given these concentrations, he indicated that a person could eat 10–15 meals a week of fish from Big Falls Reservoir for the rest of their life and remain safe.

Mr Baker also conducted a thorough review of data collected over the last 30 years on mercury levels in natural and manmade lakes (reservoirs) throughout the province. In the review of this data, he found that the levels of mercury in Big Falls Reservoir were some of the lowest levels found in the province, even lower than that occurring in some natural lakes. He also indicated that mercury levels in manmade lakes (reservoirs) typically rise after first impoundment but then begin to decline returning to pre-flood concentrations after 20 to 30 years. The Big Falls Reservoir is over 70 years old and, in Mr Baker's professional opinion, the annual drawdowns and fluctuations in inflows and reservoir levels – even during heavy storm events – will not cause noticeable increases in mercury levels in fish.

Regarding further sampling, Mr Baker indicated that no additional sampling of cutthroat trout is required, however, it may be beneficial to test Dolly Varden because as predators they are more likely to accumulate mercury. That said, he did not expect levels to exceed Health Canada standards base on the very low levels found in cutthroat trout and indicated that the testing would be done to set peoples' minds at ease regarding the consumption of these fish.

Based on the expert advice from Randy Baker, BC Hydro believes there is no need to conduct on-going mercury testing in Big Falls Reservoir as you propose. BC Hydro acknowledges that mercury continues to be a primary concern for your community. We also appreciate that you may have a different interpretation of the test results and on the amount of additional testing required. With regard to your concerns about mercury, BC Hydro is committed to:

- <u>Additional Testing</u>: BC Hydro will have a Dolly Varden (bulltrout) from the reservoir tested for mercury content whenever one can be caught. That could be the next time that BC Hydro, Fisheries and Oceans Canada or provincial field staff are in the area conducting other monitoring.
- <u>Providing expert advice to your community</u>: BC Hydro is willing to bring Randy Baker, to your community to review the results of the past mercury testing and to discuss existing knowledge about mercury levels in the reservoir. *Please let us know if you would like to accept this offer.*

<u>Monitoring Salmon in the Falls River Downstream of the Dam</u>

In your letter you recommend that a monitoring study be conducted to find out if salmon species such as coho, pink, chum and chinook spawn in the Falls River tailrace pond below the dam, and if so, at what times of the year. You indicate these studies should be conducted in the early spring, as well as, from the end of August to the beginning of October.

This recommendation is already part of the monitoring program that is being put forward to the Comptroller of Water Rights as part of the *Falls River Draft Water Use Plan*. As you will note, the monitoring Study #1 outlined in the *Falls River Water Use Plan*

Consultative Committee Report recommends that the Falls River tailrace pond be sampled from April 1 to April 30 and then again from August 15 to October 31 for up to five years.

When the Water Use Plan is reviewed by the Comptroller of Water Rights, and revised orders and licences for the project are issued under the *Water Act*, the recommended monitoring studies will be finalized and implemented. While this may not occur in time for studies to be implemented in fall 2003, your support for this work demonstrates the value of collecting more information on these species and their use of the area.

In the interim, BC Hydro recently funded a Chinook Spawner Survey in June and forwarded the results of this survey to you. While we agree with your recommendation to do more surveys and recognize additional survey work is required, we will be waiting for direction from the Comptroller of Water Rights before undertaking further studies. It should also be noted that work being done under the Bridge Coastal Fish and Wildlife Restoration Program (BCRP) discussed below may also provide additional information on salmon downstream of the dam.

Aboriginal Rights and Title

BC Hydro acknowledges your assertion of your Aboriginal Rights and Title within your traditional territory and that the members of the Allied Tsimshian Tribes Association and Lax Kw'alaams Band will continue their cultural and traditional use in the Big Falls area. Your comment about this will be added to the appropriate section of the report (Section 4.5) as requested.

Programs or Partnerships to Restore Salmon to Historic Levels

BC Hydro acknowledges your request that programs or partnerships be put in place to restore salmon to historic (pre-dam) levels. This has not been addressed under the Water Use Planning program, but it can be addressed under BC Hydro's Bridge Coastal Fish and Wildlife Restoration Program (BCRP). The BCRP program funds projects to restore fish and wildlife populations and habitat in watersheds impacted by the construction of hydroelectric generation facilities in BC Hydro's Bridge River/Coastal Generation Area. The Falls River project falls within this area.

To date, BC Hydro has supported the following studies that may lead to programs and partnerships in the future to restore salmon populations in Falls River:

- Seed funding through BCRP for Fisheries and Oceans Canada to develop a proposal for habitat restoration in the Falls River tailrace pond below the dam.
- Additional funding to Fisheries and Oceans Canada to conduct a Chinook Egg Incubation Study this summer.

In fall 2003, Fisheries and Oceans Canada and its partners (Ministry of Water Land and Air Protection, Tsimshian Tribal Council, and the Community Fisheries Development Center) are planning to submit a proposal to the BCRP for a salmon restoration project at Falls River. For more details, contact the project co-ordinator, Lana Miller by phone at 250-627-3441.

The BCRP Management Board who will decide whether to approve this proposal consists of nine members; three First Nations members, three members of the public, and three agency members (one from each of Fisheries and Oceans Canada, Province of BC, and BC Hydro). For more details, see BCRP's website: http://www.bchydro.com/bcrp/.

The Management Board will review proposals and make a decision about whether to fund this specific project. If it is approved, it could start in the spring of 2004.

Public Record

Your letter of 23 July 2003 raises important concerns related to fish, wildlife and your traditional use in the Falls River area. As a result, we believe it is important that your letter become part of the public record. Accordingly, we will be including a copy of it as an Appendix in the final *Falls River Water Use Plan Consultative Committee Report*, along with a copy of this letter that documents BC Hydro's response.

Next Steps

BC Hydro looks forward to working with your community on addressing your concerns regarding mercury and to your response on the proposed actions.

We also see the work that will be done under the Water Use Plan monitoring program as a positive way for BC Hydro, First Nations, and regulatory agencies to collect information over time on salmon so that we can make more informed decisions in the future.

Thank you again for taking the time to provide us with your comments on the draft *Falls River Water Use Plan Consultative Committee Report*. BC Hydro appreciates the positive contribution you have made to the Water Use Planning process and wishes to assure you that we value and will continue to build on our positive relationship with the community. Please contact Alison Willoughby 604-623-3814 to discuss any questions you have concerning the proposed actions.

Yours truly,

Vesta Filipchuk,

Project Manager
Falls River Water Use Plan

cc: Lana Miller – Fisheries and Oceans Canada
Steve Macfarlane – Fisheries and Oceans Canada
Jim Mattison – Comptroller of Water Rights
Terry Molstad – Area Manager, Bridge Coastal, BC Hydro
Alison Willoughby – Aboriginal Relations, BC Hydro
Kristann Boudreau – Facilitator, BC Hydro

APPENDIX G: INFORMATION SHEET ON FISH PERFORMANCE MEASURES

PERFORMANCE MEASURES FOR RIVER FISH

There were three performance measures developed by the Falls River Water Use Plan Consultative Committee to assess the impact of various operating alternatives on key objectives for river fish. They are:

- Effective Spawning Habitat Performance Measure for river spawning habitat that is not de-watered over the spawning and incubation periods for various fish species.
- Effective Summer Rearing Habitat Performance Measure for river rearing habitat that remains stable for greater than five days during the summer rearing season for various fish species.
- Effective Winter Rearing Habitat Performance Measure for river rearing habitat that remains stable for greater than five days during the winter rearing season for various fish species.

Each of these performance measures is described in greater detail in the following pages.

PERFORMANCE MEASURES FOR RESERVOIR FISH

There were four performance measures developed by the Falls River Water Use Plan Consultative Committee to assess the impact of various operating alternatives on key objectives for reservoir fish. These are:

- Effective Littoral Habitat Performance Measure for the aquatic organisms in the littoral zone, which is the nearshore habitat of the reservoir that remains productive over the growing season. These organisms are an important food source for fish.
- Tributary Spawning Habitat Lost Performance Measure for the area of tributary spawning habit in the drawdown zone that may be affected by reservoir operations (i.e., backwatered during spawning and/or incubation).
- Tributary Access Performance Measure for fish that migrate up the tributaries in Big Falls Reservoir to spawn.
- Sediment Exposure and Velocity Index Performance Measure for the reservoir at low elevations when erosion and sedimentation can have negative impacts on fish and other aquatic organisms.

Each of these performance measures is described in greater detail in the following pages.

RIVER FISH PERFORMANCE MEASURES: SPAWNING HABITAT, SUMMER REARING HABITAT, WINTER REARING HABITAT

What is the performance measure?

All three of these performance measures measure the area of suitable habitat available for various species of fish in the Falls River at key life stages:

- Spawning: Effective spawning habitat is the area of river spawning habitat in Falls River between the dam and the confluence with the Ecstall River that may be influenced by project operations. River spawning habitat is only effective if minimum incubation requirements of 0.05 metres of water depth and 0.02 m^3/s velocity are met from the day of spawning until the end of incubation. There are two related values that can be produced for this performance measure: effective spawning habitat and effective spawning habitat lost. The former describes the habitat that is available for spawning and does not get de-watered. The latter is the habitat available for spawning but subsequently de-watered such that spawning success is considered marginal.
- Rearing: Effective rearing habitat is the minimum area of rearing habitat provided over a five-day period. This is the amount of time hypothesized to be adequate for rearing activity (Cheakamus Water Use Plan, 2001).

For what locations and species timing is the performance measure relevant?

The Spawning Habitat and Rearing Habitat performance measures are calculated for the Falls River mainstem, between the dam and the confluence with the Ecstall River (see Figure G-1). This short stretch of the Falls River is approximately 400 metres in length and is referred to as the "tailrace". At the confluence, the Ecstall River is tidally influenced with water levels rising greater than three metres above normal elevations at very high tides. Recognizing the magnitude of this tidal influence, all performance measures were developed assuming low or zero (0) tide conditions, when discharges from the Falls River dam would have the greatest influence on velocity and depth downstream of the project.

- Spawning: There are three species of interest for spawning in the tailrace: chum, coho and chinook salmon. Their life histories are summarized in Figure G-2.
- Rearing: There are three species of interest for winter and summer rearing in the tailrace: chinook, coho and Dolly Varden (bull trout). It is assumed that chinook fry will smolt after one year of residence, although many populations will typically smolt 60 or 90 days after emergence in the spring. Life history information for Dolly Varden was assumed to apply to bull trout. The periodicity for the three species of fish is summarized in Figure G-2.

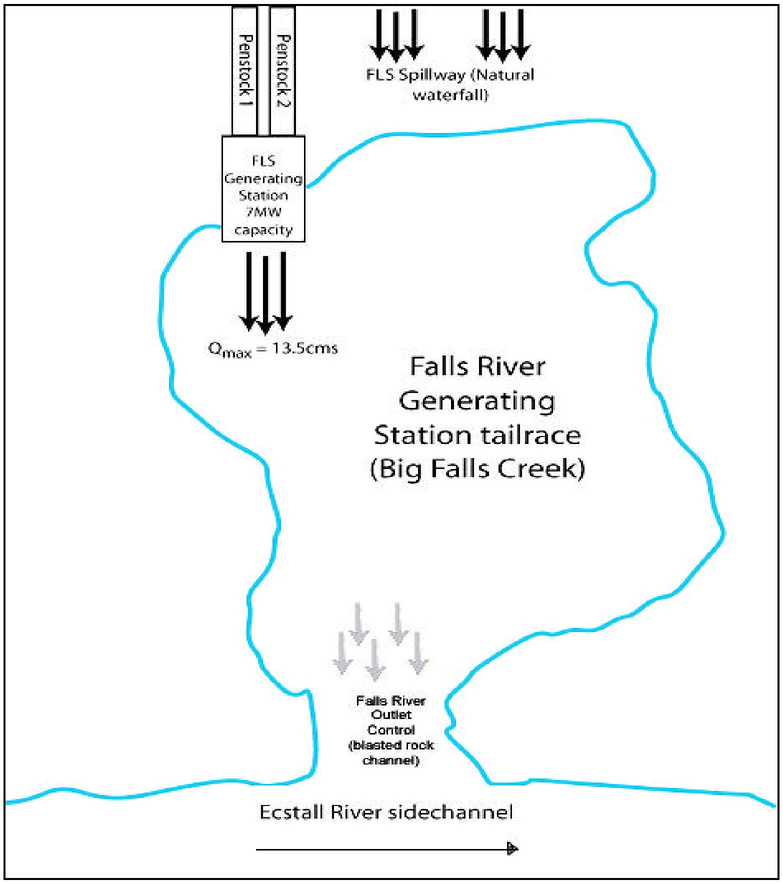

Figure G-1: Schematic of Falls River between the dam and the confluence with the Ecstall River

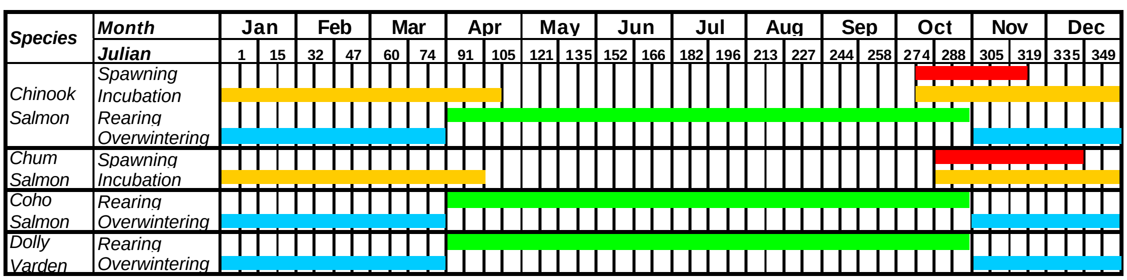

Figure G-2: Summary of life histories for chinook, chum and coho salmon, and Dolly Varden

Why are these performance measures important? How can they be affected by operational changes?

These spawning and rearing habitat performance measures assume a linkage between habitat and flows, and imply a relationship between habitat and productivity. Providing effective spawning and rearing habitat through flow management will likely increase productivity. For each of the species whose life histories the Falls River Water Use Plan Fish and Wildlife Technical Subcommittee (FWTC) selected as indicators for the system, a flow-habitat relationship was developed using River-2D hydraulic modelling. The depth-average model was set for the zero tide condition and integrated habitat suitability indices (HSI) data for each species. The performance measure "looks up" the flow-habitat relationship each day of the life history and a habitat area is derived directly from the flow for that day of a particular alternatives. These flow-habitat relationships are shown graphically below (Figure G-3 to Figure G-7).

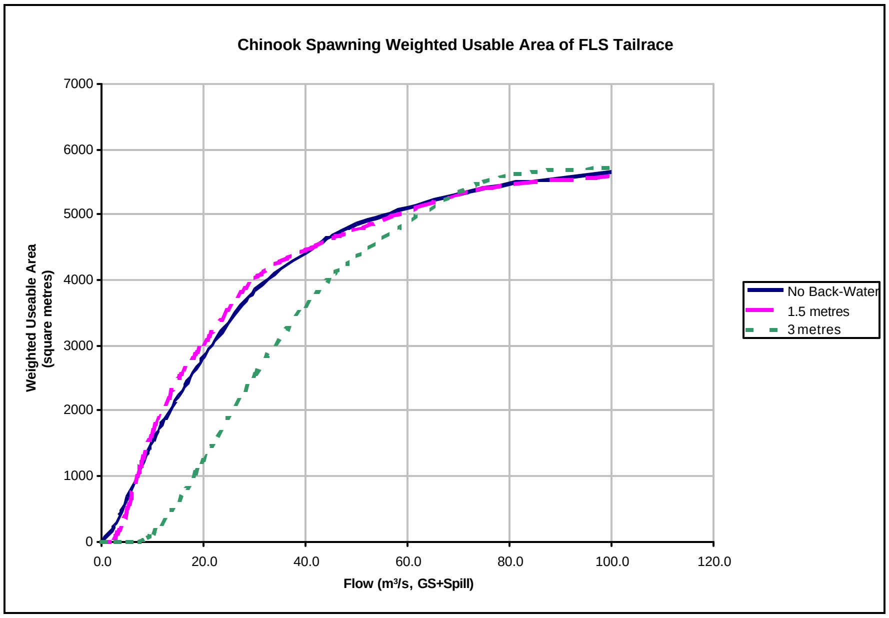

Figure G-3: Relationship between river flow and suitable spawning habitat for chinook salmon in Falls River

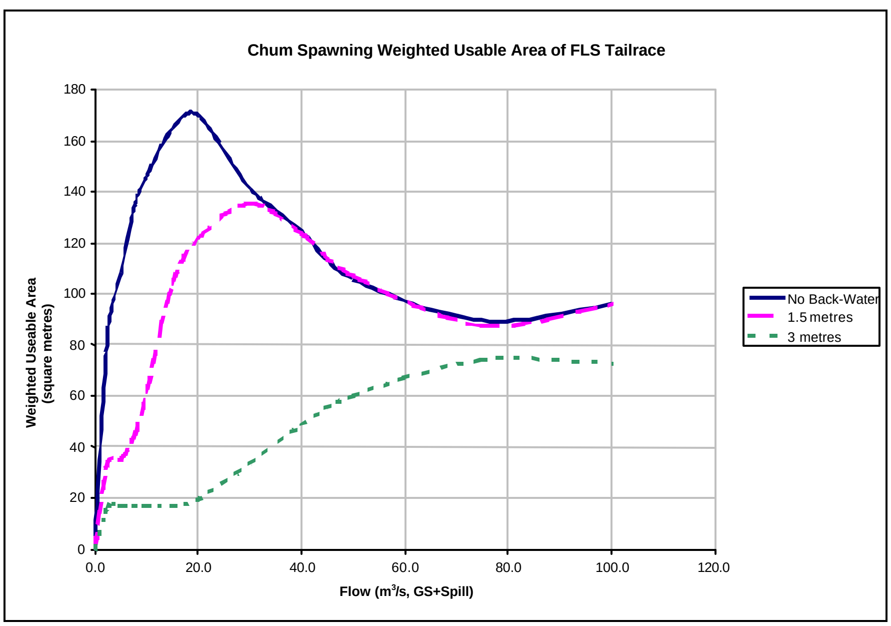

Figure G-4: Relationship between river flow and suitable spawning habitat for chum salmon in Falls River

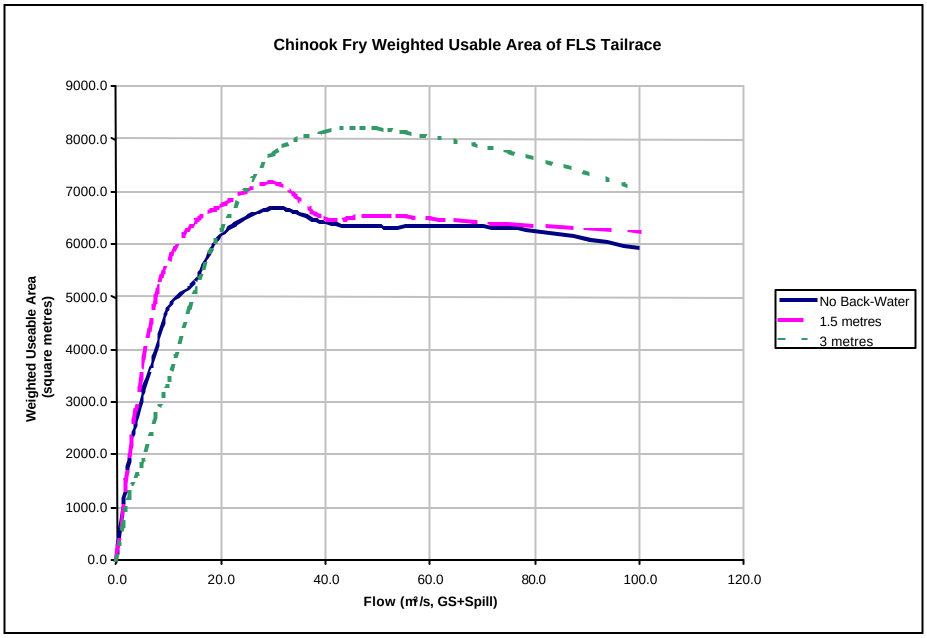

Figure G-5: Relationship between river flow and suitable rearing habitat for chinook salmon in Falls River

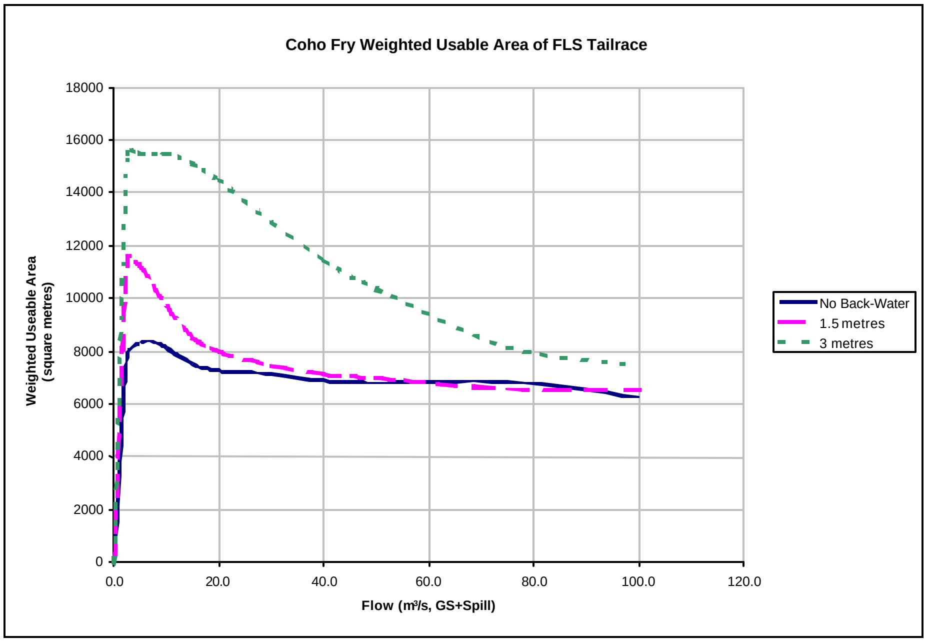

Figure G-6: Relationship between river flow and suitable rearing habitat for coho salmon in Falls River

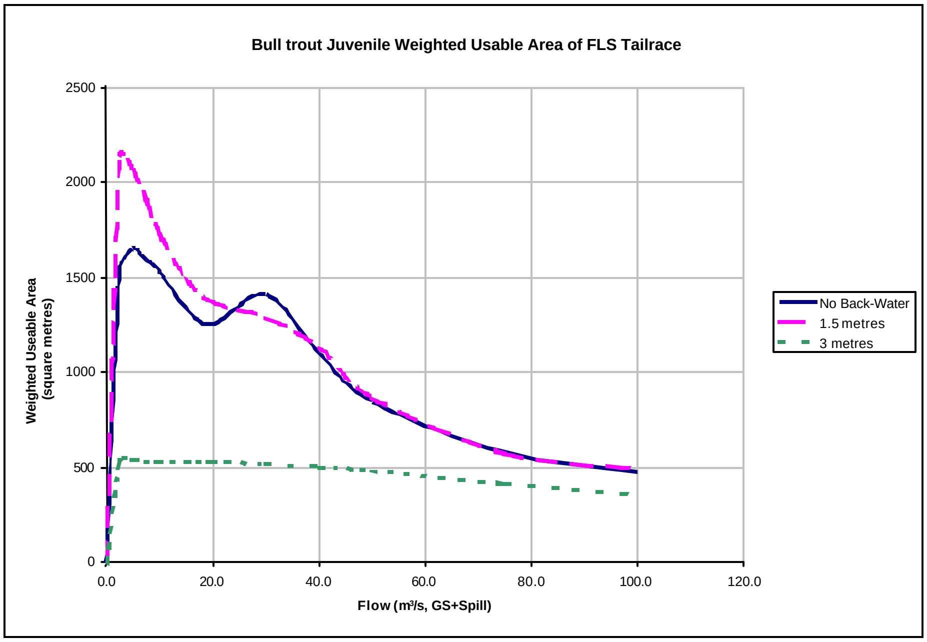

Figure G-7: Relationshipbetween river flow and suitable rearing habitat for Dolly Varden/bull trout in Falls River

How do the spawning and rearing habitat performance measures affect the Committee's river fish objectives?

One the Falls River Water Use Plan Consultative Committee's key objectives was to *maximize the abundance and diversity of fish in the Falls River*. The Committee developed two sub-objectives aimed at factors affecting fish productivity: *optimize flows for fish at all life stages (spawning, incubation, rearing and migration)* and *maximize quantity and quality of habitat*. Accordingly, effective spawning and rearing habitat are key indicators of fish productivity.

Also, spawning and rearing fish using the Falls River system can represent stocks unique to the larger Skeena River system to which it belongs. Ensuring there is habitat available for those salmonids can help maintain overall diversity of the system while enhancing the productivity of the Falls River system.

How is the performance measure calculated?

- Spawning: The performance measure calculates the available area of spawning within the tailrace on each day of spawning. From that day until the end of incubation, the minimum habitat available over that period is the effective spawning area.

  Once this metric is calculated for each day of spawning, the average over the entire spawning period is summarized for each year. The 10th percentile, 50th percentile (median), and 90th percentile values over the range of yearly averages is tabulated for each alternative. The formula used in the calculations is:

$$ESH_j = \min_{x=j \rightarrow e_{inc}}(ASH_x)$$

where *ESH* and *ASH* are effective and available respectively. E_{inc} is the date for the end of the incubation period.

- Rearing: Similarly for rearing, the effective rearing habitat is the minimum available habitat over a five-day period. The minimum habitat (effective) and the daily habitat (available) are related in the following formula:

$$ERH_j = \min_{x=j-4 \rightarrow j}(ARH_x)$$

where *ERH* and *ARH* are effective rearing habitat and available rearing habitats respectively.

What are the key assumptions and uncertainties associated with the impact the spawning and rearing habitat performance measures address?

The performance measure is dependent on the following key assumptions:

- Habitat area: The field information used to calibrate the River 2D was collected during a short field survey between 22 and 24 October 2002. During that period, habitat geometry and substrate composition was collected. Further analysis shows this survey likely underestimated the gravel resources in the tailrace and the modelling was revised to include more substrate. The modelling has very little flow calibration and can only be considered preliminary at this point. Further instream flow measurements are required to adequately calibrate the model.
- Species periodicity: The life history data used to develop these performance measures is based on references from Fisheries and Oceans Canada (SED; Lana Miller, pers. comm.). There have been no recent surveys to identify habitat use or timing on this part of the system. Opportunistic sampling has shown use by all indicator species.
- Tidal effects: The Falls River Water Use Plan Fish and Wildlife Technical Subcommittee opted to ignore the effects of tide on habitat immediately downstream of Falls River Generating Station. This was based on the premise that the habitat conditions would be selected based on the low (zero) tide base case. No habitat use studies have been conducted to determine actual use of habitats during tidal backwatering.
- Habitat suitability criteria: Habitat Suitability Index (HSI) data were incorporated from other coastal Water Use Plans and have not been tested locally. Data[2] were

[2] Data collected from: Golder (1993), Ministry of Environment Lands and Parks (MELP) BC IFIM Database, Griffiths (1995) and MELP (2001).

integrated into the decision making with the consent of the Falls River Water Use Plan Fish and Wildlife Technical Subcommittee.

Is there adequate information available to calculate these performance measures?

Calculation of the spawning and rearing habitat performance measures requires the following data:

- Information on depth, velocity and substrate in the Falls River tailrace. This information must be collected at two or more flow stages to calibrate the River 2D hydraulic model.
- Information on the suitability of various habitats for specific fish species at the spawning, summer rearing and over-wintering life stages.
- Information on the life histories (periodicity) of the fish species of concern.

All of these data are available, and their sources are discussed in the above section on “assumption and uncertainties”. Those assumptions limit the confidence in the results of the River 2D model, and the Consultative Committee was informed of the limitations of the input data before using the performance measure results to develop recommendations about operating alternatives.

References

Baxter, J.S. and J.D. McPhail. (1996). *Bull trout spawning and rearing habitat requirements: Summary of the literature.* Fisheries Technical Circular No. 98. Prepared for Province of British Columbia, Victoria, BC.

CMS WUP, (2001). *Cheakamus Water Use Plan performance measure information sheets (Round 5).* Prepared for BC Hydro Water Use Plans project, Burnaby, BC.

Griffiths, R.P., (1995). *Probability of use curves – Dolly Varden and bull trout (unpublished memo).* Prepared for B.C. Environment, Victoria, BC.

Golder, (1993). *Bull trout juvenile and spawning habitat preference criteria, Smith-Dorrien Creek, Alberta.* Prepared for Alberta Environmental Protection, Fish and Wildlife Division, Edmonton, AB.

MELP, (2001). *Habitat suitability criteria for coastal salmonids (unpublished memo).* Prepared for BC Hydro Water Use Planning Project, Burnaby, BC.

Miller, Lana, (2002). Personal email communication. Sent: February 6, 2003 9:41 AM. Subject: Spawn Timing in Falls River.

SED. *Salmonid Escapement Database: Ecstall River and Falls River historic information.* Taken from FishWizard at http://pisces.env.gov.bc.ca/

EFFECTIVE LITTORAL HABITAT PERFORMANCE MEASURE

What is this performance measure?

The Effective Littoral Habitat performance measure (also known as the Effective Littoral Zone or ELZ) calculates the nearshore habitat of the reservoir that remains productive over the growing season. Requirements are that the substrate area stay in the photic zone (the zone that receives light) and wetted at least as long as the initial establishment period.

For what locations and timing is this performance measure relevant?

The Effective Littoral Habitat performance measure applies to the littoral zone in the Big Falls Reservoir for the growing season from 1 April to 31 October.

Why is this performance measure important? How can it be affected by operational changes?

The littoral zone of a reservoir can be a productive, multi-trophic community, sustained by light penetration, stable water levels, substrate and soil adhesion, a degree of mixing and nutrient flux. Reservoir management may include altering reservoir elevations for storage and generation purposes, limiting the productive capacity of the littoral zone.

The effective littoral zone performance measure takes into consideration changes in reservoir elevations, and ties in known relationships between operations and productivity, such that littoral functions can be modelled for a variety of operating scenarios.

Stable operations optimize the performance measure results through the establishment of initial growth, and a stable habitat to maximize growth once established. Because littoral area is a function of bathymetry, and the littoral zone is bounded between the water surface elevation and photic depth (depth of effective light penetration), littoral area can may vary with water surface elevation, and may be optimized at a specific elevation. Choosing alternatives where water surface elevation is stabilized and remains near the optimal elevation stabilizing operations will increase the performance measures results. Figure G-8 illustrates the littoral relationship with reservoir elevation.

How does this performance measure affect the Committee's objectives for reservoir fish?

One of the Falls River Water Use Plan Consultative Committee's fundamental objectives is to *maximize the abundance and diversity of fish in Big Falls Reservoir*. Given the importance of littoral productivity as a food source for fish, the Committee developed a sub-objective to *maximize the quantity and quality of littoral habitat*. All operating alternatives that score high for this Effective Littoral Habitat performance measure will have a positive effect on the productive capacity of the littoral system.

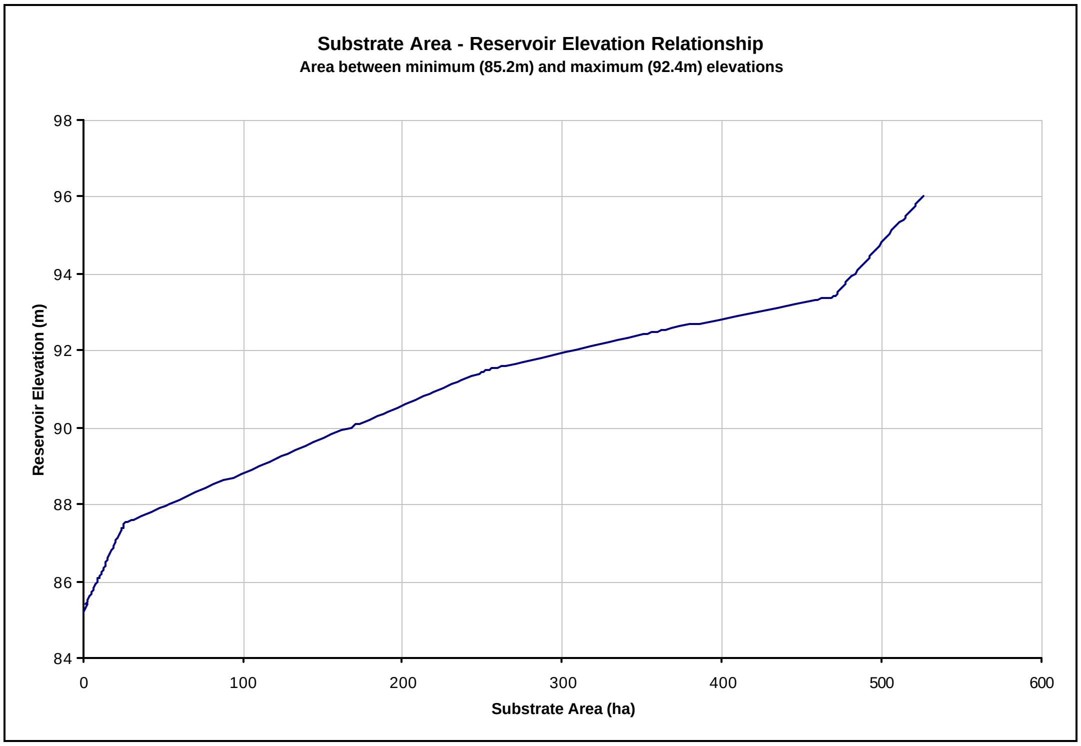

Figure G-8: Relationship between the potential area of littoral habitat (substrate area) and the elevation in Big Falls Reservoir

How is the Effective Littoral Habitat performance measure calculated?

For any given day, d_n, a daily value for Effective Littoral Habitat is calculated by following four steps:

1. Noting the reservoir elevation of that day (this is the upper boundary of the effective littoral zone).

2. Calculating the lower boundary of the effective littoral zone by subtracting the depth of effective light penetration.

3. Determining the incremental area submerged within the effective littoral zone derived from the lookup values summarized in Figure G-9.

4. Tabulating the consecutive days each increment of area (elevation band) is submerged.

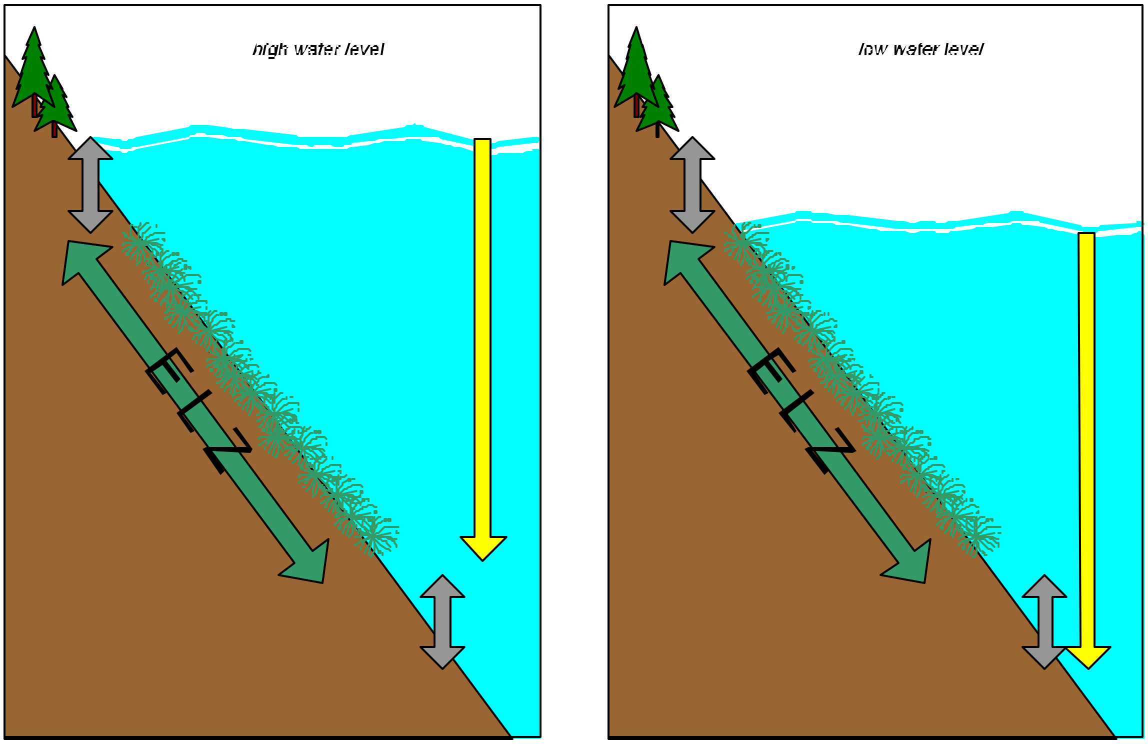

Figure G-9: Diagram showing how the extent of the effective littoral zone changes as reservoir elevation (and therefore, the depth of light penetration) changes.

What are the key assumptions and uncertainties associated with the impact that the Effective Littoral Habitat performance measure addresses?

There are several sets of assumptions and uncertainties associated with this performance measure and they are summarized in Table G-1 below.

Table G-1: Summary of assumptions and uncertainties associated with the Effective Littoral Habitat performance measure

Assumption	Uncertainty
Positive correlation between duration of inundation and littoral productivity.	Strength of correlation and shape of functional relationship is poorly understood. This is a key uncertainty. Greater understanding may change the weight given to the Effective Littoral Zone criterion and consequently influence the ranking of alternatives. Sensitivity analysis may help to reveal the effect of this uncertainty on final ranking of options.
Positive correlation between Effective Littoral Zone and ecosystem productivity.	Strength of correlation and shape of functional relationship is poorly understood. Studies elsewhere indicate that coupling between littoral and pelagic production may be strong (Hecky and Hesslein 1995), but this remains unquantified for BC lakes and reservoirs.
Other factors that may be critical to a productive littoral zone (e.g., temperature, pressure etc.) can be safely ignored.	There is a risk that the Effective Littoral Zone performance measure may not capture the true dynamics of littoral zone productivity. Other environmental factors may be limiting production and expected benefits arising from the Effective Littoral Zone measure may not be realized. This is particularly important if the performance measure will be used in an adaptive management experiment.

Table G-1: Summary of assumptions and uncertainties associated with the Effective Littoral Habitat performance measure (cont'd)

Assumption	Uncertainty
Colonization and productive benefits of littoral zone are not realized until elevation band is effective for a minimum 60-day duration.	The model assumes that growth rates are constant, and in an effort to offset this assumption, a 60-day establishment period was required before the productive benefits are documented in the measure.
Definition of euphotic zone is straightforward.	Alternative definitions of the euphotic zone (area penetrated by light) may change the depth of the littoral zone and consequently the absolute value of the Effective Littoral Zone. The effect on selection of operating alternatives may be small since it will not change the relative impact of different alternatives.
The appropriate time step for Effective Littoral Zone calculations is yearly.	The present calculations allow the Effective Littoral Zone to wander from year to year. This assumes that there is no benefit to having the Effective Littoral Zone in the same location each year. The cost/benefit difference between a stable Effective Littoral Zone and a wandering Effective Littoral Zone is not known.

Is there adequate information available to calculate this performance measure?

There are three kinds of information required to calculate this performance measure, all of which are available:

1. BC Hydro's storage curve for the Big Falls Reservoir (see Figure G-10).

2. Digitized bathymetry of the reservoir from Larratt (1983) (see Figure G-13).

3. Average daily elevation of the reservoir.

The relationship between reservoir area and elevation has been calculated by digitizing integrating the information from the digitized bathymetric map with area estimates from the BC Hydro storage curve. Surface area changes fairly linearly with surface area elevation (m) between 88 metres and 93 metres (see Figure G-8).

The assumptions and uncertainties outlined in Table G-1 limit the confidence in the performance measure results. The Consultative Committee was informed of these limitations before using the results to develop recommendations on operating alternatives.

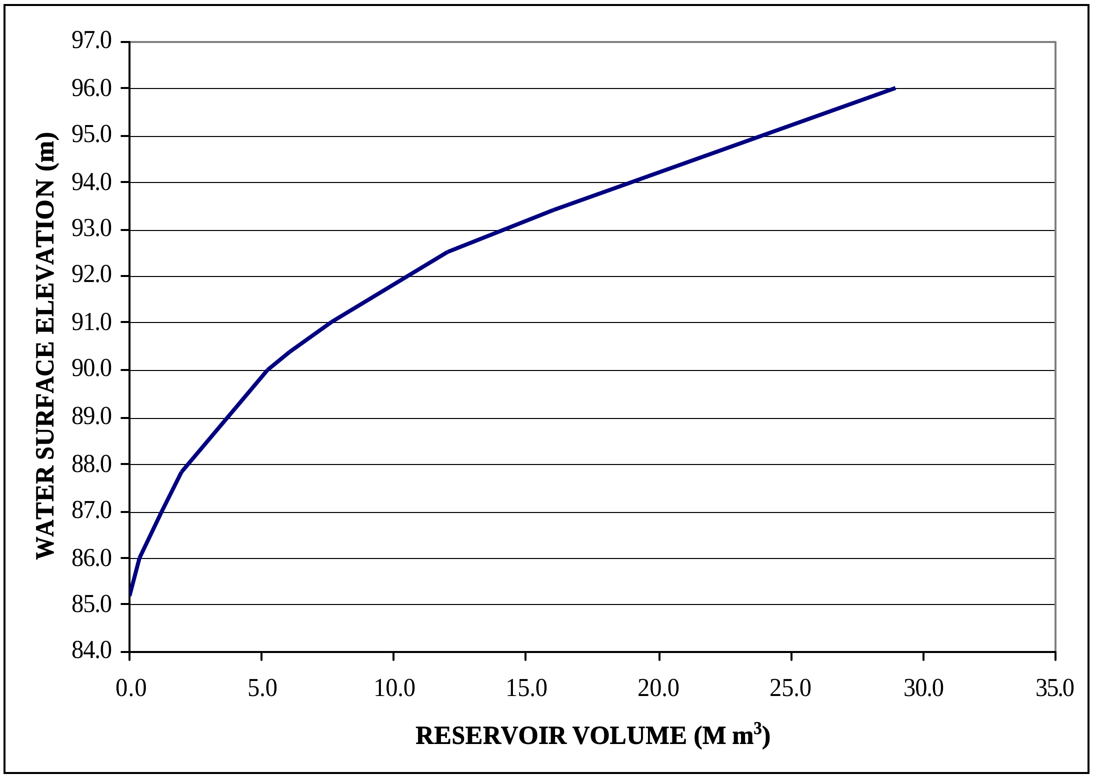

Figure G-10: BC Hydro storage curve for Big Falls Reservoir

References

Bruce, J. (1999). *Effective Littoral Zone summary report*. BC Hydro WUP report.

Hecky, R. E. and R. H. Hesslein. (1995). *Contributions of benthic algae to lake food webs as revealed by stable isotope analysis*. Journal of the North American Benthological Society 14: 631–653.

TRIBUTARY SPAWNING HABITAT LOST PERFORMANCE MEASURE

What is this performance measure?

The Tributary Spawning Habitat Lost performance measure is the area of tributary spawning habitat in the drawdown zone that is potentially affected by reservoir operations. Spawning habitat is only effective if it is not inundated over the spawning and incubation period. This performance measure is the area of spawning habitat that is available during the spawning period, and is subsequently inundated at some point later in the spawning period or during the incubation period.

For what locations, species and timing is this performance measure relevant?

This performance measure is calculated for tributary spawning habitat between elevations of 90.3 metres and 92.4 metres in the drawdown zone of the Big Falls Reservoir. The two species of interest are Dolly Varden and cutthroat trout. The species timing over which the performance measure is applied is summarized in Figure G-11 below. The information about species timing was provided by the Ministry of Water, Land and Air Protection (J. Lough, 2003).

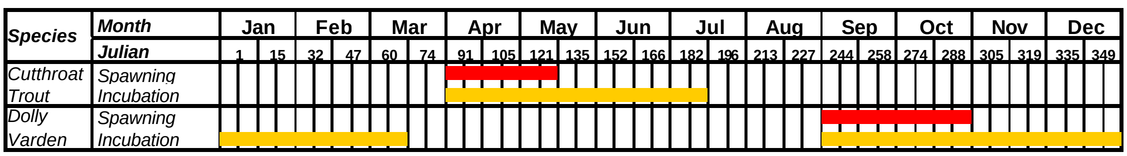

Figure G-11: Periodicity of spawning and incubation for Dolly Varden and cutthroat trout in Big Falls Reservoir

Why is this performance measure important?

Field tests (M. Lough, 2001) and other related studies have shown decreased spawning success for spawning areas that are inundated with standing water. Oxygen transfer and nutrient transport, as well as increased susceptibility to freezing, make reservoir inundation of spawning areas (redds) a negative impact.

How can it be affected by operational changes?

The area of tributary spawning in the drawdown zone was estimated by the Falls River Water Use Plan Fish Wildlife Technical Subcommittee (Lewis, 2002). This information was used to develop a functional relationship between elevation and area available (see Figure G-12). For the purposes of this performance measure it is assumed that at full pool there is no spawning habitat, as this is the limit that reservoir operations can have an impact.

There are several ways that reservoir operations can be altered to mitigate the risk of spawning habitat loss. The first is to limit the available spawning habitat and therefore reduce habitat losses due to operations. This is accomplished by holding the reservoir at full pool during spawning. The second is to keep reservoir operations stable during spawning and incubation, this will reduce habitat lost as well as make available habitat in the drawdown zone. If habitat is limiting, resource planners may wish to ensure operations make habitat available. If there is a large amount of habitat available above the drawdown zone, the strategy should be to keep spawners out of the drawdown zone.

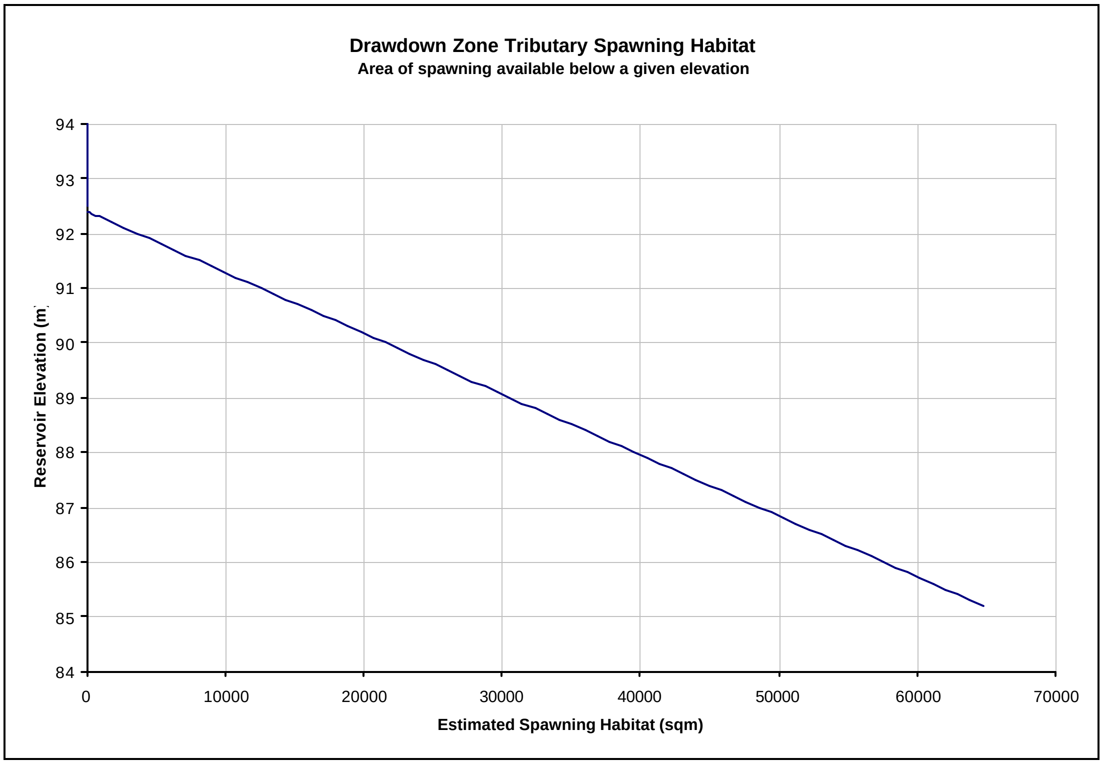

Figure G-12: Relationship between reservoir elevation and the area of potential tributary spawning habitat in the drawdown zone of Big Falls Reservoir

How does this performance measure relate to the Committee's objectives?

One of the Falls River Water Use Plan Consultative Committee's fundamental objectives is to *maximize the abundance and diversity of fish in Big Falls Reservoir*. Since reproductive success is key to meeting this objective, a sub-objective was developed to *minimize back-watering of tributary spawning and incubation habitats in the drawdown zone.*

How is this performance measure calculated?

The PM calculates the available area of spawning within the drawdown zone on each day of spawning (area between the reservoir elevation and the full pool mark). From that day until the end of incubation, the minimum habitat available over that period is the "effective" spawning area. The difference between the available area (on the day of spawning) and the effective area is considered lost habitat.

Once these two metrics are calculated for each day of spawning, the average over the spawning period is summarized for each year. The 10^{th}, 90^{th} and median values over the range of yearly averages is tabulated for each alternative.

$$ESH_j = \min_{x=j \to e_{inc}}(ASH_x)$$

$$LSH_j = ASH_j - ESH_j$$

where *ESH*, *ASH*, and *LSH* are effective, available and lost habitats respectively. E_{inc} is the date for end of incubation.

What are the key assumptions and uncertainties associated with the impacts that the Tributary Spawning Habitat Lost performance measure addresses?

The performance measure is dependent on the following key assumptions:

- Spawning area: The field information is assumed, based on map reconnaissance and reservoir bathymetry. The quality of spawning habitat in the drawdown zone is therefore not known, resulting in a performance measure that is conservative.
- Species periodicity: provided by Jeff Lough (2003) from the Ministry of Water Land and Air Protection, based on BC and northern BC references (Baxter and McPhail, 1996) and local stream temperature assumptions.
- Inundation effects: This performance measure is based on the premise that spawning success is reduced by inundation. While a field test in the Campbell River watershed showed this to be the case (M. Lough, 2001), this may be a site specific issue that may not be applicable here. Therefore, this is a conservative approach.
- Spawning habitat use: while cutthroat may use gravels in the drawdown zone, it is considered unlikely that Dolly Varden utilize drawdown zone habitats. This is yet unconfirmed, and until field monitoring is completed, the assumption that Dolly Varden spawning is affected by operations is still valid.

Is there adequate information available to calculate this performance measure?

The assumptions noted above limit the confidence in the performance measure results. The Consultative Committee was informed of these limitations before using the results to develop any recommendations about operating alternatives.

References

Baxter, J.S. and J.D. McPhail. (1996). *Bull trout spawning and rearing habitat requirements: Summary of the literature.* Fisheries Technical Circular No. 98. Prepared for Province of British Columbia, Victoria, BC.

Lewis, Adam, (2002). *Information and quick reference sheets.* Prepared for Fall River Water Use Plan Consultative Committee. Burnaby, BC.

Lough, Jeff, (2003). Personal email communication. Sent: Thursday, April 17, 2003 3:56 PM. Subject: Spawning, hatching and emergence dates for Falls River Dv and Ct.

Lough, Mike. (2001). *Preliminary investigation of spawning success at Greenstone Creek.* Prepared for JHT Water Use Plan project, Burnaby, BC.

TRIBUTARY ACCESS PERFORMANCE MEASURE

What is this performance measure?

The Tributary Access performance measure is the number of days within the spawning period when the reservoir elevation remains equal to or greater than the assumed access threshold of 88.4 metres in elevation.

For what location, timing and fish species is this performance measure relevant?

The number of days represented by this performance measure will be summed over the spawning periods for two species of concern in the Big Falls Reservoir: 1 September to 31 October for Dolly Varden and 1 April to 15 May for cutthroat trout.

Why is this performance measure important? How can it be affected by operational changes?

Studies on reservoirs in British Columbia have shown that barriers to adult and juvenile migration may emerge during drawdown conditions.

How does this performance measure relate to the Committee's objectives?

One of the Falls River Water Use Plan Consultative Committee's fundamental objectives is to *maximize the abundance and diversity of fish in Big Falls Reservoir*. Given the importance of tributary access for migration and spawning, the Committee developed a sub-objective to *maximize tributary access for reservoir fish.* This performance measure provides a direct indicator of the impact of an operating alternative on this sub-objective.

How is the Tributary Access performance measure calculated?

This performance measure is calculated as the sum of the days during the spawning period for a particular fish species when the daily reservoir elevation is above 88.4 metres.

What are they key assumptions and uncertainties associated with the impacts this performance addresses?

The Falls River Water Use Plan Fish and Wildlife Technical Subcommittee made a number of assumptions in developing this performance measure:

- <u>Distribution of spawning</u>: The spawning and rearing habitats for fish resident in Big Falls reservoir are partly known from fish inventory studies in the watershed. However, the distribution of spawning is not understood throughout the system: it is unknown what portion of the spawning population uses the lower reaches of Big Falls Creek upstream of the reservoir, or in Unnamed and Carthew Creeks. For the purposes of this performance measure, it was assumed that all areas of tributary spawning and rearing habitat are used, and the distribution of this use is equal.

- Absence of barriers to access above 88.4 metres in elevation: Based on aerial photographs, the gradient of the tributary streams is low (0.5 to 1 per cent), suggesting that barriers will not be an issue.
- Presence of a barrier at 88.4 metres in elevation: There is some evidence from bathymetry of a drop of one metre at depths of four to five metres below full pool (92.4 metres in elevation), though it is not clear that this is a barrier (see Figure G-13 below). Observations of the reservoir during drawdown would be required to confirm any suspected barriers. For the purpose of this performance measure, it was assumed that there is a barrier to upstream migrating adults at 88.4 metres in elevation (four metres below the full pool elevation of the reservoir).

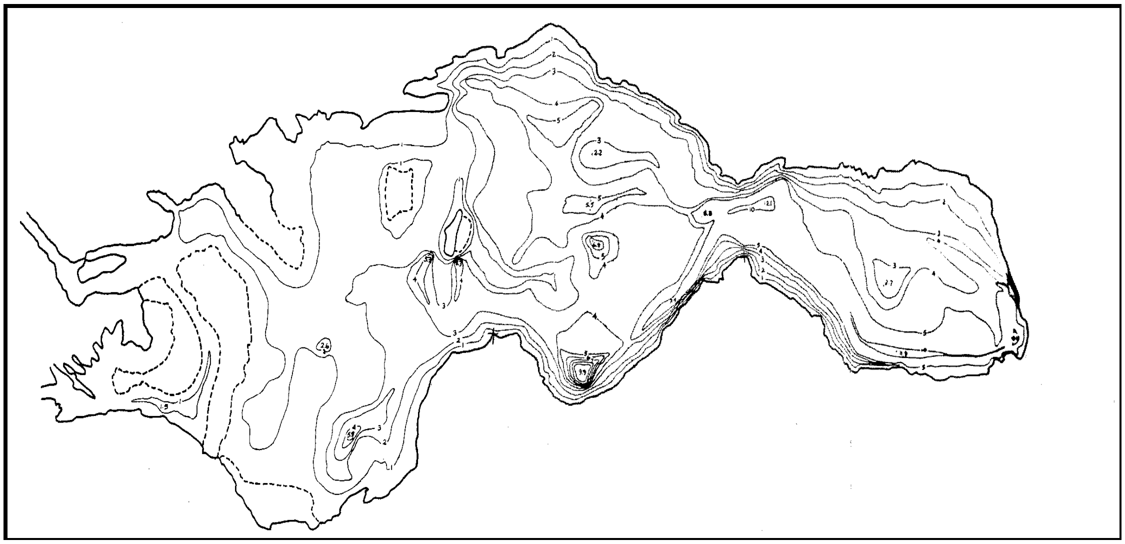

Figure G-13: Bathymetric map of Big Falls Reservoir taken from Larratt (1983)

Is there adequate information available to calculate this performance measure?

The only data required to calculate this performance measure are the daily reservoir elevation for Big Falls Reservoir, and this information can be simulated for 33 years of data under various operating alternatives.

The uncertainty about the validity of the key assumptions underlying this performance measure limits confidence in the results. The Consultative Committee was informed of these limitations before using the results to develop recommendations about operating alternatives.

References

H.M. Larratt Aquatic Consulting. (1983*). Impact of wood debris and standing trees on the productivity of Falls River Reservoir.* January 1983.

SEDIMENT EXPOSURE AND VELOCITY INDEX PERFORMANCE MEASURE

What is this performance measure?

The Sediment Exposure and Velocity Index performance measure calculates the amount of days over the year that the reservoir is below 90.3 metres in elevation. This is assumed to be the key threshold for erosion.

For what location and timing is this performance measure relevant?

This performance measure is calculated for the Big Falls Reservoir for the entire year.

Why is this performance measure important? How can it be affected by operational changes?

Eroded sediment contributes to the degradation of littoral fish habitat by interfering with light penetration. Operations may influence deposition and erosion by altering water velocity within the reservoir and the area of exposed sediment. The high rate of reservoir turnover and glacial silt input from tributaries suggests that operations cannot control erosion and deposition. However, rates of erosion will be higher at lower reservoir elevations because of the increased velocity in the reservoir and deposition will be less. Erosion and sedimentation are also of greatest concern during the growing season when turbidity caused by increased suspended sediment can reduce light penetration, lowering littoral productivity. All of these factors suggest that concerns for erosion and sedimentation are of greatest concern at lower reservoir levels during the growing season. Reducing the exposure of unvegetated areas will increase bank stability and water quality.

How does this performance measure relate to the Committee's objectives?

One of the Falls River Water Use Plan Consultative Committee's fundamental objectives is to *maximize the abundance and diversity of fish in Big Falls Reservoir*. Given the influence of sediment deposition on fish habitat, the Committee also developed a sub-objective to *minimize sediment deposition*.

How is the Sediment Exposure and Velocity Index performance measure calculated?

This performance measure is simply the number of days during the year that elevations below 90.3 metres in Big Falls Reservoir are exposed.

What are the key assumptions and uncertainties associated with the impact this performance measure addresses?

This performance measure is dependent on the validity of the assumptions that there are areas in the reservoir susceptible to erosion at lower elevations, and that threshold elevation for these impacts is 90.3 metres. There have been no field surveys undertaken to confirm this link between reservoir operations and erosion/sediment deposition, or the threshold elevation for impacts.

Is there adequate information available to calculate this performance measure?

The only data required to calculate this performance measure is the daily reservoir elevation for Big Falls Reservoir, and this information can be simulated for 33 years of data under various operating alternatives.

The uncertainty about the validity of the key assumptions underlying this performance measure limits confidence in the results. The Consultative Committee was informed of these limitations before using the results to develop recommendations about operating alternatives.

References

None.

APPENDIX H: INFORMATION SHEET ON GREENHOUSE GAS (GHG) EMISSIONS PERFORMANCE MEASURE

What is the performance measure for greenhouse gas (GHG) emissions at Falls River?

The performance measure is the expected change in greenhouse gas (GHG) emissions resulting from a change in hydroelectric generation at the Falls River project. The Reference Case alternative is used as the alternative for comparison with all other operating alternatives. A positive value for the Change in GHG Emissions performance measure indicates an increase in GHG emissions (a negative environmental impact), while a negative value indicates emissions reduction/savings (an environmental benefit).

For what locations and timing is this performance measure relevant?

This performance measure is measured for the Falls River hydroelectric project on an annual basis.

Why is it important? How can it be affected by operating changes?

The Falls River hydroelectric project is part of BC Hydro's provincial integrated generation system. This means that a decrease in generation at the Falls River project will need to be made up with other generation resources. Based on BC Hydro's current Integrated Electricity Plan or IEP (BC Hydro, 2000), these sources will include 10 per cent renewable and 90 per cent gas-fired generation, which leads to the emission of greenhouse gases (GHGs) such as carbon dioxide (CO_2) and methane (CH_4). On the other hand, any changes to operations that increase the amount of power produced at Falls River will avoid the need to use other resources (including gas-fired facilities), and therefore avoid emitting more GHGs (an environmental benefit).

How does it affect the objective?

The greenhouse gas emissions objective for the Falls River Water Use Plan is to minimize the provincial greenhouse gas (GHG) impacts of operations. Operating alternatives that maximize the amount of hydroelectric (non-GHG emitting) power generated at the project will perform best for this objective.

What are the key assumptions and uncertainties associated with the impact that this performance measure addresses?

Replacement power for average annual losses from the Falls River project is assumed to be the mix of new resources proposed in BC Hydro's most current Integrated Electricity Plan (BC Hydro, 2000). This plan states that new resources will be a combination of 90 per cent combined cycle gas turbine (CCGT) generation and 10 per cent green (renewable) power. The corresponding greenhouse gas emission intensity for the mixture of resources is 306 tonnes of carbon dioxide equivalent per gigawatt-hour (t CO_2e/GWh). If this performance measure is used again during a future review of the

Falls River Water Use Plan, this emission intensity factor should be revised based on the updated version of BC Hydro's Electricity Plan.

How is this performance measure calculated?

The standard unit for quantifying greenhouse gas (GHG) emissions is metric tonnes of carbon dioxide equivalent (abbreviated as t CO_2e). The term carbon dioxide equivalent is used to compare the different GHGs on a common basis. That is, some GHGs are more powerful than others in terms of their ability to trap heat in the atmosphere. In order to compare GHGs on a common basis they are typically converted to their CO_2e values by multiplying their mass by a factor referred to as "Global Warming Potential" or GWP. For example, one tonne of methane equals 21 tonnes of CO_2 equivalent. In the case of fossil fuel combustion, three greenhouse gases (CO_2, methane and nitrous oxide) are produced, with CO_2 comprising approximately 99 per cent of these emissions and methane and nitrous oxide contributing very small amounts (approximately 1 per cent).

To quantify the greenhouse gas (GHG) impacts of each operating alternative (Oper. Alt.) in terms of tonnes of carbon dioxide equivalent (t CO_2e), the change in power generation in gigawatt-hours (GWh) from the "Reference Case" (Ref. Case) alternative is multiplied by the GHG Emissions Intensity of the replacement power. The formula can be expressed as follows:

GHG impact (t CO_2e/year) = ($E_{REF.\ CASE} - E_{OPER.\ ALT.}$) x GHG Emission Inten. (306 t CO_2e/GWh)

$E_{REFERENCE\ CASE}$	=	Average annual energy generation under Reference Case conditions measured in GWh
$E_{OPERATING\ ALTERNATIVES}$	=	Average annual energy generation under the proposed operating alternative measured in GWh
GHG Emissions Intensity	=	Average GHG emissions released per GWh of replacement power (306 t CO_2e/GWh)

A positive change in GHG emissions value indicates an increase in GHG emissions (more environmental damage), while a negative value indicates emissions reduction/savings (an environmental benefit).

Is there adequate information available to calculate this performance measure?

Calculating this performance measure requires three pieces of data associated with each proposed operating alternative:

- Average annual energy generation under the Reference Case operating conditions, measured in gigawatt-hours (GWh).
- Average annual energy generation under the proposed operating alternative for comparison, also measured in gigawatt-hours (GWh).
- Average greenhouse gas emission intensity for replacement power, or average greenhouse gas emissions released for each gigawatt (GWh) of difference in the

amount of average annual energy generation between alternative, measured in tonnes of carbon dioxide equivalent per gigawatt-hour (t CO_2e/GWh).

All three sets of data are available.

References

BC Hydro. (2000). Integrated Electricity Plan: An Update to the 1995 IEP. January 2000. 40p.

MWA Consultants. August 2001. *Characterization of Greenhouse Gas (GHG) Emissions Related to water use planning at BC Hydro Hydroelectric facilities.* Consultant's report prepared for Water Use Planning (WUP) Interagency Management Committee (MC) and Resource Valuation Advisory Team (RVAT).

APPENDIX I: HYDROGRAPHS FOR FALLS RIVER WATER USE PLAN OPERATING ALTERNATIVES

There were 15 operating alternatives developed by the Falls River Water Use Plan (WUP) Consultative Committee with the help of the Project Team during the consultative process. These alternatives were compared by the Committee to see how different changes in operations would affect the interests at the table. This comparison was accomplished by looking at how the operating alternatives affected the values for the performance measures developed to reflect the Committee's multiple objectives for the Falls River Water Use Plan.

The operating alternatives considered by the Falls River Water Use Plan Consultative Committee are described in three ways in this appendix:

1. In terms of the objectives and interests they are designed to address (Table I-1).

2. In terms of the operating constraints used to model each one (Table I-2).

3. Finally, the alternatives are shown as graphs of water levels in the Big Falls Reservoir above the dam and in the Falls River below the facility (see graphs).

RATIONALE FOR OPERATING ALTERNATIVES

Each of the operating alternatives was designed with a specific objective or set of objectives in mind. Table I-1 helps to clarify the rationale for each alternative.

Table I-1: Rationale for Falls River Water Use Plan Operating Alternatives

#	Description of Alternative	Rationale: What objectives is this alternative designed to meet?
1	Reservoir Fish and Wildlife Friendly	Minimize backwatering of cutthroat and Dolly Varden eggs in reservoir drawdown zone during incubation. Maximize maintenance of sedge habitat around reservoir.
2	Fish and Wildlife Friendly with More Stable Reservoir	Same as for Alternative 1, plus, maximize reservoir shoreline habitat for wildlife (by targeting a narrower operating range).
3	No Flashboards	Same as for Alternative 1, but accomplished *without installing flashboards.*
4	Reference Case	Maximize power generation while mimicking existing/historic operating constraints but with new flashboard schedule.
5	Increased Minimum Flow for Fish in River	Optimize downstream flows for fish at all life stages (spawning, incubation, rearing). Maximize power generation.

Table I-1: Rationale for Falls River Water Use Plan Operating Alternatives (cont'd)

#	Description of Alternative	Rationale: What objectives is this alternative designed to meet?
6	Historic Operations	This alternative will show how BC Hydro operated in the past. While Water use planning is a forward-looking process, the Committee requested this alternative so they could see the impact of historic operations on PM values. It was modelled for comparison purposes only, and can not be considered for recommendation by the Committee since it includes the old flashboard schedule that no longer meets dam safety requirements.
7A	Improved Stable Reservoir	This alternative shares the same objectives as Alternative 7B, and also to maximize reservoir shoreline habitat for wildlife (by targeting a narrower operating range).
7B	Improved Fish and Wildlife Friendly	This alternative shares the same objectives as Alternative 1, but is designed to improve on it by: • Installing the flashboards earlier (15 March instead of 1 April) to try and get reservoir levels up before spring spawning begins in April. • Keeping the range of elevations during spring spawning (and flashboard installation) narrower to prevent backwatering during incubation. • Providing increased minimum Optimize downstream flows for fish at all life stages (spawning, incubation, rearing).
7C	Improved Stable Reservoir plus Falls Spawning	This alternative is based on 7A, but adds one operating constraint: a minimum discharge of 6.5 m^3/s from 1 August to 14 October to minimize impact of flow changes on fall spawning fish in the river.
7D	Improved Fish and Wildlife Friendly plus Fall Spawning	This alternative is based on 7B, but adds one operating constraint: a minimum discharge of 6.5 m^3/s from 1 August to 14 October to minimize impact of flow changes on fall spawning fish in the river.
8A	Flashboards Every 3 Years	This alternative is designed to see if most of the fish and wildlife objectives for Alternative 7B can be met if flashboards are only installed once every three years to maintain sedge habitat and if the reservoir is not altered for fall/winter spawning and rearing: In the one in three years when flashboards are installed, operations will be similar to those under Alternative 7B, except that this alternative does not include measures to avoid backwatering of Dolly Varden. In the two out three years when the flashboards are not installed, operations will be similar to those for Alternative 9A but with higher minimum flows for fish downstream, and it includes a target minimum elevation in the spring to minimize backwatering of cutthroat.
8B	Flashboards Every 3 Years plus Falls Spawning	This alternative is based on 8A but adds one additional operating constraint: a minimum discharge 6.5 m^3/s from 1 August to 14 October to minimize the impact of flow changes on fall spawning fish in the river.

Table I-1: Rationale for Falls River Water Use Plan Operating Alternatives (cont'd)

#	Description of Alternative	Rationale: What objectives is this alternative designed to meet?
9A	Revised Reference Case	This alternative shows how BC Hydro would operate in the future in the absence of any input from the Water Use Plan Consultative Committee. This is a revision of the original Reference Case (Alternative 4) based on the realisation that BC Hydro would not install the flashboards since it involves an annual installation cost for very little power benefit. This is the case that is intended to be used by the Comptroller of Water Rights for the purpose of calculating water rental remissions for BC Hydro under the water use planning program.
9B	Reference with No Maintenance Outage	This alternative is a variation on Alternative 9A, but without a scheduled maintenance outage in the month of March. This alternative was modelled to help isolate the cost and impacts of including a maintenance outage, and will allow for better comparison between Alternatives modelled with and without an outage (i.e., Alternatives 6–9 versus Alternatives 1–5).
10	Hybrid	This alternative is a "hybrid" or combination of Alternatives 7D and 8B. It was developed at the final meeting of the Consultative Committee during trade-off discussions as a way of trying to capture the benefits of two different alternatives. It is based on Alternative 7D, but does not include the operating constraints on the reservoir from September through March to try and prevent the backwatering of Dolly Varden (bull trout) tributary spawning habitat in the drawdown zone (like Alternative 8B).

OPERATING CONSTRAINTS FOR ALTERNATIVES

The Consultative Committee developed and evaluated a total of 16 operating alternatives (Table I-2). Each alternative was a combination of one or more constraints on operating the Falls River hydroelectric project to achieve a suite of water use objectives described in Section 4 earlier in this report. Each alternative specified up to eight constraints, including:

1. Timing of flashboard installation to maintain the sedge grass community around the reservoir (riparian habitat for wildlife).

2. Up to two desired fish flows in the Falls River, including minimum discharge requirements for the whole year and the fall salmonid spawning period from 1 August to 14 October.

3. Reservoir elevation level at which generation curtailment would start in order to ensure the provision of minimum discharges under low inflow conditions.

4. Up to four desired elevations for fish in the Big Falls Reservoir, including targets for spring spawning, spring incubation, fall spawning and fall incubation.

Note is also made of whether the alternatives were modelled with or without provision for a month-long maintenance period in March, as is the case for Alternatives 6 through 10 Alternatives, but not for Alternatives 1 through 5.

Table I-2: Specification of Operating Constraints for Falls River Water Use Plan Alternatives

	ALTERNATIVES 1	2	3	4	5	6	7A	7B	7C	7D	8A	8B	9A	9B	10
OPERATING CONSTRAINTS FOR RIVER OBJECTIVES															
Minimum discharge - year round	1.3 m^3/s	1.3 m^3/s	1.3 m^3/s	1.3 m^3/s	2.6 m^3/s	1.3 m^3/s	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m	1.3 m^3/s	1.3 m^3/s	2.6 m^3/s above 88.4 m 1.3 m^3/s below 88.4 m
Generation curtailment* starts below reservoir elevation:	88.4 m	89.3 m	88.4 m	88.4 m	88.4 m	86.5 m	89.3 m	88.4 m	89.3 m	88.4 m	88.4 m	88.4 m	88.4m	88.4m	88.4 m
Minimum discharge for fall spawning (Aug 1 - Oct 14)	same as year round	same as year round	same as year round	same as year round	same as year round	same as year round	same as year round	same as year round	6.5 m^3/s	6.5 m^3/s	same as year round	6.5 m^3/s	same as year round	same as year round	6.5 m^3/s
OPERATING CONSTRAINTS FOR RESERVOIR OBJECTIVES															
Flashboard (FB) installation	1 April – 15 May	1 April – 15 May	none	1 April – 15 May	1 April – 15 May	15 Nov – 15 May	15 Mar – 15 May	15 Mar – 15 May	15 Mar – 15 May	15 Mar – 15 May	Once every 3 years, 15 Mar – 15 May	Once every 3 years, 15 Mar – 15 May	none	none	15 Mar – 15 May
Spring Spawning Target (March/April – 15 May)**	Above 91.75 m	Above 91.75 m	Above 90.3 m	none	none	none	92.0 to 92.5 m	92.0 to 92.5 m	92.0 to 92.5 m	92.0 to 92.5 m	Above 90.3 m in non-FB years 92.0 to 92.5 m in FB years	Above 90.3 m in non-FB years 92.0 to 92.5 m in FB years	none	none	92.0 to 92.5 m
Spring incubation Target (15 May – 1 September)	none	none	Below 89.3 m	none	none	none	none	none	none	none	none	none	none	none	none
Fall Spawning Target (1 September – 15 October)	Above 90.3 m	Above 90.3 m	Above 90.3m	none	none	none	Above 90.3 m	Above 90.3 m	Above 90.3 m	Above 90.3 m	none	none	none	none	none
Fall Incubation Target (15 October – March/April)**	Below 90.3 m	Below 90.3 m	Below 90.3 m	none	none	none	Below 90.3 m	Below 90.3 m	Below 90.3 m	Below 90.3 m	none	none	none	none	none
OTHER OPERATING CONSTRAINTS															
Maintenance Outage (assuming only one unit out at a time)	none	none	none	none	none	1 - 28 March	1 - 28 March	1 - 28 March	1 - 28 March	1 - 28 March	1 - 28 March	1 - 28 March	1 - 28 March	none	1 - 28 March

*This is to prevent "0" minimum flow events downstream. By reducing power generation to 1 megawatt when the reservoir reaches a critical elevation, this attempt to ensure that if either the generating units were to malfunction, there would still be enough water in the reservoir at a high enough elevation to be released through the sluice gates to meet the minimum downstream flow requirements.

**The beginning of the spring spawning season (or the beginning of the fall incubation period) is defined as 1 April for Alterntives 1 to 5, and 15 March for Alternatives 6 to 9.

HYDROGRAPHS FOR OPERATING ALTERNATIVES

The following pages contain hydrographs for the Falls River system (Figure I-1 to Figure I-30). For each of the operating alternatives considered by the Falls River Water Use Plan Consultative Committee, you will find:

- A graph showing the expected daily reservoir elevations in Big Falls Reservoir throughout the year, based on 33 years of simulated data.
- A graph showing the expected total daily discharge from the Big Falls Reservoir into the Falls River below the project. As in the graphs for the reservoir, the discharge levels are shown throughout the year, based on 33 years of simulated data.

In both the river and reservoir graphs, all 33 years of data are shown, each represented by one grey line. Since the data for many of the years overlap, it can be difficult to distinguish any single year.

There are three coloured lines that assist in interpreting the information on the graphs. The *blue line* represents the median (or 50th percentile) values modelled over 33 years of simulated operation of the Falls River hydroelectric project. This means that for a given alternative, the value of that performance measure is expected to be equal to or lower than the median value 50 per cent of the time (or one in every two years on average).

The *green line* represents the 10th percentile values, and the *red line* represents the 90th percentile values. These statistics can be interpreted as follows: the reservoir elevation or total discharge to the river is expected to be lower than the 10th percentile value only 10 per cent of the time (or approximately one in every 10 years). Similarly, the reservoir elevation or discharge to the river is expected to be lower than the 90th percentile value 90 per cent of the time (or approximately nine out of every 10 years). Another way of interpreting these statistics is to say that over the long term, 80 per cent of all years would show a value somewhere in the range shown by the 10th and 90th percentile bars.

Note: For the following hydrographs cms = m^3/s.

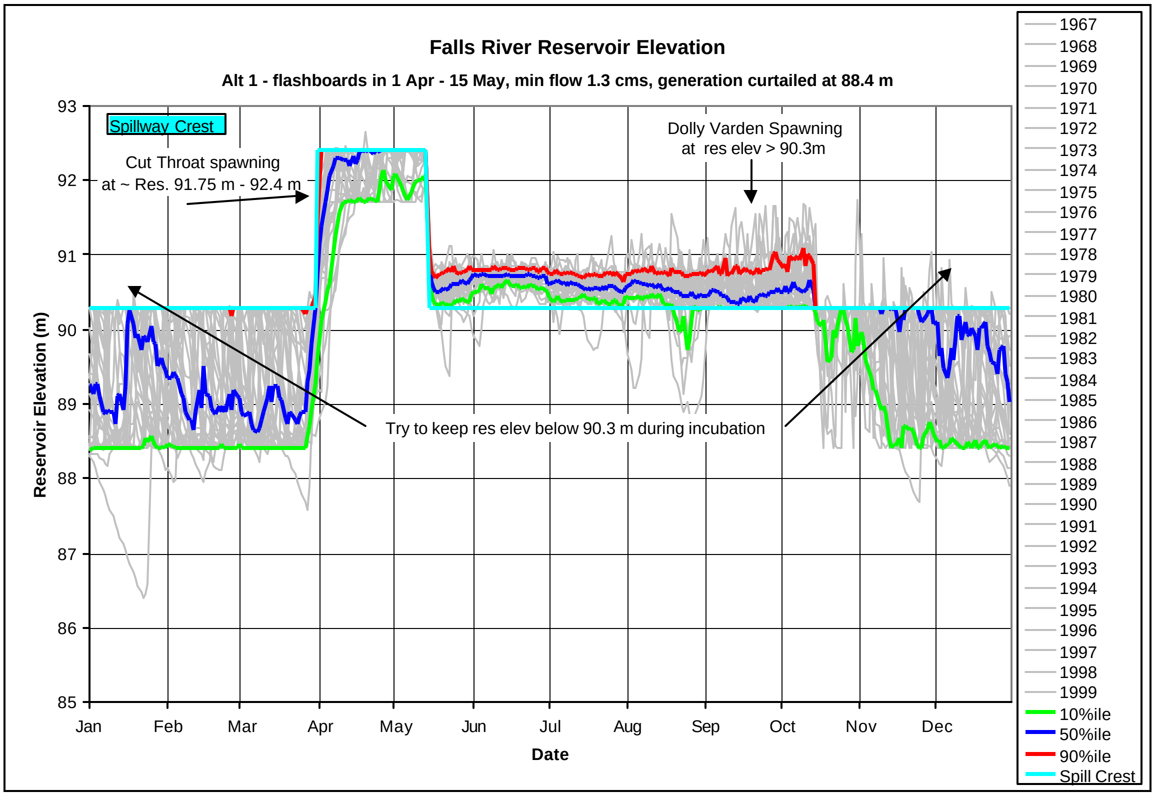

Figure I-1: Hydrograph for Big Falls Reservoir for Alternative 1

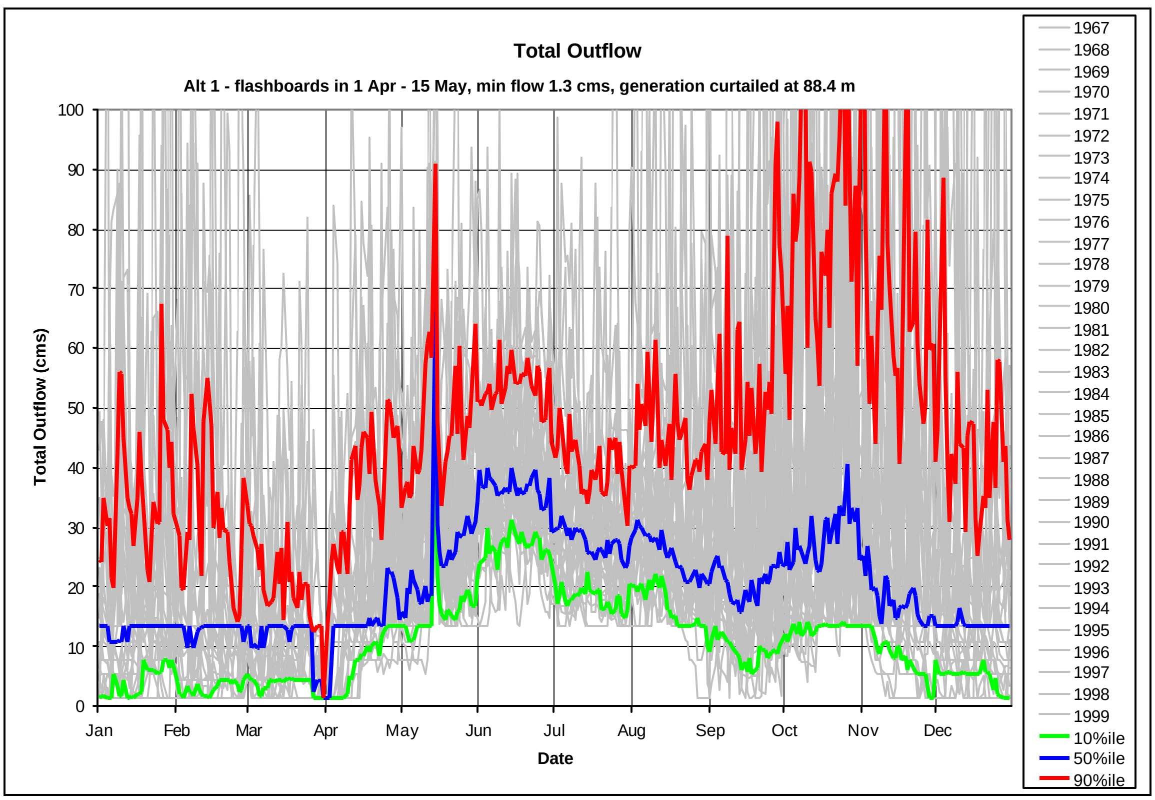

Figure I-2: Hydrograph for Total Discharge into Falls River for Alternative 1

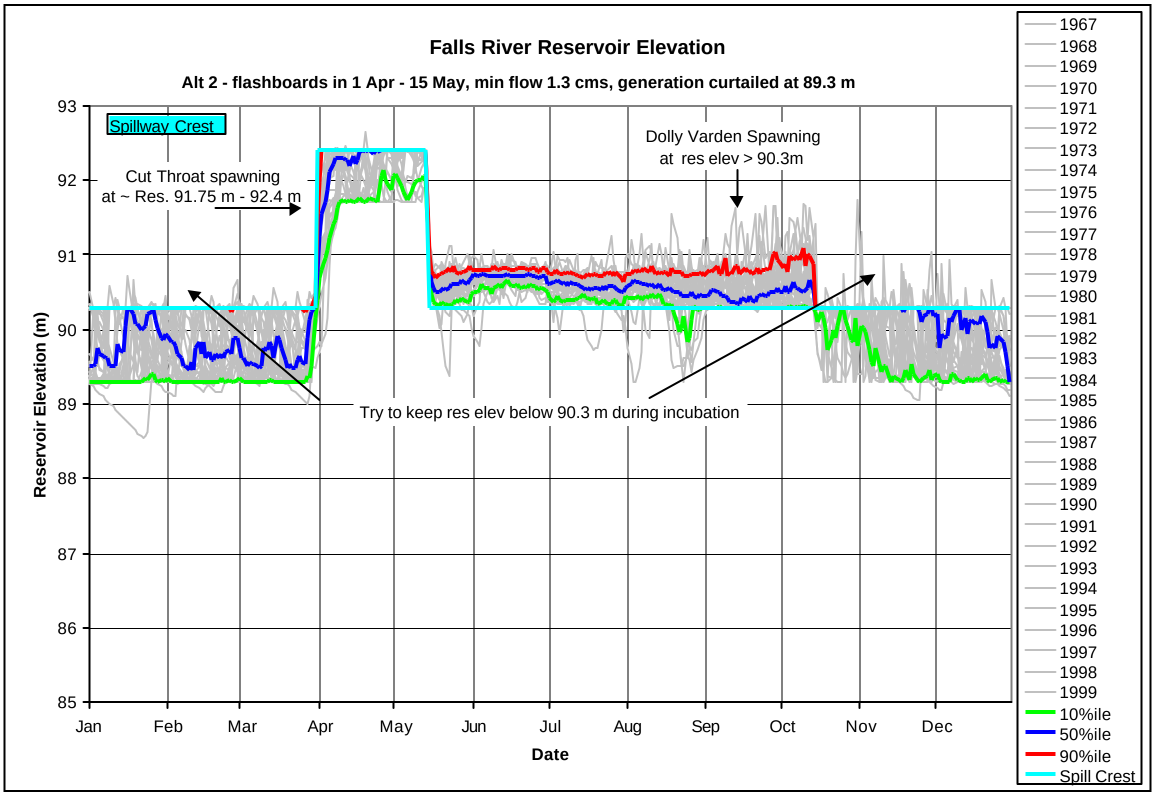

Figure I-3: Hydrograph for Big Falls Reservoir Elevations for Alternative 2

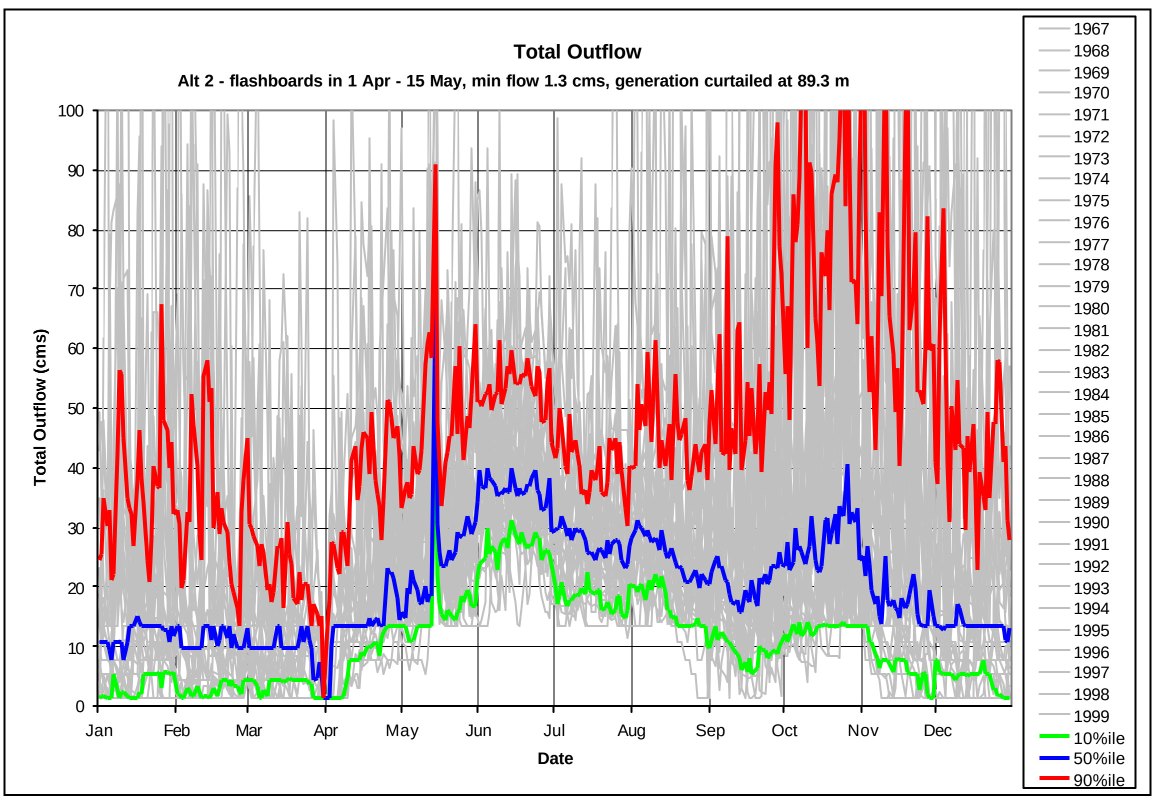

Figure I-4: Hydrograph for Total Discharge into Falls River for Alternative 2

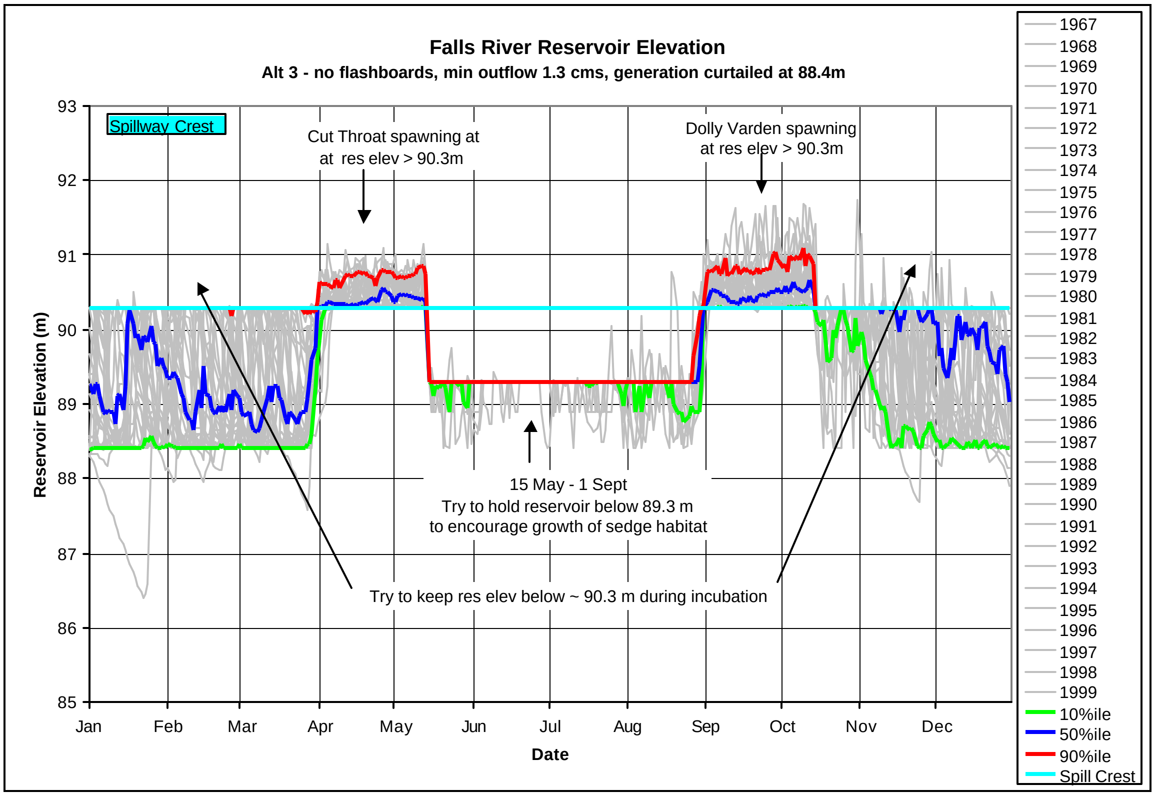

Figure I-5: Hydrograph for Big Falls Reservoir Elevations for Alternative 3

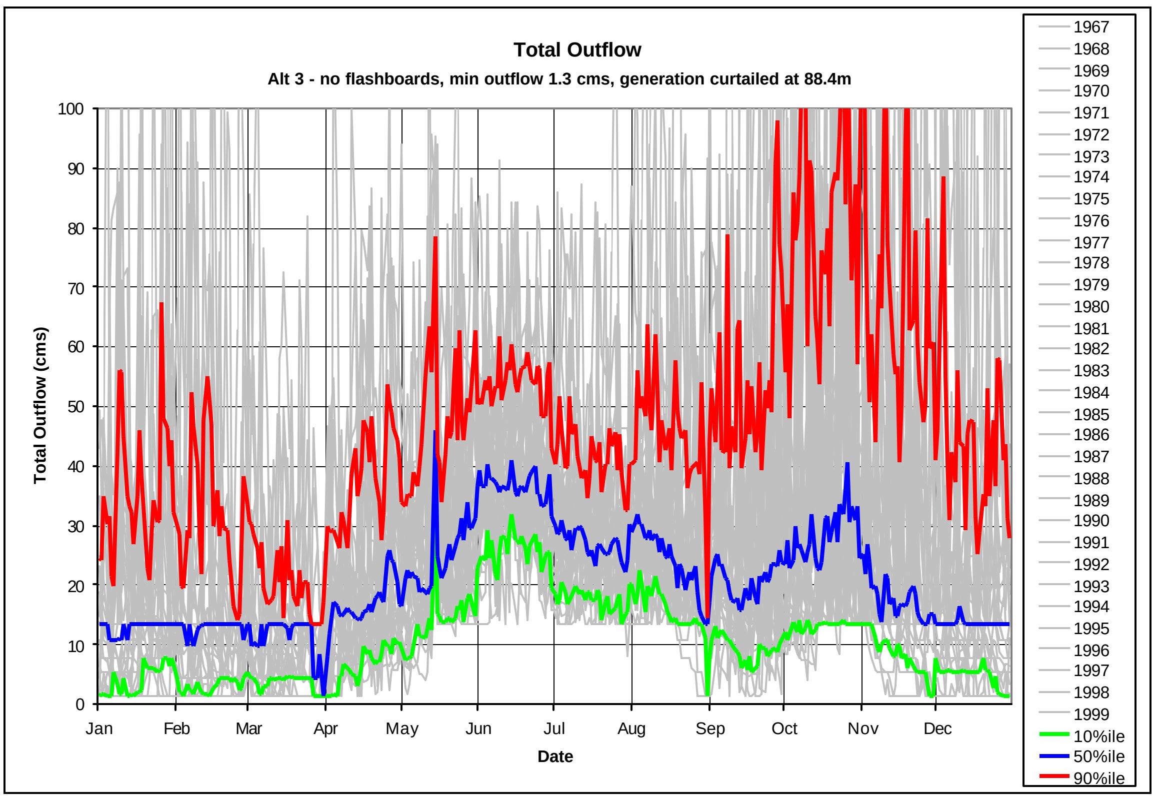

Figure I-6: Hydrograph for Total Discharge into Falls River for Alternative 3

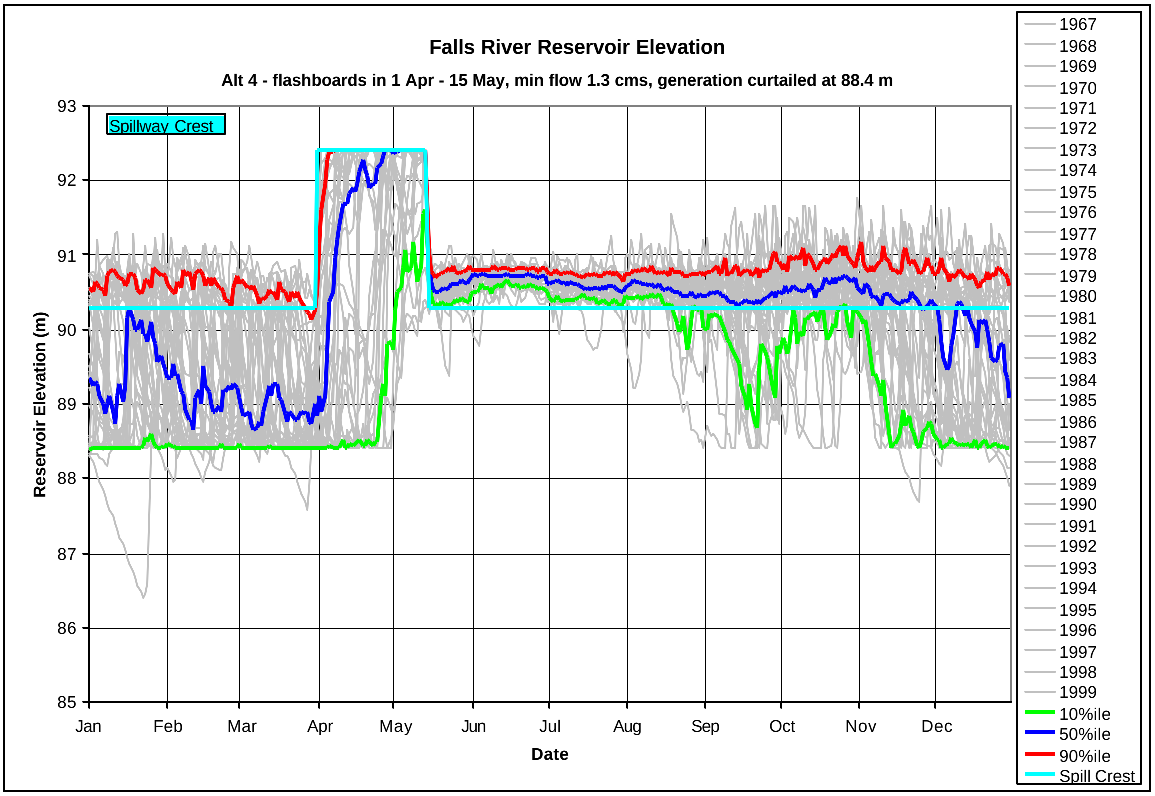

Figure I-7: Hydrograph for Big Falls Reservoir Elevations for Alternative 4

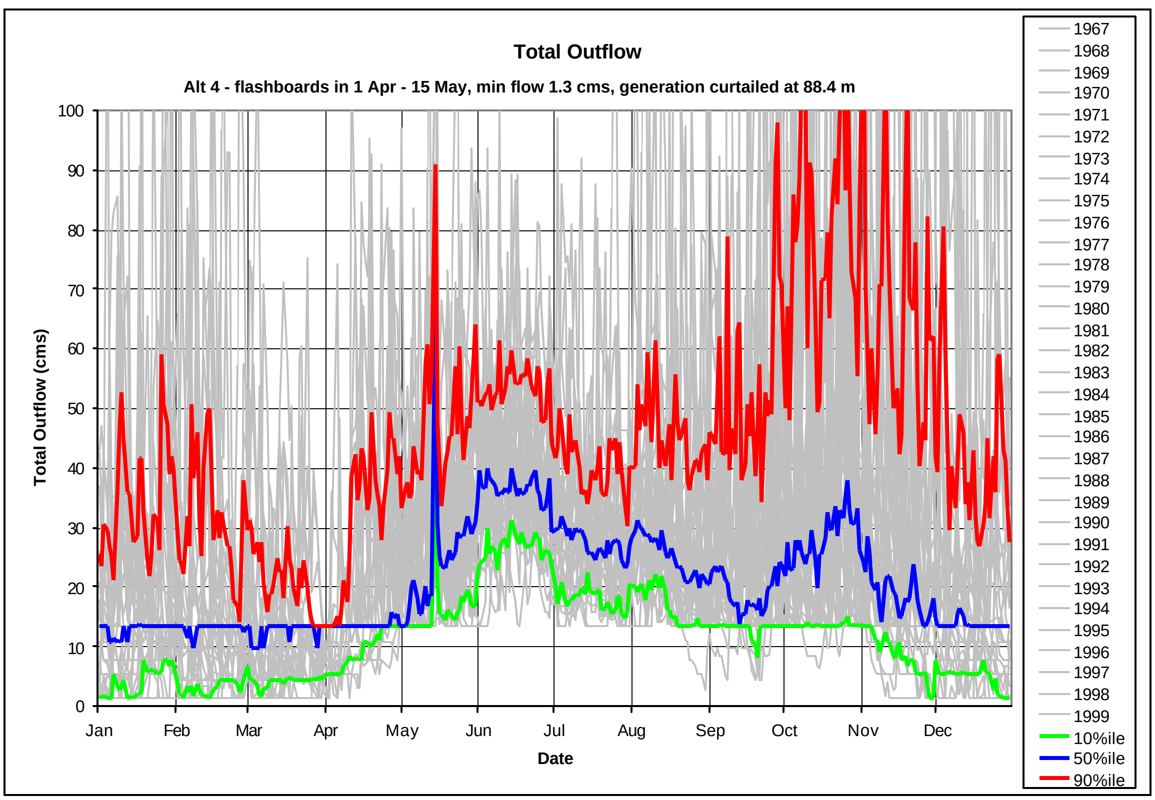

Figure I-8: Hydrograph for Total Discharge into Falls River for Alternative 4

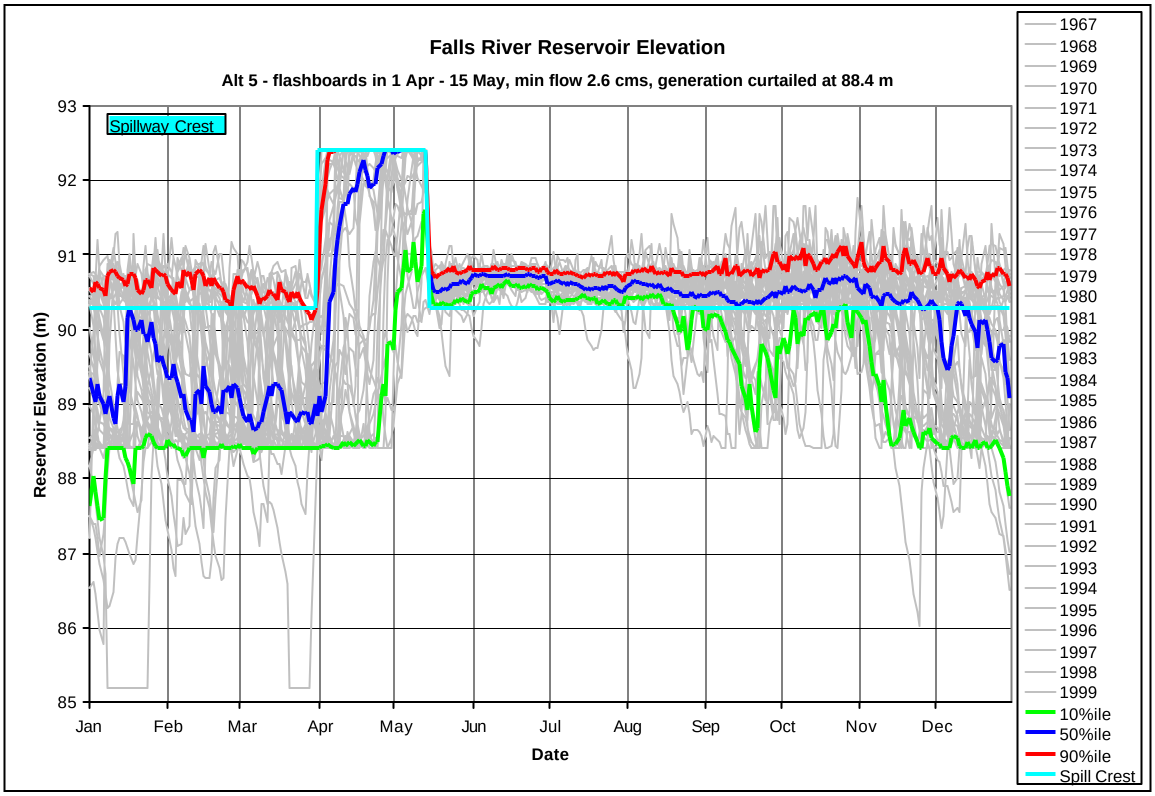

Figure I-9: Hydrograph for Big Falls Reservoir Elevations for Alternative 5

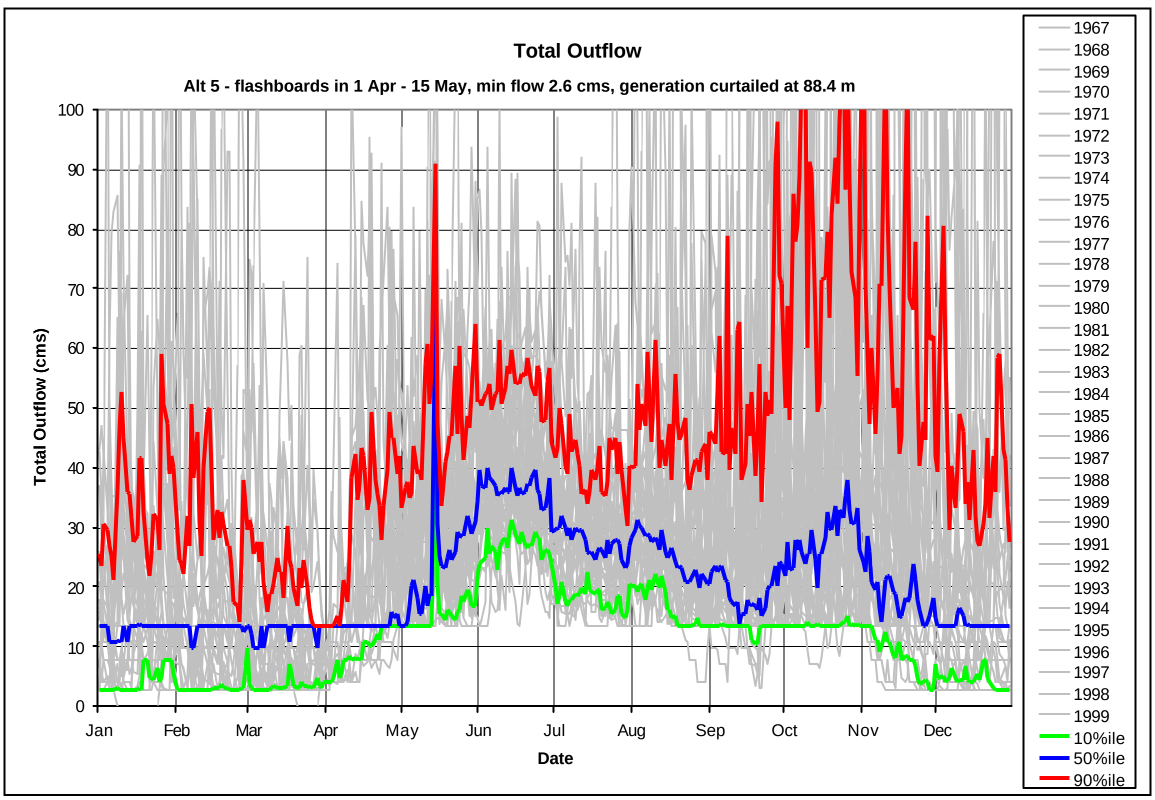

Figure I-10: Hydrograph for Total Discharge into Falls River for Alternative 5

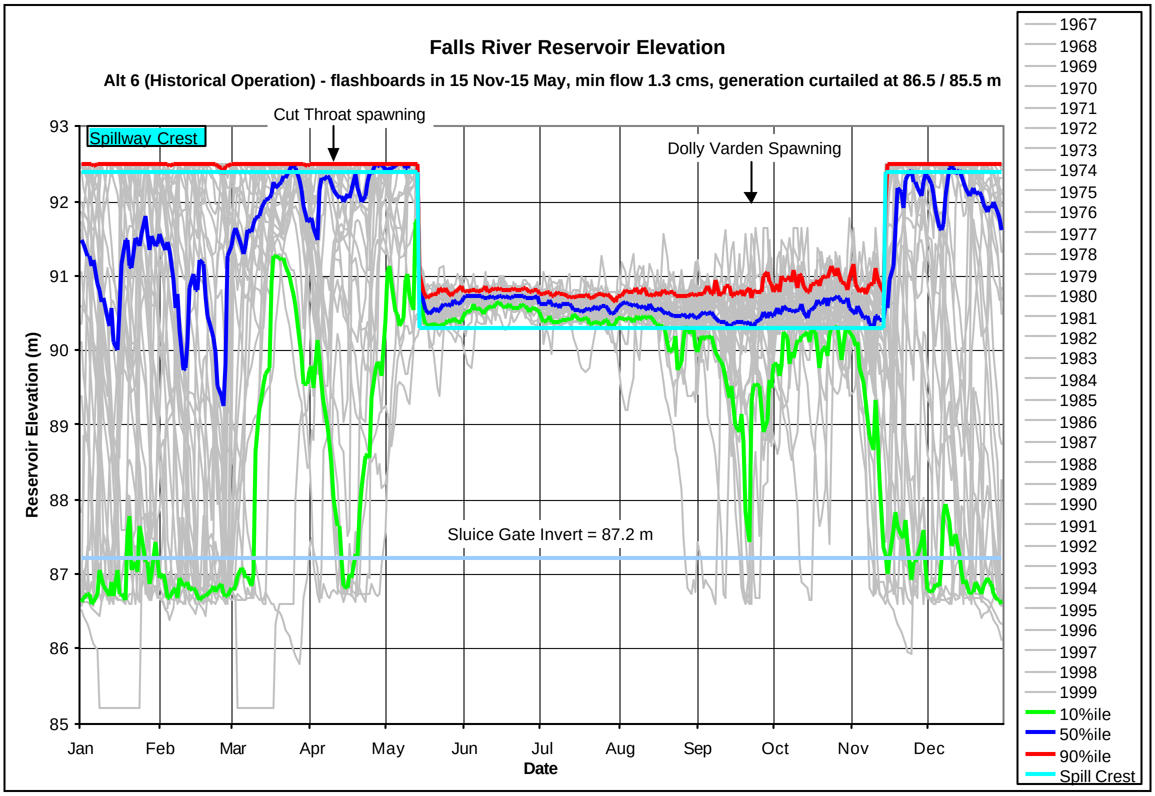

Figure I-11: Hydrograph for Big Falls Reservoir Elevations for Alternative 6

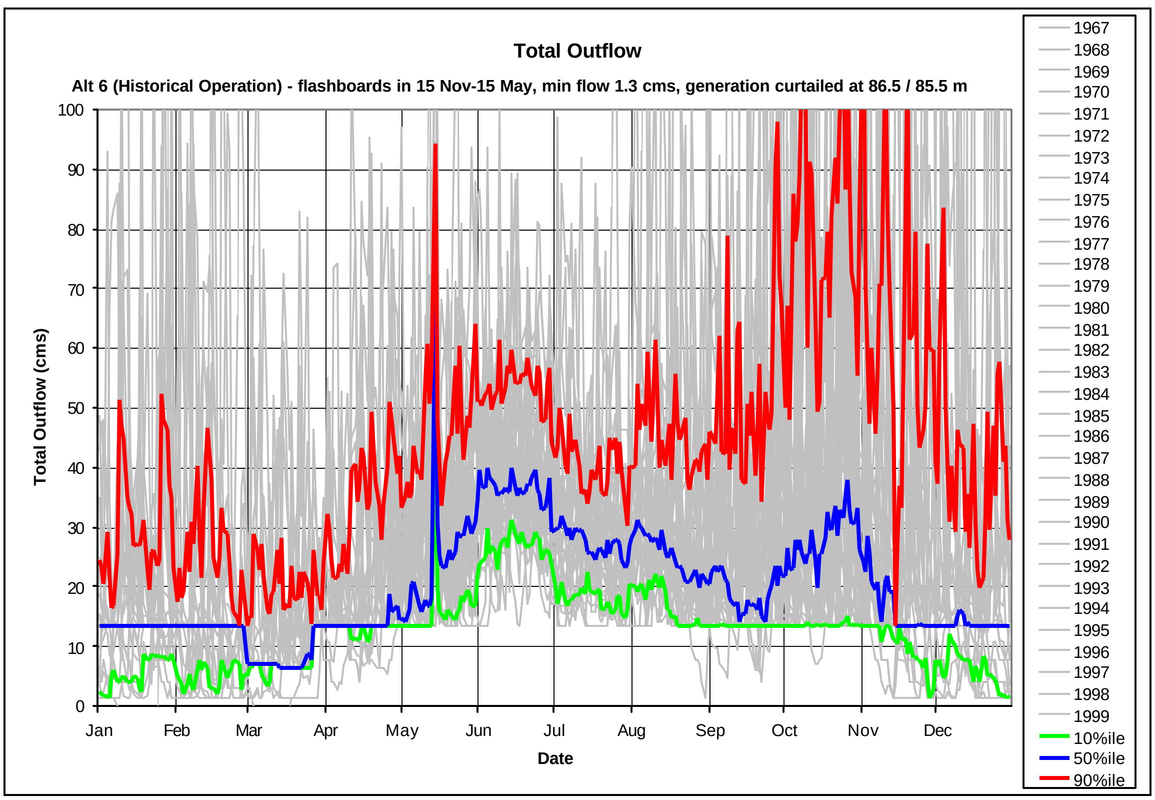

Figure I-12: Hydrograph for Total Discharge into Falls River for Alternative 6

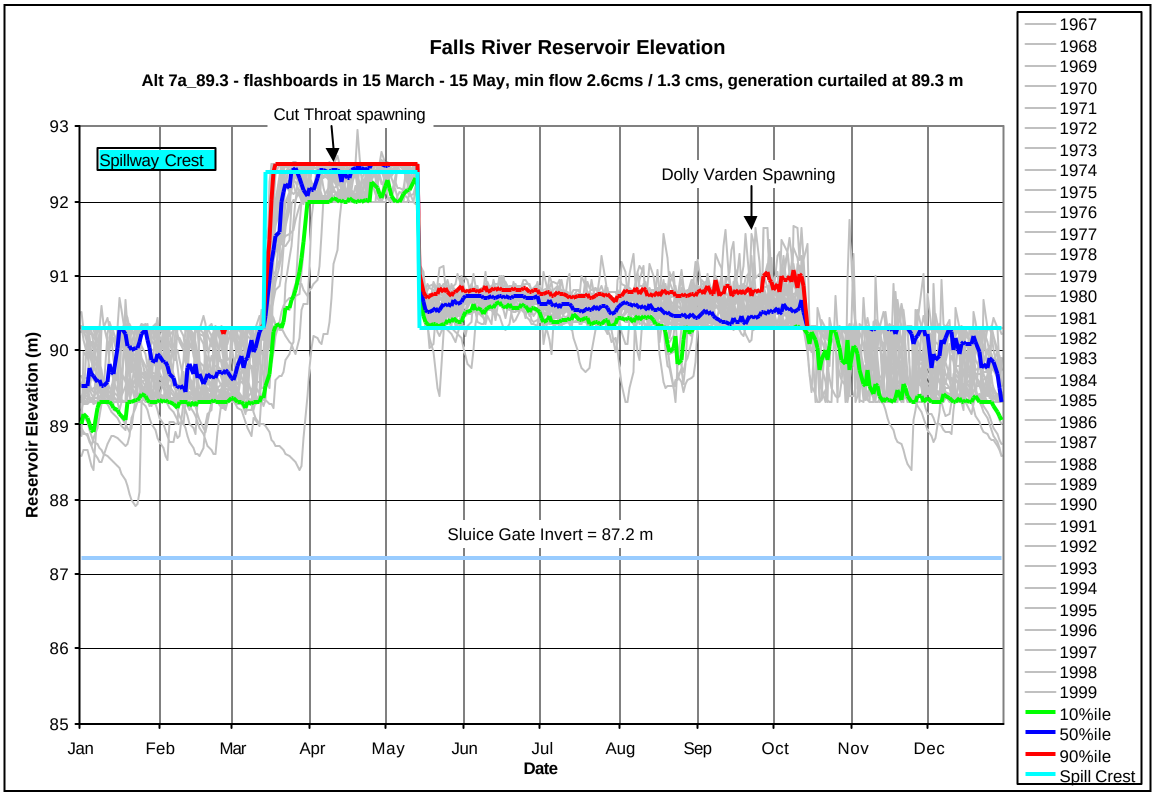

Figure I-13: Hydrograph for Big Falls Reservoir Elevations for Alternative 7A

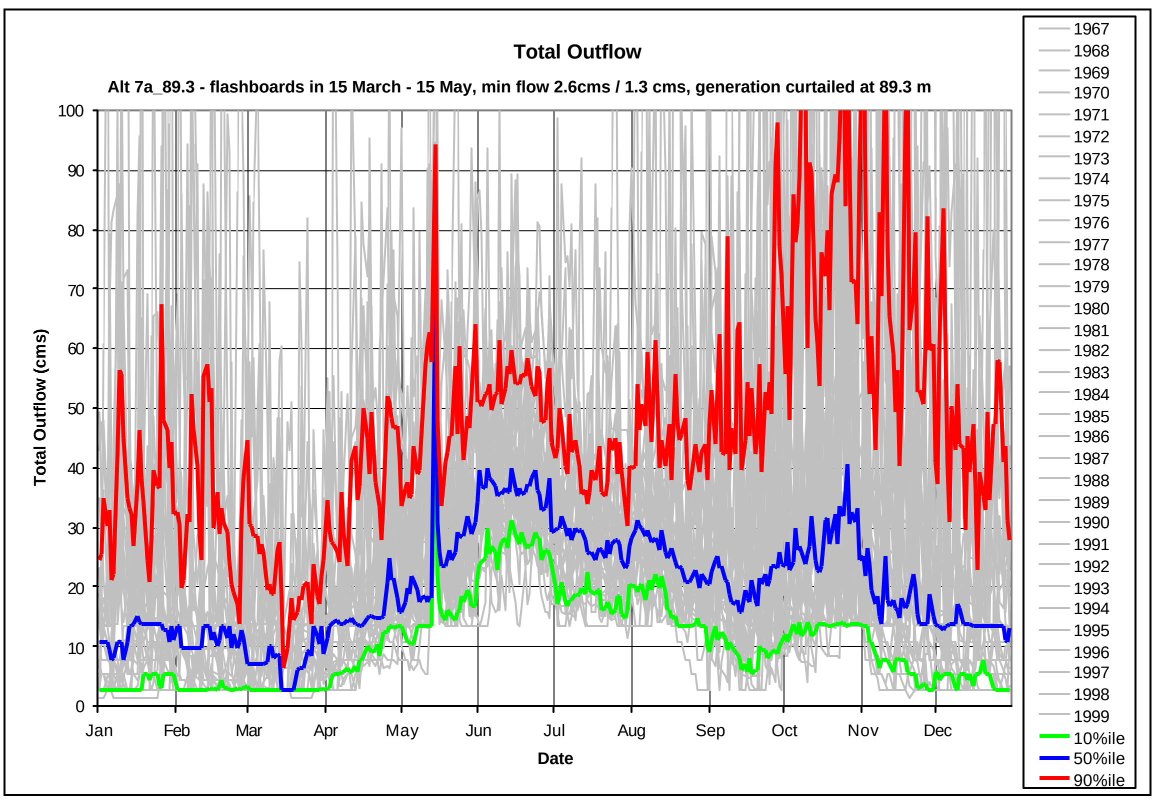

Figure I-14: Hydrograph for Total Discharge into Falls River for Alternative 7A

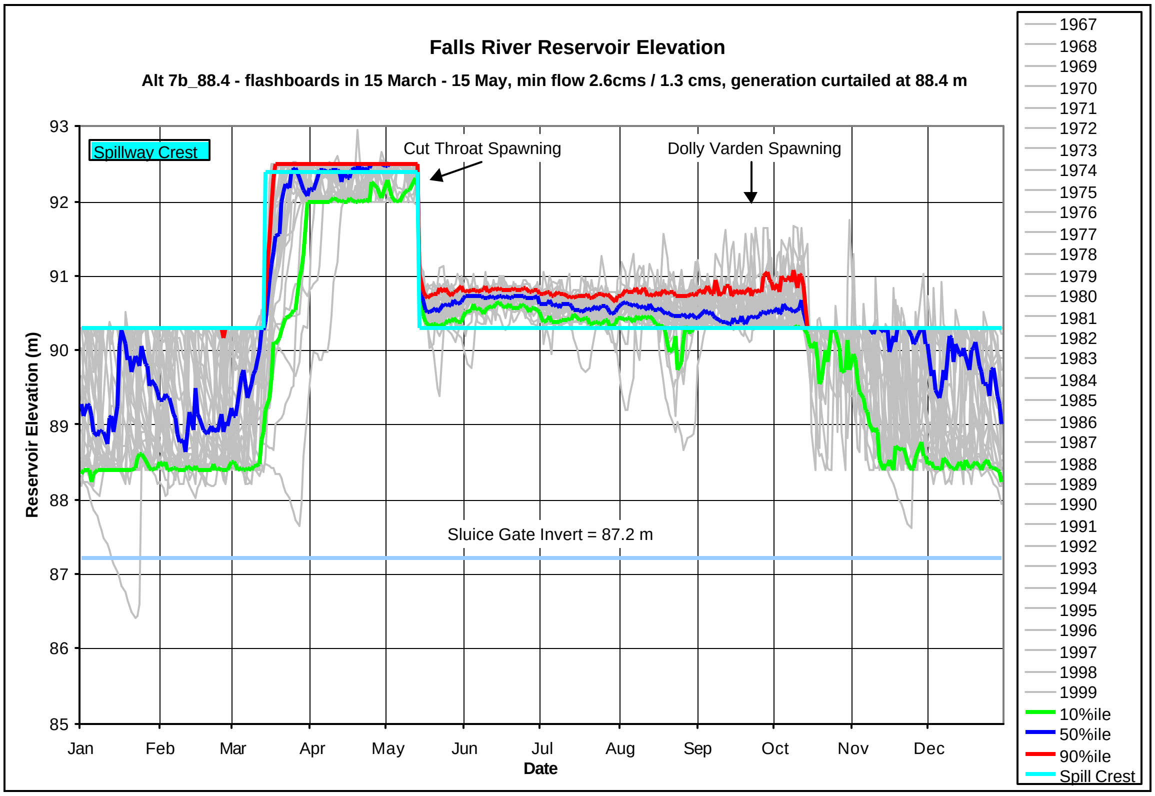

Figure I-15: Hydrograph for Big Falls Reservoir Elevations for Alternative 7B

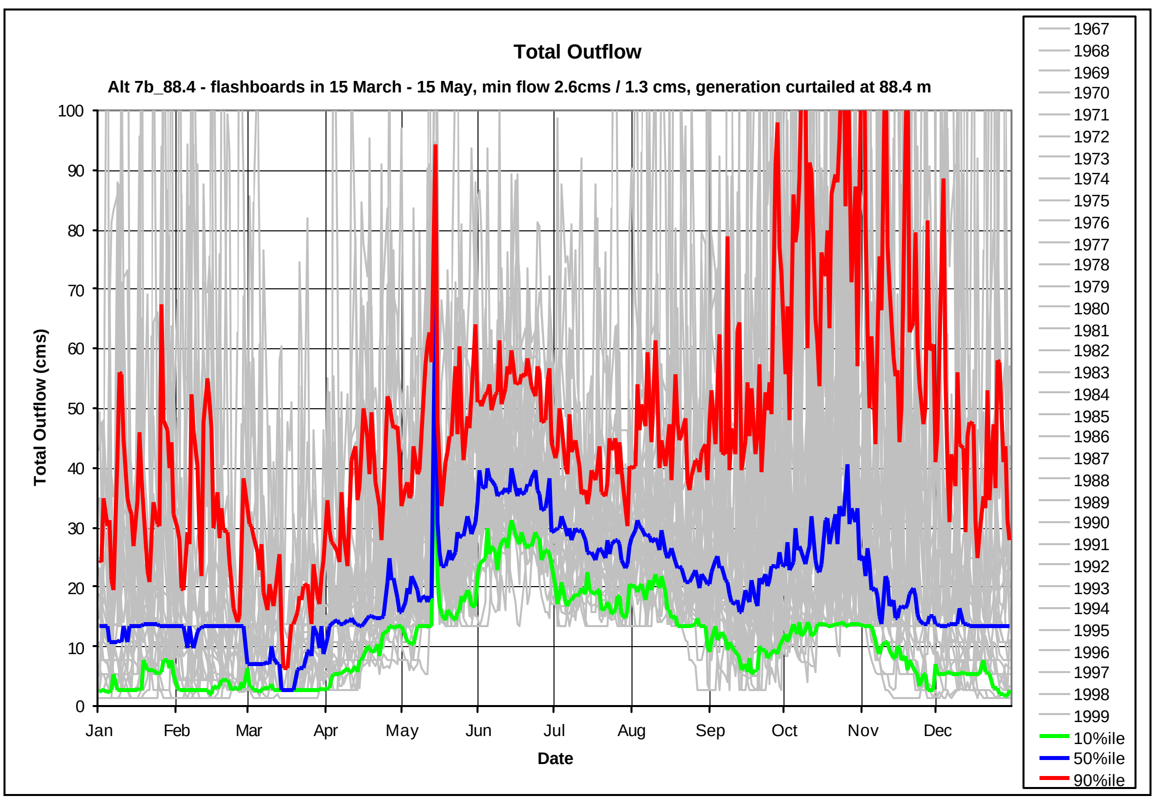

Figure I-16: Hydrograph for Total Discharge into Falls River for Alternative 7B

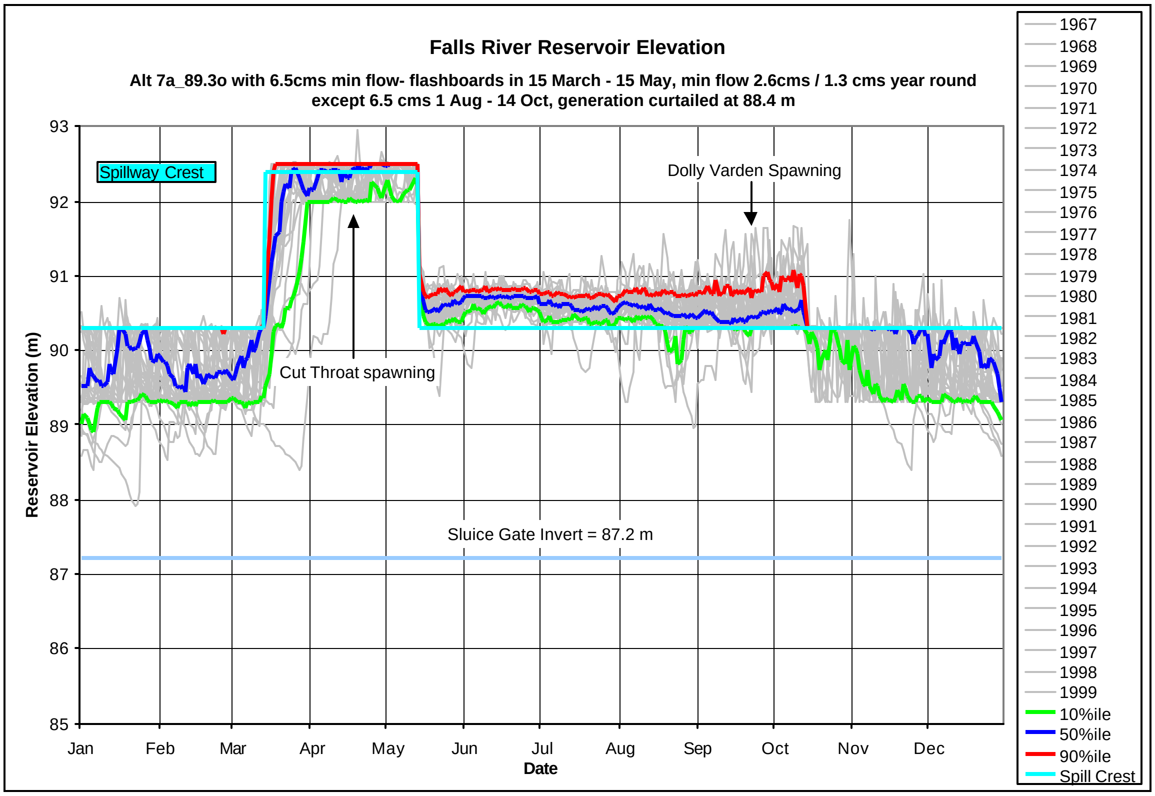

Figure I-17: Hydrograph for Big Falls Reservoir Elevations for Alternative 7C

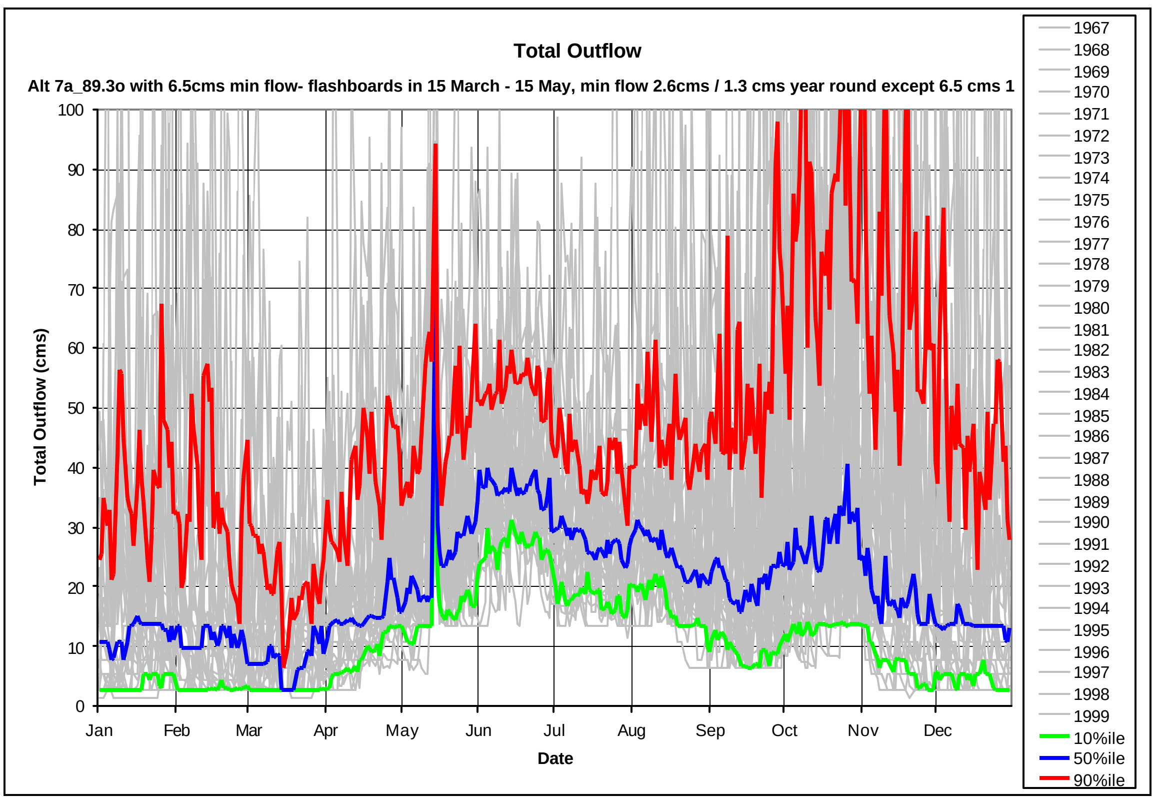

Figure I-18: Hydrograph for Total Discharge into Falls River for Alternative 7C

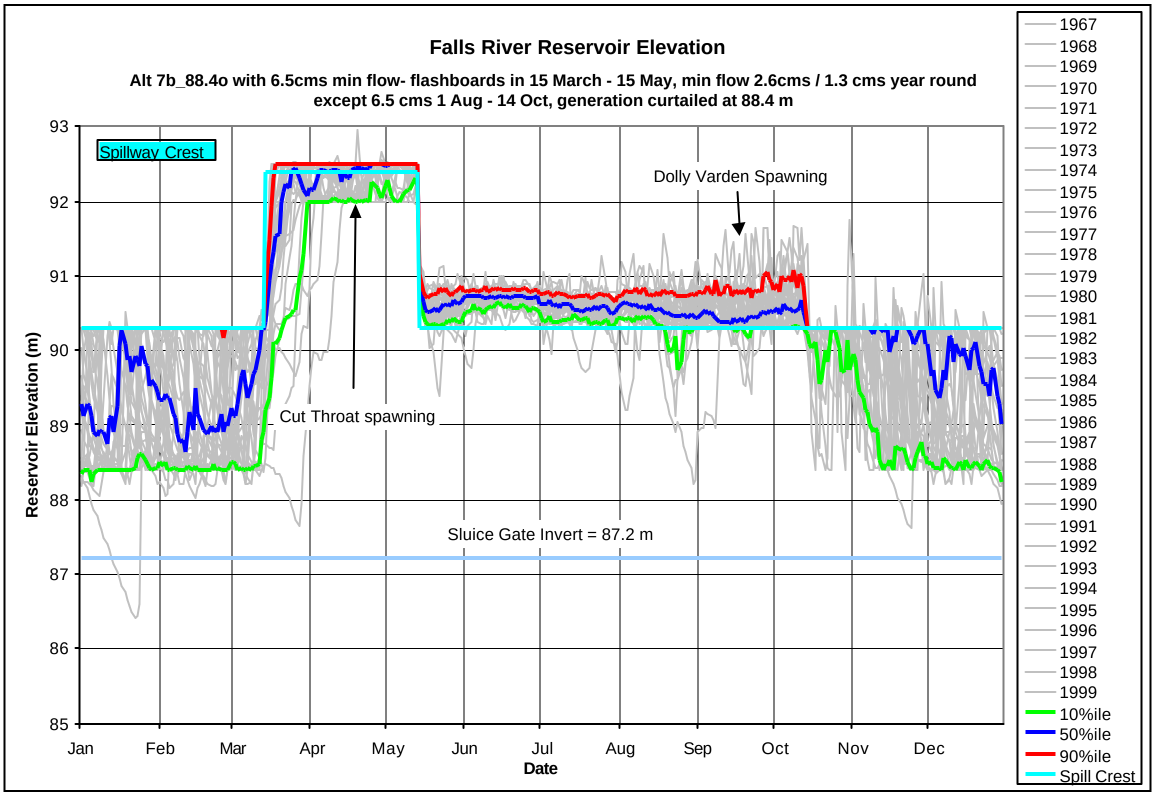

Figure I-19: Hydrograph for Big Falls Reservoir Elevations for Alternative 7D

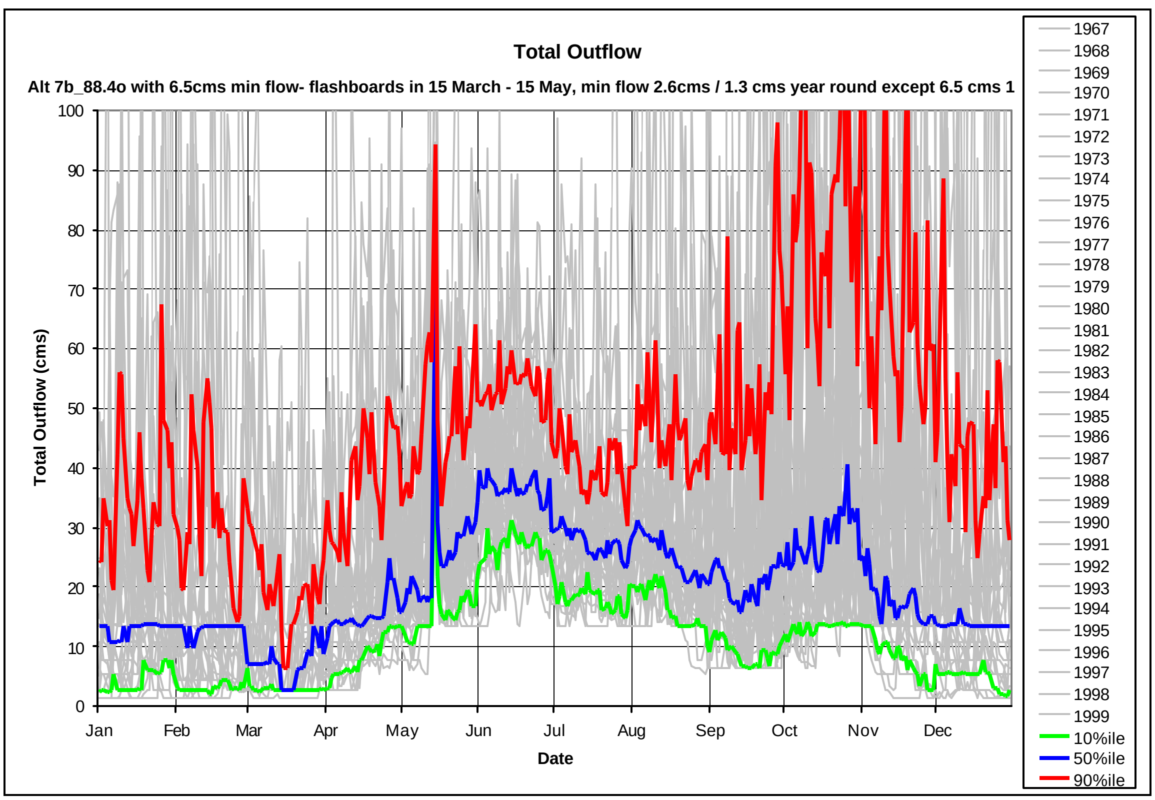

Figure I-20: Hydrograph for Total Discharge into Falls River for Alternative 7D

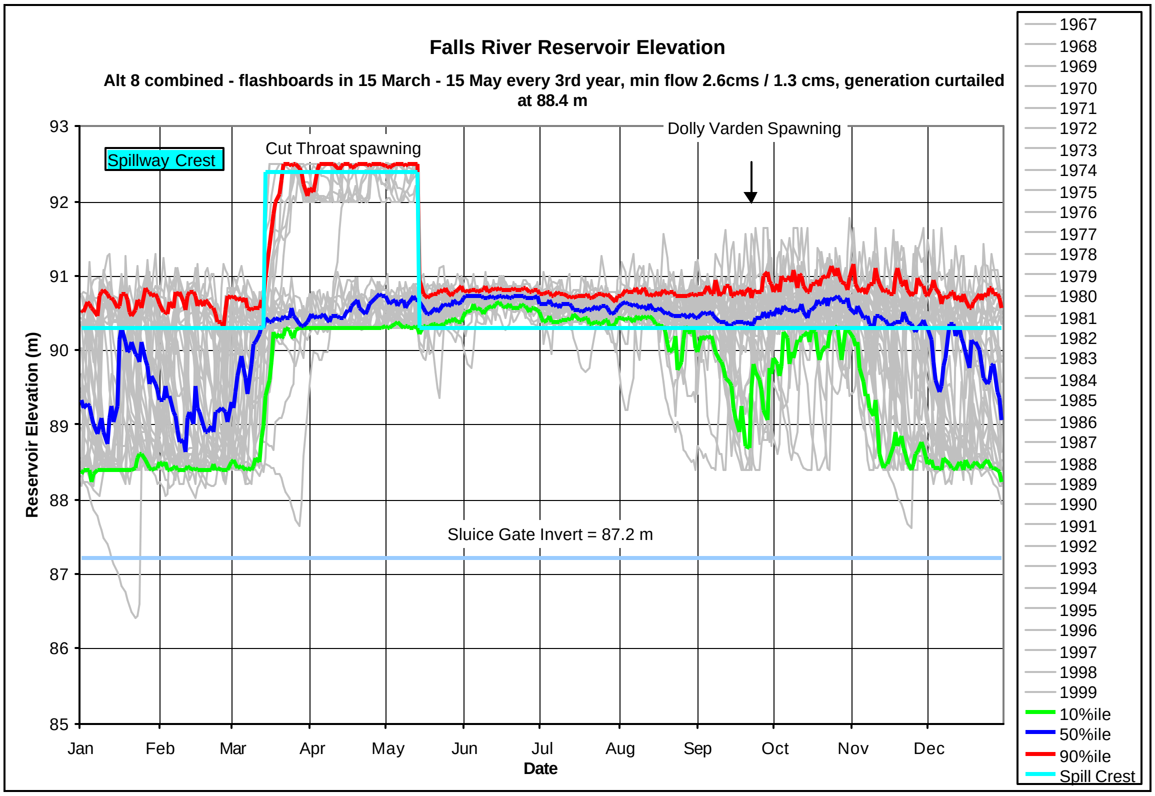

Figure I-21: Hydrograph for Big Falls Reservoir Elevations for Alternative 8A

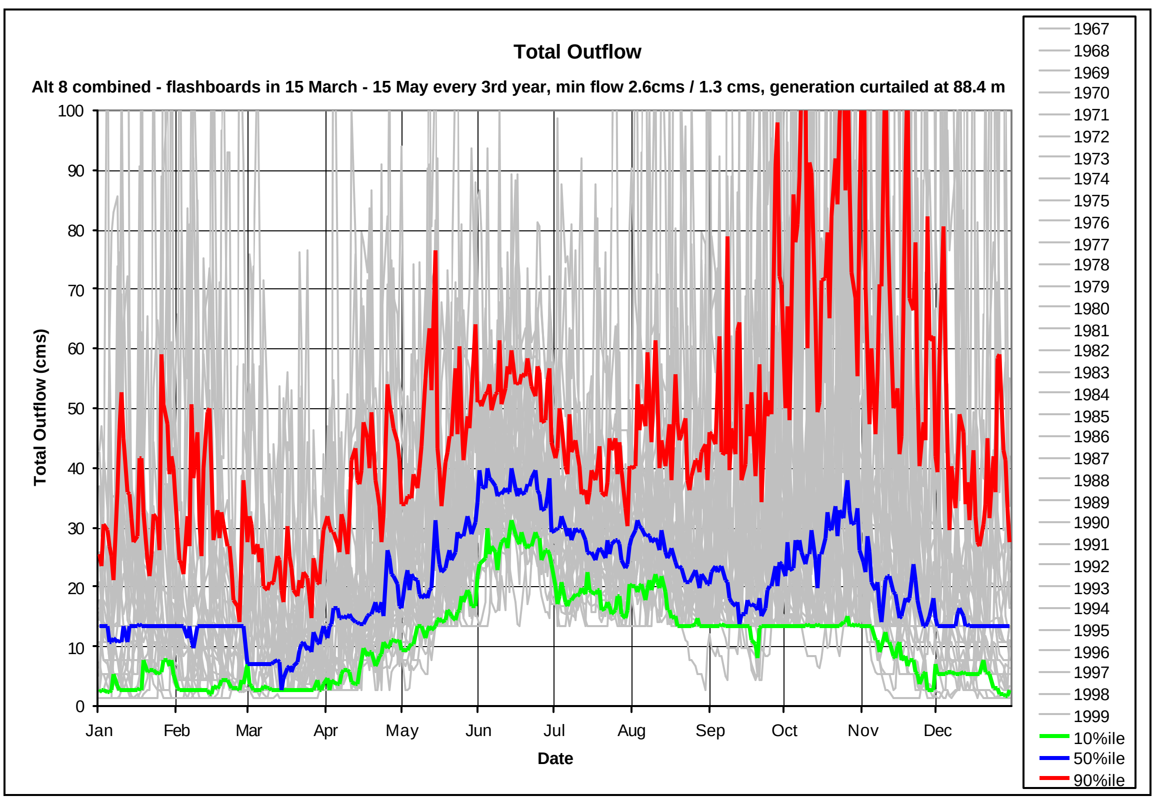

Figure I-22: Hydrograph for Total Discharge into Falls River for Alternative 8A

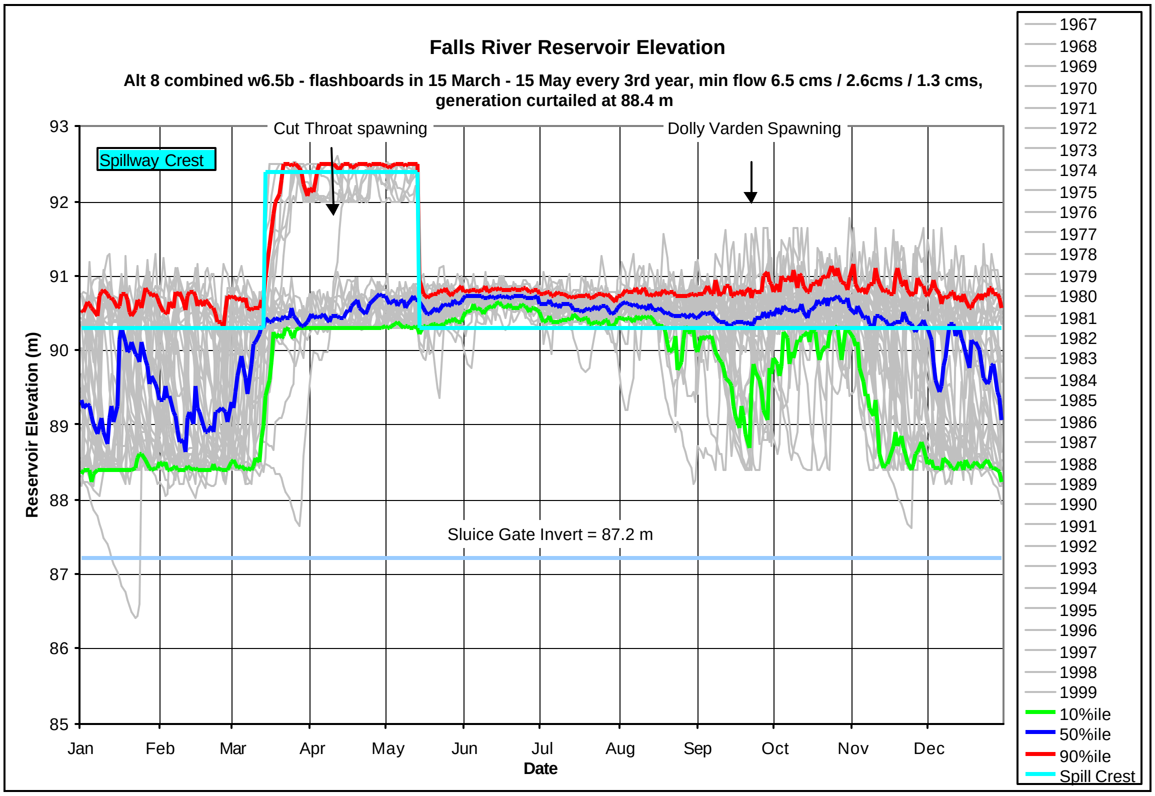

Figure I-23: Hydrograph for Big Falls Reservoir Elevations for Alternative 8B

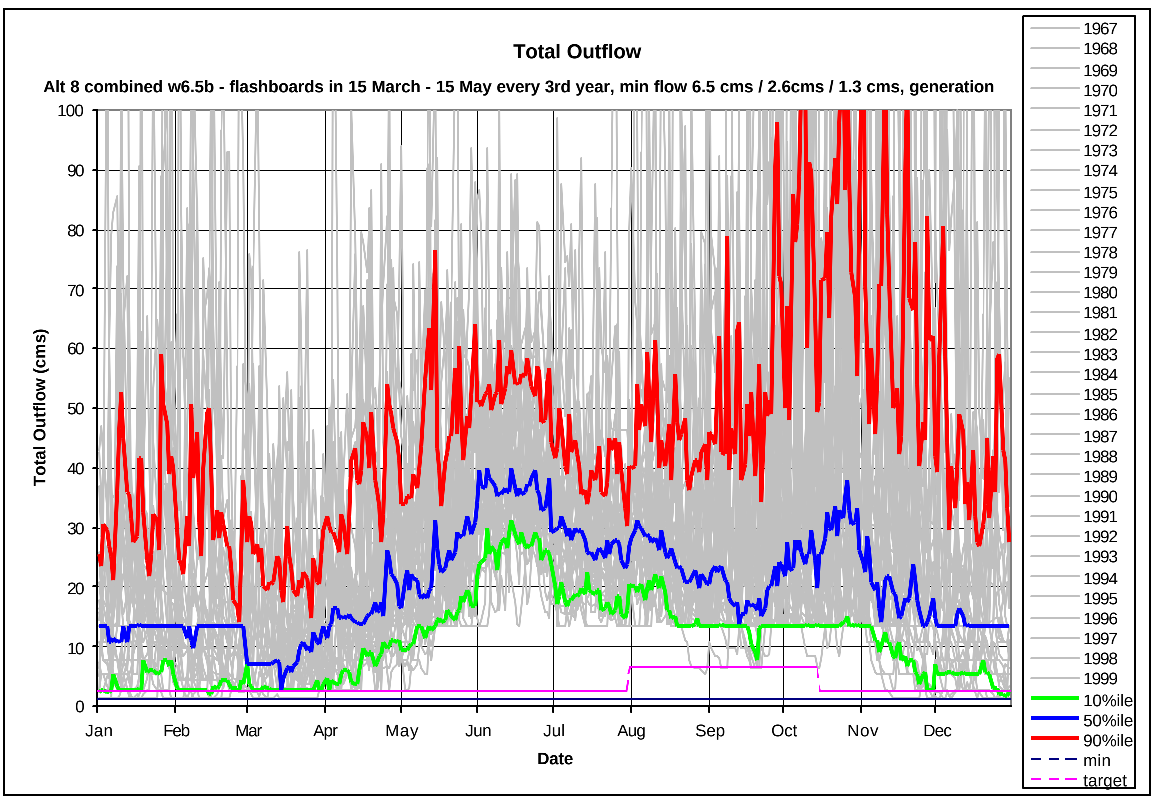

Figure I-24: Hydrograph for Total Discharge into Falls River for Alternative 8B

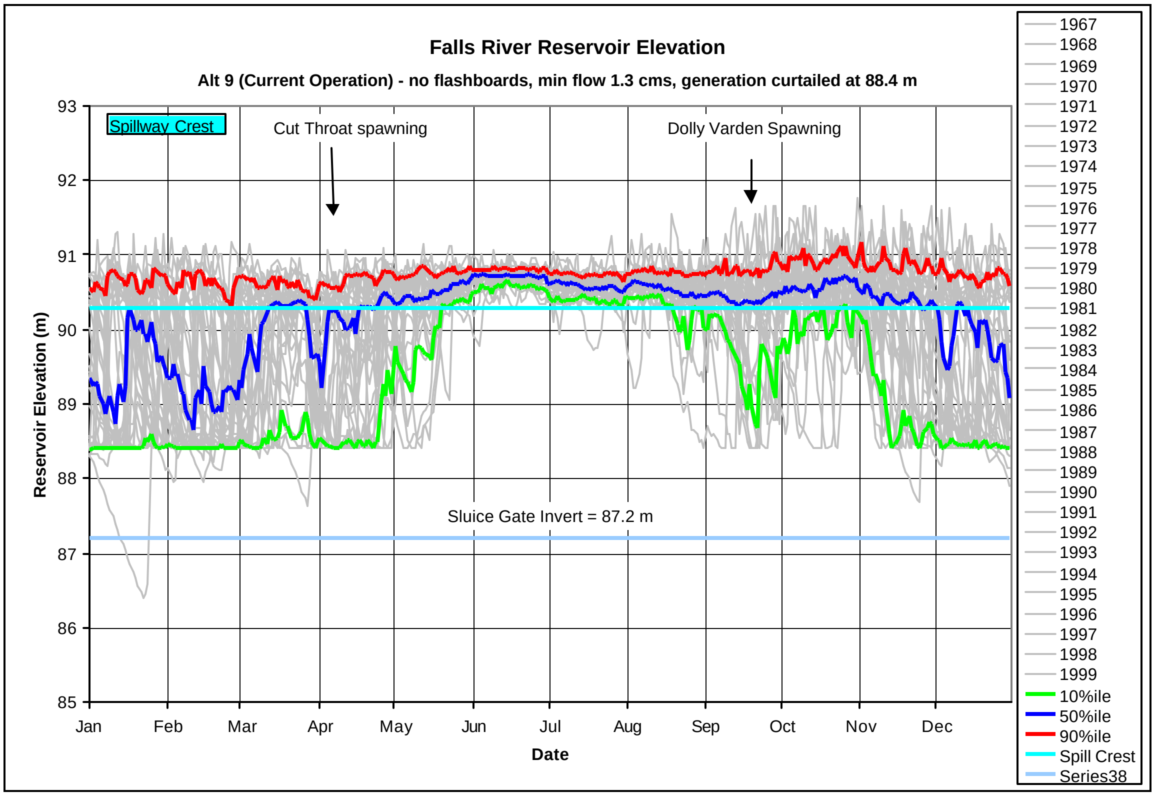

Figure I-25: Hydrograph for Big Falls Reservoir Elevations for Alternative 9A

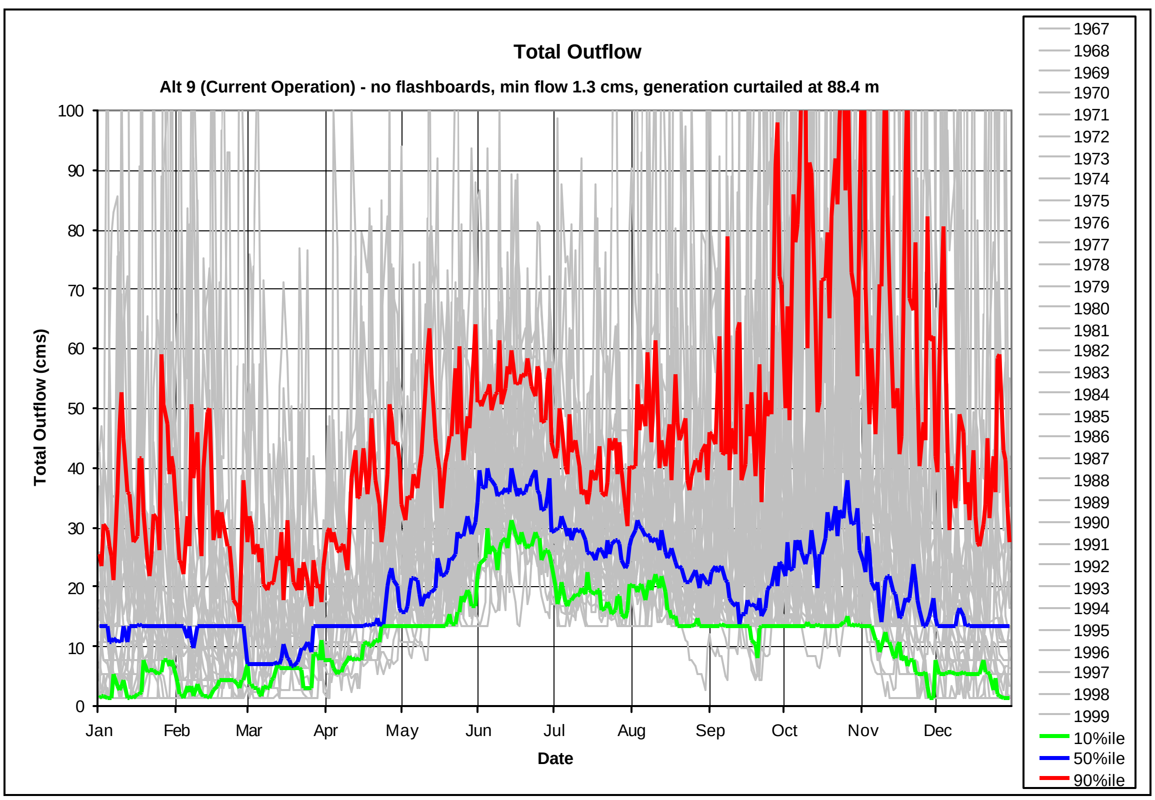

Figure I-26: Hydrograph for Total Discharge into Falls River for Alternative 9A

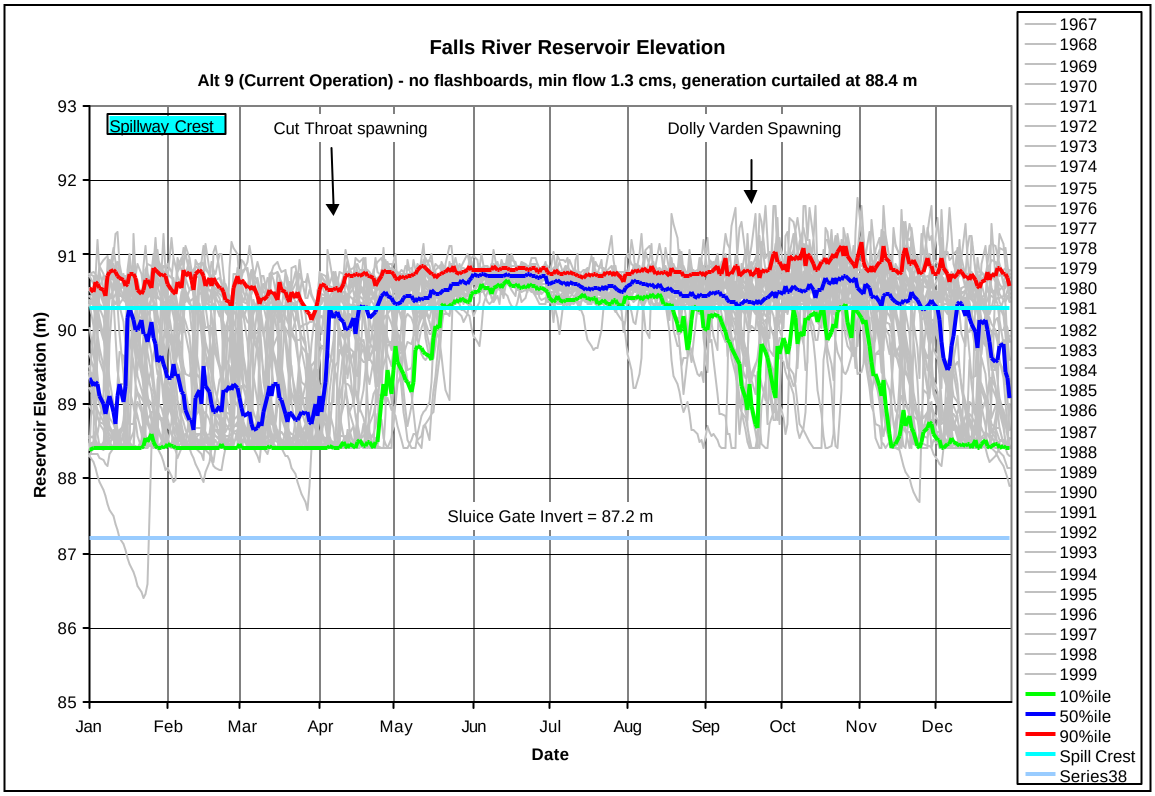

Figure I-27: Hydrograph for Big Falls Reservoir Elevations for Alternative 9B

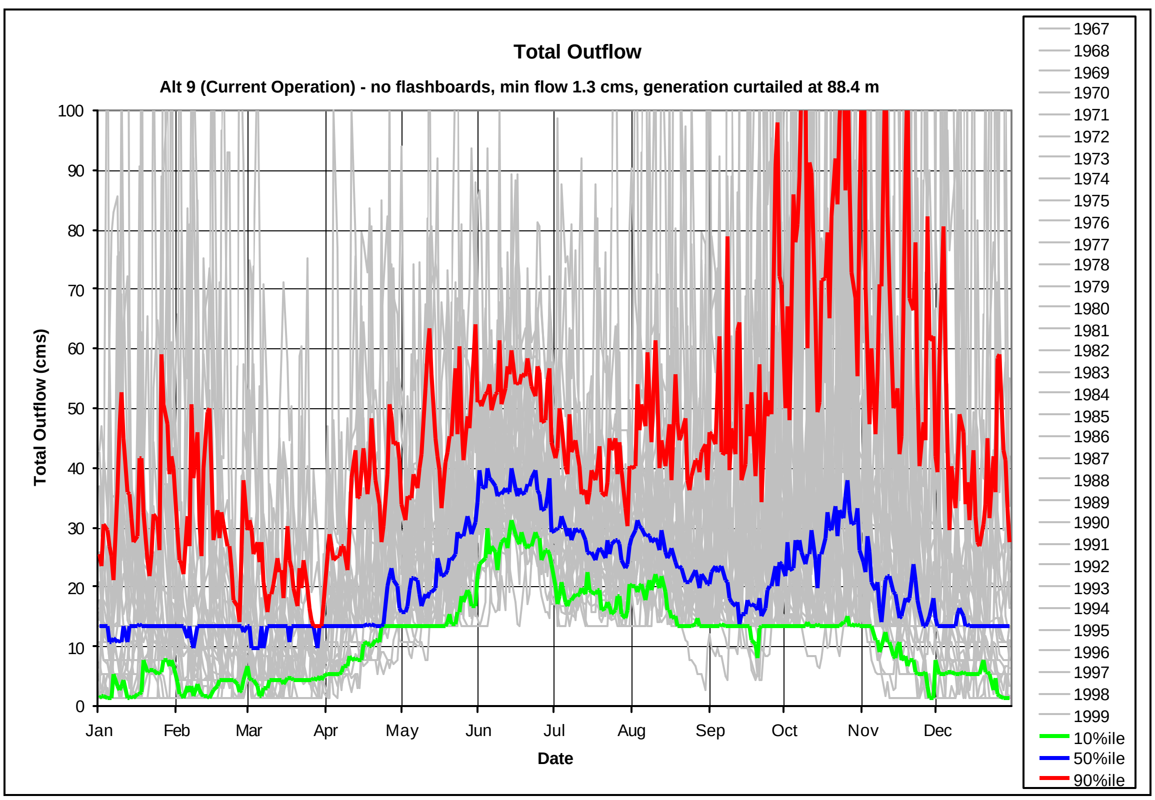

Figure I-28: Hydrograph for Total Discharge into Falls River for Alternative 9B

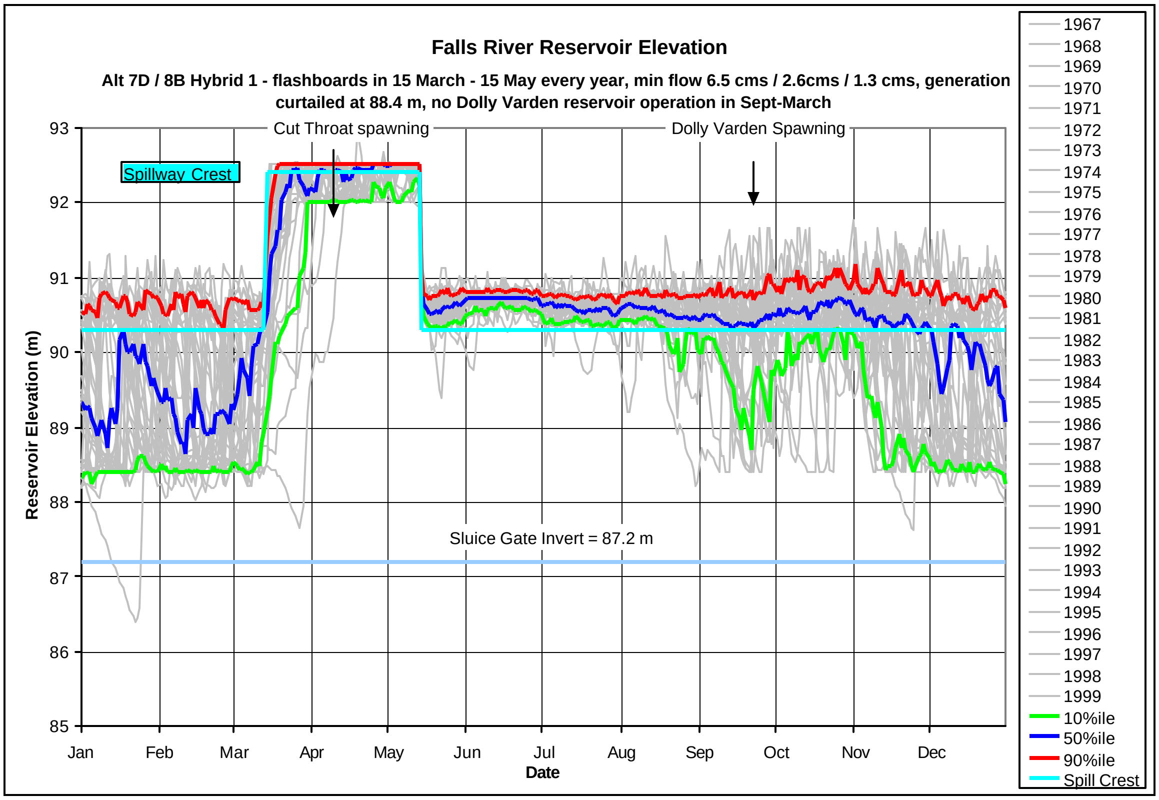

Figure I-29: Hydrograph for Big Falls Reservoir Elevations for Alternative 10

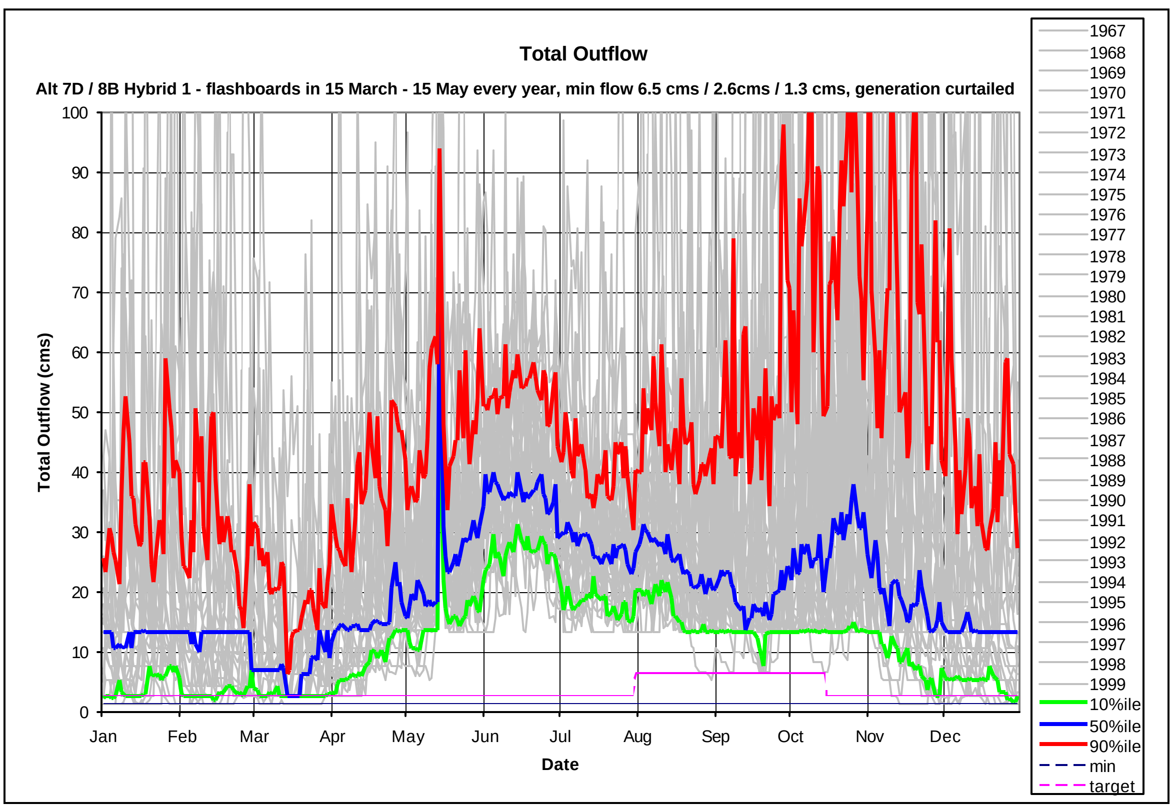

Figure I-30: Hydrograph for Total Discharge into Falls River for Alternative 10

APPENDIX J: BOX PLOTS SHOWING VARIABILITY OF FISH AND WILDLIFE PERFORMANCE MEASURE SCORES FOR FALLS RIVER PROJECT

The following pages contain box plots showing the distribution of each performance measure across the range of operating alternatives considered by the Falls River Water Use Plan Consultative Committee (Figure J-1 to Figure J-18).

Interpreting Box Plots

The main performance measures metric used is the median (50^{th} percentile) values modelled over 33 years of simulated operation of the Falls River hydroelectric project. This means that for a given alternative, the value of that performance measure is expected to be equal to or lower than the median value 50 per cent of the time. The median values are shown as diamonds (♦).

The box plots also show two other metrics that can be interpreted as follows:

- **10^{th} percentile values:** The value of the performance measure is expected to be lower than the 10^{th} percentile value only 10 per cent of the time (or approximately one in every 10 years).
- **90^{th} percentile values:** The value of the performance measure is expected to be lower than the 90^{th} percentile value 90 per cent of the time (or approximately nine out of every 10 years).

Another way of interpreting these statistics is to say that over the long term, 80 per cent of all years would show a value somewhere in the range shown by the 10^{th} and 90^{th} percentile bars. The 10^{th} and 90^{th} percentile values are shown as dashes at the end of a bar connecting the two values to the median diamond.

The box plots in this appendix compare the range of scores for each of the fish and wildlife performance measures across 11 of the 15 operating alternatives considered in the Falls River Water Use Plan. Alternative 10 is not shown in the box plots since that operating alternative was modelled at the last minute during the final meeting of the Consultative Committee. The remaining four operating alternatives that are not shown in the box plots were assumed to perform the same as other similar alternatives. Accordingly, performance measures for:

- Alternative 7C are assumed to be the same as for 7A.
- Alternative 7D are assumed to be the same as for 7B.
- Alternative 8B are assumed to be the same as for 8A.

This is because the only difference between 7C and 7A, 7D and 7B, and 8B and 8A is one additional operating constraint: a minimum discharge requirement of 6.5 m^3/s from 1 August to 14 October. Since this discharge is already met in most years for Alternatives 7A, 7B and 8A, the addition of this operating constraints was not expected to affect the median values or even the 10^{th} percentile values.

Note: Alternatives shown in the following hydrographs with **"o"** at the end indicate there is a maintenance outage modelled as part of the alternative; **"no"** at the end indicates no maintenance outage.

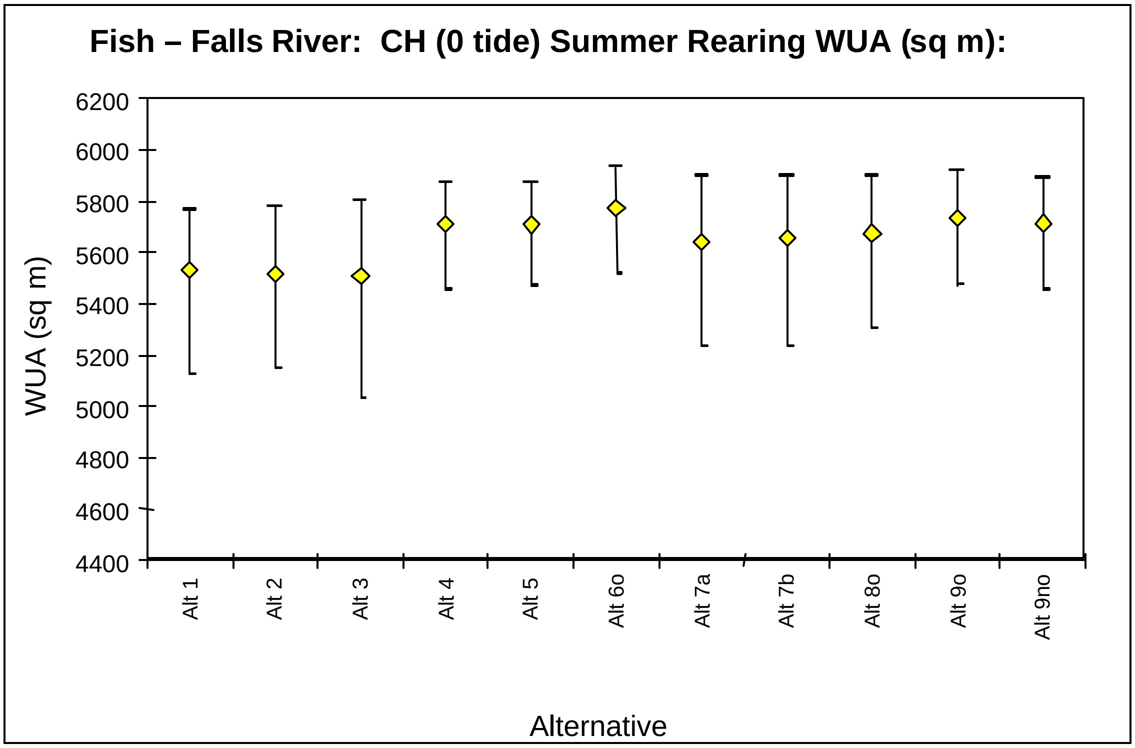

Figure J-1: Summer river rearing habitat performance measure for chinook salmon in Falls River

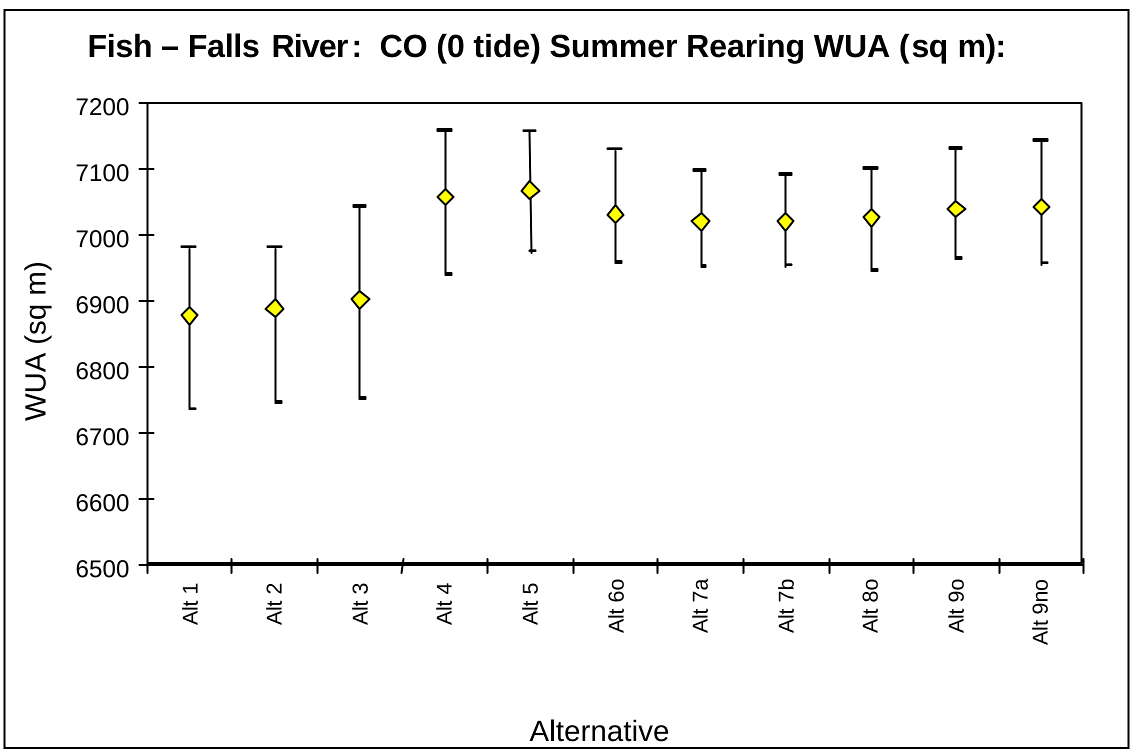

Figure J-2: Summer river rearing habitat performance measure for coho salmon in Falls River

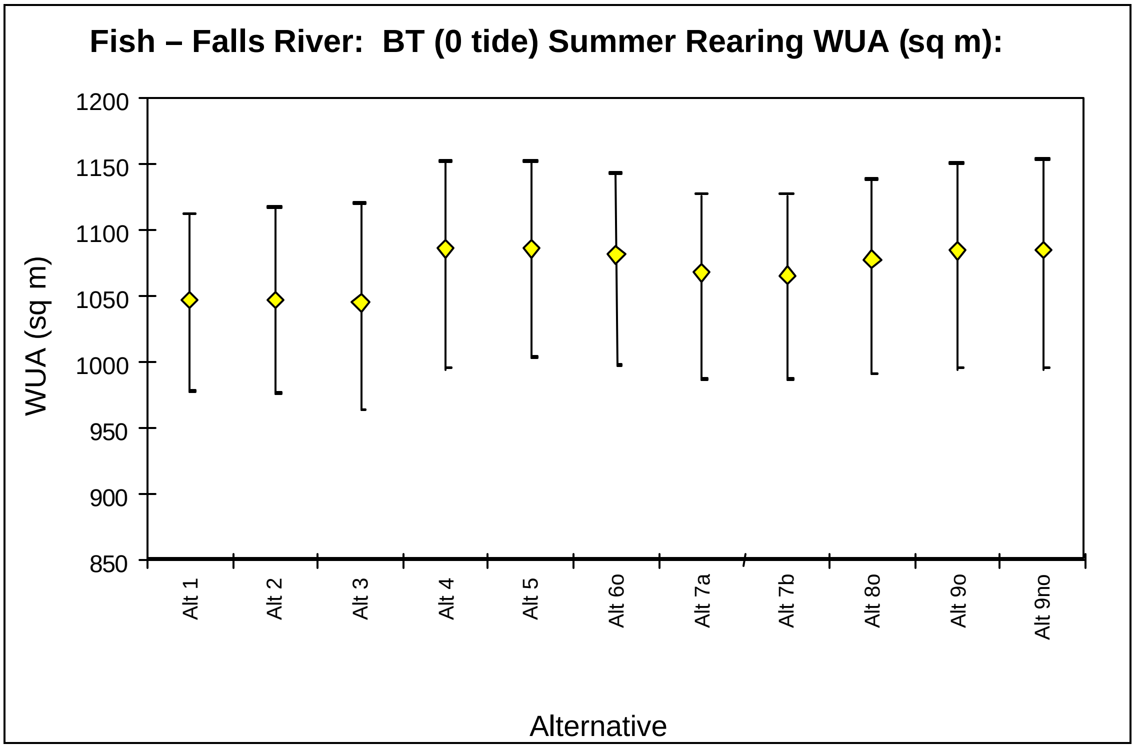

Figure J-3: Summer river rearing habitat for bull trout in the Falls River

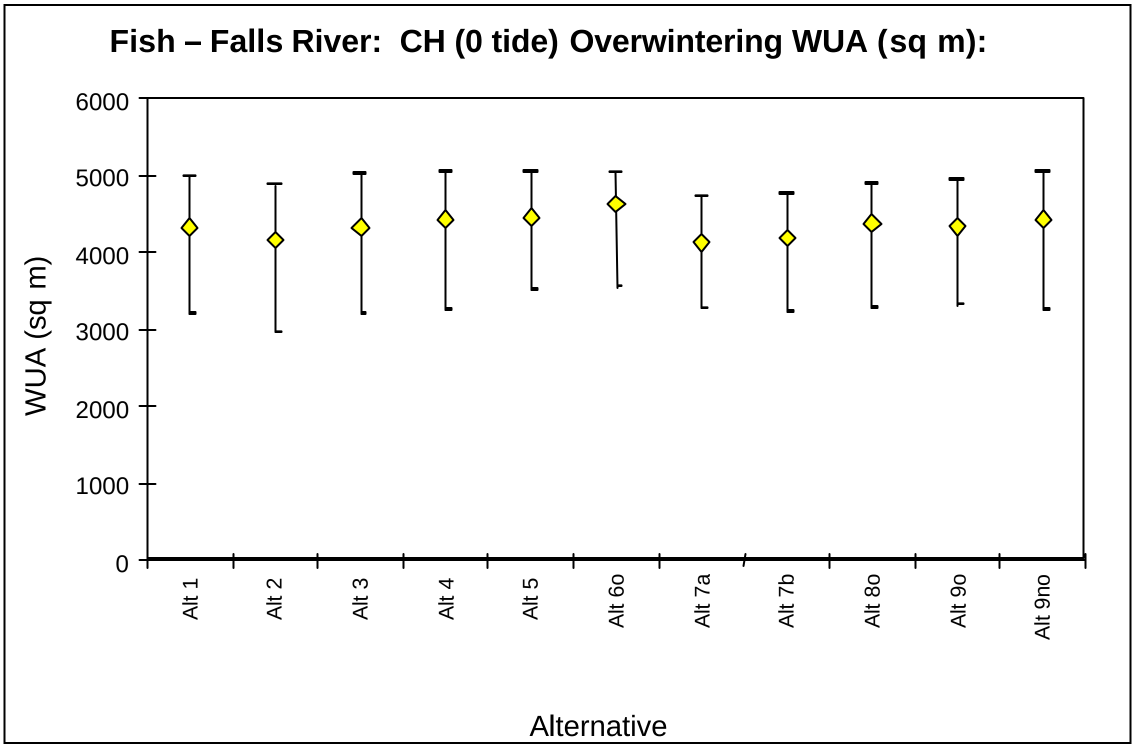

Figure J-4: Winter river rearing habitat performance measure for chinook salmon in Falls River

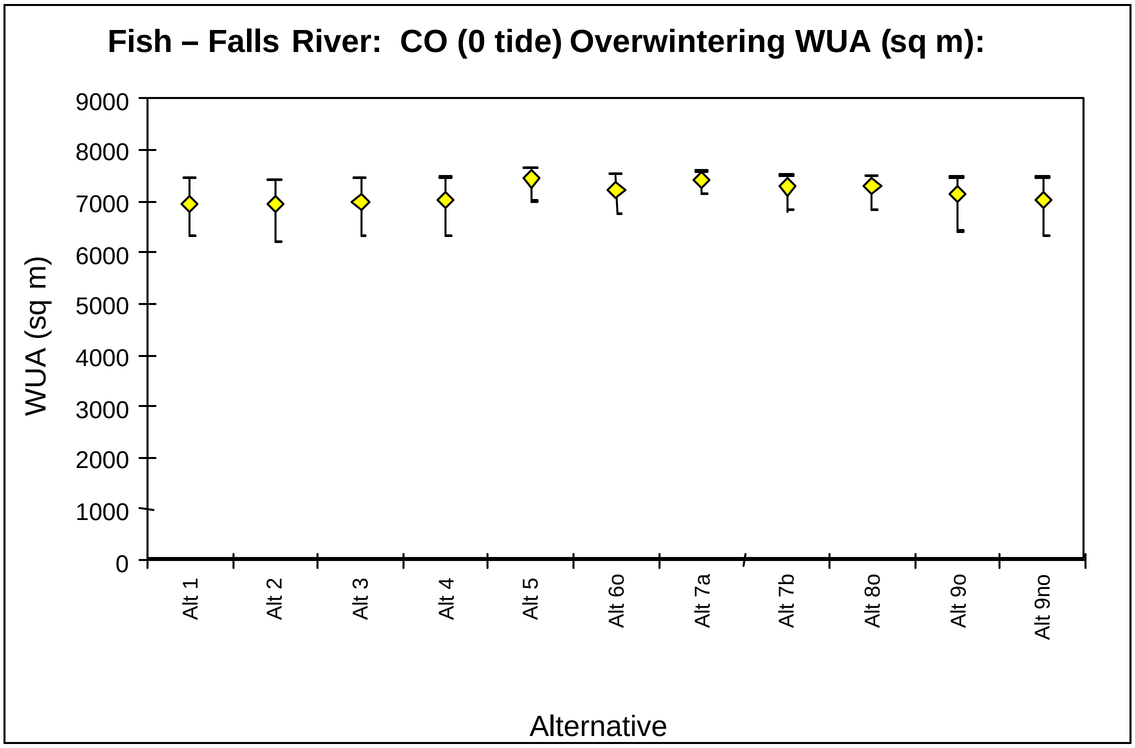

Figure J-5: Winter river rearing habitat performance measure for coho salmon in Falls River

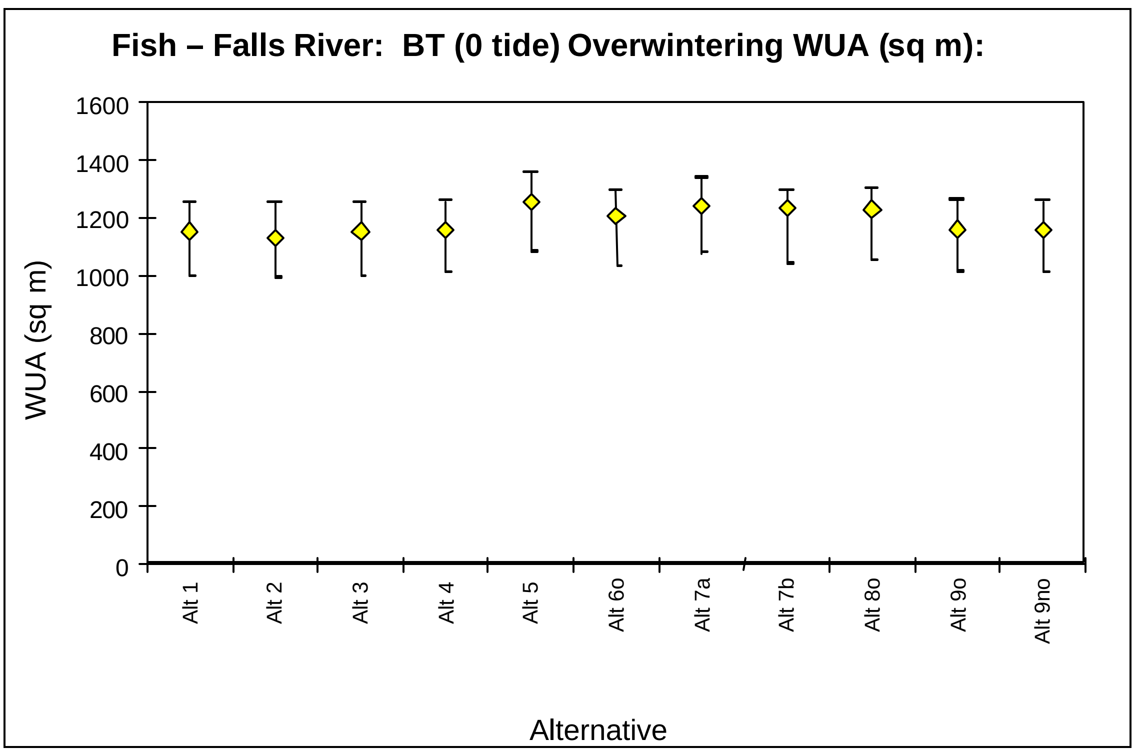

Figure J-6: Winter river rearing habitat performance measure for bull trout in Falls River

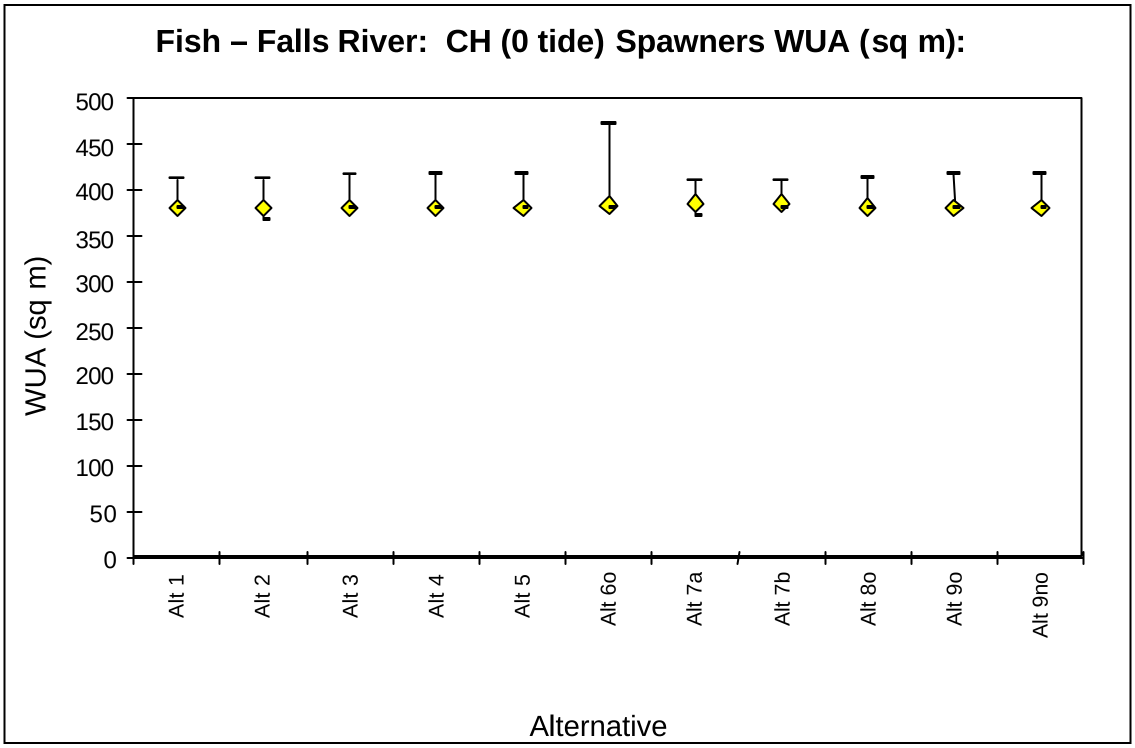

Figure J-7: Spawning river habitat performance measure for chinook salmon in Falls River

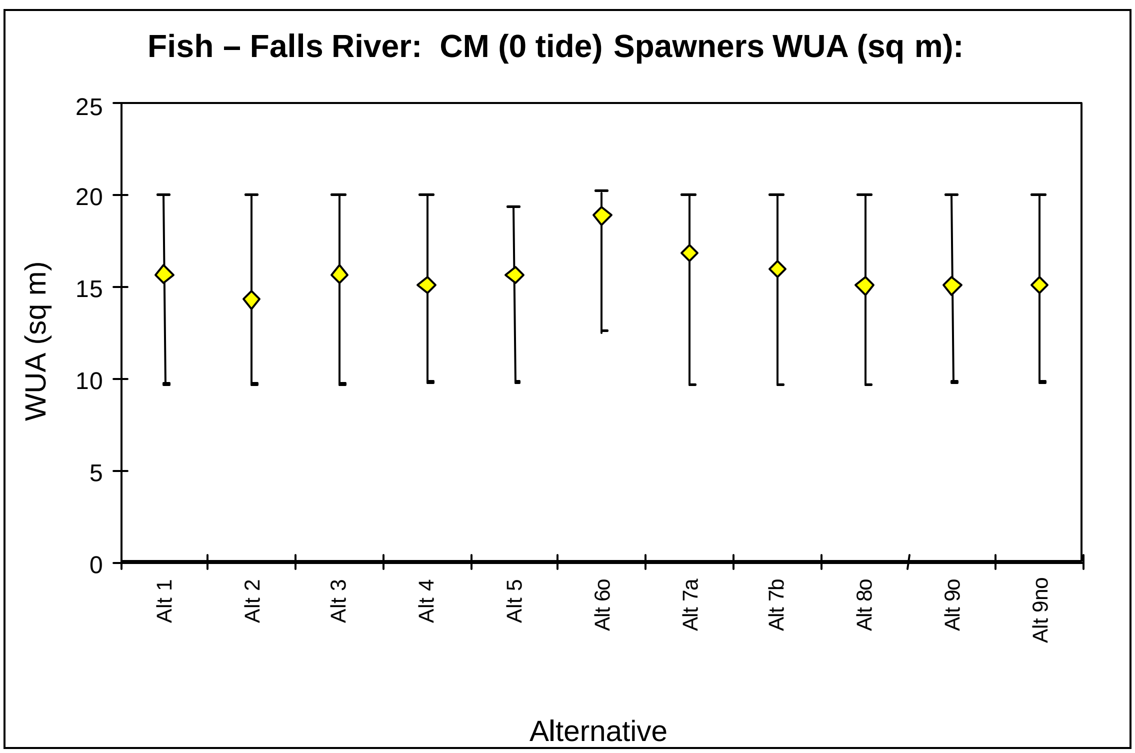

Figure J-8: Spawning river habitat performance measure for chum salmon in Falls River

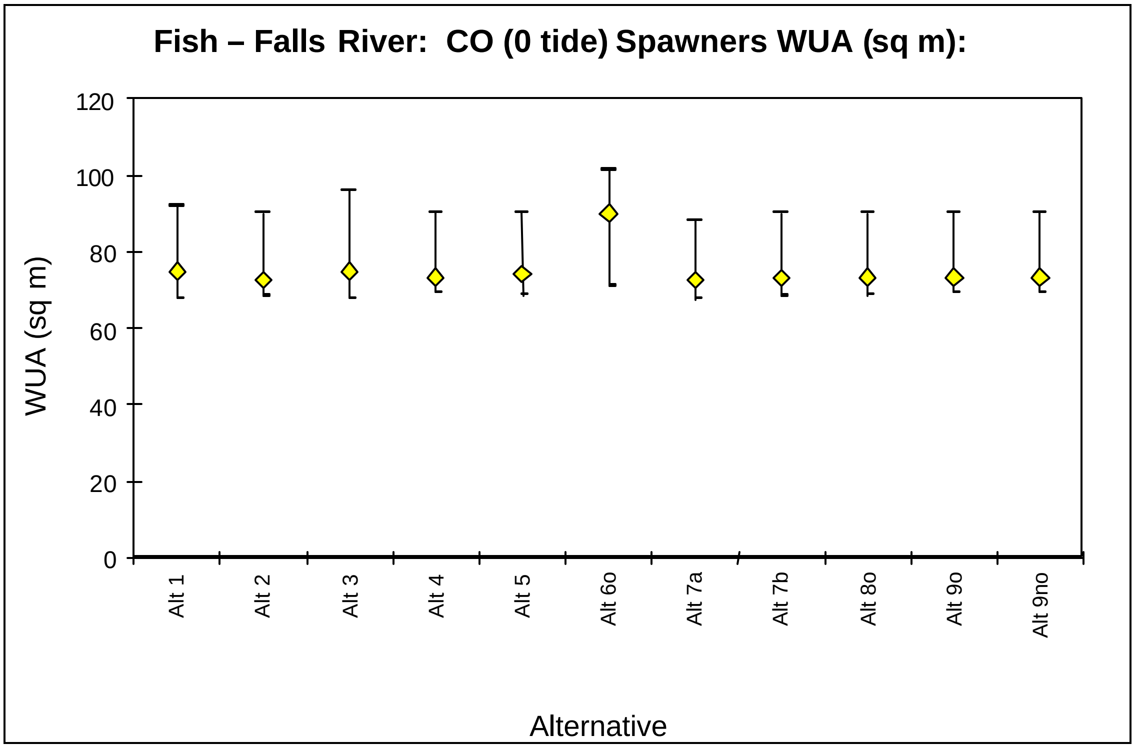

Figure J-9: Spawning river habitat performance measure for coho salmon in Falls River

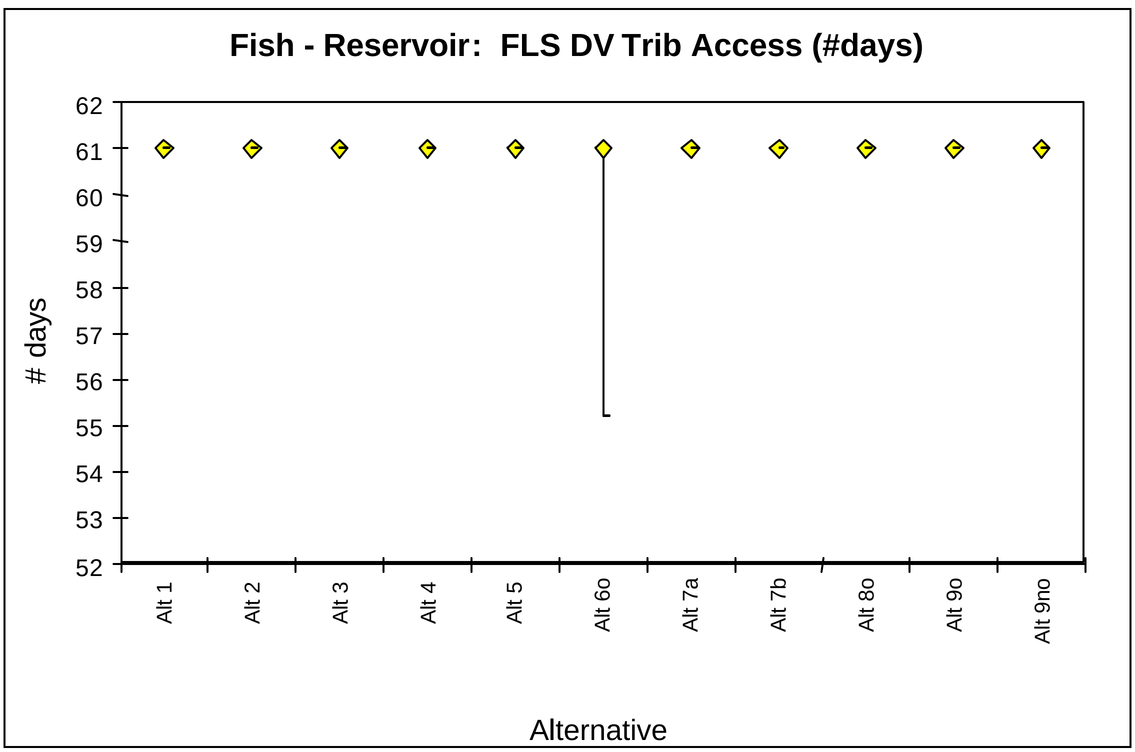

Figure J-10: Tributary access performance measure for Dolly Varden in Falls Reservoir

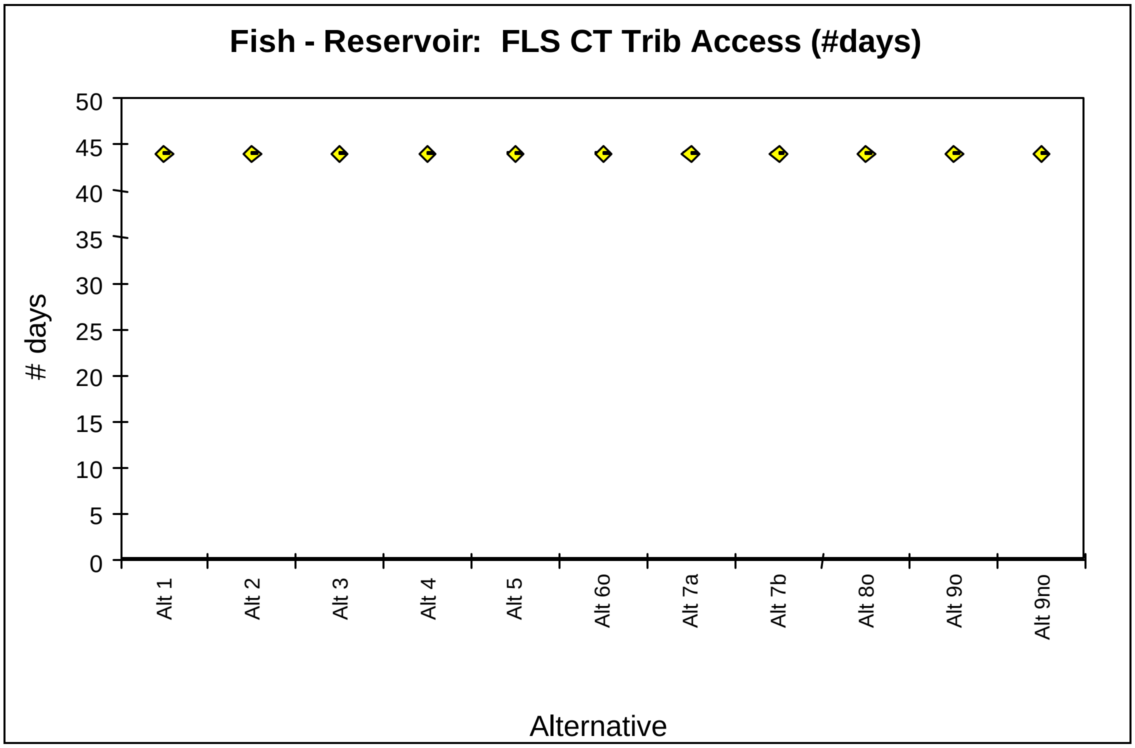

Figure J-11: Tributary access performance measure for cutthroat trout in Falls Reservoir

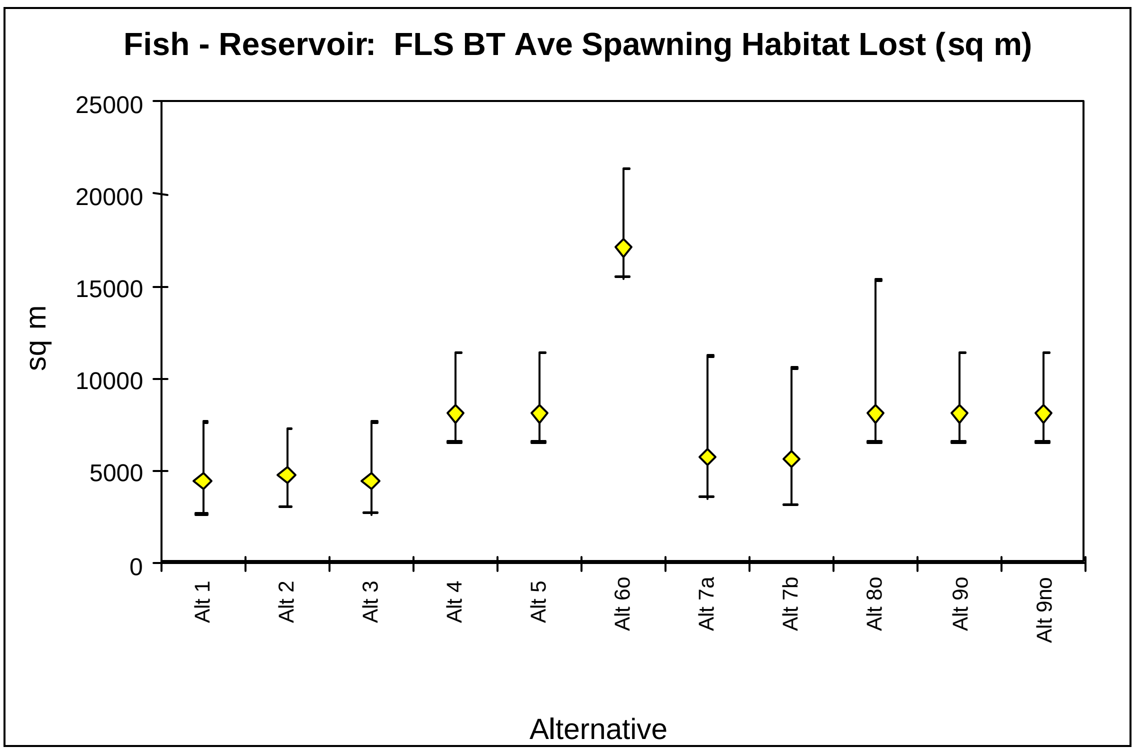

Figure J-12: Tributary spawning habitat lost performance measure for Dolly Varden (bull trout) in Falls Reservoir

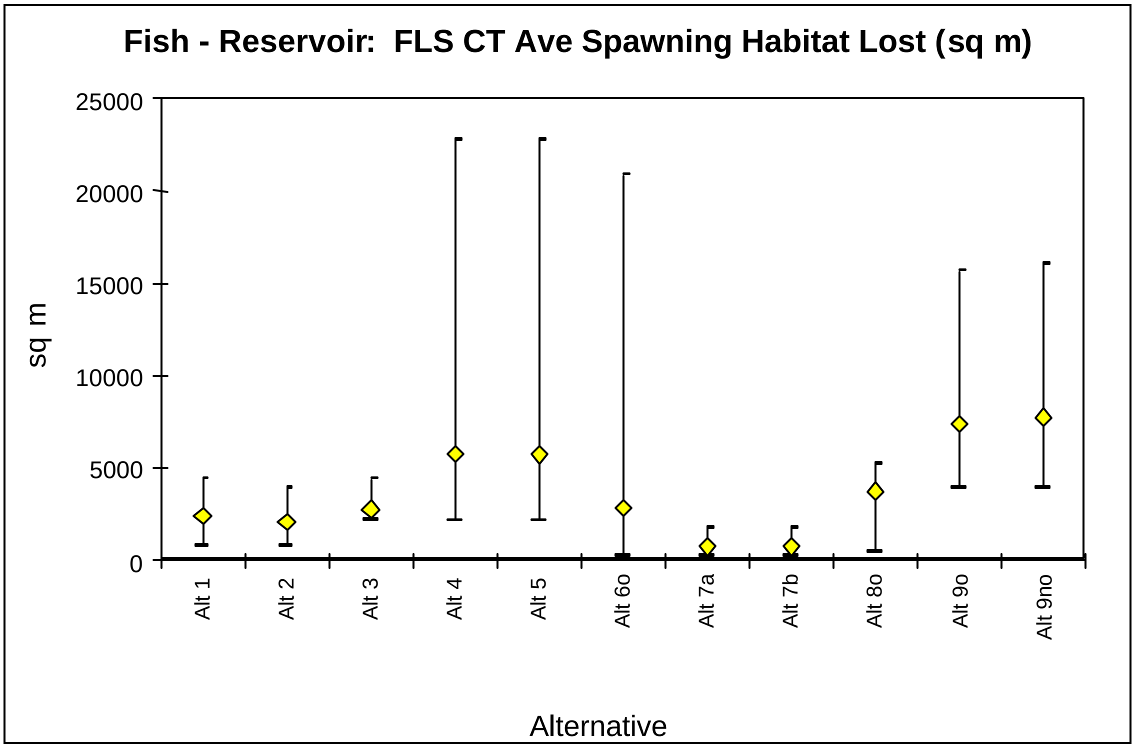

Figure J-13: Tributary spawning habitat lost performance measure for cutthroat trout in Falls Reservoir

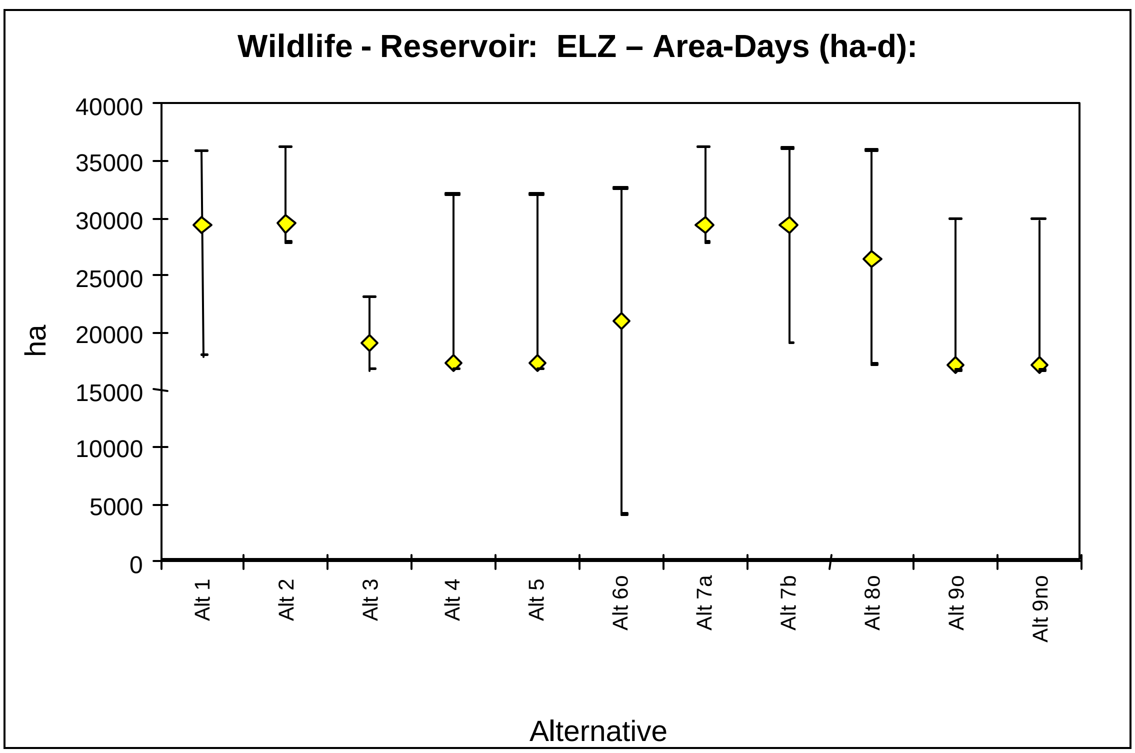

Figure J-14: Effective littoral habitat performance measure for fish and wildlife in the Falls Reservoir

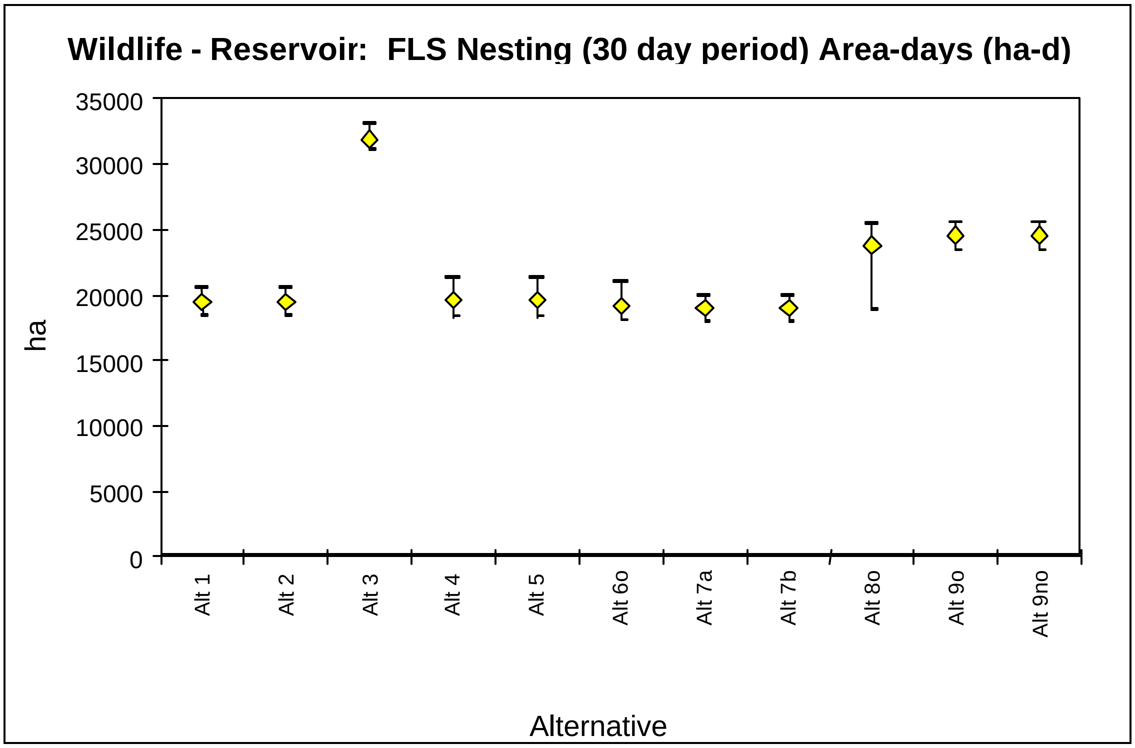

Figure J-15: Shoreline habitat performance measure for nesting and denning wildlife in Falls Reservoir

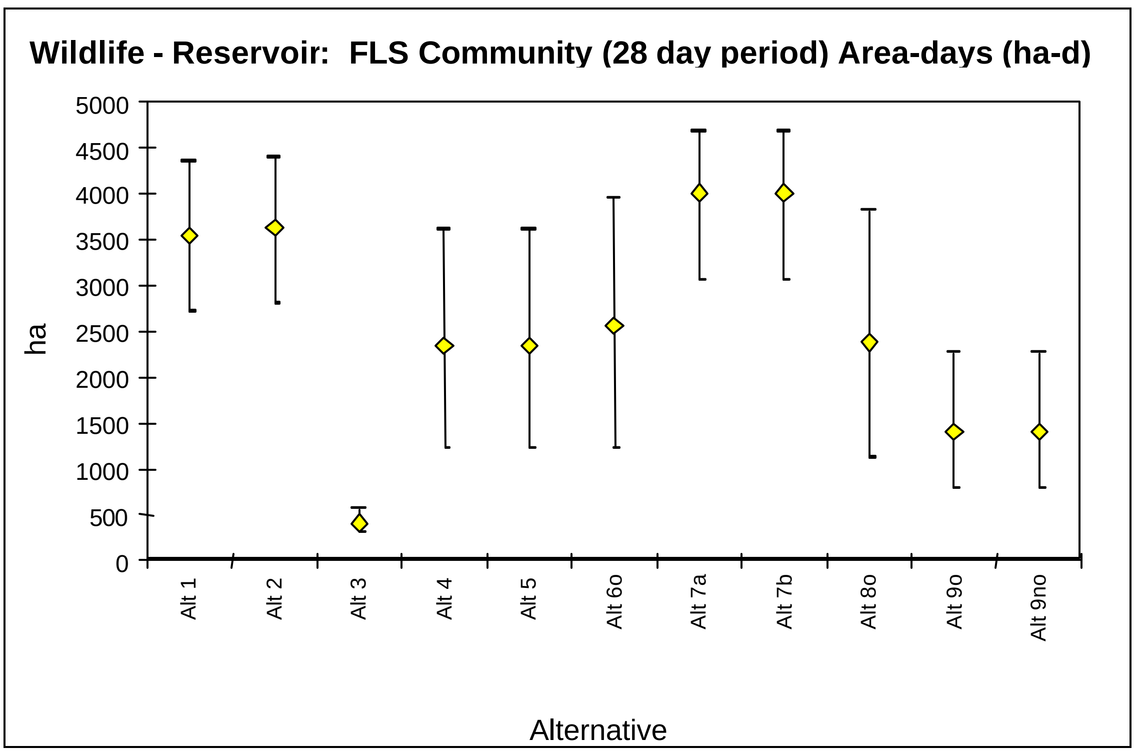

Figure J-16: Sedge grass community maintenance performance measure for riparian wildlife habitat around the Falls Reservoir

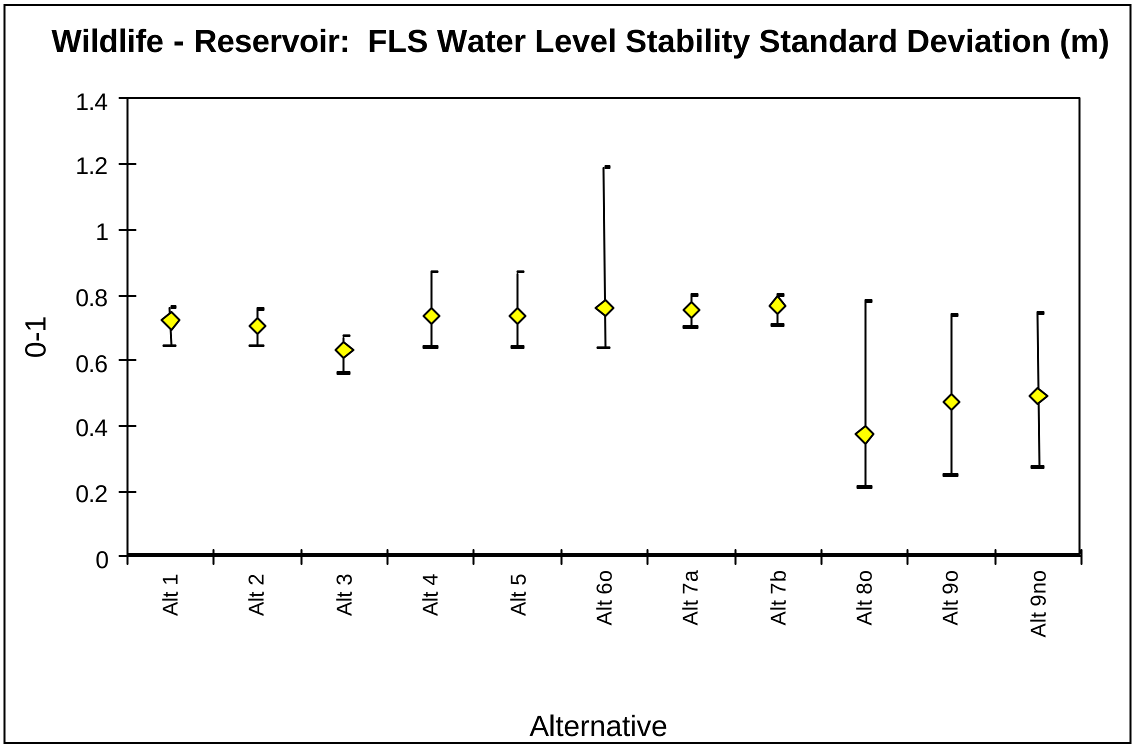

Figure J-17: Water level stability performance measure for Falls Reservoir

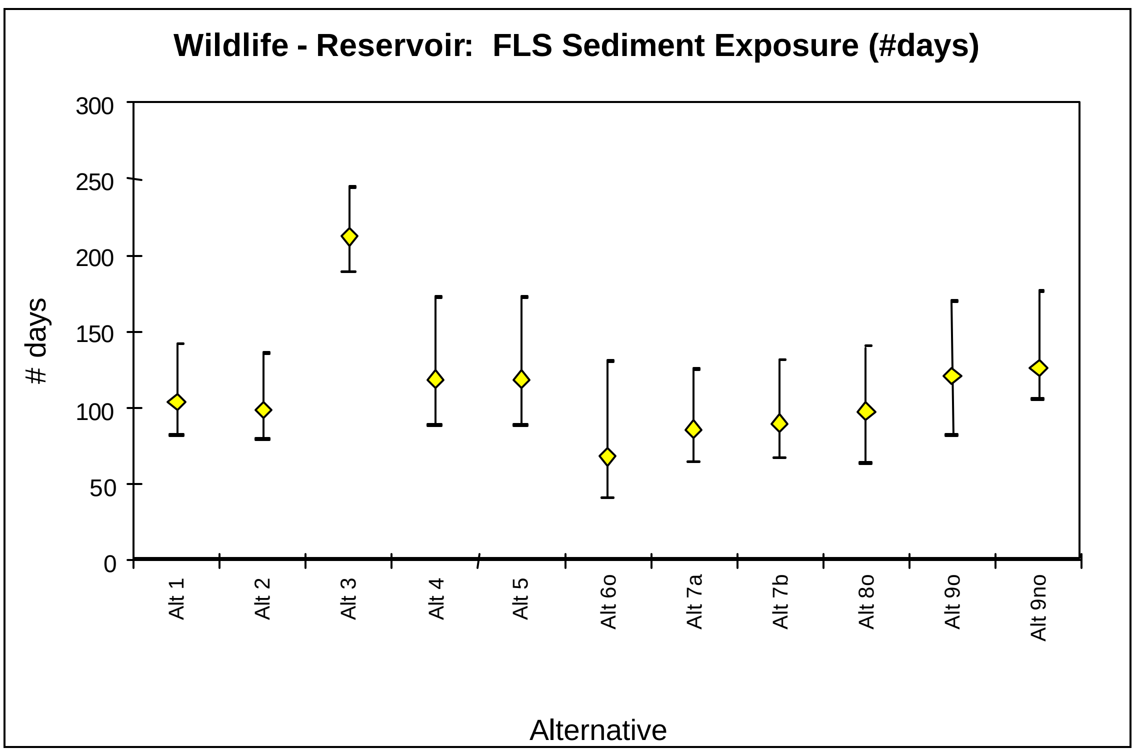

Figure J-18: Sediment exposure and velocity index performance measure for Falls Reservoir

APPENDIX K: ELIGIBILITY CRITERIA FOR WATER USE PLAN MONITORING STUDIES

The Water Use Plans for the BC Hydro facilities will contain recommended operational changes that are designed to address issues identified during the development of the Water Use Plans. However, a significant degree of uncertainty may exist regarding the effectiveness of the recommended operational changes. This uncertainty is largely due to the difficulty in drawing scientifically defensible conclusions with limited information. In some cases, there will be a need to verify the effectiveness of the recommendations put forward by the Water Use Plan Consultative Committees. These specific Water Use Plans will include recommendations for a monitoring program that will provide additional data designed to measure results/effectiveness of the operational changes specified by the Comptroller of Water Rights for each of the facilities.

Monitoring Program Elements

The primary objectives of the post-implementation Water Use Plan Monitoring Program will be to assess whether the operational changes, as specified in the Water Use Plan, provide the expected results (in terms of the performance measures and/or the fundamental objectives), or whether the operations need further adjustment (which could include adjustment back to the Reference Case operations).

Principles

The individual Water Use Plan Consultative Committees will be responsible for defining and prioritizing the recommended post-implementation monitoring studies. The recommendations for monitoring studies will be included in the Consultative Committee Report and the Water Use Plan presented to the Comptroller of Water Rights. Each monitoring study will be designed to meet the following principles:

- An expected result from each study must have the potential to change the way water is used at BC Hydro facilities.
- Each study must have the ability to distinguish between competing hypotheses. This can be assessed using a range of techniques, from a calculation of statistical power to professional judgement around the weight of evidence.
- Each study must be able to show results in a timely manner (e.g., by the next scheduled Water Use Plan review).
- Each study must show cost effectiveness by demonstrating that it is the least expensive way to generate that level of learning both within that Water Use Plan and across other Water Use Plan monitoring programs.

In order to ensure that the above principles are met, requests for monitoring studies should be described in sufficient detail to allow the evaluation of objectives, methodologies, deliverables, and estimated costs. This information will be collected by having the relevant Subcommittees and then the Consultative Committee fill out the

"Information Matrix for Water Use Plan Monitoring Requests" found later in this section (see Table K-1).

Decision Tree for Evaluating Water Use Plan Monitoring Requests

The following decision tree embodies the principles of monitoring laid out by the Water Use Planning Inter-Agency Committee developing monitoring protocol. This tree is to be used in conjunction with input from the Water Use Planning Management Committee (MC), Resource Valuation Advisory Team (RVAT) and Fisheries Advisory Team (FAT), and will be used by the facilitator to assist Subcommittees and the Consultative Committee in assessing monitoring requests. Step 1 starts at the Subcommittee levels and this process is carried out for each proposed study (see Figure K-1).

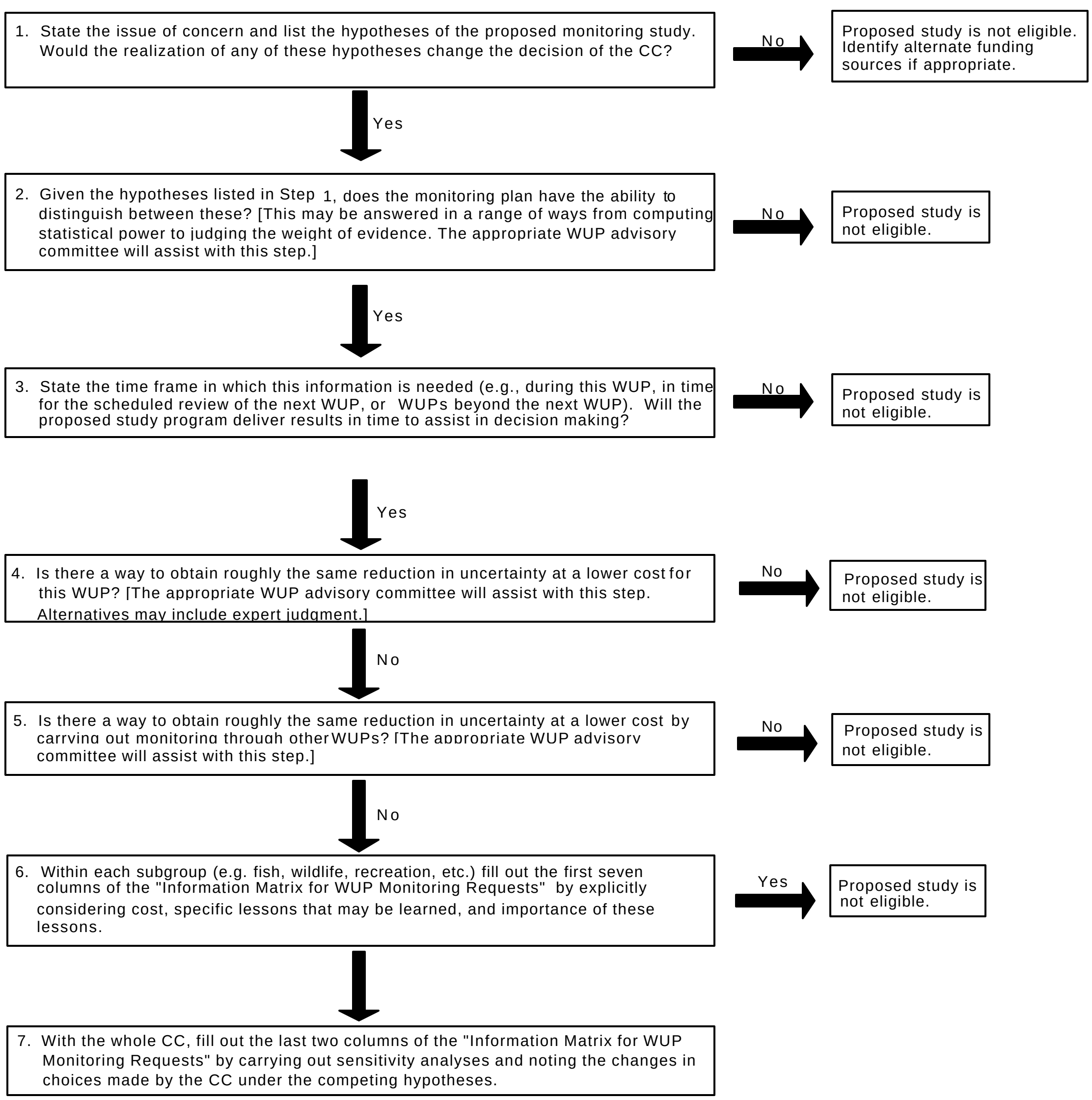

Figure K-1: Decision Tree for Evaluating Water Use Plan Monitoring Requests

Table K-1: Information Matrix for Water Use Plan Monitoring Requests

Study	Description	Data Gap Addressed	Learning	Duration	Time Frame	Cost	Willingness to change operations	Overall Rating
Location of Water Use Plan, Title of Study, Interest Area.	*Describe the scope and methodology for the study.*	*List the issue, the competing hypotheses and the estimates of the probability of these competing hypotheses being true.*	*Assess the amount of learning expected through monitoring (high, medium, low).*	*Estimate the duration of study program.*	*State the time frame in which the information will be used (before, during or after the next WUP review).*	*Estimate the cost of the study (including any losses of power revenue).*	*State the willingness of the Consultative Committee to change water allocation (high, medium or low).*	*State the overall rating/priority of the study given the information in all the other columns.*

Filling out the Information Matrix

The Subcommittees can fill out the first seven columns, and the last two are filled out by the Consultative Committee.

"Willingness to Change Water Allocation" Scale Explained

These scales will be developed once the final choice of the Consultative Committee (CC) has been made. At that time, key uncertainties about the performance measures and/or their link to fundamental objectives can be tested through sensitivity analyses, and the change in the support from the CC for the various alternatives considered can be observed.

High Importance: It is *clear* that the CC will change its final choice if one of the alternative hypotheses prevails. This change includes a shift in support *away* from the original choice made and the convergence of the CC's support on another, *existing* alternative.

Medium Importance: A large shift in support away from the final choice of the CC takes place under one of the competing hypotheses. This shift in support may include some people preferring to block the original choice of the CC. However, *it is not clear* that another, *existing* alternative would be chosen by the CC under this competing hypothesis.

Low Importance: A shift in support away from the final choice of the CC may occur. However, *it is clear* that the final choice of the CC will not be changed to another, existing alternative. This decision may be a non-consensus Water Use Plan.

"Learning" Scale Explained

High - monitoring study will definitely lead to quantitative discrimination among all of the competing hypotheses.

Medium - monitoring study will likely lead to the ability to discriminate quantitatively among some of the competing hypotheses.

Low - likely to allow only qualitative comparisons among a few competing hypotheses.

"Overall Rating of Study" Scale Explained

High Importance - There is a consensus (or close) agreement that this monitoring program should be included as a request within the consultative report.

Medium Importance - There is no clear consensus as to whether this monitoring program should be included as a request within the consultative report.

Low Importance - There is a consensus (or close) agreement that this monitoring plan should not be included as a request within the consultative report.

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APPENDIX L: EVALUATION OF PROPOSED FALLS RIVER WATER USE PLAN MONITORING STUDIES

At their second meeting on 11–12 February 2003, the Falls River Water Use Plan Consultative Committee developed a preliminary list of potential monitoring study topics. All of these related to uncertainty associated with key performance measures and their underlying fundamental objectives (see Table L-1).

Table L-1: Proposed monitoring studies discussed by the Falls River Consultative Committee at 11–12 February 2003 meeting

Related to which PM?	Data Gap to be filled	Hypothesis/Assumption to be tested	Discussion
Fish Rearing Production – River	Baseline data on current use of the area by juveniles.	More juveniles would use the Falls River if minimum flow is increased.	Too many confounding factors for monitoring to provide useful results.
Fish Rearing Habitat – River	Baseline data on current quantity of habitat and relationship to flow.	Rearing habitat in the Falls River downstream of the project will increase in response to an increase in minimum flow.	Results would not change recommendation since high certainty that an increase in minimum flow will provide benefits and will not exceed optimum levels for any fish species.
Fish Spawning – River	What is the factor that is currently limiting spawning in the Falls River?	The biggest limiting factor for spawning is the quantity and quality of substrate.	It would be helpful to know what is the egg to fry survival ratio is?
Tributary Access – Reservoir	Current level of use of tributaries for spawning.	There is a barrier to tributary access at reservoir elevations below 88.4 metres.	Monitoring could be as simple as a site visit at low reservoir to assess any barriers. If barrier is higher than 88.4 m, monitoring results may change recommendation – otherwise not.
Sedge Habitat Maintenance	What is the minimum duration and frequency of flooding required to maintain sedge habitat?	The new flashboard schedule and flooding regime will not alter the quantity or composition of the sedge.	Adam Lewis to discuss appropriate monitoring with a sedge expert, Anne Moody. See her report (Moody, 2003).
Fish Littoral Habitat – Reservoir	Baseline data on littoral productivity.	The area and productivity of littoral habitat in the reservoir will increase if the reservoir fluctuates less.	Need for monitoring depends on the alternative that is chosen – results may or may not change the Committee's recommendations.
Tributary Backwatering – Reservoir	Baseline data about current the use of reservoir tributaries for spawning.	Depends on the operating alternative chosen.	n/a
Wildlife Shoreline Habitat – Reservoir	Baseline data on how nesting and denning species use the habitat around reservoir?	Depends on the operating alternative chosen.	n/a

Water Use Plan Principles for Evaluating Monitoring Studies

The Falls River WUP Consultative Committee was responsible for defining and prioritizing the recommended Water Use Plan monitoring studies to address uncertainty. The recommendations for monitoring studies will be included in the Water Use Plan presented to the Water Comptroller for approval. Each monitoring study should be designed to meet the following principles or screening criteria:

1. **Efficacy –** the study will provide results that could change the way water is used at the Falls River facility.

   Test: Could the results from the study change the Committee's recommendations?

2. **Sensitivity –** the study will distinguish between competing hypotheses or assumptions.

   Test: If the Committee's recommendations are based on more than one hypothesis or assumption, can the proposed monitoring study isolate the impact of each hypothesis or assumption?

3. **Timeliness –** the study must be able to show results in a timely manner.

   Test: Will the proposed study program deliver results in time to assist in decision making during the next WUP Review?

4. **Cost Effectiveness –** the study is the least expensive way to generate that level of learning both within that WUP and across other WUP monitoring plans.

   Test: Is there a way to obtain roughly the same reduction in uncertainty at a lower cost for this WUP?

An additional consideration that is not addressed for each of the proposed monitoring interests concerns impacts of the preferred alternative on the power interest. If the preferred alternative has insignificant cost to the power interest, there may be less interest in monitoring its effectiveness, since there would be no economic impact on operations.

Screening Potential Monitoring Studies for Falls River

Next, the Consultative Committee reviewed its initial list of potential monitoring studies and evaluated them against the principles and requirements for Water Use Plan monitoring studies (see section above).

Table L-2 lists each monitoring interest discussed by the Consultative Committee and evaluates whether it meets each of the four Water Use Plan monitoring principles. Typically, that can be assessed as 'yes' or 'no'. For some interests, it was less clear whether they would meet a given principle, and this is indicated as a 'maybe'.

The key principle is efficacy: to qualify, a monitoring study must have the potential to lead to a change in the Consultative Committee's water allocation recommendations. For example, tributary spawning habitat backwatering is the driver behind the design of some of the operating alternatives considered by the Committee. This performance measure is critical to the interpretation and design of these alternatives. If monitoring of this performance measure showed the fish were not using the habitat of concern, the preferred alternative might change.

Sensitivity is another key principle. If an issue is poorly understood or if natural variation so high that monitoring is unlikely to yield useful new information (i.e., an ability to discriminate between alternatives), then monitoring would not qualify.

Timeliness is important for those performance measures where long term monitoring is required: very long programs may not meet the Water Use Plan review period time frame.

Cost effectiveness is important because monitoring proposals are considered with reference to BC Hydro's water use planning program as a whole. Proposals for individual Water Use Plan at specific facilities (like the Falls River Water Use Plan) will be compared across all Water Use Plans, and those individual proposals that provide the most learning per cost for the system as a whole will be favoured. Of course, there are some monitoring results that would only be relevant to Falls River (e.g., the location of barriers to migration).

Potentially Qualifying Monitoring Studies

Based on the assessment of how well each potential monitoring study meets the water use planning monitoring principles (Table L-2), six of the monitoring interests identified by the Falls River Water Use Plan Consultative Committee may qualify for funding under the water use planning program. Monitoring interests that appeared to qualify and were recommended by the Committee are described in Appendix M.

Table L-2: Evaluation of proposed Falls River Water Use Plan monitoring topics against provincial Water Use Plan monitoring principles

Monitoring Interest	Effective?	Sensitive?	Timely?	Cost Effective?	Meets WUP Principles?
Presence and Timing of Steelhead and Salmon Spawning	Yes. Finding no salmon or steelhead spawn in Falls River would reduce benefits of higher minimum flow and may lead to change in the preferred alternative.	High sensitivity. The presence of adult salmon in the restricted area can be verified with proven techniques.	Yes. Will require five years of monitoring to verify presence or lack thereof.	Small study area minimizes cost but duration of spawning by salmon and steelhead requires repeated trips. Data are site-specific and cannot be inferred from other WUPs.	Yes

Table L-2: Evaluation of proposed Falls River Water Use Plan monitoring topics against provincial Water Use Plan monitoring principles (cont'd)

Monitoring Interest	Effective?	Sensitive?	Timely?	Cost Effective?	Meets WUP Principles?
Fish Rearing Production – River	Yes. Finding that no additional fish were produced by higher minimum flow (and therefore that other factors control production such as tidal effects or recruitment) would reduce benefits of higher minimum flow and may lead to change in the preferred alternative.	Low sensitivity. Many confounding factors for monitoring to provide useful results. Tidal effects confound monitoring. Migration from Falls River River to Ecstall may mask effects.	May take five or more years.	Small study area minimizes cost. However, long term study is required and multiple parameters to be measured.	No
Fish Rearing Habitat – River	No. High certainty that an increase in minimum flow will provide more physical habitat. Therefore, little chance that results could change recommendation for higher minimum flow.	High sensitivity. Additional habitat measurements would provide high certainty that increased flow releases result in increased habitat.	Yes. Within one field season.	Small study area minimizes cost. Information is site specific and not likely to be gained from other WUPs.	No
Fish Spawning Habitat – River	Yes. We are uncertain whether minimum flow is important to effective spawning habitat. A finding that minimum flow is not important may change the preferred alternative.	Can be sensitive if focused on key parameters like egg-fry survival. Tidal effect can be measured by timing measurements to periods of minimal tide fluctuation.	Yes. A season is required for each treatment. May take several years, but should be complete within five years.	Yes. Moderate cost, but site specific info precludes using other WUP studies.	Yes
Sedge Habitat Maintenance	Yes. Sedge habitat maintenance is focus of some alternatives. Timing of reservoir operations will change dependent on sedge requirements.	Yes. Finite distribution of sedge suggests they are sensitive to water level fluctuations: can measure changes precisely.	Yes. Within five years.	Yes. However, may be able to extract necessary learning from ongoing work on Stave Reservoir.	Maybe. Stave Reservoir work may provide necessary information.

Table L-2: Evaluation of proposed Falls River Water Use Plan monitoring topics against provincial Water Use Plan monitoring principles (cont'd)

Monitoring Interest	Effective?	Sensitive?	Timely?	Cost Effective?	Meets WUP Principles?
Tributary Access and Shoreline Stranding – Reservoir	Yes. If barriers or stranding areas were discovered in upper drawdown zone then there would implications for alternatives.	Yes. Direct observation will provide high certainty of presence of barriers and stranding areas, therefore monitoring will be sensitive.	Yes. Within one field season.	Yes. Low cost and site-specific info precludes using other WUP studies.	Yes
Water Level Stability	No. The reservoir is relatively stable and closer to a natural lake in this parameter than to a reservoir. All operating alternatives show high stability.	No. The response of wildlife to stability of regime would be difficult to distinguish from effects of other factors (reservoir level, annual differences).	? May take years to understand effects of stability.	No. This could be better answered in a larger reservoir with larger drawdown magnitudes.	No
Fish Littoral Habitat – Reservoir	Maybe. Existing alternatives focused on minimizing drawdown. If drawdown was not damaging to the littoral zone then more water would be available for power generation and fish downstream, so the results of the study might lead to a change in operations.	No. The existing drawdown magnitude is low, therefore there may not be much of a difference between the existing operation and the preferred alternative. Small chance of observing an effect even if there is one.	May take years to understand.	No. Ongoing studies in other reservoirs with larger drawdown (e.g., Stave) will have a better chance of answering this question. Stave is a coastal system therefore results will probably be transferable.	No
Tributary Back-watering – Reservoir	Yes. Current alternatives designed around this issue.	Yes. Potential impacts from backwatering occur and can be measured accurately and precisely.	Yes. Within one field season.	Yes. Low cost and site-specific info precludes using other WUP studies.	Yes
Wildlife Shoreline Habitat – Reservoir	Yes. Changes in operations may improve habitat for nesting or denning.	Yes. Key information on presence of nests and dens can be accurately collected.	Yes. Within one or two field seasons.	Yes. Key information is site specific and inexpensive to collect.	Yes

APPENDIX M: FALLS RIVER WATER USE PLAN RECOMMENDED MONITORING PROGRAM

This appendix outlines the monitoring program recommended by the Falls River Water Use Plan Consultative Committee. The monitoring program consists of six monitoring studies. The Committee has evaluated each study against the four key eligibility criteria for water use planning monitoring studies, and believes these studies could qualify. The costs estimated here are roughly estimated and assume that external consultants are retained for this work and that each study is implemented on an individual basis. Costs may be substantially reduced by using in-house (BC Hydro) staff, implementing more than one of the studies simultaneously or combining this work with other environmental monitoring activities in the area.

STUDY 1 – PRESENCE AND TIMING OF STEELHEAD AND SALMON SPAWNING

The primary management question for this monitoring study is: Do steelhead and salmon spawn in the Falls River tailpond? Given this management question the primary hypothesis is: H_o: steelhead and salmon do not spawn in the tailpond, and H_a: they do spawn in the tailpond. A secondary but important question is: When do steelhead and salmon spawn in the tailpond?

The key water decision use affected is the minimum flow provided by power plant to the Falls River. Water used to provide this minimum flow could otherwise be stored (at some times of the year) for generation or used to maintain a higher reservoir elevation.

The proposed study meets all four principles of water use planning, as long as the study period is limited to the months of April, September and October when there is potential to recommend a change in operations. BC Hydro has the ability to influence total discharge levels during these months, but not from May to August. However, to accurately determine presence and timing, the months of March and August need to be included in the study. If the study is to be limited, the following priorities are suggested:

- *Steelhead*: If the duration is to be limited to only one month for steelhead, April is the most appropriate month. If two months are possible, March and April are recommended.
- *Salmon*: If the study must be limited to only two months for salmon, 15 August to 15 October is likely the most appropriate timing. If three months are possible, August, September and October are recommended.

The sensitivity of this monitoring study is high. Spawning adult salmon and steelhead are highly visible in clear water and easily captured in turbid water using a various proven techniques.

The proposed monitoring study will observe and/or capture adult steelhead and salmon using several techniques applied to suit on-site conditions.

The study will consist of the following tasks:

1. Sample the Falls River tailpond every 10 days during key months. In order to accurately determine presence and timing, monitoring should ideally be conducted from 1 March to 30 April and 15 August to 31 October. If the study is to be limited, then at a minimum, monitoring should be conducted from 1 April to 30 April and 15 August to 15 October.

2. Observe or capture adult salmon and steelhead by using one or more of the following techniques: boat survey, snorkel survey, underwater video, tangle net, gill net, seine net and angling. Gill net and seine net are not recommended for steelhead because those methods often results in death or severe loss of fish scales. Angling is likely to be the best method for sampling steelhead and is often a useful method for sampling other species such as chinook. The behaviour of salmon holding, territorial defence, nest digging, spawning etc. will be documented, as will the condition and adult spawners (green or ripe, pre- or post-spawn). It will also be necessary to sample post-spawners and count retained eggs (again, to provide evidence of spawning). Note that juvenile surveys, which can confirm adult spawning by capturing juveniles post-emergence, will be insensitive here because egg-fry survival may be very low. Further, juvenile presence will be confounded by the influence of juveniles from stocks in the Ecstall River (a few hundred metres downstream).

3. Snorkel or video tape potential spawning areas to identify redds during and post spawning. This technique will require clear water and may be ineffective for steelhead, which spawn in turbid water during the spring freshet. However, it may be possible to hold water back in the reservoir for a few hours to lower flows in the tailpond and increase visibility during a brief survey of potential spawning areas post spawning. Any redds identified can be partly excavated to demonstrate the presence of eggs.

4. Analyze data and interpret effects of flow regime changes.

5. The high degree of variability in spawning escapement, particularly in marginal populations where no returns have been previously recorded in some years, requires multiple years of data collection. Careful documentation of the behaviour and condition of the captured fish will be required because salmon straying from the Ecstall River may enter the tailpond, hold there, but not spawn. Since interest concerns spawning rather than holding and we must observe spawning or infer spawning from a composite of observations. Adult salmon defend their nests after spawning, so the capture of live, spent adults will be compelling evidence that spawning has taken place. Further, the presence of redds will be evidence that spawning has taken place. Any redds observed could be partly excavated to demonstrate the presence of eggs. This activity could be combined with the “Fish Spawning Habitat (River)” monitoring program to reduce costs and increase effectiveness. That program proposes to place egg

boxes in-river using divers, who could assist this study by looking for and excavating redds in deep water.

The cost of the monitoring program is expected to be $12,000 per annum over five years for a total cost of up to $60,000. This cost is based on a one-day long trip every 10 days over two periods: one month in April and two months in September and October. This frequency can be modified based on site-specific information or professional opinion. It will probably be more effective to cluster the observations around the most likely dates for spawning, rather than space them out evenly over the two periods. The cost may be reduced by overlapping with Fisheries and Oceans Canada work that is currently being planned for the area.

STUDY 2 – FISH SPAWNING HABITAT IN THE RIVER

The primary management question for this monitoring study is: Do increases in the minimum flow increase the effective spawning habitat of salmon? Given this management question, the primary hypothesis is: H_o: existing flow is better, and H_a: the preferred alternative is better.

The key water decision use affected is the minimum flow provided by power plant to the Falls River. Water used to provide this minimum flow could otherwise be stored (at some times of the year) for generation or used to maintain a higher reservoir elevation.

The proposed study meets all four principles of WUP planning. The sensitivity of this monitoring study will strongly depend on the specific variable monitored. Adult spawning density or adult returns would not be sensitive measures of habitat effectiveness. In contrast, egg-fry survival should show a rapid response to changes in river flow.

The proposed monitoring study will evaluate salmon egg-fry survival using experimental egg boxes while monitoring physical parameters important to egg incubation. By combining survival data with physical parameters, we will be able to directly measure the effects of depth and velocity and be able to infer the effect of specific flow regimes.

The study will consist of the following tasks:

1. Collect eggs from adult broodstock (either Falls River or another stock) and placed in egg boxes.

2. Plant egg boxes – survey in location so they can be retrieved.

3. Monitor depth, velocity, salinity and substrate at each location repeatedly during incubation.

4. Retrieve the boxes prior to egg hatching and evaluate mortality.

5. Analyze data and interpret effects of flow regime.

The high degree of variability in river flow between years may require that multiple years of data be collected to define the effects of low flow operations. The effect of a minimum flow will not be measurable in high flow years, creating the risk that any individual year of study may not yield useful results from the perspective of testing the effect of a particular flow regime. However, learning can be advanced by using the relationships between egg-fry survival and habitat parameters observed in any one year to infer the potential effects of various flow regimes. For example, if a strong link between velocity and survival is identified, the existing habitat model can be re-run, substituting the new information for the HSI curve used for our current modelling. Such an approach would allow us to lever the new information gained to increase the rate of learning, and may avoid multiple years of monitoring. At this time, the rate of learning is hard to predict, so while a single year may provide adequate information, we have planned for 5–years of monitoring to ensure that useful results are provided.

The cost of the monitoring study is expected to be $20,000 per annum over five years for a total cost of $100,000. This cost may be reduced by overlapping with work by Fisheries and Oceans Canada (DFO) that is presently planned for this and possibly future years.

STUDY 3 – TRIBUTARY ACCESS AND SHORELINE STRANDING IN THE RESERVOIR

The primary management question for this monitoring study is: Are there barriers in the area of potential drawdown within the reservoir and are there locations of possible stranding along the reservoir? Until the location of barriers and potential stranding are known, we cannot reliably understand whether operating alternatives will create blockages to upstream migration or whether drawdowns will strand fish.

The key water decision use affected is the operating regime for the reservoir. This has implications for the minimum flow provided by power plant to the Falls River and therefore on power and downstream fisheries interests.

The proposed monitoring study will meet the principle of sensitivity because it will be straightforward to determine the location and height of barriers, and potential areas of stranding should be readily identifiable by examining the shoreline and looking for isolated pools of water. Given that the proposed monitoring study will meet water use planning monitoring principles, the study should be eligible for Water Use Plan funding.

The study would require access to the three major tributaries during a drawdown period and consist of a foot or boat survey to identify potential barriers to fish migration. Each barrier would be photographed and its height measured either with a tape or laser range-finder. The entire shoreline would be examined by boat to identify areas along the shore where water has pooled to create isolated habitats that strand fish. These isolated pools would be examined on foot and measured for area (length and width) and maximum depth. If extensive areas were identified it might be necessary to monitor them for several days to determine if they de-water and kill fish or persist and provide suitable habitat.

The study would require the following tasks:

1. Survey of each of the three tributaries within the drawdown zone and the lake shoreline during a low reservoir elevation condition (<88.4 m); and

2. Analysis and reporting.

The cost of this study is estimated at $5,000 for one year only. Since the study would be undertaken in a year of low reservoir elevation (less than 88.4 m), it might not necessarily occur in the first of second year following Water Use Plan implementation. However, there would probably be an opportunity to undertake the study within a five year span.

STUDY 4 – SEDGE HABITAT MAINTENANCE IN THE RESERVOIR

The primary management question for this monitoring study is: Can sedge habitat be effectively maintained by the preferred operating alternative? The key water decision use affected is the reservoir operating regime. This has implications for the minimum flow provided by power plant to the Falls River and therefore on power and downstream fisheries interests. This also has implications for the reservoir elevation maintained and therefore, has a minor effect on operating head and power production.

The proposed study may meet all four principles of water use planning. Although there is an ongoing monitoring program on the Stave Reservoir that might provide related information, site-specific information is required for the Falls River site.

The study would consist of monitoring sedge and other vegetation in the existing drawdown zone. A survey would be taken in the first year of the study to document existing conditions and creating a benchmark against which future change could be measured. A survey would be taken some years later to measure the productivity of sedge and the succession of other species.

The study would consist of the following tasks:

1. Detailed vegetation mapping. Take large scale colour aerial photographs at 1:5000 scale or greater to prepare an aerial photo mosaic identifying the location of key areas of sedge habitat and quantifying their extent in hectares. This will document the quantity of habitat and identify the best locations for a detailed study.

2. At key sites, we will measure plant species density and biomass at several locations in key habitats within in the existing drawdown zone. A series of sample quadrats would be established along the transect lines and these sites would be permanent (surveyed so the coordinates and elevation were known and could be relocated).

3. Return in three to five years and take a new set of aerial photographs. This will allow us to identify any areas of sedge habitat lost or gained. Repeat the detailed measurements at each quadrat.

4. Analyse data and prepare report. This may demonstrate that the preferred alternative is adequate, or may identify the need for additional monitoring.

This study may require only a survey in the first year and one follow-up survey. However, if the alternative is shown to be ineffective there would presumably be a need for further monitoring. The results could be interpreted with reference to the Stave Reservoir and other monitoring programs. That would allow more rapid learning, and may eliminate the need for additional monitoring after the follow up sampling three to five years following the start of the program.

The cost of the study is estimated to be $15,000 in year one and $15,000 in the follow-up year for a total cost of $30,000.

STUDY 5 – TRIBUTARY BACKWATERING IN THE RESERVOIR

The primary management question for this monitoring study is: Do cutthroat or bull trout spawn in tributaries to Falls River Reservoir within the drawdown zone? Until this in known, the potential benefits of the preferred operating alternative (or conversely, the disadvantage of other alternatives) cannot be known with sufficient certainty.

The key water decision use affected is the reservoir operating regime. This has implications for the minimum flow provided by power plant to the Falls River and therefore on power and downstream fisheries interests.

The proposed monitoring study will be sensitive in that it will be straightforward to determine the presence of spawning fish, and because small changes in reservoir elevation have the potential to backwater large areas of stream habitat. Given that the proposed monitoring study will meet water use planning monitoring principles, the study should be eligible for Water Use Plan funding.

The study would require that the three major tributaries be examined during the spawning periods for the two species of interest. Three potential techniques are proposed: sampling (capturing) spawning fish directly, confirming their presence through visual observation, or inferring presence by identifying redds.

The study would require the following tasks:

1. Survey of each of the three tributaries within the drawdown zone during the spawning period (for cutthroat and bull trout); and

2. Analysis and reporting.

The cost of this study would largely depend on which technique is most effective. If redds can be readily identified in these streams, only a single trip would be required. The trip would have to be timed to correspond with low inflow conditions so that redds could be seen. The presence of redds could be confirmed by excavating a portion of a small number of redds. If redds cannot be reliably identified, it may be necessary to capture spawning fish or to observe them directly. The reliability of redd identification can be confirmed by examining reaches upstream of the drawdown zone for redds – if none are observed it probably means that they are difficult to see, since we know that both species of interest spawn in this watershed. Netting or angling can be effective ways of catching spawning fish, and snorkelling, foot surveys, or boat surveys may allow visual observation.

If no redds or spawning fish are observed, the study would not have to be repeated unless observation of gravel quality suggests that there is high potential for spawning in the drawdown zone.

The study would include the deployment of temperature data monitors to help identify the timing of migration and spawning. Also, all fish would be assessed for age and maturity to help define life history. Together, this information would allow for better prediction of the key spawning and incubation periods for fish in the reservoir.

The cost of this study could range from $6,000 (a single trip where adults or redds are identified throughout the drawdown zones) up to $20,000, where multiple trips are required to capture spawning adults.

STUDY 6 – WILDLIFE SHORELINE HABITAT IN THE RESERVOIR

The primary management question for this monitoring study is whether there is active nesting and denning in the drawdown zone at elevations and during periods when flooding occurs. There is the potential that nesting and denning will be interrupted and/or that juveniles or adults may be killed by operations. This potential cannot be assessed accurately, however, unless the locations of nests/dens are known.

Specifically we are concerned about the possibility of wildlife species establishing nests or dens around the reservoir at elevations below 92.4 metres between 1 January and 15 March, as these nests and dens will be at risk of flooding when the flashboards are installed after 15 March. Secondly, activities above and around 92.4 metres between 15 March and 15 May may be disadvantaged by losing proximity to the water's edge when the flashboards are removed on 15 May.

The key water decision use affected is the reservoir operating regime. This has implications for the minimum flow provided by power plant to the Falls River and therefore on power and downstream fisheries interests.

The proposed monitoring study will be sensitive because it will be straightforward to identify the locations of nests and dens and measure their elevation. This in turn will allow us to calculate the frequency and duration of inundation under the past operating regime and the preferred alternative. Given that the proposed monitoring study will meet Water Use Plan monitoring principles, the program should be eligible for Water Use Plan funding.

The study would require that any Traditional Ecological Knowledge (TEK) on the area be identified to help identify the location and timing of nesting and denning. The drawdown area must be inventoried for nesting and denning. The area of sedge habitat will be of key interest. However, nests and dens may be located along the entire shoreline, so a comprehensive inventory will be required within the drawdown zone. The techniques used will be air photo interpretation to identify potential habitats (undertaken as part of the sedge habitat analysis) and a survey by boat to identify areas for detailed investigation on foot. Nests and dens will be identified by locating entrances, digging, fur and feather signs, tracks and scats. Also, animals may be observed directly.

The study would require the following tasks:

1. Identify Traditional Ecological Knowledge from First Nations (particularly traplines) that may highlight timing and location of nesting and denning.

2. Survey of each of the drawdown zone of nest and dens and two or more times during the season.

3. Analysis and reporting.

The cost of this study is estimated to be $15,000. The results of monitoring from other Water Use Plans may help focus the assessment, however, the species composition and timing of habitat use along the Falls River is likely different and we do not anticipate that the monitoring results of other Water Use Plan would be directly transferable. The study meets a basic data gap for the Falls River Water Use Plan and is essential if meaningful analysis is going to be provided. The study would have to be repeated over two years to account for strong interannual (within year) variations in abundance that might bias any one year of study. The second year of survey would likely be more efficient as it would build on the findings of the first year.

SUMMARY OF PROPOSED FALLS RIVER WATER USE PLAN MONITORING PROGRAM

The Falls River Water Use Plan Consultative Committee recommended a monitoring program consisting of six monitoring studies that appear to meet the principles or evaluation criteria for monitoring studies under the Water Use Planning program. Table M-1 summarizes the studies and their costs and schedules.

The costs estimated here are roughly estimated assuming that external consultants are retained for this work and that each study is implemented on an individual basis. Costs may be substantially reduced by: using in-house (BC Hydro) staff, implementing more than one of the related studies simultaneously or combining this work with other environmental monitoring activities in the area.

Table M-1: Summary of Falls River Use Plan Monitoring Program Recommended by the Consultative Committee

Monitoring Interest	**Meets WUP Principles?**	**Description**	**Annual Cost**	**Schedule**	**Maximum Total Cost**
Presence and Timing of Steelhead and Salmon Spawning in Falls River	Yes	Monitor timing of adult presence in Falls River during March, April, August, September and October.	$12,000/ year	Up to five years	$60,000
Fish Spawning Habitat in the Falls River	Yes	Monitor egg-fry survival. Place egg boxes and measure habitat at site. Evaluate effect of operation on survival.	$20,000/ year	Up to five years	$100,000
Tributary Access and Shoreline Stranding in Big Falls Reservoir	Yes	Survey location of barriers within drawdown zone in three tributaries and identify location and size of potential areas of stranding along the shore in the drawdown zone.	$5,000	In first year	$5,000
Sedge Habitat Maintenance in Big Falls Reservoir	Yes	Aerial overflight to identify extent of sedge habitat. Detailed assessment of species composition and density of vegetation in sedge habitat community.	$15,000/ year	In first year + follow up three to five years later	$30,000
Tributary Backwatering in Big Falls Reservoir	Yes	Survey for redds in drawdown zone of three tributaries or, if necessary, sampling for adult spawners by netting, angling, or direct observation by snorkeling. Deploy temperature monitors and collect life history data.	$6,000 to $20,000	In first year	$6,000 to 20,000
Wildlife Shoreline Habitat in Big Falls Reservoir	Yes	Survey drawdown zone for dens and nests established by birds and mammals. Map locations and measure elevation.	$15,000	In 1st and 2nd years	$30,000
Total Program	**Yes**	**Implementation of all 6 studies described above.**		**Over 5 years**	**$245,000**

APPENDIX N: COMMITTEE MEMBERS ACCEPTANCE OF THE FALLS RIVER WATER USE PLAN CONSULTATIVE COMMITTEE REPORT

This consultation report records the deliberations of the Falls River Water Use Plan (WUP) Consultative Committee and provides the context for the committee's recommendations for the future operations of the Falls River hydroelectric project.

The undersigned confirm that this report accurately captures the water use interests, objectives and associated values expressed by the Consultative Committee members during the process.

Eugene Bryant

Lax Kw'alaams Band — See APPENDIX F

Name & Organization — *Signature*

James Bryant

Allied Tsimshian Tribe Association — See APPENDIX F

Name & Organization — *Signature*

Lana Miller

Fisheries & Oceans Canada

Name & Organization — *Signature*

Barry Drees

Prince Rupert Salmonid Enhancement Society

Name & Organization — *Signature*

Larry Keene

Ridley Terminals

Name & Organization — *Signature*

Jeff Lough

Ministry of Water, Land & Air Protection

Name & Organization — *Signature*

Terry Molstad

BC Hydro

Name & Organization — *Signature*