Consultative Committee Report

July 2003

Prepared on behalf of:

The Consultative Committee for the Clayton Falls Water Use Plan

Clayton Falls Water Use Plan

A Project of BC Hydro

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This report was prepared for and by the Clayton Falls 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 Clayton Falls Draft 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 purpose 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 Clayton Falls water use planning process was initiated in September 2002 and completed in April 2003. The consultative process followed the steps outlined in the provincial government's *Water Use Plan Guidelines* (Province of British Columbia 1998).

This report summarizes the consultative process, and records the areas of agreement and disagreement arrived at by the Clayton Falls Water Use Plan Consultative Committee (CC). It is the basis for the *Clayton Falls Draft Water Use Plan*. Both the Clayton Falls Consultative Committee Report and Draft Water Use Plan will be submitted to the Comptroller of Water Rights for review and approval.

Clayton Falls Hydroelectric Project

The Clayton Falls hydroelectric project is not part of BC Hydro's integrated generation system which provides electricity to most of the province. The facility is located about four kilometres (km) west of Bella Coola on Clayton Falls Creek, which is part of a non-integrated system that combined with Ah-Sin-Heek Diesel Generating Station provides power to the Bella Coola valley.

The Clayton Falls project is a run-of-river facility, and is controlled remotely from Ah-Sin-Heek Diesel Generating Station. The non-integrated system in Bella Coola consists of six diesel generators, two hydroelectric generators, and a 25 kV distribution power line. The Clayton Falls hydroelectric project comprises: Clayton Falls Dam located appropriately 720 m upstream from the mouth of Clayton Falls Creek, which flows into North Bentinck Arm; Clayton Falls headpond, which has negligible storage capacity; and the Clayton Falls Generating Station. Water flows from intakes in the headpond via a penstock to two generating turbines in the powerhouse. Water from the turbines is discharged into a 60 m long tailrace, which also serves as a spawning channel for pink and chum salmon.

Consultative Committee Process

The Clayton Falls Water Use Plan Consultative Committee consisted of six representatives and their designated alternates. Key interests included fish, wildlife, First Nations' traditional use and power. The representatives included BC Hydro, provincial and federal agencies, the Nuxalk Nation, community fisheries organizations and industry.

The main Consultative Committee and its Fish Technical Subcommittee held a total of six meetings, ultimately reaching unanimous acceptance of a preferred operating alternative for the Clayton Falls hydroelectric project, and a specified monitoring program.

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

- **Cultural and Traditional Use:** Minimize impacts on traditional use by maximizing the abundance and diversity of fish and wildlife around the Clayton Falls facility.
- **Fish in the Clayton Falls Headpond:** Minimize de-watering of fish habitat and stranding of fish during headpond drawdown.
- **Fish in Clayton Falls Creek:** Maximize fish abundance and diversity by minimizing dewatering of habitat below Clayton Falls; minimize siltation of spawning habitat downstream of Clayton Falls.
- **Power:** Minimize revenue losses, minimize air pollution, minimize traffic accident risk and maximize long-term power supply availability at the Clayton Falls facility.
- **Recreation:** Maximize recreational quality and diversity.

Consensus on a Preferred Operating Alternative

Based on the objectives established by the Consultative Committee, three performance measures (indicators) were developed for fish, power and recreation. Operating alternatives were then developed to address the various objectives.

A number of minimum flow alternatives were considered by the Consultative Committee for the 51 m of accessible fish habitat on Clayton Falls Creek between Clayton Falls and the confluence of the powerhouse tailrace channel. The Committee also expressed concern that sufficient flows be provided in the tailrace channel during winter months to ensure freeze-up of spawning habitat does not occur.

The Consultative Committee reached a consensus decision on the future operations of the facility at their final meeting on 28–29 January 2003. The group agreed to the following constraints:

- minimum dam release of 0.05 m^3/s.
- minimum flow of 0.08 m^3/s in the powerhouse tailrace.

- 2-hour rate for headpond drawdown.

A summary of the constraints and their intent is provided in Table 1. The cost of the operational change is estimated at about $7,000 to $11,000/year plus a one-time cost of $5,000 for capital works.

Consequences of the Preferred Alternative

The expected consequences of the final recommended operating alternative are summarized in Table 2. The main benefit over the reference case will be ensuring a minimum flow in lower Clayton Falls Creek (i.e., below the dam), which will benefit fish and fish habitat.

Table 1: Recommended Operating Constraints for the Clayton Falls Hydroelectric Project

Area	Operating Variable	Constraint	When	Intent
Dam	Minimum discharge	0.05 m^3/s from dam	Year round	Maximize fish abundance and diversity in 51 m of river between the falls and the tailrace channel outlet
Tailrace	Minimum discharge	0.08 m^3/s	Year round	Maintain adequate flow and water depth for spawning and egg incubation
Headpond	Drawdown	Over two hours	During maintenance and inspection	Minimize stranding of fish and suspended sediment levels associated with headpond drafting

Although the Consultative Committee had an interest in minimizing diesel use and the associated transportation of fuel down the Bella Coola valley, the Committee felt that improvements in fish habitat that would be achieved through provision of a minimum flow would be worth the incremental increase in diesel use.

Table 2: Expected Consequences of Recommended Operating Alternatives

Interest	Consequences
Fish in Clayton Falls Creek	Increase in invertebrate and fish productivity Improve rearing habitat
Fish in Clayton Falls Headpond	Minimize fish stranding during both the September and February headpond drawdown events
Fish in Clayton Falls Tailrace	Minimize impacts on fish during key life stages and during the winter months
Power Generation	Decrease in power revenue of $7,000 to $11,000 per year on average (approximately 2%) over reference case Capital cost of flow mechanism of $5,000 (one-time cost) Marginal increase in diesel fuel transportation and use

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 discussed the need to undertake a monitoring program. The Consultative Committee agreed to undertake an Aquatic Ecosystem Productivity Monitoring program to assess the effectiveness of providing the minimum flow. The estimated cost of this program is about $38,000 over four years.

Once operational changes are approved under the final Clayton Falls Water Use Plan, BC Hydro will: 1) develop detailed terms of reference for the monitoring program; and 2) initiate the monitoring 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.

Results of the approved monitoring program will be sent to all interested members of the Consultative Committee as they become available.

Review Period

The Clayton Falls Consultative Committee recommended that a technical review of the monitoring program results be undertaken by BC Hydro, appropriate government agencies, First Nations and interested parties five years after implementation of the Clayton Falls Water Use Plan (or as soon as the results are available). 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 formal review is not recommended as a result of the five-year technical review of monitoring results, the next review of the Clayton Falls Water Use Plan will be conducted 10 years after implementation.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

APPENDICES

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] in 1996 as an approach to ensuring provincial water management decisions reflect changing public values and environmental priorities. A Water Use Plan (WUP) is a technical document that, once reviewed by provincial and federal agencies and approved by the provincial Comptroller of Water Rights, defines how water control facilities will be operated. The purpose of water use planning is to understand public values and develop recommendations defining a preferred operating strategy using a consultative process. This consultative process is outlined in the provincial *Water Use Plan Guidelines* (Province of British Columbia, 1998).

A Water Use Plan is intended to accommodate a range of water use interests through incremental changes to how water is currently stored and released at water control facilities. 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. Treaty entitlements and historic grievances from facility construction are specifically excluded from Water Use Plans, but can be considered as part of other processes (Province of British Columbia, 2000).

The Clayton Falls consultative process was initiated in September 2002 and completed in April 2003. The purpose of this Consultative Report is to document the consultative process and present the recommendations of the Clayton Falls Water Use Plan Consultative Committee. The interests and values expressed in this Consultative Report will be used by BC Hydro to prepare a draft Water Use Plan for the Clayton Falls hydroelectric project. Both the *Clayton Falls Water Use Plan Consultative Committee Report* and BC Hydro's Draft Water Use Plan will be submitted for review and approval by the Comptroller of Water Rights.

[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.

2 DESCRIPTION OF CLAYTON FALLS PROJECT

The Clayton Falls hydroelectric project is not part of BC Hydro's integrated generation system. The facility is located about four kilometres (km) west of Bella Coola on Clayton Falls Creek (Figure 2-1), and is controlled remotely from Ah-Sin-Heek Diesel Generating Station. The non-integrated system in Bella Coola consists of six diesel generators, two hydroelectric generators, and a 25 kV distribution power line.

BC Hydro owns eight hectares (ha) encompassing the Clayton Falls generating facility. A block northeast of the powerhouse is owned by Rivtow Straights Limited, a log sort area is located on Crown land to the west, and a private forest company owns property to the east. The remaining land in the area is owned by the Crown. There is a secondary road that follows North Bentinck Arm from Bella Coola to the powerhouse. A logging road and a gated single lane access road provide access to the dam site from the powerhouse.

The current physical structures (Figure 2-2) comprising the Clayton Fall project include:

- **Concrete gravity dam**: The dam has a total length of 41 metres (m) and maximum height of 7 m. The elevation of the top of the dam is El. 80.1 m above sea level. The dam is located approximately 720 m upstream from the mouth of Clayton Falls Creek, which enters the ocean at North Bentinck Arm.

- **Overflow spillway**: The 30.1 m long overflow spillway has a crest elevation of El. 76.45 m, and is fitted with flashboards that are used to increase the elevation to El. 77.97 m. The flashboards are left in place year round. Maximum discharge capacity of the spillway is 176 cubic metres per second (m^3/s) at headpond elevation El. 80.1 m.

- **Sluiceway**: The sluiceway consists of a concrete channel with stoplogs and a vertical lift gate that is normally closed. The gate has a screw-stem hoist that is operated either manually or by electric drill. The sill elevation is El. 73.85 m, and the discharge capacity is 12 m^3/s at headpond elevation El. 77.97 m.

- **Power Intake**: The single power intake has a 1.22 m by 1.22 m vertical slide gate. The centre line of the intake is at elevation El. 75.08 m. The intake is fitted with coarse and fine trashracks to prevent debris from passing through the intakes and generating units.

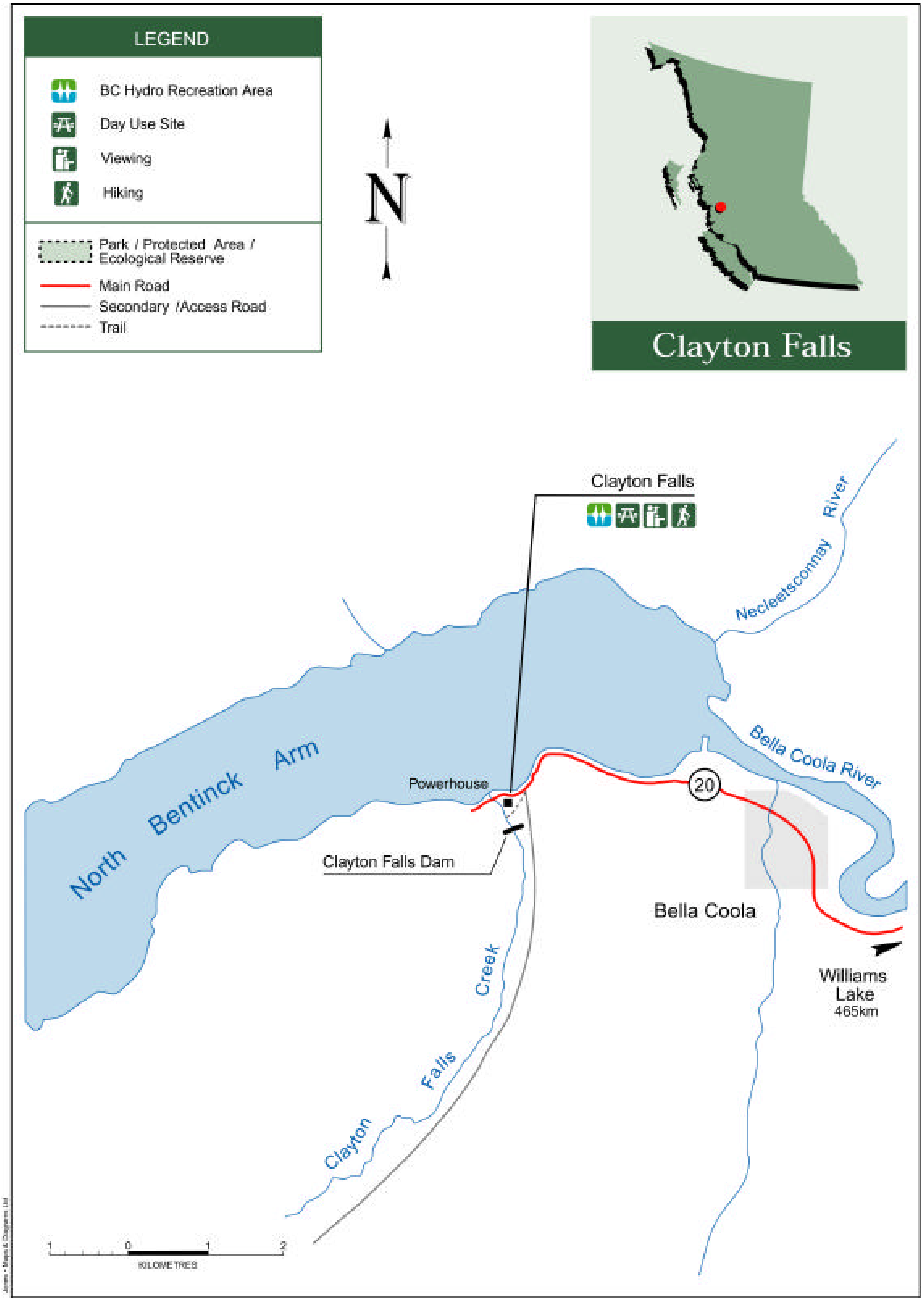


Figure 2-1: Location of Clayton Falls Hydroelectric Facility

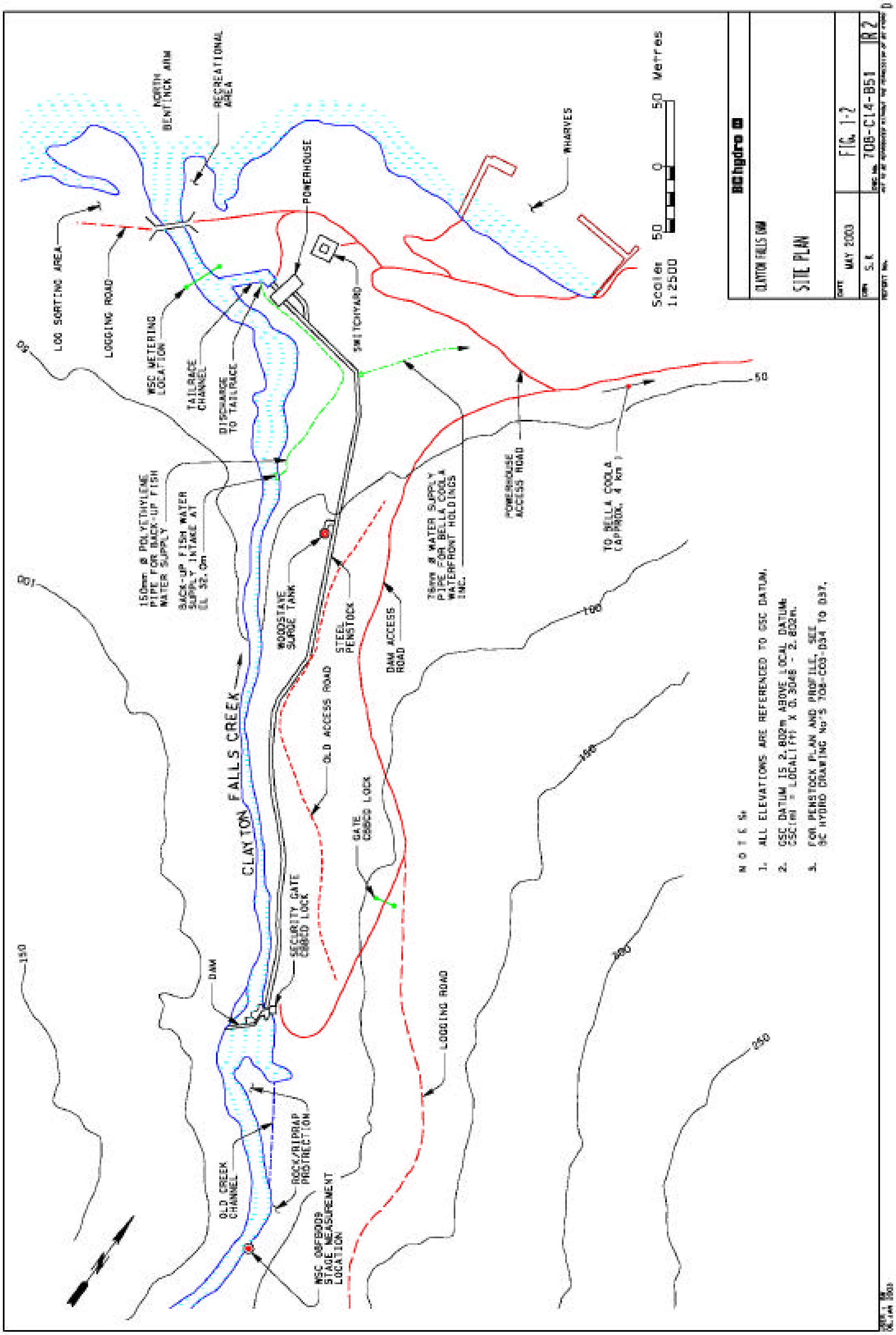


Figure 2-2: Schematic of Clayton Falls Hydroelectric Facility

- **Penstock**: The 580 m long penstock delivers water from the power intake at the headpond to a powerhouse located about 100 m upstream from the creek mouth (Photo 2-1).

- **Clayton Falls Powerhouse**: The powerhouse contains two Francis turbines of 0.72 MW and 1.33 MW capacity for a total output of 2.05 MW. The total discharge capacity of the two generating units is 3.8 m^3/s at rated output (maximum continuous output).

- **Clayton Falls Headpond**: Clayton Falls Dam impounds a small headpond, which has negligible storage capacity of 2500 m^3 (Photo 2-2). The headpond is approximately 0.1 ha in size at the maximum normal level of El. 77.97 m. The maximum drawdown of about 4.1 m completely drains the headpond leaving only a small river. This can be accomplished using the sluiceway during low inflow periods.

Photo 2-1: Clayton Falls Dam, Creek and Penstock

Clayton Falls was originally brought into service in 1962 by the BC Power Commission as a 720 kW plant. In 1992, the project was upgraded and expanded to better utilize flows and reduce costly diesel fuel use. This involved replacing the old powerhouse and woodstave penstock, installing a second turbine/generator, and redesigning the powerhouse tailrace. The tailrace channel was reconfigured to redirect discharge from the turbines back to Clayton Falls Creek (as opposed to North Bentinck Arm), and redesigned specifically to replace spawning habitat lost in the old tailrace and the accessible section of lower Clayton Falls Creek. To ensure stable flow conditions in the tailrace channel for spawning and egg incubation of pink and chum salmon, a Fish By-pass Line was installed at the facility to provide a minimum flow downstream. As the facility is unmanned, the by-pass line opens automatically when both units are shutdown to pass flow directly from the penstock to the head of the tailrace channel. A Backup Water Supply Line is also available for periods when the penstock is drained for maintenance or other reasons. This line is independent of the penstock, and is the final backup water supply for the tailrace channel.

Photo 2-2: Clayton Falls Dam and Headpond

There is also a 76 mm (3 inch) water supply line that draws water off of the penstock and delivers it to the Government Wharf and Ice Plant in Bella Coola. The water supply line is typically in operation from mid May to mid September, and is closed by late fall (October/November) to prevent damage to the line from freeze-up.

As the Clayton Falls project has negligible storage capacity in the headpond, it operates as a run-of-river facility year round passing inflows through the turbines and/or over the dam with little to no regulation of the total flow pattern. Any changes in headpond level are caused primarily by fluctuations in inflow (rainfall and snowmelt runoff throughout the year), and energy production is varied as a function of river flows, energy demand and coordination with diesel generation. There is occasionally the need to draw the headpond elevation down for maintenance and inspection purposes. This typically occurs in mid February for annual maintenance and again in September for complete civil inspection, both of which require the headpond to be drawn down completely.

Relevant current operating aspects of the Clayton Falls project include the following:

- Water licences permit a maximum diversion of 3.83 m^3/s for power purposes.

- The water licences require BC Hydro to maintain a minimum water flow from Clayton Falls Generating Station of 0.08 m^3/s (or 3 cubic feet per second (cfs)) for fish habitat within the tailrace.
- There is no storage licence – storage only exists between maximum and minimum river elevations.
- There are no requirements for ramping of downstream flows; however, the project is presently operated in a manner that does not result in frequent flow fluctuations.
- Operating directions related to flow management at Clayton Falls are outlined in BC Hydro's Local Operating Order (LOO).
- The OMS Manual for Dam Safety (Report No. OMSCLA) also includes operating requirements.

2.1 Normal Seasonal Operations

During the period from April through November, daily inflows to the Clayton Falls headpond typically exceed the maximum discharge capability of the turbines (Figure 2-3). Under these conditions, both units operate near maximum load and spill occurs and fluctuates naturally in response to runoff conditions. For the remainder of the year (December–March), daily inflows fluctuate in response to changing climate conditions but are frequently less than the maximum turbine discharge capability. On low inflow days, generation is adjusted such that turbine discharge does not exceed the project inflow and the headpond level is maintained at the top of the spillway flashboards with little flow passing over the flashboards. The operators prefer to have a small overflow to maximize the response time to changes in load and inflows. Spill over the dam is usually curtailed only during full annual maintenance shutdown in February, dam safety inspection in September, and occasional winter freeze-overs. In the first two circumstances, overflows are only curtailed during headpond refill when the sluiceway is closed.

The normal discharge of water through the two turbines into the Clayton Falls tailrace is more than adequate to maintain the minimum 0.08 m^3/s flow required for conservation purposes. In the event that the generators in service trip off line (shut down), a 200 mm (or 8 inch) valve opens automatically to ensure that the flow of water is uninterrupted. This water supply line provides an estimated 0.2 m^3/s flow to the tailrace (Photo 2-3). The Backup Water Supply Line provides the minimum flow (0.08 m^3/s) as required by the water licences during periods when the penstock is dewatered for maintenance purposes or emergencies. The intake for this 150 mm (6 inch) line is located just above the falls on Clayton Falls Creek (close to the Surge Tower).

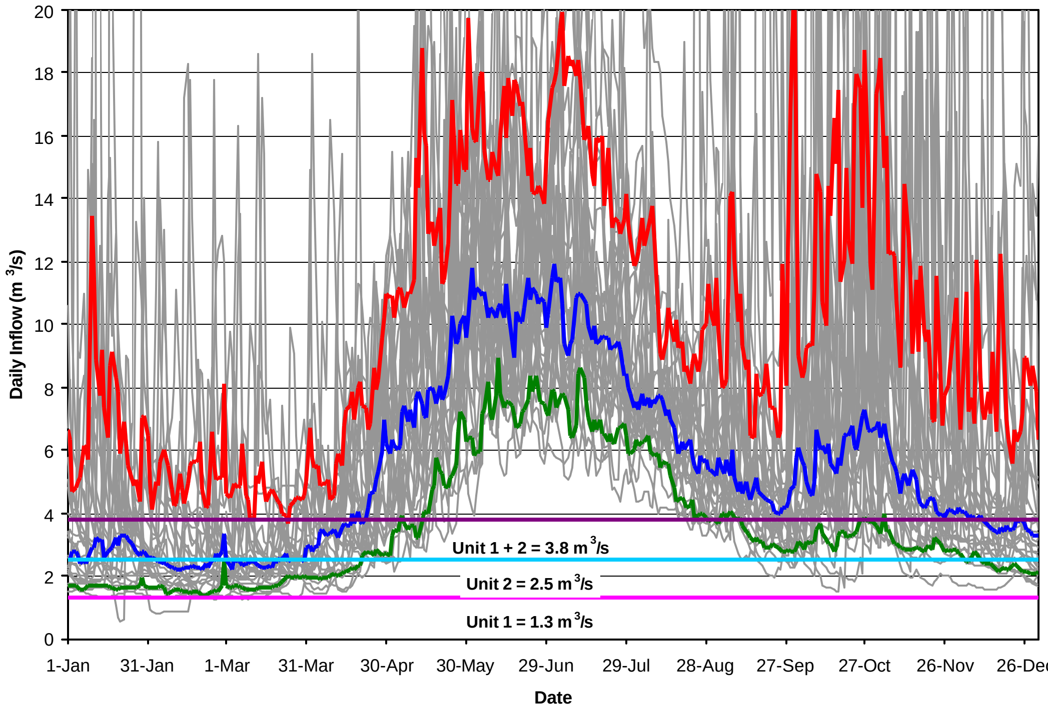


Figure 2-3: Clayton Falls Historical Daily Inflows (1972–1999) and Maximum Turbine Discharge

Note: Variation in inflows is represented by charting the 10th (thick green line), 50th (thick blue line) and 90th (thick red line) percentile for 28 years of inflow data. Inflow data are taken from Water Survey of Canada (WSC) gauge data, except for 1972–79 and 1996–99, which are synthetic data generated from comparable systems in the Bella Coola region.

2.2 Maintenance and Inspection

Annual maintenance is typically scheduled during the low inflow period in mid February and occurs over a three week period. Maintenance generally involves taking both units out of service for one week, with one of the units remaining out of service for an additional two weeks. In total, the penstock may be partially dewatered for one to two weeks. During this time, the headpond is drawn down for a period of 3–5 days to permit dredging of sediment that has accumulated within the headpond, and to allow for any concrete repairs that may be required at the dam. The headpond is drafted over a 1.5 to 2-hour period by discharging water over the spillway and through the sluice. The sediment is removed from the headpond and is trucked away to an onsite gravel pit. On completion of the dredging and concrete repair works, the sluice gate is closed to refill the headpond, which typically requires about 20–25 minutes. Over recent years, the nature and extent of sediment accumulation within the headpond has significantly changed, generally requiring the removal of 8–12 truck loads of primarily silt and sand material annually. Historically, the majority of the dredged material consisted of larger substrates, and as much as 100 truck loads were removed from the headpond each year.

An annual civil inspection of the facility is undertaken in the fall, usually September. The headpond is drawn down quickly (i.e., 15–20 minutes) for about two hours to permit inspection activities.

One year in ten, the penstock is completely drained for a walk-through civil inspection and maintenance.

Photo 2-3: Clayton Falls Generating Station

2.3 Annual Maintenance Shutdown

During unit shutdown for annual maintenance, flow to the generating station is managed through the Turbine Inlet Valves, the G2 By-pass Drain Valve (BDV-2), the Backup Water Supply Line, and the G1 Penstock Drain Valve (PDV-1) (Figure 2-4). Water is supplied to the tailrace through the Backup Water Supply Line, with the Intake Operating Gate opened about 3" to allow extra water to flow through the two open Drain Valves.

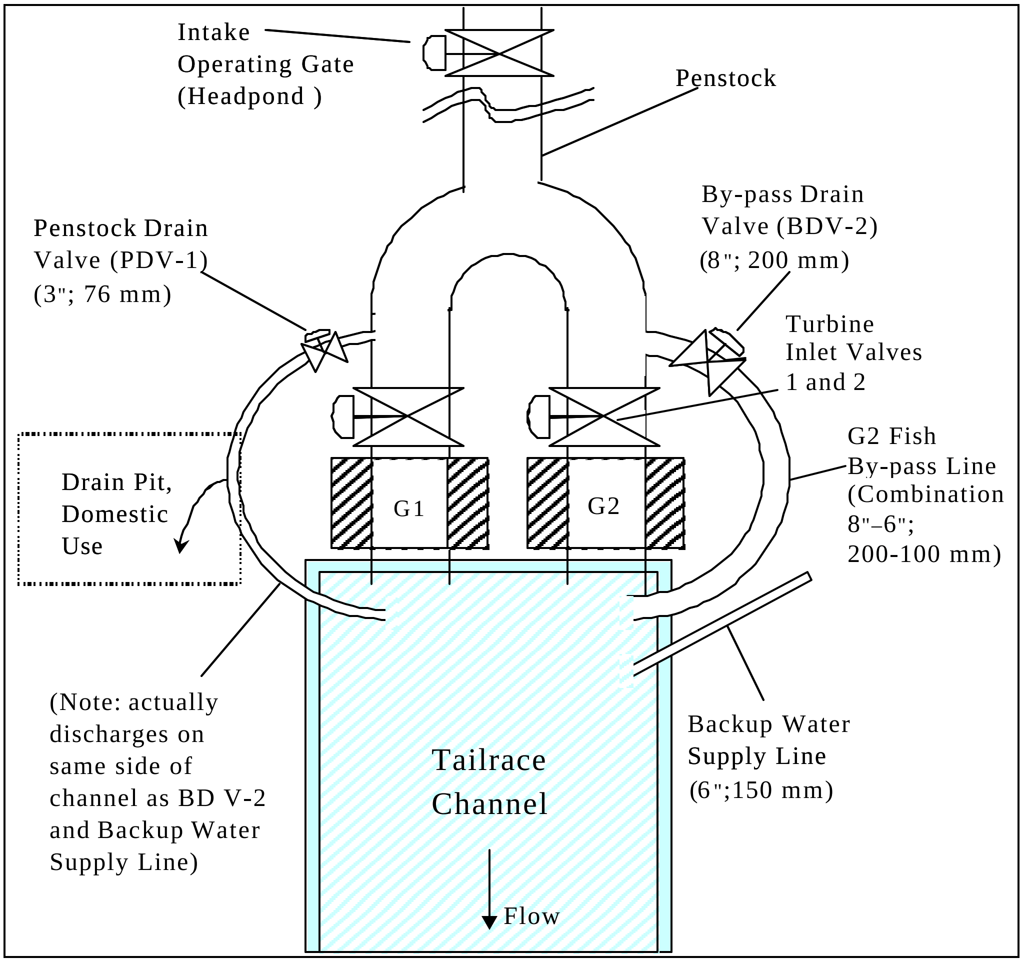


Figure 2-4: Generating Station and Tailrace Flow Schematic

In the event that the Backup Water Supply Line is unavailable during annual maintenance (e.g., the line is frozen), the Intake Operating Gate is opened more (4" to 5") to meet the minimum flow requirement in the tailrace via the two Drain Valves. When the penstock is completely dewatered for walk–through inspection (about 1/10 years), the flow is provided solely through the Backup Water Supply Line.

3 CONSULTATION PROCESS

The Clayton Falls Water Use Plan consultation process followed the steps outlined in the provincial government *Water Use Plan Guidelines* (Province of British Columbia, 1998). These steps provide the framework for structured decision-making (Table 3-1).

Steps 3 to 8 encompass the consultation aspect of the water use planning process, and are the focus of this report.

Table 3-1: Water Use Plan Process

Steps	Components of Water Use Plan 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 a periodic and ongoing basis

3.1 Initiation and Issues Scoping

On 9 September 2002, BC Hydro issued a news release to publicly announce the Clayton Falls water use planning process. The newspaper advertisement ran in the *Valley Coast Mountain News*. BC Hydro also contacted agencies, organizations, industries, local governments and other groups to solicit interest in the Clayton Falls Water Use Plan. Those contacted also suggested others in the community who may be interested in the process. In addition, BC Hydro responded to individuals who inquired about the advertisement or news release. Respondents received a questionnaire asking about their interests and issues.

On 24 September 2002, BC Hydro held a public Open House at the Bay Motor Hotel to promote awareness of the Clayton Falls water use planning process and to invite potential participants. At this meeting, information and interests summarized from the questionnaires, informal meetings, meetings with provincial and federal agencies, e-mail and telephone conversations were used to confirm the issues already identified, and to provide an opportunity for the public to raise new issues related to facility operations. An *Issues Identification Report* (BC Hydro, November 2002) was completed and submitted to the Comptroller of Water Rights. This report completed Step 2 of the *Water Use Plan Guidelines*. Key interests identified in this report included:

- Power Generation
- Fisheries
- Recreation, Tourism and Industry
- Cultural and Heritage

3.2 First Nations Involvement

The Clayton Falls hydroelectric project is in the traditional use areas of the Nuxalk Nation. In September 2002 as part of initiating the Clayton Falls Water Use Plan, BC Hydro's Aboriginal Relations Department met with Elected Chief Anfinn Siwallace, Frank Webber (Capital Works) and Cecil Moody (Elected Councillor) of the Nuxalk Nation to discuss concerns that they may have regarding operation of the Clayton Falls facility.

At that time, there was an indication that the Nuxalk were interested in fish and Megan Moody was asked to represent them in fish-related discussions and data collection. Megan Moody participated throughout the process but felt she could not represent the Nuxalk Nation on non fish-related issues.

3.3 Committee Structure and Process

The Clayton Falls Water Use Plan Consultative Committee was comprised of six members, with a number of active observers (Appendix A). In addition to the Water Use Plan Consultative Committee, a Fish Technical Subcommittee (FTC) was formed to focus on specific issues related to fish and fish habitat in Clayton Falls Creek, and to provide technical advice to the Committee.

In October 2002, the Consultative Committee developed and adopted Terms of Reference and a consultation work plan. The Terms of Reference were included within the *Proposed Consultative Process Report: Clayton Falls Water Use Plan* (BC Hydro, 2002) and submitted to the Comptroller of Water Rights to fulfil Step 3 of the *Guidelines*. The Committee met between October 2002 and January 2003 to move through the steps in the process. Table 3-2 highlights the meeting dates and main activities of the Consultative and Fish Technical committees.

A listing of detailed meeting notes, along with other documents prepared during the Clayton Falls water use planning process, is provided in Appendix B.

Table 3-2: Consultative Committee Meetings and Activities

Water Use Plan Steps	Consultative Committee Meetings	Fish Technical Subcommittee Conference Calls/Meetings
Step 1: Initiate Water Use Plan	24 September 2002 • Public announcement	
Step 2: Issues Scoping Step 3: Determine the Consultative Process Step 4: Develop Objectives and Performance Measures Step 5: Additional Information Gathering	16–17 October 2002 • Overview of process • Confirm terms of reference • Confirm committee members • Confirm issues • Presentation of Clayton Falls project operations • Site tour of dam and powerhouse • Presentation on structured decision-making • Develop influence diagrams, objectives and performance measures	
Step 4: Develop Objectives and Performance Measures Step 5: Additional Information Gathering Step 6: Creating Alternatives		14 November 2002 • Follow up on technical issues • Develop performance measures • Develop alternatives 22 January 2003 • Follow up on technical issues • Assess collected data
Step 7: Assess Trade-Offs Step 8: Document Areas of Agreement and Disagreement	28–30 January 2003 • Discussion of alternatives and impacts • Discussion of operating scenarios and trade-offs • Decision on recommended operational protocol • Discussion of recommended monitoring program	24 March 2003 • Follow up on technical issues and monitoring plan

3.4 Community Awareness and Communication

In addition to the Open House held in September 2002, BC Hydro issued two news releases to inform residents of the Bella Coola area about developments in the Clayton Falls Water Use Plan.

Materials related to the Clayton Falls Water Use Plan and the consultative process were made available at the Bella Coola Public Library, which served as a local resource for those who wanted to find out more about the work of the committee and the water use planning process. The BC Hydro Water Use Plan web site also provided information for those interested in the Clayton Falls project, as well as those interested in Water Use Plans being undertaken for other BC Hydro facilities in the province.

4 INTERESTS, OBJECTIVES AND PERFORMANCE MEASURES

Step 4 of the provincial water use planning process requires the Consultative Committee to take the issues and interests confirmed by the group and express them in terms of specific objectives and performance measures. In defining the objectives, the participants articulate what they are seeking to achieve through a change in operations, while the performance measures provide the means to assess the degree to which those objectives are achieved. This section describes the objectives and performance measures developed by the Consultative Committee for the Clayton Falls Water Use Plan. A more detailed description of the performance measures and how they were calculated can be found in Appendices C and D.

4.1 Power Generation

In 1962, Clayton Falls Creek was developed as a hydroelectric site to supply power to the community of Bella Coola, in conjunction with a diesel generating plant (Ah-Sin-Heek Diesel Generating Station). The original plant consisted of one generating unit with a capacity of 0.72 WM and a hydraulic capacity of 1.33 m^3/s. Based on an analysis of stream flow, it was evident that the creek was not fully developed; however, low electricity loads in Bella Coola did not justify a larger plant capacity at that time. In 1992, the Clayton Falls project was upgraded and expanded to help meet an increased load demand and displace the high cost of diesel generation. The existing plant now consists of two units for a total capacity of 2.05 MW and a discharge capacity of about 3.8 m^3/s (Photo 4-1).

4.1.1 Issues

As the plant is a run-of-river facility with minimal storage, the output of the plant is reduced at times when inflow is less than the generating capacity. The difference between system load and hydroelectric output is made up with diesel generation. The Consultative Committee identified concern that any constraint to power generation from Clayton Falls would require an increase in diesel generation to meet the load, and this would have a number of undesirable consequences. These included:

- **Increased cost to BC Hydro –** Hydroelectric power facilities have a low variable to fixed operating cost ratio, whereas this ratio is higher for diesel facilities primarily due to the cost of fuel.

- **Increased air emissions associated with increased burning of diesel fuel –** Air quality was not considered a major issue for the Water Use Plan, although there was concern over unnecessary emission of airborne pollutants.

- **Increased risk of traffic incidents associated with increased transport of diesel fuel into Bella Coola –** This risk was considered of key importance for some participants since the highway leading to the area is thought to be a significant risk for transportation of fuel, and the environmental consequences of an accident involving a fuel delivery truck were considered to be potentially significant.
- **Potential economic impacts of limiting capacity –** BC Hydro noted it had an obligation to supply the area with sufficient power; however, some participants thought that there may be a risk that, in the future, a private supplier of power to the community might not have such an obligation, and limited power capacity could potentially affect future economic development.

Photo 4-1: Clayton Falls Generating Station

4.1.2 Objectives and Performance Measures

Based on the above power-related interests, the Consultative Committee developed four power **objectives.** These are to:

- maximize long-term power supply availability;
- maximize revenue (minimize financial losses of the system);
- minimize air pollution; and
- minimize the risk of vehicular incidents involving diesel fuel trucks.

It was recognzied by the Consultative Committee that constraining hydroelectric operations to meet environmental or social objectives may increase the quantity of diesel fuel consumed to replace this lost hydroelectric power. The Committee was presented with several options for qualifying this power-related impact, each of which pertained to the power objectives listed above. These included:

- the *absolute* quantity of hydroelectric power that would be generated (average MWh per year);
- the *absolute* and *incremental* volume of diesel fuel (average litres/year) required to generate sufficient power at the Ah-Sin-Heek diesel plant to meet overall power demand;
- the *absolute* and *incremental* cost (average $/year) of generating sufficient power at the Ah-Sin-Heek diesel plant to meet overall power demand; and
- the *absolute* and *incremental* increase in the number of truck trips used to deliver the fuel to the Ah-Sin-Heek diesel plant.

No attempt was made to relate these differences to anticipated releases of air pollutants, although this could have been undertaken through the use of emission factors. While air emissions from the Ah-Sin-Heek plant are not thought to significantly affect local air quality, any increase in emissions of air pollutants is considered undesirable.

It was agreed that an appropriate single indicator or **performance measure** for all the power-related interests would be the *quantity of diesel fuel (L/yr)* required by the Ah-Sin-Heek Diesel Generating Station (Table 4-1). The Committee decided that the *absolute* and *incremental* volume of diesel fuel was the most useful primary indicator of replacement power.

Table 4-1: Power Generation Objectives and Performance Measures

Objectives	Performance Measures	Location
Maximize revenue Minimize traffic accident risk Minimize air pollution Maximize long-term power supply availability	Quantity of diesel fuel (L/yr)	Ah-Sin-Heek Diesel Generating Station

More information on the assumptions and limitations of this performance measure are detailed in Appendix D **(**Performance Measure Information Sheet: Volume of Diesel Required to Meet System Demand).

4.2 Recreation, Tourism and Industry

The Clayton Falls property owned by BC Hydro affords the only salt-water access in the vicinity of Bella Coola. BC Hydro's small recreation development in this area allows for sightseeing, fish and wildlife viewing, picnicking and access for swimming, canoeing, windsurfing and scuba diving (Photo 4-2). Recreational use is limited to day-use activities. Local residents are the primary users of this site, although most tourists to Bella Coola also visit the site. BC Hydro currently has no plans for further development of the Clayton Falls Recreation Area, as the site has been extensively developed given the small amount of water front available.

The falls on lower Clayton Falls Creek (below the dam) are considered a scenic feature, which attracts locals and visitors to the area. The lower river downstream of the powerhouse is used to some extent for recreational activities such as birdwatching and fishing. Water-based recreational opportunities in the Clayton Falls headpond are limited by the small size of the headpond and possible hazards associated with the intake structures.

Photo 4-2: View of North Bentinck Arm from the lower Clayton Falls Creek

4.2.1 Issues

No specific issues related to the effects of current operations of the Clayton Falls project on recreational use of the area were identified through the process; however, regional stakeholders expressed a number of issues related to recreational management in the area. These include:

- the need to maintain or improve fish populations for angling;
- the relationship between flow in the falls and aesthetic value; and
- safety in the headpond area, and public safety in the vicinity of the falls area.

The latter issue was discussed by the Consultative Committee due to concern related to increasing numbers of fatalities associated with people attempting to walk out to the falls. There is a marked trail that extends from the recreation site to the Clayton Falls Viewing Area (Photo 4-3), where there are two large signs that warn people of the slippery and dangerous conditions of the rocks around the falls. Despite these warnings, a number of people have drowned in Clayton Falls Creek over the past 20 years; the most recent incident occurring in the summer of 2002 when a tourist fell off the rocks into the creek and drowned in the plunge pool below the falls.

While it was recognized that this issue could not be addressed through the water use planning process (i.e., changing operations would not reduce or prevent further drowning from occurring), the Consultative Committee agreed that it could be dealt with through a joint effort involving BC Hydro, the province, local community, and the coroner. Partly as a result of this issue being raised by the Consultative Committee, BC Hydro undertook a public safety audit of the area.

Photo 4-3: Clayton Falls Viewing Area

Concern was also expressed that operational changes at Clayton Falls facility could affect the availability of water in the penstock for water supply to the Government Wharf in Bella Coola during the summer recreation season. During maintenance periods, there are times when the penstock is at least partially drained and supply of water to the wharf could be interrupted. Under current operations, partial penstock draining occurs over a one-week period during mid February. Although this is outside the period requested for recreational water supply (mid May to mid September), concern was raised that brief interruptions in water supply could occur if the maintenance period was shifted to later in the year.

4.2.2 Objectives and Performance Measures

The Consultative Committee developed one recreation-related **objective**, which is to ***minimize interruption of water supply to the wharf***. The **performance measure** is the number of days during which supply is interrupted during the period 15 May to 15 September (Table 4-2).

Table 4-2: Recreation Objectives and Performance Measures

Fundamental Objectives	Means (Sub-) Objectives	Performance Measures
Maximize recreational quality and diversity	Minimize interruption of water supply to the wharf	Number of days during which supply is interrupted during the period 15 May to 15 September

4.3 Fish and Fish Habitat

Clayton Falls Creek is a high gradient stream that drops steeply over numerous falls to a final falls located about 200 metres (m) upstream of the creek mouth. This final falls is 20 m high, and acts as a total barrier to upstream fish passage (Photo 4-4). Below this, the creek is characterized by a short section of boulder/bedrock habitat and a section of low gradient habitat, part of which is influenced by tidal waters.

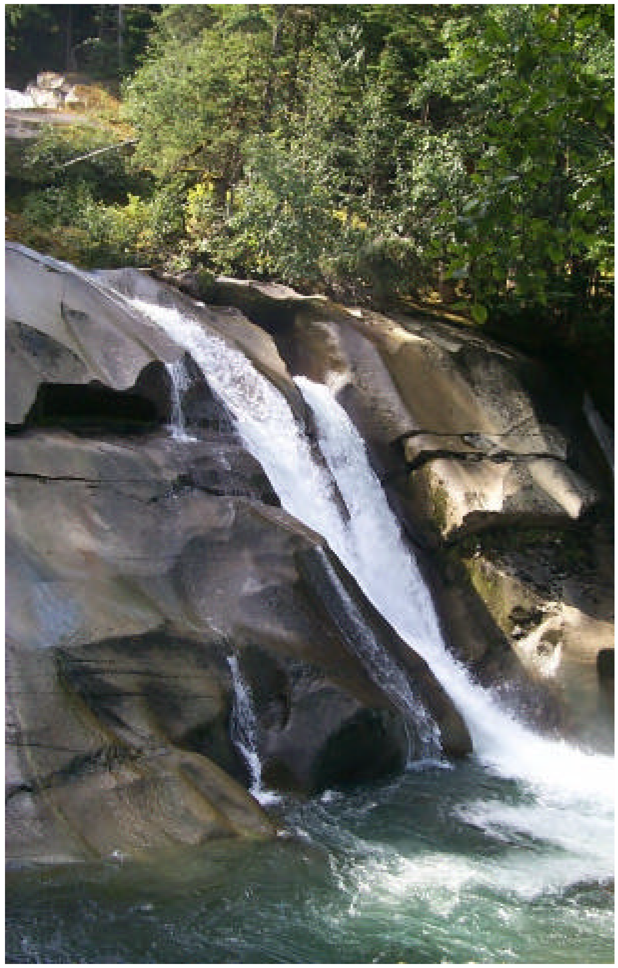


Photo 4-4: Clayton Falls

The lower 200 m of Clayton Falls Creek provide intertidal and stream spawning habitat for pink and chum salmon. The majority of spawning takes place in the tailrace channel. However, in most years, escapements to the system exceed the capacity of the channel, and pink and chum are thought to migrate as far upstream as the base of the falls to spawn. Spawning success within the mainstem is limited by the availability of suitable gravels, which account for only between 1–2 per cent (based on a 2003 visual inspection) and 10 per cent (Croll and Monk 1993) of substrates within this reach.

The lower creek also provides ideal rearing habitat (i.e., boulder/cascades, high gradient); however, there is little information available regarding fish species presence, abundance or periodicity. Based on limited fish sampling conducted prior to redesign and relocation of the powerhouse tailrace (Jones 1990) and during test unit shutdown in January 2003 (Willis 2003), this habitat appears to be utilized by steelhead, coho, Dolly Varden and sculpin to some degree. Cutthroat trout juveniles have been observed rearing at the mouth of Clayton Falls Creek, although these are likely individuals from the Bella Coola River population that are passing through the area.

The only fish species reported upstream of Clayton Falls Dam is Dolly Varden. A limited number of Dolly Varden has been observed in the headpond during annual maintenance activities; however, the extent and seasonality of use is unknown. Small resident populations of cutthroat trout and rainbow trout may also be present in the upper part of the system but this has not been documented.

4.3.1 Issues – Headpond

A number of fish-related concerns associated with headpond operations were identified and discussed by the Consultative Committee during the first Consultative Committee meeting. Some of these issues were considered either outside the scope of water use planning or did not warrant further consideration. These issues and the rationale for not pursuing them further are outlined below (Table 4-3).

Table 4-3: Headpond Fish-related Issues Discussed but not Pursued by the Consultative Committee

Interest	Issue/Concern	Decision/Rationale
Fish Entrainment into the Penstock	The Consultative Committee considered the possibility that fish could be injured or killed as they pass through the power intake and generating units.	The coarse and fine trashracks that cover the penstock intake would likely be effective in preventing entrainment of fish larger than one inch (i.e., the width of the openings of the fine trashracks). Given the small numbers of fish suspected to utilize the headpond and the very limited opportunity to further minimize or prevent entrainment through operations, the Consultative Committee did not consider this to be a major concern.
Fish Passage over the Spillway	The Consultative Committee considered the possibility that fish could be passed over the spillway during normal operations.	It was agreed that fish are likely passed over the spillway, but that this would occur naturally in the absence of the dam. As spill always occurs during freshet, there is no feasible way to prevent or minimize this through changing operations at the facility.
Increased Suspended Sediments and Turbidity in the Headpond	During drafting and refilling of the headpond for sediment control (dredging) and civil inspection, silts and sands could be suspended and cause an increase in turbidity.	The Consultative Committee agreed that any increases in turbidity due to headpond drawdown and refill would be relatively limited in extent and duration. The headpond can be naturally turbid as a result of heavy rainfall events. As the headpond is used by only a limited number of Dolly Varden and does not provided critical habitat for this species, any temporary minor increase would not likely be of concern.

The following summarizes those fish-related issues associated with headpond operations that the Consultative Committee considered important to address through water use planning. These issues were brought forward by the Committee, and discussed in detail during subsequent technical committee meetings. In one case, recommendations were developed to address the issue, while in the other case, the issue was referred to a regional initiative outside of water use planning.

Fish Stranding

The Consultative Committee discussed the issue of fish stranding during headpond drafting for annual maintenance (February) and civil dam inspection (September). Over the past two years, BC Hydro has undertaken a fish salvage operation during the February drawdown event. (There is currently no requirement for a salvage operation during drawdown in September). These operations have resulted in the recovery of four small Dolly Varden that were stranded in an isolated pool on the east side of the headpond. This is the only area in the headpond that has been documented as being prone to isolation as water levels recede. During the February drawdown event, the headpond is drafted slowly over a 1.5 to 2-hour period. The headpond is drafted much more quickly (about 15–20 minutes) in September, but is drawn down for only a short period of time to permit inspection activities.

To address the potential for fish stranding, the Committee was interested in developing a protocol for headpond drawdown events (see Section 6.0). This involves implementing a slower ramp rate during all drawdown events to minimize the incidence of stranding.

Gravel Recruitment

The Consultative Committee identified concern that annual dredging of sediment from the headpond and the presence of the dam itself could be limiting the quantity and quality of gravels that would naturally move through the system. This could, over the long term, be causing a degradation of spawning habitats in the lower creek below the falls. The Consultative Committee noted that downstream recruitment of gravel could be encouraged by preferential use of the sluiceway (as opposed to discharging water over the spillway). However, as most of the sediment that accumulates within the headpond is sand, this could also result in increased siltation of downstream fish habitat. Passing the larger size fraction (large rocks) through the sluice could also pose a safety problem.

The Consultative Committee agreed that this issue could not be satisfactorily addressed through operations and, therefore, discussed non-operational mitigative options (i.e., importing gravel by truck to the lower creek). Some members of the Consultative Committee expressed support of this option, which could be pursued through making application to the Bridge Coastal Restoration Program.

4.3.2 Issues – Powerhouse Tailrace

During the first Consultative Committee meeting, several issues related to effects of operations on fish and fish habitat in the powerhouse tailrace were identified by the Consultative Committee. Some of these issues were dropped from further consideration because the potential impact on fish/fish habitat was considered inconsequential. The issues and rationale for not considering them further within water use planning are outlined below in Table 4-4.

Table 4-4: Tailrace Fish-related Issues Discussed but not Pursued by the Consultative Committee

Interest	Issue/Concern	Decision/Rationale
Total Gas Pressure	Elevated levels of dissolved gas could cause injury and mortality in fish downstream of the dam.	Total gas pressure (TGP) has not been monitored at the Clayton Falls facility, but it is not believed to be an operational issue as TGP levels are naturally elevated by the series of waterfalls located below the dam.
Increased Water Temperatures downstream of Powerhouse	Concern was expressed that water temperatures in the spawning channel could be higher than within the mainstem as a result of heating of water as it flows through the generating units.	In the early operation of the Clayton Falls Generating Station, BC Hydro was required by the Ministry of Environment, Lands and Parks to measure and record water temperatures in the tailrace and mainstem during the annual incubation period for pink and chum eggs. Testing results indicated that water temperatures in both areas were equivalent. No further testing has been required.

Tailrace issues brought forward by the Consultative Committee and discussed in more detail during technical committee meetings focused primarily on the adequacy of flow conditions within the channel for pink and chum spawning and incubation. Discussion also focused on the condition of the spawning habitat within the tailrace channel and how this could be affecting its performance.

<u>Adequacy of Flow in the Tailrace during Plant Shutdown</u>

The Backup Water Supply Line is crucial in providing flow within the tailrace channel during periods when the generating units are shutdown for annual maintenance. If the minimum flow supplied by this line is inadequate in maintaining suitable spawning and incubation conditions, impacts on spawning success could be significant.

Concern was expressed by members of the Consultative Committee regarding the potential for prolonged dewatering of the tailrace channel during full plant shutdowns and its effect on pink and chum egg survival. Specifically, there was concern whether the required minimum flow of 0.08 m^3/s is sufficient to ensure egg survival within the channel, particularly during winter (i.e., provides adequate intragravel flow and protects substrate from freezing).

Based on visual observations, it appears that weirs at the lower end of the channel help to maintain an approximate 6 inch bank-to-bank coverage at minimum flow. While most of the Consultative Committee members were satisfied that these provisions adequately provide for spawning fish and incubating eggs and that these should be followed through within the Water Use Plan, some members of the Consultative Committee felt that further confirmation of this was warranted. Specifically, it was recommended that photo documentation of the tailrace channel be obtained during low flow periods, and flow from the Backup Water Supply Line be metered to confirm that it provides the required minimum flow of 0.08 m^3/s.

Two test unit shutdowns were performed at the request of the Committee to demonstrate the condition of the tailrace under minimum flow (Backup Water Supply only) (Photo 4-5). (A detailed description of this assessment is provided in Section 6.0). The Consultative Committee agreed that the current backup flow appears to be adequate to maintain a wetted channel for fish/egg survival for at least the brief period of the test. However, they agreed that assessment of habitat conditions over longer periods of minimum flow conditions would be required to determine the adequacy of this during annual maintenance activities.

Photo 4-5: Tailrace Channel during Test Unit Shutdown, with 0.08 m^3/s Minimum Flow provided through the Backup Water Supply Line
(Photos taken by Ron Ptolemy, 29 January 2003)

<u>Freezing Conditions during Maintenance Periods</u>

Concern was expressed by some Committee members that freezing temperatures could compromise the performance of the backup line, causing a reduction or complete restriction of flow to the powerhouse tailrace at a time when supply of the minimum flow is required. In addition, there was concern about the formation of frazil and anchor ice within the spawning channel due to sustained cold weather during the maintenance period. In either case, conditions within the channel could be detrimental to the survival of incubating pink and chum eggs.

As the intake gate is usually kept open about 3 inches (7.5 cm) during annual maintenance providing additional flow to the tailrace, freeze-up of the backup line would be of most concern during the 1 in 10 year maintenance when the penstock is completed dewatered to allow walk-through inspection. Prior to penstock inspection, the dam operators check the intake of the backup line to ensure that it is free of debris and that the line is capable of providing the minimum flow. If problems are encountered, the work is deferred until such a time that the line is functioning as intended.

The potential for formation of frazil or anchor ice within the tailrace channel would also be greatest during the 1 in 10 year penstock inspection. However, there is the potential for freeze-up conditions to also occur during annual maintenance in February during sustained cold periods. While it is thought that the additional flow provided through the intake gate would effectively prevent freeze-up, it was noted that there is insufficient information to confirm this. The Committee agreed that recommendations should be included within the local operating order for the facility for the February shutdown period to ensure that there are sufficient flows for incubating eggs, particularly during very cold weather when there might be a risk of the channel freezing over (see Section 6.0).

Siltation of the Tailrace Channel

In the first year of operation of the tailrace channel (1993), Fisheries and Oceans Canada (DFO) monitored the condition of the spawning gravels and performed hydraulic sampling to determine egg survival rates (Croll and Monk 1993). Fisheries and Oceans Canada estimated the survival rate of pink eggs to be about 93 per cent, which is well above the survival rate of 30–60 per cent expected from a spawning channel. Some siltation was observed to be occurring but, in general, the gravel was still loose except for the lowest section just upstream of the creek. The source of the silt was not determined, but was likely from sediments being passed through the generating units, and possibly the Backup Water Supply Line.

The Consultative Committee discussed the potential for ongoing siltation of spawning gravels and its effects on the performance of the channel. During a site visit, members of the Committee observed the gravels and agreed that the channel is still in good condition, although some siltation was noted in the channel, primarily in the upper section above the first weir (Photo 4-5 and Photo 4-6).

Photo 4-6: Powerhouse Tailrace Channel during Test Unit Shutdown, with 0.08 m^3/s Minimum Flow provided through the Backup Water Supply Line. (Note sedimentation along right upstream bank)

Local Fisheries and Oceans Canada staff carried out hydraulic sampling in January 2003 to provide the Committee with more recent information on egg survival rates. It was estimated that pink egg survival was about 60 per cent for the entire channel, but lower (30 per cent) in the uppermost section, likely due to the accumulation of fines and the presence of less gravels than the downstream end at the tailout.

The Consultative Committee agreed that regular maintenance will be required in the future to maintain the integrity of the tailrace channel for spawning. BC Hydro recognizes the need to monitor the condition of the tailrace and undertake remedial works when necessary to maintain the performance of the spawning channel. Interest was expressed by Fisheries and Oceans Canada to participate/assist with tailrace channel maintenance activities if required.

4.3.3 Issues – Lower Clayton Falls Creek

During the first Consultative Committee meeting, several issues related to effects of operations on fish and fish habitat in the mainstem of the lower Clayton Falls Creek were identified. Some of these issues were not pursued further within water use planning because the Committee considered the potential impact on fish values to be inconsequential. The issues and rationale for not addressing them further are outlined below in Table 4-5.

Table 4-5: Mainstem Fish-related Issues Discussed but not Pursued by the Consultative Committee

Interest	Issue/Concern	Decision/Rationale
Flow and River Stage Reduction in the Canyon Channel (between the dam and final falls)	During winter, flows within the canyon channel are limited to minimal spill and dam leakage. Reduced flow and river stage could cause isolation of fish between the dam and falls, and cause dewatering of fish habitat and stranding of fish.	This section of creek is characterized by steep canyon, which has very low fish habitat value. The dam has likely reduced the numbers of fish that are passed downstream into this section. The Committee viewed this as being a positive change, as this area is liable to freeze up during winter low base flows. It was agreed that it is not necessary to manage for fish values specifically within this creek section, and that any operations undertaken to address fish habitat concerns below the final falls would likely benefit the entire reach.
Loss of Flow in the Mainstem during Headpond Refill	During annual maintenance, inflows to the headpond are passed downstream through the sluice. However, there is a short period of time (about 20–25 minutes) when the sluice gate is closed to fill the headpond, which causes flow over the dam to stop. Fish and eggs in the mainstem could become stranded during this time.	The potential for fish/egg stranding would be greatest following the February maintenance period, as this coincides with the incubation period of pink and chum. The Committee felt that, since the loss of flow in the mainstem would be short lived, the risk of fish/egg mortality would be low. In addition, any actions taken to address the effects of low flows on rearing fish in the mainstem (i.e., specification of a minimum discharge from the dam, see below) would also further ameliorate this impact.

The following summarizes issues associated with operational impacts on mainstem fish and fish habitat that the Consultative Committee considered important to address through water use planning or requiring further investigation. These issues were brought forward by the Committee, and discussed in detail during subsequent technical committee meetings. In some cases, recommendations for operational changes were developed to address the issue, while in other cases, further study was required to determine the significance of the issue.

Low Winter Flows

One of the primary issues discussed by the Committee relates to the low winter inflow period, when flows below the falls are largely restricted to dam leakage and local inflow (estimated at about 0.05 m^3/s), and periodic spill. On an opportunistic basis, BC Hydro voluntarily spills water over the dam to provide the dam operators with a longer response time to natural inflow reductions. By utilizing this natural spill ramping effect over the spillway, spill varies both daily and hourly with headpond levels and is reduced to zero as required. The lack of flows in the mainstem could have a critical effect on fish values in this lower reach.

Lower Clayton Falls Creek provides high quality rearing habitat, and occasional periods of very low or zero flow could affect the suitability and availability of these habitats and the survival of rearing fish and their food supply (insects) (Photo 4-7). This effect is of most significance within the 51 metres of habitat between the final falls and the outlet of the powerhouse tailrace, where dam discharges are the only reliable source of flow. Although there is no information on local inflows, it can be conservatively assumed that these can not be relied upon to guarantee adequate flows for fish utilizing this creek section.

Photo 4-7: Clayton Falls Creek between Base of Falls and Tailrace Outlet

Operationally, it is possible to provide a sustained minimum flow from the dam to minimize the impacts of such low flow events on fish below the falls. The Consultative Committee was interested in pursuing this issue, which became the focus of an objective and associated performance measure.

Fish Access to Standing Pool

During the second Consultative Committee meeting, there was discussion as to whether lower flow conditions during the summer period (mid July to end of September) would prevent pink and chum spawners from accessing the holding pool at the base of the falls. It was agreed that this is a valuable pool for spawners waiting to access the tailrace channel, particularly given the limited availability of suitable spawning habitat within the mainstem. While it was felt that blockage of access could occur, it is unlikely that this condition would persist for long periods of time and pose a significant risk to spawning fish. Nevertheless, the Committee expressed an interest in reviewing actual spill data for the summer period to determine whether flows drop below 1.0 m^3/s during this time and whether they could remain low for a period of a week. Based on habitat-flow observations made during the 29 January 2003 site visit, it was concluded that a flow of 0.9 m^3/s would likely provide sufficient water depth for fish movement within the channel as well as access to the holding pool. It was agreed that spill data for the Clayton Falls facility would be distributed to the Fish Technical Subcommittee members for review.

Subsequent to the Consultative Committee meeting, the Fish Technical Subcommittee was provided with actual spill data for the years 1995, 2001 and 2002, as well as theoretical spill data based on historical inflow for the period of record (1979–1999). Based on a review of these data, the Fish Technical Subcommittee confirmed that there would be only brief periods of time during summer when flows below the dam would drop below 2 m^3/s (primarily towards the end of September). In addition, they noted that there are sufficient daily fluctuations in flow to allow fish to undertake movements within the mainstem, similar to that which would occur naturally in a unregulated system.

It was agreed that no operational change or monitoring would be required to address this issue.

Increased Suspended Sediment and Turbidity below the Dam

Elevated levels of suspended sediments caused by drawdown events could cause siltation of spawning habitat below the final falls. As headpond drafting typically occurs in September and mid February, there is potential for overlap with pink and chum spawning and egg incubation. Some sand and silt is passed downstream through the sluice when it is partially opened to draft the headpond, but much of the finer materials are retained within the headpond.

The Consultative Committee agreed that there is little that could be done by modifying the timing of operations to further reduce levels of suspended sediments. Conducting maintenance operations (i.e., dredging) at other times of the year when fish are least sensitive is not a viable option as most of the sediment is deposited within the headpond later in the year (September–November). However, the Consultative Committee noted that implementation of a slower ramp rate during drafting in September (as is currently done in February) to minimize fish stranding in the headpond would also minimize suspended sediment levels downstream of the dam.

4.3.4 Objectives and Performance Measures

Based on the fish-related issues identified, the Consultative Committee developed the primary objective of maximizing fish abundance and diversity in Clayton Falls Creek. Initially, three sub-objectives were developed for managing fish habitat within the creek. These related to ***minimizing dewatering of habitat below the final falls, minimizing fish stranding within the headpond, and minimizing siltation of spawning habitat downstream of the final falls*** (Table 4-6). It was agreed that no performance measure was required for fish stranding as the Consultative Committee recommended an operational protocol for headpond drawdown events in February and September that would minimize the incidence of occurrence.

The Consultative Committee also noted that implementing a slower (i.e., two-hour) ramp rate during headpond drawdown to minimize the incidence of fish stranding would also help to minimize suspended sediment levels within and downstream of the headpond. In addition, the Consultative Committee would support an application to the Bridge Coastal Restoration Program to fund a program to mitigate for loss of gravel recruitment in lieu of an operational alternative that could have caused increased siltation of downstream spawning habitats.

Table 4-6: Fish Objectives and Performance Measures

Objective	Performance Measure	Location
Minimize dewatering of habitat below the final falls on Clayton Falls Creek.	Number of days that a target elevation below the falls is not reached.	Elevation measured from the staff gauge installed at the base of the falls.
Minimize fish stranding within the headpond.	(Operational protocol to minimize incidence of stranding).	
Minimize siltation of spawning habitat downstream of the final falls.	(Operational protocol to minimize suspended sediment levels and turbidity in headpond).	

Subsequent to the development of the initial fish objectives, the Consultative Committee agreed that the sub-objective to "minimize dewatering of habitat below the falls" be re-worded to reflect the importance of increasing parr rearing habitat in the creek. This change is reflected in the final set of objectives and performance measures agreed to by the Consultative Committee.

4.4 Wildlife and Wildlife Habitat

There is currently little available information on wildlife and wildlife habitat in the Clayton Falls Creek area. The watershed lies within grizzly bear (*Ursus horribilis*) range in an area with moderate to plentiful populations. The area also supports a number of Blue-listed species, including lesser salt marsh sedge (*Carex glareosa* var *aphigens*), Chamisso's Montia (*Montia chamissoi*) in a grassy/sedge meadow at the mouth of the Bella Coola River and five-leafed cinquefoil (*Potentilla quinquefolia*) along Clayton Falls Creek. Other species that may potentially occur in the vicinity of Clayton Falls Dam include the coastal tailed frog (Blue-listed) and marbled murrelets (Red-listed).

4.4.1 Issues

Few wildlife issues related to operation of the Clayton Falls facility were identified during the consultative process. One concern raised by a community member is that marbled murrelets fly over the area to old growth forest in the upper watershed, and could be potentially disturbed by operations. The Consultative Committee agreed that as the murrelets do not utilize habitat surrounding the facility, it is unlikely that these individuals would be affected by operations.

There have been a number of sightings of the coastal tailed frog in adjacent watersheds and streams in the Bella Coola region, and it is highly probable that this species is also present in upper Clayton Falls Creek (including the headpond). This species spends three years as a tadpole, during which it prefers cold clear streams where there is riffle/rapid habitat and low densities of fish. During the adult stage, they live within the riparian zone and are found in fast flowing streams with cobble. Although it was thought that the tailed frog occurs primarily in headwater areas, it has been reported in lower portions of watersheds close to the tidewater.

Given the habitat preference of the coastal tailed frog, this species would likely occur in the upper end of the headpond in riffle habitat as opposed to within the headpond itself, as it does not provide suitable habitat and there is no substantial flow. Should this species be found to utilize the headpond, the Consultative Committee agreed that there would be no operational change that could be made to mitigate effects beyond implementing a slower ramp rate during headpond drawdown (as recommended by the Consultative Committee to minimize the incidence of fish stranding).

4.4.2 Objectives and Performance Measures

The Consultative Committee agreed that there are no wildlife issues that need to be addressed through the Clayton Falls Water Use Plan. Consequently, the Consultative Committee did not develop any wildlife-based objectives or performance measures.

4.5 Cultural Use and Heritage Resources

The Clayton Falls hydroelectric system is in the traditional use areas of the Nuxalk Nation. Discussions with Nuxalk Nation representatives indicated that their primary interest regarding the Clayton Falls facility focused on fish and public safety. The Nuxalk Nation also expressed issues regarding construction of the dam but recognized these were outside of the scope of the Water Use Plan process because they are not linked to operations. Beyond these issues and the safety issue mentioned above, there were no cultural heritage issues that could be affected by operations and therefore considered within this process.

4.6 Summary of Objectives and Performance Measures

The Consultative Committee agreed to the following objectives, sub-objectives and performance measures for this water use planning process (Table 4-7).

Table 4-7: Summary of Objectives and Performance Measures

Fundamental Objectives	Means (Sub-) Objective	Performance Measure
Maximize revenue Minimize traffic accident risk Minimize air pollution Maximize long-term power supply availability	Minimize diesel generation at the Ah-Sin-Heek diesel plant	Quantity diesel fuel (L/yr)
Maximize recreational quality and diversity	Minimize interruption of water supply to the wharf	Number of days during which supply is interrupted during the period 15 May to 15 September
Maximize fish abundance and diversity	Maximize effective parr rearing habitat in the creek[1]	Percentage of effective rearing habitat available

[1] At an early Consultative Committee meeting, it was agreed that the fish sub-objective was to "minimize dewatering of habitat below the falls". However, the performance measure developed by Ron Ptolemy and Alf Leake did not reflect this precise wording and the sub-objective was re-worded to reflect this.

5 INFORMATION COLLECTED

During the process of identifying issues, structuring objectives and developing performance measures, a number of questions were raised by the Consultative Committee. In the case of wildlife, recreation and cultural/heritage interests, current information was considered adequate for decision-making regarding the need for developing performance measures. However, specific information gaps related to the effects of operations on fish habitat in Clayton Falls Creek were identified through the process, and some data collection was undertaken to address these data gaps.

A summary of the information collected during the Clayton Falls water use planning process is provided in Table 5-1.

Table 5-1: Summary of Information Collected during the Clayton Falls Water Use Planning Process

Interest	Information Collected	Description/Rationale
Fish/Fish Habitat	Measurement of flows from the CLA Generating Station water supply lines (7 January 2003)	Measurement of flow from the Fish By-pass Line and Backup Water Supply Line using a portable flow meter to confirm that the lines provide the required flows of 0.2 m^3/s and 0.08 m^3/s, respectively.
	Fish/fish habitat sampling during a test plant shutdown (9 January 2003)	Field observations and photo/video documentation of flow and fish habitat conditions within the tailrace channel to assess the adequacy of 0.08 m^3/s minimum flow for pink and chum spawning and egg/alevin survival. Instream flow measurements within the tailrace channel during unit shutdown. Field observations and photo/video documentation of flow and fish habitat conditions within the mainstem between the falls and tidewater to determine whether provision of a minimum flow within the diversion reach is required for spawning and rearing fish.
	Sampling of juvenile fish in lower Clayton Creek (9 January 2003)	Deployment of Gee minnow traps in the lower reach of the mainstem between the falls and tidewater.
	Fish/egg sampling within lower Clayton Creek and powerhouse tailrace channel (20 January 2003)	Electrofishing in the lower reach of the mainstem and tailrace to determine species and extent of rearing use. Hydraulic sampling within the tailrace channel to obtain an estimate of egg survival for pink and chum.
	Flow measurements during a test plant shutdown (29 January 2003)	Instream flow measurements within the tailrace channel to confirm earlier estimates

Table 5-1: Summary of Information Collected during the Clayton Falls Water Use Planning Process (cont'd)

Interest	Information Collected	Description/Rationale
Power	Clayton Falls historic daily inflow data (1972–1999)	Compilation of historic daily inflow data from Clayton Falls Creek Water Survey of Canada (WSG) gauge (1980–95) and synthetic inflow data based on correlation to Salloomt River WSG gauge (1972–79; 1996–99)
	Clayton Falls estimated free spill data (1995, 2001, 2002)	Compilation of headpond elevation data converted to estimated spill (15 min. intervals) for select years
	Clayton Falls theoretical spill data (1972–1999)	Compilation of historic daily theoretical spill (inflow-3.8 m^3/s turbine discharge)
Recreation	Interviews with regional stakeholders, and review of available information	To scope issues
Wildlife	Review of available information	To scope issues
Cultural and Heritage Resources	Correspondence with agencies and knowledge holders in the aboriginal and non-aboriginal communities	To scope issues

Details of the field studies are presented in Appendix E: Summary of Field Work undertaken during the Clayton Falls water use planning process.

5.1 Fish and Fish Habitat Studies

The Consultative Committee requested that a study be undertaken to better understand the impacts of operations on fish and fish habitat of the lower Clayton Falls Creek. This study involved conducting a test session in which generator flows from the plant were shut off for a period, and photos/video taken to capture habitat conditions within the tailrace channel and mainstem below the final falls. The test provided the opportunity to determine whether the minimum required flow (0.08 m^3/s) from the Backup Water Supply Line is adequate for spawning and incubation within the tailrace channel during winter. While it is thought that weirs at the downstream end of the tailrace maintain bank-to-bank wetted habitat within the channel during full plant shutdown, the Consultative Committee agreed that a photographic record would be valuable for comparing flows and habitat. This required flow within both the By-pass Fish Line and the Backup Water Supply Line to be measured to confirm that they provided the required 0.2 m^3/s and 0.08 m^3/s flow, respectively.

During the test unit shutdown, additional sampling was carried out to help address uncertainty related to rearing use of Clayton Falls Creek. Gee minnow traps were deployed between the final falls and tidewater to capture juvenile fish that were utilizing rearing habitat within this creek section.

A test shutdown was repeated during the second Consultative Committee meeting to confirm flow measurements taken earlier and allow evaluation of fish habitat conditions under low flows.

Additional sampling was also conducted within the tailrace channel and the mainstem below the falls to provide more up-to-date information on fish habitat utilization and survival rates of pink and chum eggs. Hydraulic sampling was carried out at four sites within the tailrace channel, and electrofishing sampling was conducted in the channel and mainstem. This provided some indication of the importance and performance of these habitats.

6 OPERATING ALTERNATIVES

In Step 6 of the water use planning process, the Consultative Committee created and evaluated various operating alternatives for satisfying the water use planning objectives described in Section 4.

The only operational factor that was varied for formal trade-off consideration was the provision of a minimum discharge from the dam to improve effective rearing habitat in the mainstem, particularly between the final falls and the tailrace outlet during the overwintering period. This section provides an overview of the minimum flow options and operating alternatives considered by the Consultative Committee.

6.1 Minimum Flow Alternatives

During development of alternatives, the Consultative Committee thought that an ‘optimal’ rearing flow for parr in Clayton Falls Creek was likely in the range of 0.25 m^3/s to 1.25 m^3/s. Flows either less than or greater than the optimal flow would not be beneficial to fish as these flows may not provide suitable depth and velocity in parts of the habitat required for rearing and insect production.

It was proposed that minimum flows of 0.25 m^3/s, 0.5 m^3/s, 0.75 m^3/s, 1.0 m^3/s and 1.25 m^3/s in the mainstem between the falls and tailrace be taken as discrete alternatives for trade-off purposes. Zero minimum flow, the current situation, was not explicitly listed as an alternative *per se*, although this was acknowledged as an alternative with impacts that were apparent.

While it is assumed that these minimum flows are maintained year round, impacts on diesel use and fish habitat would occur only during winter. During the remainder of the year, system inflows are typically greater than the diversion capacity of the generating units (see Figure 2-3). Since the timing of this period varies from year-to-year, there is no disadvantage to specifying the minimum flow throughout the year as provision of the flow would not affect hydro power generation during this period.

Since there are no data on local inflows between the dam and the falls, it is conservatively assumed that discharges from the dam are equivalent to flows in the mainstem.

All other aspects of system operations were assumed to be constant across all minimum flow alternatives. These include:

- overall system demand;

- headpond drawdown and refill protocol as currently detailed in local operating order, or as otherwise defined below, including timing and nature of maintenance activities; and
- tailrace activities as currently detailed in local operating order, or as otherwise defined below, including timing and nature of maintenance activities.

Appendix D: Performance Measure Information Sheet: Volume of Diesel Required to Meet System discusses the key assumptions involved in modelling the alternatives from a power modelling perspective.

6.2 Headpond Drawdown Protocol

Currently, the Clayton Falls headpond is drawn down twice each year for the purposes noted below.

- February drawdown is for sediment removal and dam maintenance (3–5 day period). The headpond is drafted over a 1.5 to 2-hour period, and there is a requirement to have a survey crew on-site to monitor fish stranding and undertake salvage work if required. The requirement for a drawdown rate is to minimize suspended sediment and turbidity levels and fish stranding due to headpond drafting.
- September drawdown is for civil inspection (2-hour period). There is no drawdown rate followed, as there is no requirement for fish salvage operation.

During the first Consultative Committee meeting, the Committee recommended that fish salvage operations should occur each time there is a major drawdown event to monitor fish impacts, but that this may be discontinued if experience shows that stranding is not a significant issue. During the second Consultative Committee meeting, the Consultative Committee agreed that the headpond area is not a highly productive environment for fish, and a 2-hour drawdown rate appears effective in minimizing stranding in that it provides sufficient time for fish to move out of areas prone to isolation as headpond levels drop. There was agreement that fish stranding/salvage surveys are not necessary during either of the drawdown events in the headpond.

The agreed specified conditions for drawdowns are summarized in Table 6-1.

Table 6-1: Headpond Drawdown Conditions

Drawdown Period	**Feb (3–5 days)**	**Sep (2 hours)**
Drafting Time	Occur over a period of 2 hours	Occur over a period of 2 hours
Stranding/Salvage Surveys	None required	None required
Minimum Flow in Tailrace	Yes	Yes

Due to concerns related to low flows within the mainstem channel (between dam and tailrace outlet), the Consultative Committee recommended that a minimum flow be maintained below the dam throughout the headpond drawdown/refill operation by keeping the sluice gate partially open.

6.2.1 Recommended Operations for February Unit Shutdown

The Consultative Committee agreed that current flow management procedures for unit shutdown continue to be followed to ensure that the minimum required flow be provided to the tailrace channel. This involves delivering the 0.08 m^3/s flow through the Backup Water Supply Line, with additional water being supplied through the Intake Operating Gate. In the event that the minimum flow cannot be supplied through the Backup Water Supply Line (freeze-up, debris), the Intake Gate Opening is to be increased to compensate for this loss of flow to the tailrace.

The Consultative Committee also developed the following recommendations to ensure protection of pink and chum incubating eggs within the tailrace channel during annual maintenance, particularly during periods of cold weather.

- Do not begin maintenance if frazil or anchor ice is present within the powerhouse tailrace.
- If frazil or anchor ice is present during maintenance, increase the flow via the Fish By-pass Valve or stop maintenance and bring the generators online.
- It is important to observe the long-term adequacy of the Backup Water Supply Line (0.08 m^3/s for 6 hours). If it begins to fail, “crack” the Intake Gate Opening to increase flows to the powerhouse tailrace.

7 TRADE-OFF ANAYLSIS

The Consultative Committee considered a range of minimum flows for fish and fish habitat in the lower Clayton Falls Creek in the trade-off discussion and analysis. These minimum flows and associated impacts on the performance measures are explored below.

7.1 Initial Simplifications

During development of the flow alternatives, it was thought that the flow-rearing habitat relationship would peak somewhere between 0.25 m^3/s and 1.25 m^3/s. Following subsequent field inspections, it was decided that the optimal rearing flow was between 0.63 m^3/s and 0.7 m^3/s. Therefore, Alternatives "1.0 m^3/s" and "1.25 m^3/s" were considered to be "dominated" by "0.7 m^3/s" since they would result in greater use of diesel fuel to generate electricity.

Since none of the minimum flow alternatives altered the timing of maintenance activities, the recreation objective became redundant and was eliminated from the trade-off discussion.

7.2 Overview of Alternatives and Impacts on Performance Measures

The primary focus of the trade-off discussion and analysis was comparing alternatives and how the fish and power performance measures responded under the different flow regimes.

7.2.1 Impacts on Fish Performance Measures

The fish performance measure considered during the Consultative Committee meeting is illustrated in Table 7-1. The table has been simplified from that used by the Consultative Committee, as the following extraneous data have been removed:

- Data for Alternatives "1.0 m^3/s" and "1.25 m^3/s"; (Alternative "0 m^3/s" has been added for completeness);
- Data for "Yearly Average" or "Growing Season Average" time periods (these were considered to be important by the Consultative Committee before trade-off discussions);
- Data are only presented for the flow-habitat relationship that assumes an optimal flow at 0.7 m^3/s; the two other data sets discussed in Appendix C were considered redundant.

Table 7-1: Fish Performance Measures associated with Flow Alternatives

Modified Curve: Peak = 0.70 m^3/s	Minimum Flow											
	0 m^3/s			*0.25 m^3/s*			*0.5 m^3/s*			*0.75 m^3/s*		
Parr Habitat PM - % of Maximum Habitat	*10th*	*Median*	*90th*	*10th*	*Median*	*90th*	*10th*	*Median*	*90th*	*10th*	*Median*	*90th*
Overwintering Average	0.00	0.00	0.00	0.53	0.57	0.64	0.87	0.87	0.88	0.92	0.94	0.95

The data are presented as median values, with 10th and 90th percentiles showing the variation in values expected as a result of inflow variations. In Figure 7-1, these ranges are represented by the y-bars extending from each median point.

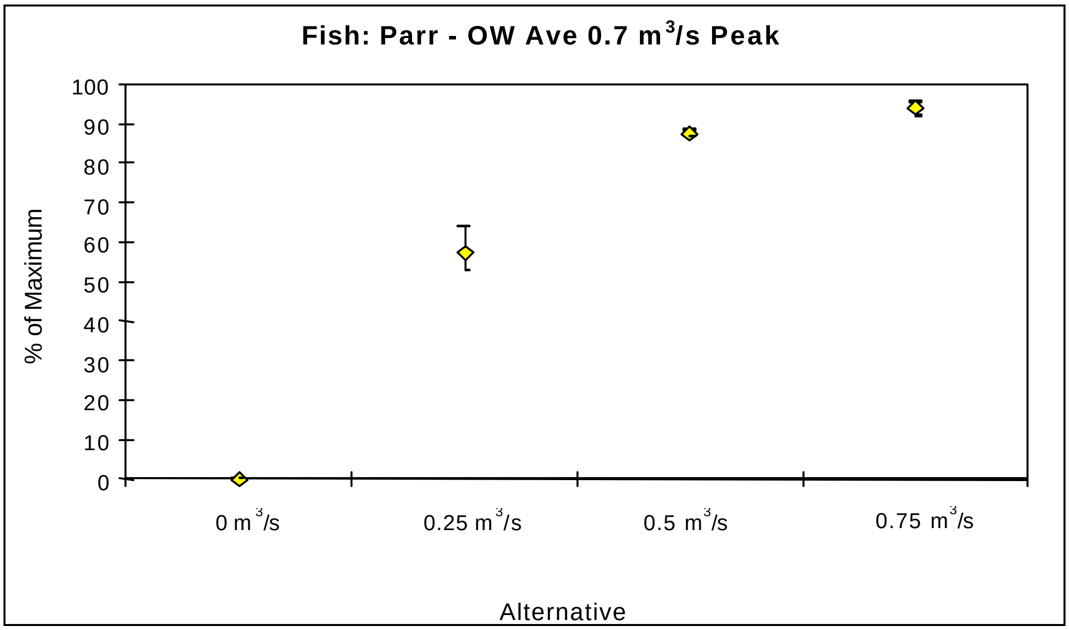


Figure 7-1: Assumed Per Cent of Maximum Parr Habitat Available by Alternative

Note: Due to the lack of overwintering data, rearing curves were used in the habitat analysis to describe overwintering habitat use (see Appendix C, Performance Measure Sheet: Effective Rearing Habitat).

7.2.2 Impacts on Power Performance Measures

The impacts of each of the minimum flow alternatives on power-related interests are tabulated in Table 7-2 and illustrated graphically in Figure 7-2. The loss of power generation directly relates to an increase in diesel use, truck deliveries and costs for diesel. For each scenario, a range of estimates of hydro generation, diesel use and traffic are provided to account for within daily variation in generation, which occurs in response to system power demand. For the upper bound estimate, maximum daily generation of up to 2000 kW was used (i.e., hourly generation of up to 2000 kW may occur when there are sufficient inflows). For the lower bound estimate, maximum daily generation was capped at 1500 kW. Based on the daily inflow data set, it was not possible to accurately calculate the effects of current or future within day load shaping, but it is reasonable to assume that hydro generation for each scenario would be within this range.

For each of the minimum flow alternatives, calculations of lost power generation at the Clayton Falls facility were based on historical daily inflow data for the period of record (1972–1999).

The Consultative Committee was asked to select the measure that best represents their power interest. There was agreement to focus on absolute volume of diesel and replacement volume of diesel.

Table 7-2: Impacts of Alternatives on Power-related Interests

Range in Daily Generation	Minimum Flow Alternatives			
	0 m^3/s	0.25 m^3/s	0.5 m^3/s	0.75 m^3/s
MWh Hydroelectric Generated				
Low	12 457	12 166	11 875	11 506
High	15 598	15 155	14 711	14 195
Volume of Diesel litres/yr				
Low	2 133 000	2 218 841	2 304 681	2 413 678
High	2 133 000	2 263 826	2 394 652	2 547 012
Incremental Volume of Diesel/yr				
Low	0	85 841	171 681	280 678
High	0	130 826	261 652	414 012
Average Annual Cost of Diesel Energy				
Low	$ 980,000	$ 1,020,740	$ 1,061,480	$ 1,113,210
High	$ 980,000	$ 1,042,090	$ 1,104,180	$ 1,176,490
Average Annual Incremental Cost of Diesel Energy				
Low	$ -	$ 40,740	$ 81,480	$ 133,210
High	$ -	$ 62,090	$ 124,180	$ 196,490
Equivalent Truck Deliveries				
Low	41.0	42.7	44.3	46.4
High	41.0	43.5	46.1	49.0

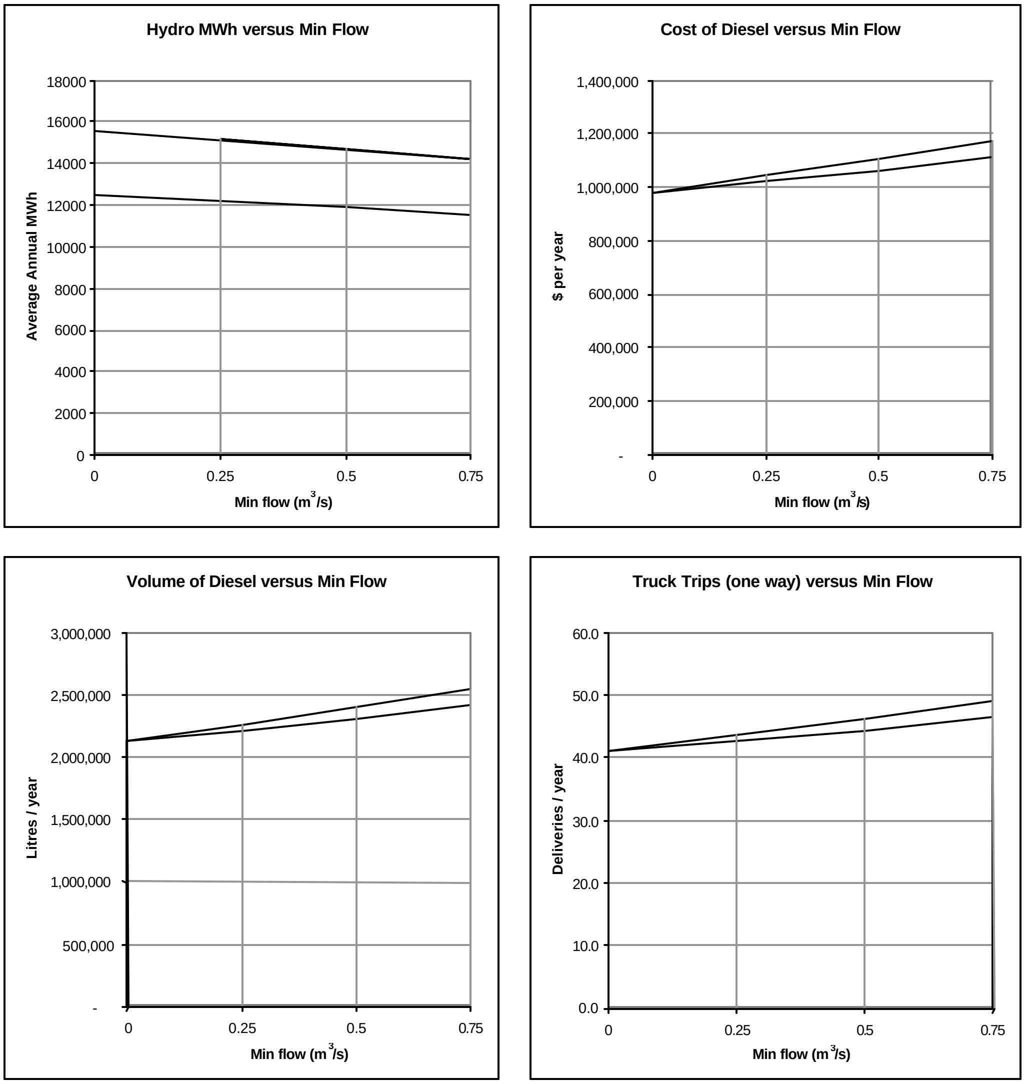


Figure 7-2: Impacts of Various Minimum Flow Scenarios on Hydro Generation, Diesel Use and Traffic

7.3 Alternatives and Impacts on Performance Measures – Discussion

The alternatives considered by the Consultative Committee in the trade-off discussion and the associated impacts on fish and power performance measures are summarized in Table 7-3.

Table 7-3: Summary Consequence Table

Objective	Performance Measure	Units	What's Good	0 m^3/s	0.25 m^3/s	0.5 m^3/s	0.75 m^3/s
				Median	Median	Median	Median
Fish	Parr - OW Ave 0.7 m^3/s Peak	% of Maximum	more	0.0	57.1	87.5	93.9
				Mid Point	Mid Point	Mid Point	Mid Point
Power	Volume of Diesel	000 litres/yr	less	2 133	2 241	2 350	2 480
	Replacement Volume of Diesel	000 litres/yr	less	-	108	217	347

This information was also presented to the Consultative Committee as a trade-off curve (Figure 7-3). The greater the gradient of this curve, the greater the increase in fish benefits per unit diesel. Assuming no threshold exists for fish benefits, each incremental unit of diesel required has a proportionally reduced incremental benefit for fish. Therefore, if low guaranteed minimum rearing habitat (e.g., 10 to 30 per cent) is all that is required, this can be provided with relatively little increase in diesel requirements relative to the amount of diesel that would be required to increase the guaranteed minimum to nearer 100 per cent.

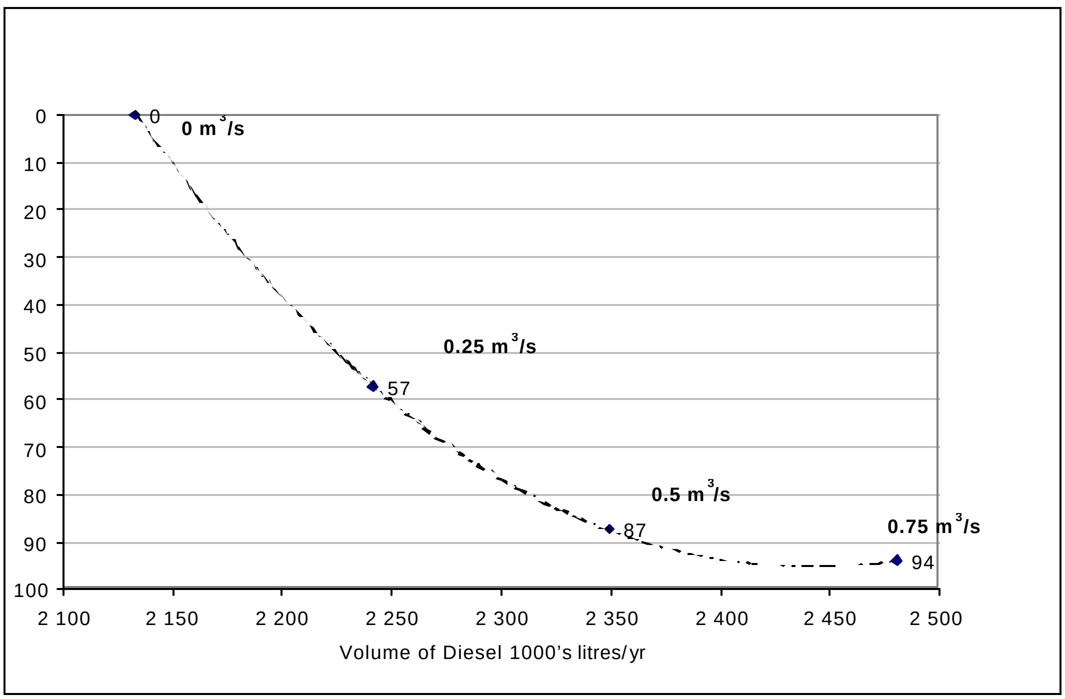


Figure 7-3: Trade-Off Curve for Diesel versus Fish

Note: Curve based on mid-point values for diesel volume

7.4 Trade-Off Discussions

Throughout this water use planning process, there had been a focus on an operational alternative that would "be best for fish". However, when the Committee considered the associated impacts of providing flows that were best for fish, discussion focused more on operations that would be "better for fish" than under the current situation.

Key to this trade-off was considering the benefits of guaranteeing a particular percentage of rearing parr habitat. While ensuring no periods of zero flow was considered important, the actual *minimum* quantity of habitat available at any one time was not considered to be as critical, given that the system is considered quite "flashy" and sustained periods of low flow are unlikely to occur.

The following summarizes the key discussion points of the Consultative Committee in their trade-off deliberations. This is presented as three stages, reflecting the progression of the discussions of the Consultative Committee, and amendments to points of agreement made in response to new considerations made during the process.

7.4.1 Stage 1 Trade-Off Discussions

A number of questions were posed to the Consultative Committee to place some perspective on the discussion of a minimum flow for fish and fish habitat in the lower Clayton Falls Creek. What level of cost is reasonable to incur for 51 metres of largely boulder habitat? Are there any changes that could be made to current operations to achieve fish benefits within this 51 metres of habitat? Is the potential risk associated with increasing transportation of diesel fuel greater than the risk of no minimum flow to the 51 metres of fish habitat? It was also noted that the cost of changing operations is a reallocation of provincial wealth, and that the Consultative Committee needs to determine whether they believe reallocating $100,000 of provincial money is appropriate to achieve benefits for fish. (This corresponds to the average cost of providing a 0.5 m^3/s minimum flow).

It was noted by a Consultative Committee member that, even under optimum flows, one could expect to get only a handful of fish in the mainstem channel below the falls. The current flow regime in Clayton Falls Creek is sustaining fish, but there will not be major increases in productivity even at optimal flows.

There was some question as to whether the status quo ("0 m^3/s") was a viable option, where current operations are maintained and monitoring is conducted to determine whether these flows are adequate for rearing fish. The Consultative Committee was reminded that if fish could tolerate zero flow for a couple of days, there would be no need to specify any minimum flow. For the vast majority of the year, there is some flow within the mainstem channel of the creek between the dam and tailrace outlet. A minimum flow would prevent zero flow on occasions during winter when the headpond water level drops below the freecrest spillway. It was noted by a Consultative Committee member that habitat would have to be assessed under these conditions but there are ethical issues about allowing the 51 m of fish habitat to become dewatered. While some Consultative Committee members did not accept that zero flow is appropriate, they had some difficulty accepting a minimum flow greater than 0.25 m^3/s given the impacts on diesel use and related interests.

It was pointed out that if the calculations of wetted area are truly reflective of actual conditions, the mainstem channel could remain wetted at relatively low flows. Based on habitat conditions captured on the video during the test shutdown, it is likely that very low flows would not pose a significant risk to rearing fish.

A 0.05 m^3/s minimum flow release through the dam, in addition to the estimated 0.05 m^3/s from leakage and local inflows, was suggested for consideration by the Committee. This would result in an effective 0.1 m^3/s minimum flow in the mainstem (Figure 7-4).

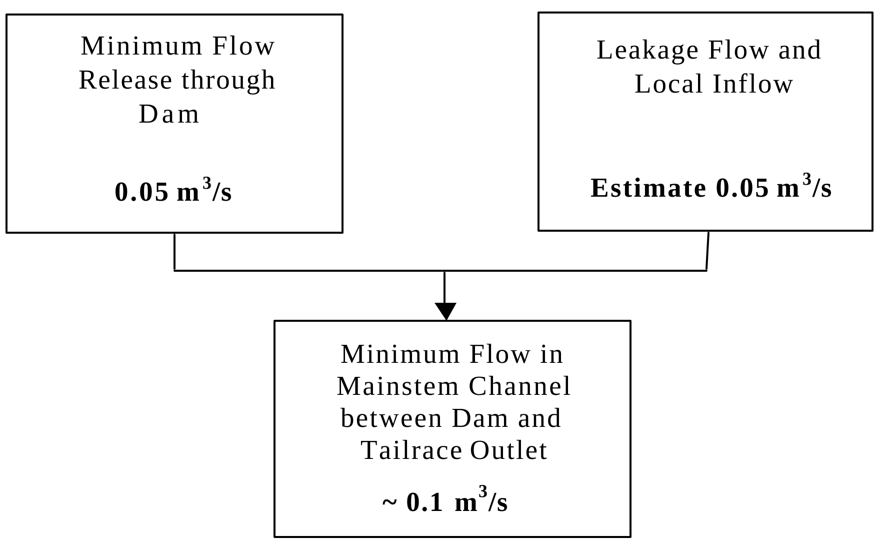


Figure 7-4: Minimum Flow Conditions within the Mainstem Channel proposed during Stage 1 Discussions

It was agreed by the Consultative Committee that a 0.1 m^3/s flow would likely have a positive effect on rearing habitat within the mainstem channel, as it would ensure that the toe-width of the channel would remain wetted and, thus, minimize the risk of fish stranding.

Benefits of a 0.05 m^3/s Minimum Flow

The Consultative Committee agreed that provision of a 0.05 m^3/s minimum flow through the dam (plus leakage and local inflow) would provide the following benefits:

- Prevent the creek from drying up
- Minimize fish stranding and mortality
- Toe-width flow unknown, but likely a flow in the order of 0.1 m^3/s would sustain aquatic life populations (survival flow)

Concern was expressed by a Consultative Committee member that increased volume of traffic would result from any minimum flow provided that diesel fuel continues to be transported to Bella Coola via trucks (historically, diesel fuel was barged in). However, it was recognized that a 0.05 m^3/s minimum flow would be associated with only one additional truck journey per year, which would be acceptable to this Consultative Committee member.

7.4.2 Stage 2 Trade-Off Discussions

It was brought to the Committee's attention that the requirement to deliver water through the Backup Water Supply Line to the powerhouse tailrace was overlooked in the calculation of flow in the Water Supply Line mainstem channel (Figure 7-4).

After discussion, the group revised the alternative to include a 0.1 m^3/s minimum flow from the dam to ensure that the requirement for a 0.08 m^3/s minimum flow within the tailrace would always be met, as illustrated in Figure 7-5.

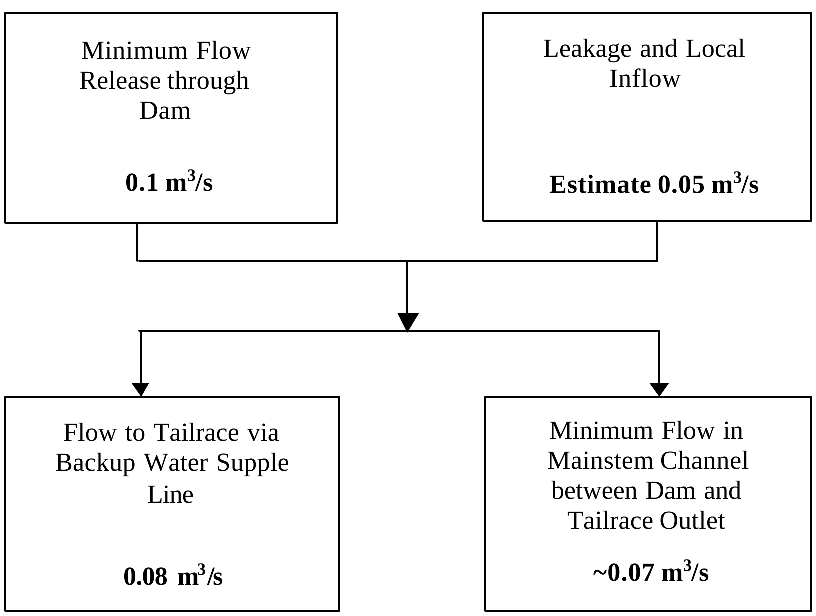


Figure 7-5: Minimum Flows within the Mainstem Channel proposed during Stage 2 Discussions

Concern was expressed by a Consultative Committee member that accepting the 0.1 m^3/s minimum flow would result in an increase in traffic associated with the additional diesel fuel required to offset this lost hydro power generation. This would represent a 2 per cent increase in risk associated with a tanker truck accident. Many of the Consultative Committee members agreed that the benefit of providing an increased base flow below the dam is worth the risk associated with the additional diesel fuel.

The Consultative Committee agreed with the recommendation that BC Hydro provide a minimum flow of 0.10 m^3/s below the dam.

7.5 Preliminary Agreement on a Minimum Flow

The Consultative Committee agreed unanimously that there should be the provision of a minimum flow year round in Clayton Falls Creek. As a result, the following recommendation was tabled.

BC Hydro should provide a 0.1 m^3/s minimum flow from the dam year round.

The underlying values expressed by the Consultative Committee around this recommendation are provided in Table 7-4.

Table 7-4: Underlying Values of the Consultative Committee: Stage 2 Trade-Off Discussions

Name	Comments
Ron Ptolemy	Representing a fisheries agency in the province, it is easier for me to provide a flow for fish rather than zero. Will there be a benefit to fish by providing the minimum flow? Under the current operation, there are fish that use the system. There are fish that survive if flows go to zero; however, an increase in flows will likely provide some enhancement to habitat. Based on available data, it is difficult to judge what the degree of enhancement would be with this minimum flow, but there would be some incremental benefits to fish.
Ken Woo	Providing a minimum flow will ensure that flows in the mainstem will not drop to zero.
John Willis	Agrees with points made by Ken Woo.
Bob Tritschler	Although there is no evidence there has been a zero flow, the 0.1 m^3/s is an acceptable minimum flow as long as it does not affect transportation of fuel on Hwy 20. I acknowledge that there will be an increase of one more fuel truck. Believe that monitoring is required, and that a review should be undertaken within a 5-year timeframe.
Darrell Fritz	Feel that a guarantee of 0.1 m^3/s is better than no flow. BC Hydro is not the only user of diesel. There are probably closer to 70 trucks/year, so the additional requirement for one more trucks a year is not a major issue. The minimum flow would also provide some aesthetic value for the falls area.
Terry Molstad	Feels that the increase in flows to the mainstem will provide some assurance that fish will have at least a certain amount of water during the low flow period. The minimum flow would provide some benefit by maintaining wetted toe width.The provision of some flow also provides an aesthetic value because the falls is a tourist attraction.
Megan Moody	Agree with the 0.1 m^3/s flow. I have never seen it go to zero in the past; however, I have not observed the falls during the winter. The trade-off of increased traffic to the benefits of the flow is a difficult one and not sure if one outweighs the other. However, the 2% increased risk of a diesel truck accident can be seen as minimal, when you consider zero flow and the possibility of stranding fish.

7.6 Stage 3 Trade-Off Discussions

Following agreement on provision of a 0.1 m^3/s minimum flow, it was pointed out that there could be a savings of 10 000 litres of fuel if the Backup Water Supply Line could be shutoff at times when the 0.08 m^3/s flow to the tailrace is not required. This backup water supply is needed only when the penstock is drained for maintenance and inspection.

The Consultative Committee discussed the option of modifying current operation of the Backup Water Supply Line. At present, this line is left open year round, although it becomes clogged with leaves and other debris from time to time and requires cleaning. By shutting off the water supply, an additional 0.08 m^3/s would be left to supplement flows within mainstem channel (Figure 7-6).

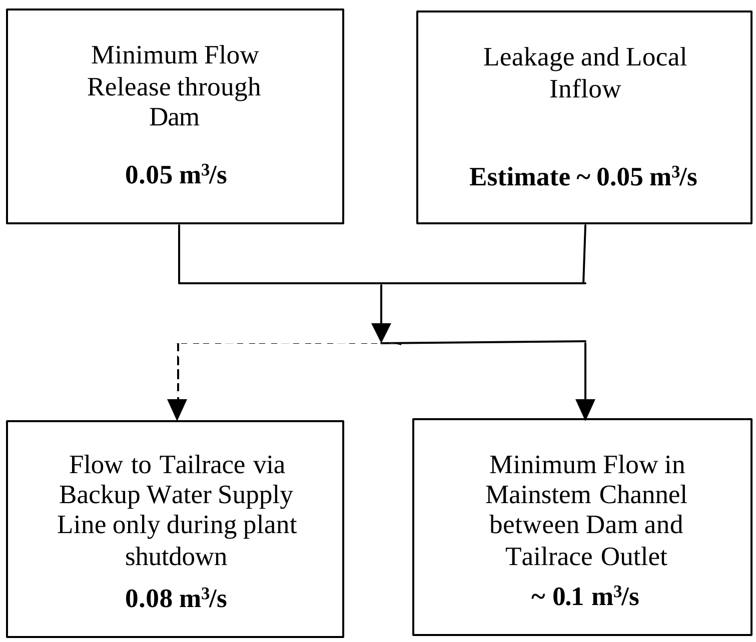


Figure 7-6: Minimum Flows within the Mainstem and Tailrace Channels proposed during Stage 3 Discussions

It was agreed that the 0.08 m^3/s flow being provided to the tailrace channel through the Backup Water Supply Line is a waste of water for most of the year when the generating units are operating, and the G2 Fish By-pass Line is available to provide an additional 0.2 m^3/s. Providing the 0.08 m^3/s to the mainstem channel would be a better use of this water, particularly during the low inflow period. It was recognized that the backup line is only required to deliver flow to the tailrace during maintenance or emergency situations that would require the generating units to be shut down. Inflows to the headpond would be spilled over the dam, providing more than adequate flow to the lower creek during these periods.

This led the Consultative Committee to develop the following recommendation:

- **Shut off and empty the Backup Water Supply Line for 51 weeks of the year.**
- **Open the line during penstock inspection and unit maintenance only.**
- **Provide a flow of 0.05 m^3/s from the dam (rather than the previously agreed 0.1 m^3/s).**

Table 7-5 summarizes the values expressed by each committee member related to the recommended operation.

Table 7-5: Underlying Values of the Consultative Committee: Stage 3 Trade-Off Discussions

Name	Comments
Ron Ptolemy	We have changed the cost-benefit ratio by making this change. It was obvious when we were out in the field that there are sufficient flows in the spawning channel. By diverting water away from the spawning channel back into the spillway channel, a lower minimum flow can be provided at the dam to achieve the same benefits in the section of river below the falls. Same result or better without wasting water. It does not detract from the earlier agreement.
Ken Woo	Agree that we are not wasting the water going into the tailrace so can reduce the water spilled over the dam to ensure you get the same flow downstream. By diverting water from the channel we can achieve the same minimum flow.
John Willis	I like this proposal because you still get a minimum flow at the base of the falls but we have the benefit of not using as much diesel.
Bob Tritschler	This is a good and innovative thought. I agree that by doing this we minimize fuel and still provide the same minimum flow to the spillway.
Darrell Fritz	By doing this it is not costing any more money or resulting in the use of more fuel.
Terry Molstad	This proposed change put water in a place where it is more valuable for fish.
Megan Moody	I like this proposal because we are not losing much power but gaining benefits of not using as much diesel as originally suggested.

7.7 Summary of Recommended Operations and Anticipated Outcomes

The following provides a summary of the Consultative Committee's recommended operations, and the anticipated costs and benefits associated with this change in operations.

7.7.1 Recommended Operations

The Consultative Committee's recommended operation is summarized below:

- Minimum flow release from dam of 0.05 m^3/s
- Anticipate 0.1 m^3/s at falls assuming balance is leakage and local inflow
- If dam leakage is repaired, the minimum flow release requirement is changed to 0.1 m^3/s
- Shutoff the Backup Water Supply Line except for maintenance and shutdown periods
- Implement headpond protocol and tailrace recommendations (as described in Section 6)
- Monitor flows and habitat below the falls (Section 8)

7.7.2 Anticipated Benefits

Anticipated benefits of the 0.05 m^3/s release include the following:

- Prevent the creek from drying up and thus prevent a major loss of fish as a result of stranding
- Toe-width flow is unknown, but likely a flow in the order of 0.1 m^3/s would sustain fish populations
- Sustain other aquatic life populations
- *Monitoring proposal suggested another benefit not discussed at the time of the agreement* – Maintain a minimum rearing flow in the creek to "partially restore" fish values in the creek

7.7.3 Impacts of Operations on Performance Measures

The following summarizes the anticipated impacts of the proposed operation on the fish and power performance measures.

Interests and Performance Measures

Using linear interpolations, it is possible to estimate the impact of the agreed flows on the fish performance measure (Table 7-6).

Table 7-6: Minimum Per Cent Parr Habitat anticipated from 0.05 m^3/s Minimum Flow (Dam Release) and 0.1 m^3/s Flow at Falls (Dam Release with Leakage and Local Inflow)

	0.05 m^3/s Flow from dam only	**0.1 m^3/s Flow from dam plus leakage and inflows**
10^{th} percentile	11%	21%
Median	11%	23%
90^{th} percentile	13%	26%

Power-related Interests and Performance Measures

It is anticipated that a 0.05 m^3/s release from the dam will also result in:

- One extra truckload of fuel delivered each year
- An average increase of 15 000 to 24 000 litres of diesel consumed per year
- An average increase of $7,000 to $11,000 per year in operating costs

This information was plotted on the previously developed trade-off curve as shown in Figure 7-7. The shaded region shows the anticipated trade-off between the fish and diesel performance measures.

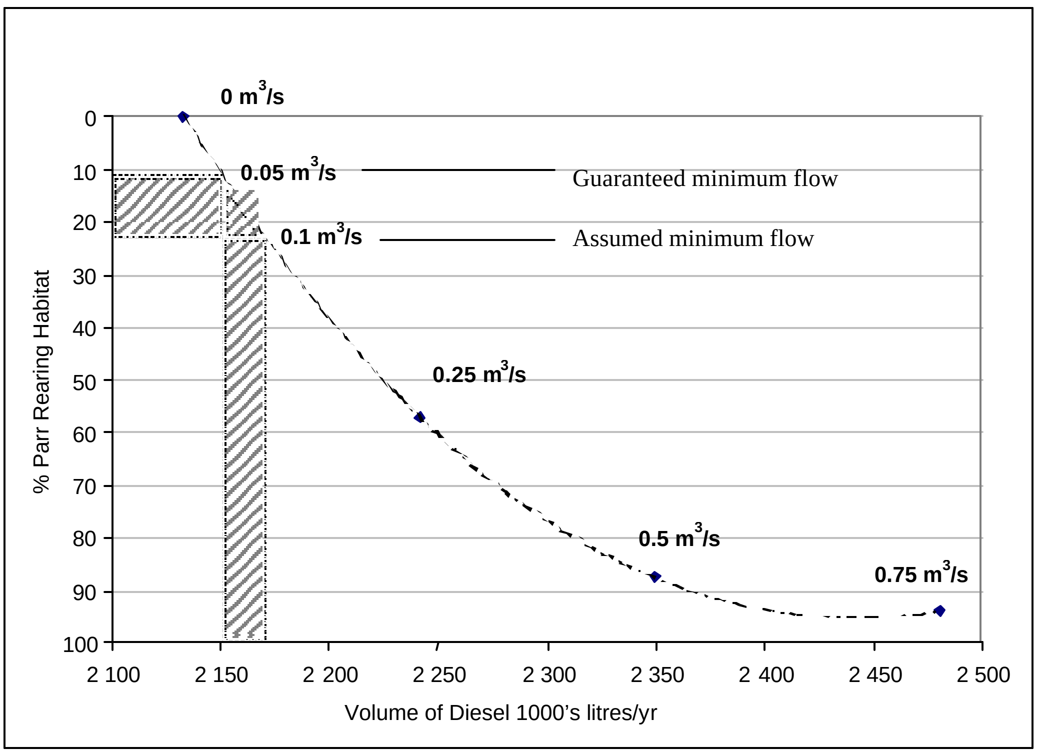


Figure 7-7: Trade-Off Curve for Diesel versus Fish with Recommended Minimum Flows

While there was agreement that a 0.05 m^3/s release from the dam was appropriate and would result in benefits to fish, there was less agreement on whether the flow is beneficial because it eliminates the risk of a zero flow period, or because it contributed significantly to the “restoration” of rearing habitat. This difference of perspective became evident in discussion of monitoring requirements.

8 MONITORING PROGRAMS

In addition to recommending a preferred operating alternative for Clayton Falls hydroelectric project, the Consultative Committee recommended associated monitoring programs designed to address key uncertainties and answer specific questions that may change future decisions on operations. The monitoring programs are intended to assess:

- effectiveness of the operational change for the Clayton Falls facility relative to the water use objectives; and
- compliance with the authorized Water Use Plan for the Clayton Falls facility.

The first program is critical to assessing the benefits of the operational change once the Water Use Plan is approved by the Comptroller of Water Rights. The second monitoring program is considered a mandatory undertaking required to demonstrate compliance with any water licence requirements that might result from the Water Use Plan.

The expected biological response in the mainstem under the preferred operating alternative represents the best judgment of Consultative Committee members based on the available information. A guaranteed minimum flow release from the dam will prevent flows within the lower Clayton Falls Creek from reaching zero, which in turn is expected to increase the suitability and availability of rearing habitat and ensure survival of rearing fish and their food supply. A monitoring program will provide the opportunity to assess how well the operating alternative achieves the desired fundamental objective of increasing effective parr habitat and, therefore, provide better data for future decision-making and reduce uncertainty around the biological response to changes in operations.

8.1 Eligibility of Clayton Falls Creek Monitoring Program

The Aquatic Ecosystem Productivity Monitoring Program recommended by the Consultative Committee was tested against the Eligibility Criteria for Water Use Monitoring Studies (Stumborg, 2003). These criteria state that a monitoring program should:

- Provide information that will help in deciding the best use of water.
- 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 judgment around the weight of evidence.

- Provide results in a timely manner (e.g., by the next scheduled water use planning period).
- 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.

8.2 Monitoring of Water Use Plan Benefits

The lower Clayton Falls Creek provides high quality rearing habitat utilized by coho, rainbow trout (steelhead), Dolly Varden and sculpins, and occasional periods of very low or no flow could affect the suitability and availability of these habitats and the survival of rearing fish and their food supply (insects). This effect is of most significance in the 51 m of habitat between the final falls and the outlet of the powerhouse tailrace, where dam discharges may be the only reliable source of flow. The period of the lowest flows is from February to March, when fish would be overwintering beneath cobbles/boulders and at a time when benthic insects are active. Insect production during this period is important as many insects have a three-year life cycle. The dewatering of habitat could have also a significant impact on insects as well as fish.

During the Clayton Falls water use planning process, the Consultative Committee undertook expert judgment to estimate the optimum flow conditions for rearing fish. Through observations and a professional knowledge of rearing habitat requirements for species utilizing the lower creek, the Committee hypothesized that provision of a 0.1 m^3/s minimum base flow below the falls (0.05 m^3/s minimum dam release plus 0.05 m^3/s leakage and local inflow) year round will improve the physical conditions of rearing habitats and, in turn, influence the community composition and productivity of invertebrate and fish in lower Clayton Falls Creek.

The Aquatic Ecosystem Productivity Monitoring Program (Appendix F) will assess the benefits of a continuous minimum flow on invertebrate and fish communities in lower Clayton Falls Creek. The suggested duration of the monitoring program is four years (one year of baseline, followed by three years of post-treatment monitoring).

Table 8-1 summarizes the values expressed by each of the Consultative Committee members related to the recommended monitoring program.

Table 8-1: Underlying Values of the Consultative Committee: Monitoring Agreements

Name	Comments
Ken Woo	It is important to monitor because we need to get idea of the baseline. Need to verify. We have a sense that the minimum flow will improve conditions but not certain to what degree. I do not think that monitoring will give us a significant result. I will agree to it so you can justify the decision to provide a minimum flow.
Ron Ptolemy	I will not speculate on response and feel it is important that we understand what is currently there. If the base case is limiting, there will be a limited response but I am expecting a measurable response.
Terry Molstad	I think it is worthwhile to understand the aquatic habitat in the area. I think it is important to measure to determine if there is a response because we made choices to provide a minimum flow. The information we collect may result in different decisions in the future. I think the request for monitoring is reasonable.
John Willis	Uncertain if we need to do monitoring but better to get the data.
Bob Tritschler	Agree with Terry's comments.
Darrell Fritz	Agree with Bob and Terry's comments.
Megan Moody	(Not present for these discussions)

8.3 Compliance Monitoring

BC Hydro will be required to undertake compliance monitoring and report out to the Water Comptroller once a change in operations has been ordered. Under the Clayton Falls Water Use Plan, BC Hydro will be required to report on the following.

8.3.1 Minimum Release of 0.05 m^3/s from the Dam

Objective: Demonstrate that BC Hydro is providing the 0.05 m^3/s minimum flow from the dam.

Measured: Compliance monitoring is conducted at the dam. The 0.05 m^3/s release will be provided via an engineered structure:

- notch,
- siphon, or
- pipe in lower part of dam.

Physical works to delivery the minimum flow from the dam will cost about $5,000. If this flow were provided through a notch in the dam, measurements of flow would be calibrated based on design.

The Consultative Committee agreed that this would be appropriate.

8.3.2 Minimum Flow of 0.1 m^3/s at the base of Clayton Falls

Objective: Ensure that the required minimum flow of 0.1 m^3/s (0.05 m^3/s dam release and 0.05 m^3/s dam leakage plus local inflow) is provided to the mainstem channel of lower Clayton Falls Creek (at base of falls).

Measured: At the staff gauge

Compliance monitoring of the anticipated 0.1 m^3/s in the mainstem channel will be required to confirm the estimated 0.05 m^3/s flow contribution from dam leakage and local inflow. This would be a one-time measurement unless works are undertaken at the dam that affect the amount of leakage.

8.3.3 Minimum Flow of 0.08 m^3/s in the Powerhouse Tailrace

Objective: Ensure that the required minimum flow of 0.08 m^3/s is provided within the tailrace channel.

Measured: At the staff gauge

The following steps would need to be taken during annual maintenance or plant shutdown when the Backup Water Supply Line is needed to provide the 0.08 m^3/s minimum flow to the tailrace:

- Clean intake of the water supply line
- Establish a 0.08 m^3/s minimum flow
- Take a reading on the staff gauge
- Monitor the tailrace reading throughout the day
- Ensure the line is cleaned a minimum of twice each day during the maintenance period

If maintenance work is undertaken in the tailrace channel, the staff gauge would need to be recalibrated. There is no need to undertake monitoring during use of the G2 Fish By-pass Line.

9 IMPLEMENTATION OF RECOMMENDATIONS

BC Hydro agreed to begin providing a year-round minimum flow release for fish in the lower Clayton Falls Creek (between the falls and tailrace outlet) one year after implementation of the Clayton Falls Water Use Plan. Current flow conditions would be maintained during the first year of implementation to allow baseline data on fish and fish habitat in the lower creek for the collection of comparative purposes. This would be followed by three years of monitoring with the year-round minimum flow release.

The sequence of implementing the minimum flow operation and its associated monitoring program will be as follows:

- **Approval of the Water Use Plan:** As described for Step 10 of the *Water Use Plan Guidelines*, the Comptroller of Water Rights will review and issue a decision on the Clayton Falls 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, provincial agencies and First Nations.

  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 these. The outcome of the review process will be a plan authorized by the Comptroller.

- **Implement Operational Change:** Once the Comptroller of Water Rights has approved the Clayton Falls Water Use Plan and provided BC Hydro with direction, BC Hydro will implement the Water Use Plan and approved operational changes as requested.

- **Initiate Monitoring Program:** BC Hydro will develop detailed Terms of Reference for the monitoring program and will initiate data collection, analysis and reporting once the Clayton Falls Water Use Plan has been approved and implemented.

- **Review of Water Use Plan:** Five years after implementation of the Clayton Falls Water Use Plan, appropriate government agencies, First Nations and interested parties will meet to review the monitoring results and assess the need to recommend to BC Hydro that a formal review of the Clayton Falls Water Use Plan be undertaken.

10 REVIEW PERIOD

The Clayton Falls Consultative Committee agreed that a technical review of the monitoring program results should be undertaken five years after implementation of the Clayton Falls Water Use Plan. A formal review of the Water Use Plan is recommended in 10 years but could be triggered sooner if significant risks are identified through of the monitoring programs.

During this five-year timeframe, the Committee also recommended that an Annual Data Review be undertaken by BC Hydro, appropriate government agencies, First Nations and interested parties. This would be a general review that would be conducted through distribution of monitoring results and teleconference meetings.

11 REFERENCES

Anderlini, G. (2002). *Clayton Falls Generating Station Staff Gauge Installation and Back-up Water Supply Flow Measurements*. BC Hydro Inter-Office Memo.

BC Hydro. (1999). *Recreation Opportunities Inventory*. BC Hydro, Burnaby, B.C.

British Columbia. (1998). *Water Use Plan Guidelines*. Government of BC, Victoria, B.C.

British Columbia. (2000). *Creating Water Use Plan Alternatives. Identifying Appropriate Issues and Developing Preferred Strategies.* Government of BC, Victoria, B.C.

Croll, G.E. and Monk, R.J. (1993). *Environmental Improvements at the Clayton Falls Hydroelectric Plant*, BC Hydro Report.

Jones, R. R. (1990). *Fisheries Assessment of the Clayton Falls Creek Hydroplant Expansion*. Prepared for Sigma Engineering Ltd., Vancouver, B.C. 11p. + tables, photos and appendices.

Stumborg, B. (2003). *Water Use Planning Monitoring Program: Principles, Decision Tree, and Required Information (Draft)*, BC Hydro, Burnaby, B.C.

APPENDIX A: CLAYTON FALLS WATER USE PLAN CONSULTATIVE COMMITTEE MEMBERS AND OBSERVERS

Final Committee Members	**Organization**	**Primary Interest**
Ken Woo	Fisheries and Oceans Canada	Fish
Ron Ptolemy[1]	Water, Land and Air Protection	Fish
Bob Tritschler	Watershed Habitat Stewardship	Fish/Wildlife
Darrel Fritz	Bella Coola Harbour Authority	Water Supply
Terry Molstad	BC Hydro – Corporate Representative	Power
John Willis	Fisheries and Oceans Canada, Snootli Creek Hatchery	Fish
Observers		
Megan Moody	Nuxalk Nation	Fish
Jude McMillan	Local Resident	Process (potential IPP developer on another system)
Mohammed Sabur	Water, Land and Air Protection	Fish
Mike Ramsay	Water, Land and Air Protection	Fish
Ken Dunsworth	Water, Land and Air Protection	Fish/Wildlife
Todd Rambo	Bella Coola Harbour Authority	Water Supply
Ted White	Land & Water BC (Water Comptroller's Office)	Process
Denis Tippie	Fisheries and Oceans Canada	Fish
Jennifer Turner	Ministry of Forests	Forestry
Barry Layton	Director – Central Coast Regional District	Local economic development
BC Hydro Process Team		
Vesta Filipchuk	BC Hydro	Project Manager
Pat Vonk	BC Hydro	Environment Task Manager
Kathy Groves	BC Hydro	Power Modelling
Graham Long	Compass Resource Management	Facilitator and Resource Valuation

[1] WLAP was represented by Ken Dunsworth at the first Consultative Committee meeting.

APPENDIX B: LIST OF DOCUMENTS GENERATED BY THE CLAYTON FALLS WATER PLANNING PROCESS

This appendix summarizes the documents prepared or used in the 2002–2003 Clayton Falls water use planning process.

A. Meeting Notes

Meeting notes summarizing presentations, discussion and agreements at the Clayton Falls Water Use Plan Consultative Committee and Fish Technical Subcommittee meetings are listed below. In most cases, the draft minutes were circulated for review and comment by the Committee members, and a final version of the notes was distributed as digital files.

Committee or Subcommittee	Meeting Notes
Clayton Falls Consultative Committee	16–17 October 2002
	28–30 January 2003
Fish Technical Subcommittee	14 November 2002
	24 March 2003

B. BC Hydro Clayton Falls Water Use Plan – Interim Reports

These reports are in bound and digital formats.

BC Hydro. (2002). *Preliminary Issues Identification Report*: *Clayton Falls Water Use Plan.* November 2002.

BC Hydro. (2002). *Proposed Consultation Process Report*: *Clayton Falls Water Use Plan.* November 2002.

C. Reports and Memos generated by the Clayton Falls Water Use Planning Process

These reports exist in bound and digital formats.

Anderlini, G. (2003). *Clayton Falls Generating Station staff gauge installation and backup water supply flow measurements.* Memo prepared by BC Hydro, Burnaby, B.C. 20 January 2003.

Kator Research Services. (2001). *Clayton Falls Water Use Plan References by Author*. 10 June 2002. 3p.

Leake, A. (2003). *Clayton Falls Generating Station test shutdown habitat assessment. Clayton Falls Water Use Plan Data Collection Report.* Prepared by BC Hydro, Burnaby, B.C. January 2003.

Vonk, Pat. (2002). *Installation of staff gauges and habitat assessment during a test plant shutdown.* Memo prepared for the Clayton Falls Water Use Plan Consultative Committee, 16 December 2002.

Vonk, Pat. (2003). *Fish Technical Subcommittee Meeting – 24 March 2003.* Update prepared for the Clayton Falls Water Use Plan Consultative Committee, 25 March 2003.

Willis, J. (2003). *Hydraulic and electrofishing sampling results, Clayton Creek,* 20 January 2003. Prepared by Fisheries and Oceans Canada for the Clayton Falls Water Use Plan Consultative Committee.

APPENDIX C: PERFORMANCE MEASURE INFORMATION SHEET: EFFECTIVE REARING HABITAT (PERCENTAGE OF MAXIMUM HABITAT)

What is the performance measure?

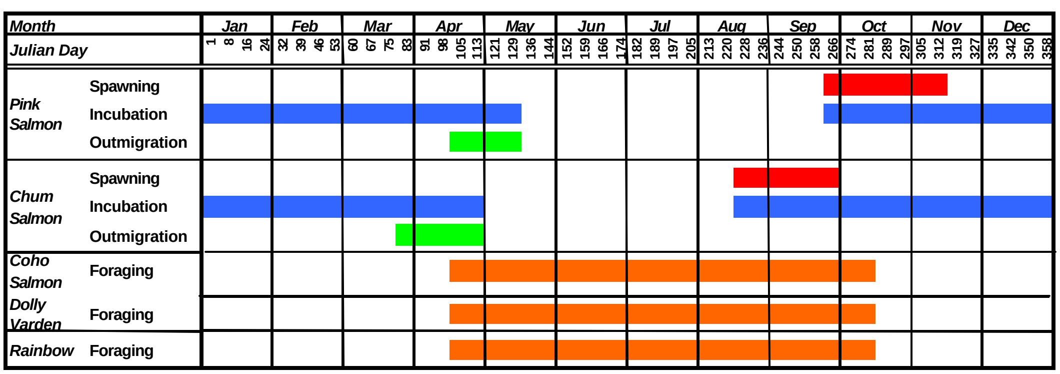
Fisheries technical input into the process has assessed that rearing habitat in the mainstem (spillway) is affected by operations at the Clayton Falls facility, and has recommended that an effective rearing habitat performance measure (PM) be developed to quantify the impacts of various alternatives being considered by the Consultative Committee.

Effective habitat is that which remains stable, productive and/or viable for the duration of a species life history. From a water use planning perspective, such habitats are considered variable to flow changes. There are different requirements that define the effectiveness of habitat depending on the species and life history utilizing the habitat.

Rearing habitats utilized by juveniles (Dolly Varden and rainbow trout) need to be relatively stable. During the rearing period (year round), the minimum habitat over a 5-day period is considered to be productive for juveniles. This approach assumes habitats available less than 5 days are not viable and not utilized.

The following periodicity chart (Figure C-1) describes the life histories utilizing the mainstem and tailrace sections of the Clayton Falls system.

Figure C-1: Periodicity Charts of Key Life Stages in Clayton Falls Creek



In what locations is the performance measure relevant?

The effective rearing habitat PM is limited to the mainstem section of habitat between the spillway plunge pool and its confluence with the tailrace.

Why is this performance measure important?

The fisheries technical group wishes to review the changes in rearing habitat resulting from different operational strategies. The availability of rearing habitat may be a limiting factor for fish populations in Clayton Falls Creek. Increases in habitat area may lead to increases in fish productivity. Variations in flow over the rearing period may limit the productivity of juvenile habitats.

How can they be affected by operational changes?

Generally, the greater the flow, the larger the physical habitat created. Fisheries sensitivities are related to their life history timing and habitat uses; changes in the availability of spawning and incubation habitats will affect spawning success.

What are the key assumptions and uncertainties associated with the impact that these performance measures address?

As it was not possible to collect further data for this Water Use Plan, it was proposed that wetted area be used to approximate available habitat for spawning and rearing species. Due to the limited capacity of the plant and the low flow conditions that dominate the spillway channel, it is assumed that wetted area will track usable area to serve the needs for decision-making in this Water Use Plan.

This PM uses information from a habitat assessment conducted on 9 January 2003, during a test shutdown of the Clayton Falls Generating Station (Table C-1). The following table is considered preliminary, as it represents only limited information collected from one transect at each site. Note that the data collected for the tailrace was not ultimately required by the Consultative Committee.

Table C-1: Physical Habitat Conditions in the Mainstem and Tailrace Channel

Operation	*Tailrace* Flow (m^3/s)	*Tailrace* Staff Gauge El (m)	*Tailrace* Wetted Width (m)	*Tailrace* *WUA (L=55m)* CM WUA	*Tailrace* *WUA (L=55m)* PK WUA	*Mainstem (Spillway)* Flow (m^3/s)	*Mainstem (Spillway)* Staff Gauge El (m)	*Mainstem (Spillway)* Wetted Width (m)	*Mainstem (Spillway)* *WUA (L=51m)* CM WUA	*Mainstem (Spillway)* *WUA (L=51m)* PK WUA
Full Load	3.73	3.50	8.60	23.6	285.8	0.05	2.46	8.50	0.0	47.2
Normal Operations	3.57	3.47	8.60	28.7	311.9	0.07	2.47	9.30	-	-
G1 Off	2.40	3.38	8.40	51.9	344.9	1.25	2.76	13.30	66.0	271.1
G2 Off	0.30	3.12	7.75	27.5	121.8	3.35	2.96	15.75	-	-
By-pass valve Off	0.08	3.05	7.40	-	-	3.57	2.97	15.85	-	-

*estimated at time of write-up; to be confirmed

Figure C-2 illustrates the relationship of parr habitat with flow. This was originally applied to the mainstem for this performance measure based on a limited number of samples (df = 2 for regression).

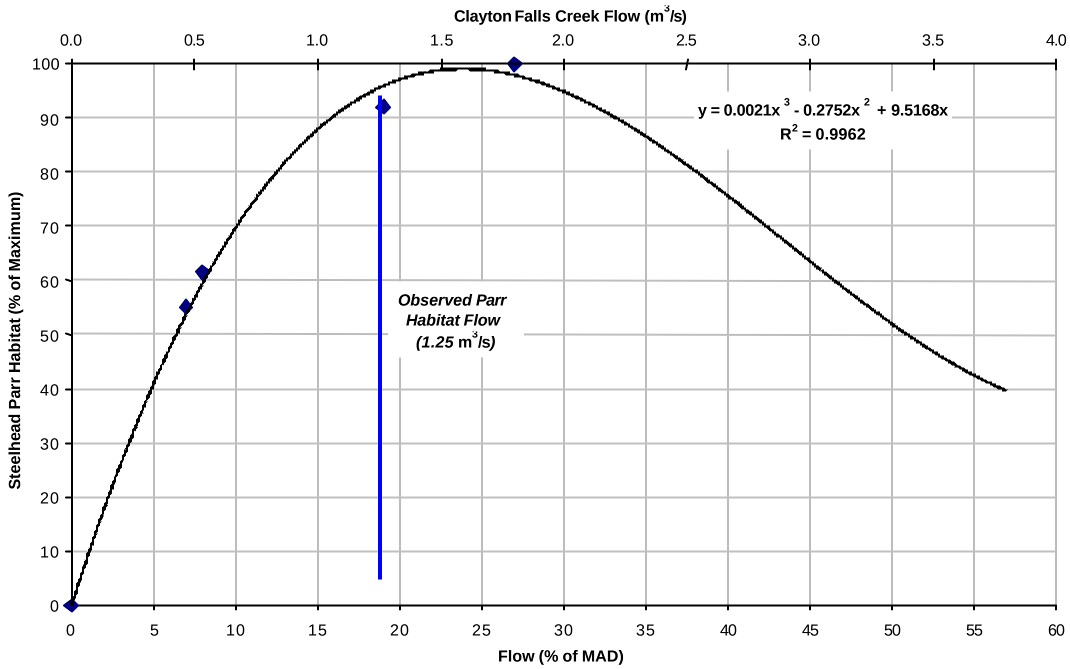


Figure C-2: Relationship of Steelhead Parr Habitat (% of Maximum) with Flow (% of MAD)

MAD for Clayton Falls Creek = 6.6 m^3/s (BCH, 2003).
Relationship based on integrating results from Englishman River and observations on Clayton Falls Creek

Developed in the absence of better information, the fish performance measure represents one expert's (Ron Ptolemy) opinion of the likely relationship between rearing habitat and flow. Notable limitations of this performance measure, or questions raised by it, include the following.

The performance measure expresses impact of flow on rearing fish as it relates to the percentage of available effective parr rearing habitat. However, it does not provide an indication of:

- The absolute quantity of habitat available for fish. An estimate of pink and chum spawning habitat within the mainstem section was calculated by Alf Leake based on weighted useable area (WUA) for the range of flows measured at one transect. This did not consider, however, rearing habitat for other species such as trout, as there was no data at the time to confirm utilization of Clayton Falls Creek by species other than pink and chum salmon. At a flow of 1.25 m^3/s, WUA was calculated as 66 m^2 for chum and 271 m^2 for pink. This is likely an overestimate, as substrate condition was not assessed for suitability.

- The relative importance of the incremental change in the percentage of available habitat. For example, how much better is always having 50 per cent of the habitat available relative to always having 10 or 2 per cent?

- The relationship above describes rearing habitat and is used as a surrogate for overwintering habitat in the absence of adequate habitat suitability information.

Based on review of the videotape taken during the test shutdown, Ron Ptolemy noted that an optimum rearing flow was probably more in the range of 0.7 m^3/s to 1.25 m^3/s rather than the 1.66 m^3/s assumed by this curve. He pointed out that the relationship between flow and per cent of maximum rearing habitat is probably more realistically represented by a curve that is shifted to the left, where a greater per cent of maximum rearing habitat could be achieved by a lower flow (percentage of MAD). This meant that the performance measures developed by this relationship would also be different, and would need to be recalculated based on this new theoretical relationship. After site inspection, Ron reviewed his estimate of the location of the peak of this curve to 0.63 m^3/s.

Ron Ptolemy also noted that the performance measure calculations took too literally the tailing off of the curve to suggest that higher than optimal flows would be negative for rearing fish. Although it was agreed that flows in excess of the optimum would cause some negative impacts (e.g., flushing of insect populations), the tail of the curve exaggerated this negative impact, and should be redrawn with a shallower decay at high flows.

Rather than redevelop the performance measures for this new relationship, the Consultative Committee agreed to use the performance measures generated by the data developed for the 0.7 m^3/s curve, as shown in Figure C-3.

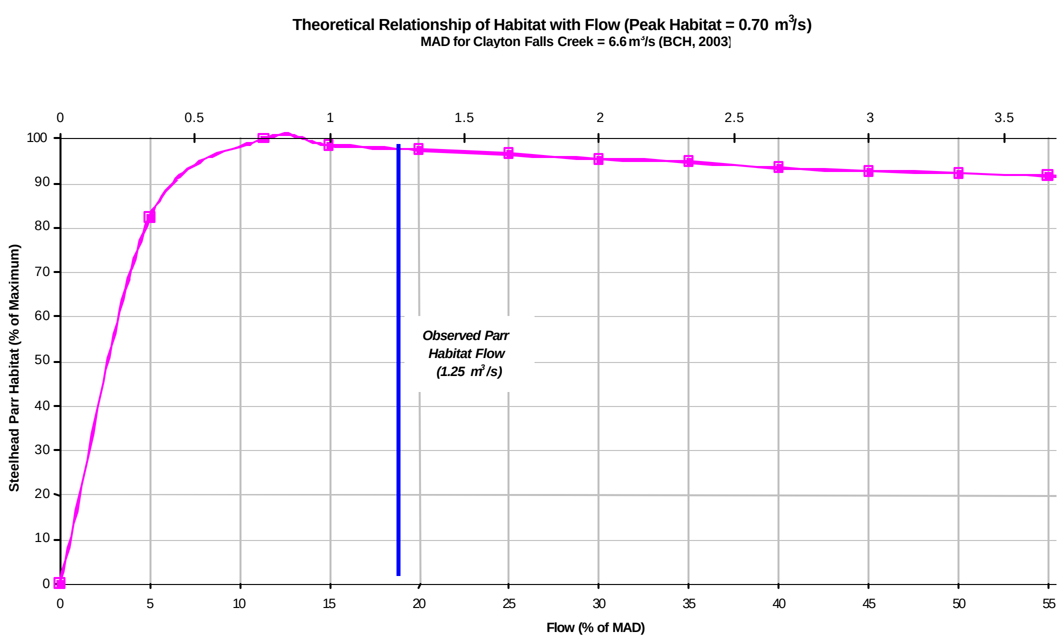


Figure C-3: Modified Flow-habitat Relationship used to Generate Fish Performance Measures

Since the Clayton Falls is a run-of-river facility, the Consultative Committee was not as concerned with the high inflow periods because BC Hydro has very limited control during these times. The primary concern related to low flow periods over the winter months when there is control over inflows. There was also agreement that the overwintering period was the major period of concern, which extends from November to March.

How is the performance measure calculated?

Effective Rearing Area: the measure calculates the effective rearing habitat limited by the minimum discharges over a 5-day duration, described in equation 1 below:

(equation 1): $A_{Rr,j} = Min(A_{Rr,x-5} \ldots A_{Rr,x})$

where: $A_{Rr,j}$ = Area of rearing habitat for day, j
$A_{Rr,\ x-5}$ = Area of rearing habitat for day x-5

and equation 2 describes how each effective rearing day is rolled up into an output for an alternative:

(equation 2): $$A_{ER} = Mdn\left(\frac{\sum_{j_{eRr}}^{j=j_{sRr}} A_{ER,j_i}}{j_{sRr} - j_{eRr} + 1} \right)_{y_{End}}^{y=y_{St}}$$

where: A_{ER} = Species specific median effective rearing area (sqm) for the alternative
sRr and eRr are start and end dates of the rearing period (set for entire year)
y_{St} and y_{End} are start and end years for the alternative

The quantity of habitat for the entire rearing period is summarized as the average of the daily values. Over the range of average habitats for the period of record, median, 10th and 90th percentiles will represent the range of habitats provided for each flow.

APPENDIX D: PERFORMANCE MEASURE INFORMATION SHEET: VOLUME OF DIESEL REQUIRED TO MEET SYSTEM DEMAND

What is the performance measure?

This performance measure indicates the volume of diesel that would be required at the Ah-Sin-Heek Diesel Generating Station to meet the electrical demand of the Bella Coola Community.

In what locations is the performance measure relevant?

Ah-Sin-Heek Diesel Generating Station

Why is this performance measure important?

This performance measure indicates the impacts associated with constrained hydroelectric power generation facility on a range of objectives articulated by the Consultative Committee.

How can it be affected by operational changes?

Demand from the community of Bella Coola is assumed to be constant across alternatives. Since the community is not connected to the main power grid and hydroelectric power is the least cost resource, hydroelectric generation will always be deployed where possible in preference to diesel generation. Constraints that reduce the generation of hydroelectric power will, therefore, result in an equivalent increase in diesel generation at the Ah-Sin-Heek Diesel Generating Station to meet overall electrical power demand.

What are the key assumptions and uncertainties associated with the impact that these performance measures address?

For each of the alternatives being considered, calculations of lost power generation at the Clayton Falls facility were made based on historical daily inflow data for the period of record (1972–1999). This 28-year data set consists of 16 years of data measured on Clayton Falls Creek (WSC Gauge No. 08FB009) and 12 years of synthetic data that were estimated by correlations between the Clayton Falls Creek recorded data and data recorded on the Salloomt River near Hagensborg (WSC Gauge No. 08FB004).

The estimates of replacement diesel take into account the fact that the generating units are not operated at maximum capacity all of the time even when there is sufficient inflow. For this reason, estimates were calculated for a range of maximum daily generation (1500–2000 kW). Based on the daily inflow data set, it is not possible to calculate the effects of within day load shaping but it is reasonable to assume that the cost estimates would lie somewhere within this range.

The performance measure calculations assumed that on days when daily inflow is not sufficient to satisfy the maximum turbine flow plus the minimum flow, then the minimum flow would be taken off turbine generation and replaced by diesel generation of equivalent replacement energy.

Effects that were not considered within the cost estimates of the minimum flow scenarios include the following:

- Stepped effects of bringing a diesel unit online, which needs to be compensated by reducing hydro power generation more than required to meet the specified minimum flow;
- Lost power generation caused by taking the units offline on days when inflow is equal to or close to the minimum flow requirement (i.e., minimum operating threshold for the generating units); and
- Assuming that the community of Bella Coola is growing, the future increase in overall community demand for power will increase demand for diesel power regardless of hydroelectric operating scenarios. The ratio of diesel to hydroelectric power generation will likely increase over time, since the use of hydroelectric power will be maximized within operational constraints, with the balance coming from diesel. Such changes over time are not represented.

On an opportunistic basis, BC Hydro voluntarily spills water over the dam to provide the dam operators a longer response time to natural inflow reductions. By utilizing this natural spill ramping effect over the spillway, spill varies both daily and hourly with headpond level and is reduced to zero as required. With provision of a specified minimum flow, some additional spill would likely still occur to maintain a natural flow ramping effect for operation purposes without violating the specified minimum flow. The cost estimates calculated for replacement diesel associated with each of the alternatives do not include lost generation associated with this voluntary spill. Voluntary spill is treated as an operational cost that is the same across all the alternatives.

How is the performance measure calculated?

The hydro operations model used to calculate these performance measures was a daily time step spreadsheet simulation model that routes the historical daily inflows through the project in accordance with a specific operating scenario and calculates the daily turbine flow, daily spill flow, and the associated daily project generation. Although the simulation is performed on a daily time step, daily variations in generation have been approximated from historical operation data and are reflected in the calculation of simulated daily generation.

The unit price for diesel fuel was based on the current cost of diesel fuel at the site of $0.46/litre. The volume of diesel fuel was based on an energy conversion rate of 3.39 kWh/litre diesel fuel. The volume of a truck was assumed to be 52 000 litres.

APPENDIX E: SUMMARY OF FIELD WORK UNDERTAKEN DURING THE CLAYTON FALLS WATER USE PLANNING PROCESS

1.0 Installation of Staff Gauges at Clayton Falls Creek and Measurement of Flow from the Backup Water Supply Lines

The Water Use Plan Consultative Committee requested the installation of two staff gauges at Clayton Falls Generation Station to monitor water depths and flows in Clayton Falls Creek and the powerhouse tailrace. They also requested the measurement of the water flows through the Backup Water Supply Line and G2 Fish By-pass Line.

The G2 Fish By-pass Line and the Backup Water Supply Line provide flow to the powerhouse tailrace when both generators are not in operation. As a requirement of the Water Licence, a minimum flow release of 0.08 m^3/s must be supplied to the tailrace at all times for fish purposes. The G2 By-pass line is a combination 200–100 mm diameter pipe, which only operates when G2 is shut down, providing an estimated 0.2 m^3/s to the tailrace. The Backup Water Supply Line is a 150 mm diameter pipe and provides an estimated 0.08 m^3/s to the tailrace. This line operates continuously year round.

Installations of Staff Gauges

On 7 January 2003, two staff gauges were installed at Clayton Falls. The installations were performed by Gordon Anderlini (BC Hydro, Engineering Services), along with John Willis (Fisheries and Oceans Canada, Snootli Creek Hatchery) and Megan Moody (Nuxalk Nation Fisheries Department). Each staff gauge was surveyed and referenced to the geodetic powerhouse floor elevation of 6.37 m.

Clayton Falls Creek Staff Gauge

A staff gauge was installed along the north bank of Clayton Falls Creek upstream of the tailrace entrance (Photo E-1). The staff gauge may be accessed and read via a small trail running around the back of powerhouse that provides public access to Clayton Falls view point.

Tailrace Staff Gauge

The tailrace staff gauge was installed along the southeast side of the tailrace channel slightly downstream of the first rock weir (Photo E-2). The staff gauge was installed facing the powerhouse to allow site personnel to easily read the gauge from the powerhouse parking lot.

Photo E-1: Clayton Falls Creek Staff Gauge

Photo E-2: Powerhouse Tailrace Staff Gauge

Verification of Design Bypass Flows in the Tailrace

Flow measurements were taken on the G2 Fish By-pass and Backup Water Supply Lines to determine the flows contributed by each pipe into the tailrace. As an alternate method for measuring the combined discharge from both pipes, Alf Leake, (BC Hydro) recorded stream flow measurements within the tailrace at a time when the two supply lines were the only supply of water to the tailrace.

A Doppler flow meter (Greyline model PDFM-IV) was used to measure the pipe flows. The meter uses an ultrasonic sensor to determine the fluid velocity in a full pipe. The sensor continuously injects high frequency sound through the pipe wall and into the flowing liquid. Gas bubbles or solids suspended in the water reflect the ultrasonic signal back to the sensor. When the sound is reflected from the moving bubbles or particles, it is returned to the sensor at an altered frequency. This frequency shift is used to calculate the water velocity, and in turn a flow. The factory specifications recommend the following in order to obtain reliable, repeatable measurements.

- The pipe must be completely full of water.
- The water contains solids or bubbles of a minimum size of 100 microns with a minimum concentration of 75 PPM.
- The position of the sensor be at least 20 pipe diameters upstream or 30 diameters downstream from velocity increasing devices and 6 pipe diameters upstream or 10 diameters downstream from turbulence increasing devices.
- The sensor be mounted longitudinally on a straight section of pipe, not on any bends, elbows or fittings.

The following describes the results obtained during field measurements and observations made on site.

G2 By-pass Line Flow Measurement

On initial inspection of the G2 supply line, it was determined that a desirable location to mount the sensor in accordance with the user specifications was unavailable. The only location to mount the sensor was on a flanged tee about 1–1/2 pipe diameters downstream of the flanged cross. This location did not meet the user guide recommendations that the sensor be located 30 diameters downstream from any velocity increasing devices, and not mounted on bends, elbows or fittings.

Despite the undesirable sensor location, measurements were recorded in hopes that some useful information may be obtained. The measurements recorded by the flow meter indicated a flow of 0.08 m^3/s through the 200 mm pipe, well below the calculated design flow of 0.2 m^3/s. This large discrepancy between the calculated designed flow through the pipe and the measured flow combined with the poor sensor location casts doubts on the credibility of the reading. For the above stated reasons, it is recommended that the measured flow value of 0.08 m^3/s obtained using the flowmeter be considered invalid.

Back-up Water Supply Line Flow Measurement

The Backup Water Supply intake is located in a pool downstream of Clayton Falls Dam and above Clayton Falls. While on site, it was observed that the original intake box had been removed. The intake now consists of the 150 mm polyethylene pipe enclosed within a 300 mm steel pipe suspended in a pool of water. The 150 mm-polyethylene pipe is extended by approximately 15" to 18" of square grating protruding from the end to keep debris from entering the pipe.

Water levels in the pipe intake pool are completely dependent on the amount of water flowing over Clayton Falls Dam. It should be noted that the water level in the intake pool is not always above the pipe intake. While on site, it was observed that at times the water level was only half way up the 150 mm polyethylene pipe. Conversations with on-site personnel also indicated that the intake grating is often plugged with debris and requires cleaning on an ongoing basis. Prior to taking measurements, the intake screen was cleaned to remove the buildup of debris.

Numerous flow measurements were taken at various locations along the exposed length of polyethylene pipe. Sensor locations at all times were within the manufacturer guidelines with respect to placement upstream and downstream of obstructions. However, because the pipe follows the natural ground contour, it was difficult to find an accessible straight section of the pipe without bends.

While taking flow measurements, the maximum water level at the intake pool was 7–8" above the top of the 150 mm pipe. Small vortices were observed above the pipe intake. The observation of vortices may indicate that the intake pool level was insufficient to allow the pipe to run completely full and may affect the flow measurements taken with the Doppler flow meter.

The flow measurement results indicate flows through the pipe were between 0.03 and 0.05 m^3/s, which is below the calculated design flow of 0.08 m^3/s.

The discrepancy between the measured flows using the flow meter and the calculated design flow through the pipe may be due to the following factors.

1. The low intake water levels at the time of measurement did not allow the pipe to run completely full.

2. The sensor location was to close to sags and bends in the pipe.

Considering these potential errors, determination of actual flows from the Backup Water Supply line should not be based solely upon the measurements recorded with the Doppler flow meter.

The results of the flow measurements are summarized below in Table E-1. The results include design flows, measured tailrace flows collected by Alf Leake, and measured pipe flows using the Doppler flow meter.

Table E-1: Calculated and Measured Minimum Flows in Clayton Falls Tailrace

Water Supply Line	Design Flow (m^3/s)	Instream Flow Measurement (m^3/s) 9 Jan 2003	Metered Pipe Flow Measurement (m^3/s) 9 Jan 2003
G2 Fish By-pass	0.2	---	Undetermined
Backup Water Supply	0.08	---	Suspect (0.03–0.05)
Total Flow	0.28	0.30	---

The measured instream tailrace flows are generally in agreement with the calculated design flows for the two water supply lines. Individual pipe flow measurements using the Doppler Flow Meter were inconclusive due to the unavailability of a suitable sensor location and the potential for error in measurement.

Verification of Instream Flow Measurements

Prior to a Fish Technical Subcommittee meeting in November 2002, one of the Consultative Committee members (R. Ptolemy) indicated his desire to confirm that the actual generator bypass flows in the tailrace were meeting their design flows. Although verification of this flow is considered outside the scope of Water Use Plans, this was considered an important issue to investigate for both compliance reasons, as well as informing the Consultative Committee as to current operations (i.e., what are the appropriate flows in the spawning channel?)

During trial shutdowns of the generating units, flows were measured in both the Backup Water Supply Line and Fish By-pass Line (Table E-2). To resolve outstanding uncertainty regarding actual flows, instream measurements were taken by Ron Ptolemy using a calibrated Swoffer 3000 Meter on 29 January 2003.

Table E-2: Summary of Tailrace Flow Measurements

	Design Flow (m^3/s)	Instream Flow Measurement 09 Jan 2003	Metered Pipe Flow Measurement 09 Jan 2003	Instream Measurement 29 Jan 2003
G2 Tailrace By-pass	0.2	---	"Undetermined"	---
Backup Water Supply	0.08	---	"Suspect" (0.03–0.05)	0.081
Total Flow	0.28	0.30	---	0.2956

Based on the instream flow measurements, the Consultative Committee agreed that the water supply lines were performing to their design specifications.

2.0 Clayton Falls Generating Station Test Shutdown Habitat Assessment

During the Clayton Falls water use planning process, the Consultative Committee requested that a fish habitat assessment be carried out during a test unit shutdown to determine:

- Whether the 0.08 m^3/s flow within the spawning channel from the 6" Backup Water Supply Line is adequate for egg incubation during plant shutdowns in winter.
- What constitutes an appropriate flow for spawning and rearing within the mainstem (below the falls).

This assessment was carried out on 9 January 2003, covering five different operations:

- *Full Load:* 3.73 m^3/s, generating 2030 kW
  Where inflows are less than operation inflows, the headpond will be drafted and operations will be required to change once it has been drained. The recorded flow was 3.80 m^3/s.
- *Normal Operations:* 3.57 m^3/s, 1950 kW
  During normal operations, the generating station will operate such that the headpond is always functional (i.e., there is enough reserve to accommodate sudden load changes at the plant). This requires that a small portion of the creek's flow be spilled over the dam into the spillway channel. The recorded flow was 3.47 m^3/s.
- *G1 Off:* 2.40 m^3/s, 1330 kW
  The recorded flow was 2.20 m^3s^{-1}.

- *G2 Off:* 0.28 m^3s^{-1}, 0 kW
  The Fish By-pass and Backup Water Supply lines were the only source of flow in the tailrace. The recorded flow was 0.30 m^3/s.

- *By-pass Valve Off*
  The Backup Water Supply Line was the only source of flow in the tailrace. The likely flow (not recorded) was 0.08 m^3/s, as per the rated valve capacity.

Each operational change resulted in changes to the mainstem flows (a small lag time of 10–15 minutes generally followed flow changes). The difference between inflow and generated flow was spilled into the mainstem for each operation.

For each operation and at both the tailrace and mainstem channels above their confluence, the following data were collected:

- flow (m^3/s), wetted width (m) and staff gauge elevation (m, above sea level);
- video, audio and photo observations; and
- general habitat assessments by BC Hydro, Fisheries and Oceans Canada and Nuxalk representatives.

The following analyses were completed based on the data collected:

- weighted usable area and wetted width vs. flow for the range of flows observed at one transect per site;
- stage-discharge vs. flow for the range of flows observed; and
- photo summary and conclusions.

2.1 Results

Physical habitat measurements obtained during the 9 January 2003 plant shutdown are summarized below in Table E-3.

Stage discharge curves were developed based on the range of flows observed in the tailrace and mainstem channels during the assessment, (Figure E-1 and Figure E-2).

Table E-3: Physical Habitat Conditions the Mainstem and Tailrace Channel

	Tailrace					Mainstem (Spillway)				
				WUA (L=55m)					WUA (L=65m)	
Operation	Flow (cms)	Staff Gauge El (m)	Wetted Width (m)	CM WUA	PK WUA	Flow (cms)	Staff Gauge El (m)	Wetted Width (m)	CM WUA	PK WUA
Full Load	3.73	3.50	8.60	23.6	285.8	0.05	2.46	8.50	0.0	60.2
Normal Operations	3.57	3.47	8.60	28.7	311.9	0.07	2.47	9.30	-	-
G1 Off	2.40	3.38	8.40	51.9	344.9	1.25	2.76	13.30	84.1	345.5
G2 Off	0.30	3.12	7.75	27.5	121.8	3.35	2.96	15.75	-	-
By-pass valve Off	0.08	3.05	7.40	-	-	3.57	2.97	15.85	-	-

* Mainstem refers to river section between the base of Clayton Falls and the tailrace channel outlet.

WUA Analysis

As in Table E-3, WUA (in square metres) was calculated at transect flows. Note that substrate conditions were not assessed for suitability. The assumption readers can apply is that about 50–75 per cent of the habitat in the tailrace is suitable for spawning by chum and pink, while the mainstem habitat (between falls and tailrace outlet) is about 10 per cent suitable at best (Croll and Monk 1993).

Stage – Discharge Summary

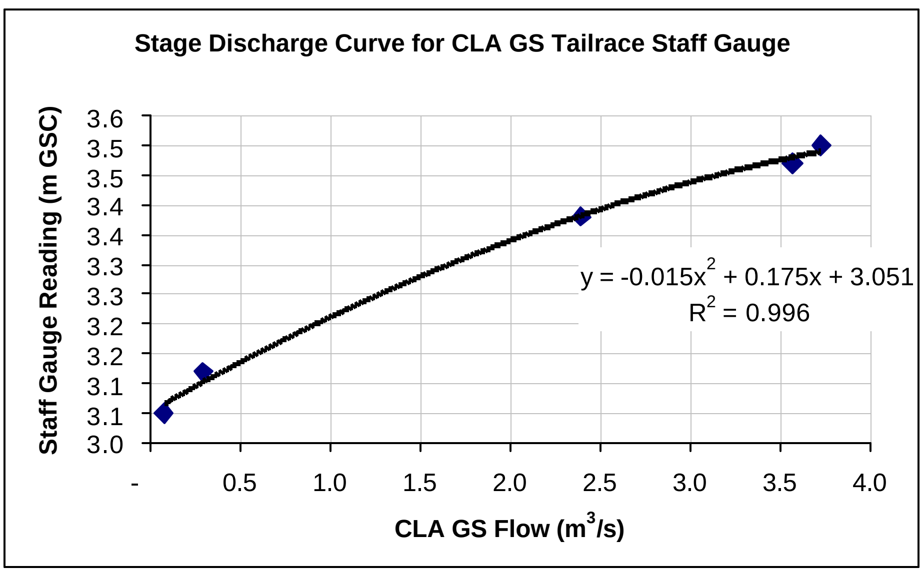


Figure E-1: Clayton Falls Generating Station Curve

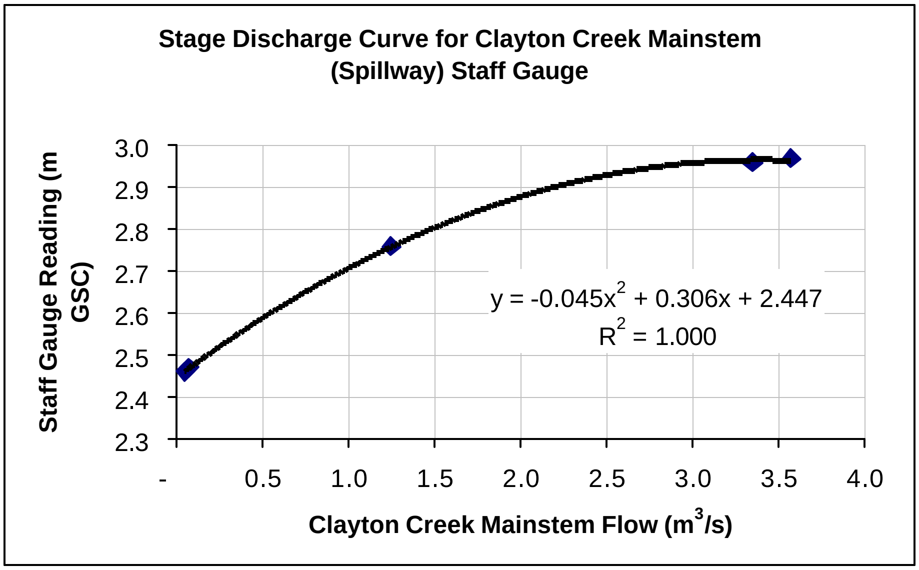


Figure E-2: Spillway Staff Gauge Relationship

2.2 Discussion

Based on the objectives of this assessment, the Fish Technical Subcommittee was tasked with identifying concerns related to minimum flows in the tailrace channel and mainstem section between the falls and tailrace outlet. Several factors must be considered in evaluating each habitat requirement.

- **Fish Use by Species:** The tailrace supports primarily pink and chum spawning and incubation; rearing residents have not been sampled in this portion of the creek. The mainstem channel supports juvenile and adult resident use, as demonstrated in gee-trap sampling conducted during the test unit shutdown on 8–9 January 2003, when two Dolly Varden juveniles were captured from the creek.

- **Available Habitat:** Chum and pink salmon have been observed in the mainstem above the tailrace confluence. However, given the lack of adequate spawning gravel (estimated around 1–2 per cent of wetted area at any one time), these sitings may simply be holding salmon. Depth and velocity profiles conducted for the majority of flow observations show that, at similar flows, the tailrace provides the majority of available habitat of the two sites. Due to the channel profile, habitat in the tailrace is considered much more stable across a similar range of flow. Between high and low flows, change in wetted width is 7.3 m in the mainstem and 1.2 m in the tailrace.

- **Operations:** Typical operations provide flows around 0.1 m3/s in the mainstem between the dam and tailrace channel outlet, due to the requirement for headpond levels to address short-term load changes. At even the lowest flows (via the Backup Water Supply Line), incubating and short-term rearing requirements are adequately met in the tailrace channel.

Other concerns focused on the following three issues:

- **Mainstem Channel Minimum Flows:** Draft instream flow guidelines from the province may require a minimum flow be provided in the mainstem channel between the dam and tailrace channel outlet. This will depend on the factors above and the approach taken by provincial representatives around the flexibility in these requirements
- **Tailrace Channel Flow Changes:** It was mentioned that ramping rates might be an issue between operations and minimum flow changes (e.g., going from flow generation to no generation – bypass flows). A short discussion should conclude that the channel profile should sufficiently direct flow and juveniles off the banks during these fluctuations.
- **Tailrace Gravel Placement:** There was also discussion about the maintenance requirements of the tailrace spawning platforms. There is an accumulation of sediment in two places along the channel, as well as an observed scarification of original spawning gravel. One solution to be considered would be the placement of clean and appropriately sized screened/stockpiled gravel taken from the yearly headpond dredging.

3.0 Fish Sampling of lower Clayton Falls Creek and Tailrace Spawning Channel

Hydraulic Sampling

On 20 January 2003, local Fisheries and Oceans Canada staff carried out hydraulic sampling in the tailrace of the Clayton Falls Generating Station to obtain an estimate of egg survival rates in the spawning channel. Four probes were made into the substrate, resulting in an average of 227 live pink alevins, 0 live pink eggs, 22 dead pink alevins and 69 dead pink eggs (Table E-4). Based on these data, pink survival rate was estimated at about 60 per cent. The lowest egg survival rate was noted in the uppermost section of the spawning channel, upstream of the first weir where accumulation of fines and scarification of gravels is most evident.

A total of 24 live chum alevins were sampled within the tailrace. No live or dead chum eggs were evident, which was thought to be due to timing of sampling. It was noted that chum spawning occurs earlier than pink spawning in Clayton Falls Creek, and it is likely that any of the dead chum eggs would have decomposed by the time of the field work.

No hydraulic sampling was carried out in the mainstem channel, as most of the small pockets of suitable spawning gravel were above the wetted area. No eggs were observed on digging into several of these areas.

Table E-4: Hydraulic Sampling of the Tailrace Spawning Channel

Probe	Live Pink Alevins	Live Pink Eggs	Dead Pink Alevins	Dead Pink Eggs	Pink Survival Rate	Live Chum Alevins
1	103	0	14	7	80%	0
2	14	0	2	5	50%	0
3	38	0	2	11	66%	0
4	72	0	4	46	31%	24
Average:	**227**	**0**	**22**	**69**	**60%**	**6**

Electrofishing

Electrofish surveys were also conducted both in the powerhouse tailrace as well as within the mainstem of lower Clayton Falls Creek between the base of the final falls and the outlet of powerhouse tailrace (Table E-5). One 77 mm coho and one 85 mm Varden were captured within the tailrace channel, while one 109 mm coho, one 145 mm rainbow trout, four Dolly Varden (105–160 mm) and one sculpin were captured in the mainstem channel.

Table E-5: Fish Captured by Electrofish Sampling within the Tailrace Channel and lower Clayton Falls Creek

Fish Species	Fish Numbers	Fish Length (mm)
Tailrace Channel		
Coho	1	77
Dolly Varden	1	85
Lower Clayton Falls Creek		
Coho	1	109
Rainbow Trout	1	145
Dolly Varden	1	160
Dolly Varden	1	113
Dolly Varden	1	112
Dolly Varden	1	105
Sculpin	1	--

Conclusions

Based on hydraulic and electrofish sampling, the following conclusions were made.

- While there is some potential for improvement to the performance of the tailrace, the channel appears to functioning well. The lowest pink egg survival rate was estimated at the uppermost section of the channel (above the first rock weir; 31 per cent), which is likely due to the accumulation of fines and the presence of less gravel than the downstream end of the channel at the tailout.
- Although there are no indicators of the importance of mainstem channel below the falls for fish, sampling confirmed the presence of trout within this reach.

APPENDIX F: CLAYTON FALLS CREEK WATER USE PLAN AQUATIC ECOSYSTEM PRODUCTIVITY MONITORING

Rationale

The Clayton Falls Consultative Committee identified the lack of a guaranteed continuous flow in the mainstem channel between the falls and the confluence of the tailrace channel as an important issue to be addressed by the Clayton Falls Water Use Plan. During the December–March period, daily inflows fluctuate with changing weather conditions but are frequently less than the maximum turbine discharge capability. On low inflow days, generation is adjusted such that turbine discharge does not exceed the project inflow and the headpond level is maintained at the elevation of the top of the spillway flashboards. During this period, flows in the channel are restricted largely to minimal dam leakage and local inflow (estimated at ~0.05 m^3/s) and periodic spill. On an opportunistic basis, BC Hydro voluntarily spills water over the dam to provide the dam operators a longer response time to natural inflow reductions. By utilizing this natural spill ramping effect over the spillway, spill varies both daily and hourly with headpond level and is reduced to zero as required.

Since lower Clayton Falls Creek provides high quality rearing habitat utilized by coho, rainbow trout (steelhead), Dolly Varden and sculpins, occasional periods of very low or no flow could affect the suitability and availability of these habitats and the survival of rearing fish and their food supply (insects). This effect is of most significance in the 51 m of habitat between the final falls and the outlet of the powerhouse tailrace, where dam discharges may be the only reliable source of flow. The period of the lowest flows is from February to March, when fish would be overwintering beneath cobbles/boulders and at a time when benthic insects are active. Insect production during this period is important as many insects have a three-year lifecycle. The dewatering of habitat could have also a significant impact on insects as well as fish.

The Consultative Committee recommended that a minimum flow be provided to increase fish and invertebrate populations within lower Clayton Falls Creek by maximizing effective parr habitat (including their food supply). As current information only confirms the presence of fish within the 51 metres of habitat between the falls and tailrace outlet, there is a requirement to undertake baseline sampling to determine fish and invertebrate population densities and community structure. This would be followed by monitoring with the minimum treatment flow to demonstrate the benefits of providing a continuous year-round flow to the mainstem channel. Results of monitoring are expected to provide the rationale for continuing or increasing the currently agreed minimum flow above zero release.

Management Questions

The fundamental goal of the monitoring program is to reduce uncertainty related to the expected ecological benefits of releasing a minimum flow from Clayton Falls Dam year round. As such, the primary management question for the monitoring program is, as follows:

How does the minimum flow alter the physical conditions of habitats within lower Clayton Falls Creek and, in turn, influence the community composition and productivity of invertebrate and fish?

Research Hypothesis

The primary hypothesis to be tested by the monitoring program is:

Ho: Provision of a 0.1 m^3/s minimum base flow below the falls (0.05 m^3/s minimum dam release plus 0.05 m^3/s anticipated natural inflow and dam leakage) year round will partially restore the productive capacity of the lower Clayton Falls Creek.

This hypothesis reflects the view that higher flow during winter will provide a gain in wetted habitat area and will improve the quality of juvenile rearing habitat. It assumes that the current low winter flows within the mainstem channel between the dam and tailrace outlet have had a significant negative effect on fish population density, and invertebrate density and community structure (i.e., aquatic ecological productivity is significantly different from the unregulated state).

Key Water Use Decision Affected

The key water use decision affected by the results of the monitoring program is the magnitude of the long-term flow release regime from Clayton Falls Dam into lower Clayton Falls Creek. This decision has implications for ecological and power generating values. The lower creek is viewed as providing ideal rearing habitat for salmon and steelhead, and the opportunities to improve productivity in this river are highly valued. Alternatively, releasing water from the dam will increase the volume of diesel fuel required to generate an equivalent amount of energy at the Ah-Sin-Heek diesel plant to replace the decrease in annual generation at the Clayton Falls plant. This, in turn, will increase the number of truckloads of fuel delivery (assuming these are not barged) required each year, which is an area of concern due to the increased risk of fuel spills and its potential effects on larger river systems in the Bella Coola area. The results of the monitoring program are to provide the scientific rationale for selecting a long-term flow regime for Clayton Falls Creek.

Methods

The monitoring program will involve obtaining measurements of fish and invertebrate diversity and abundance and water quality parameters to determine how the changed flow regime has influenced habitat conditions and aquatic productivity of the lower creek. In general, this will include measurements of:

- Physical habitat (discharge, stage, wetted area, hydraulics at riffles, water temperature);
- Fish community composition and productivity (species diversity, population size and density of all species present); and
- Benthic invertebrate community composition and productivity (species diversity, density).

Physical Conditions

Field surveys will be conducted to obtain habitat inventory data for Clayton Falls Creek. The objectives of the survey will be to quantify the area of wetted channel and to estimate the basic hydraulic conditions of habitat at each of the monitoring sites.

Measurements of water quality (temperature, nutrients), discharge and stage will be collected at established transects (riffle, cascade, tailout of falls plunge pool) within the lower creek. A sufficient number of transects will be established in the lower creek to capture any differences in habitat. Records of discharge will also be obtained from operators at Clayton Falls Dam to provide an indication of flow conditions within the spillway channel throughout the year prior to monitoring.

Fish Species Composition and Abundance

As Dolly Varden in the lower creek is likely to be a self-sustaining resident population, this species would serve as a good indicator species for monitoring (i.e., no effect of ocean survival). However, the Consultative Committee is also interested in coho and rainbow trout that ascend Clayton Falls Creek. All fish species (non-sport and sport fish) will be identified.

Fish abundance and composition will be estimated by electrofishing via the multiple removal method and snorkel survey. Fish captured by electrofish sampling will be identified to species, measured for length and weight and returned to the point of collection. On an opportunistic basis, stomach content analysis will be undertaken.

Invertebrate Composition and Abundance

To provide an index of secondary productivity, benthic invertebrate density will be estimated by placing four gravel-filled colonization baskets at each monitoring site (study site, control site).

Taxonomic analyses of benthos collected from the sample basket will be undertaken to determine community structure and composition. An upstream control site will be established in similar habitat for comparison with data collected downstream of the falls. The baskets will be placed in the stream for a period of 6–7 weeks to allow an adequate period of time for colonization. Physical measurements (water depth, flow, and velocity, turbidity) will be taken at weekly intervals.

Food availability for fish will be measured by limited overnight drift sampling.

Study Area

The study area will include the entire reach of the mainstem from the base of the falls to the tidewater, with particular emphasis on the river section upstream of the confluence with the tailrace.

Monitoring Period

Monitoring of lower Clayton Falls Creek will be conducted during the low flow period. While it would be preferable to obtain 2–3 years of baseline data, at least one year will be required prior to implementing the flow change. The Consultative Committee recommends that opportunities for collecting additional years of baseline data prior to implementation of the Water Use Plan should be explored. The one year of baseline data will be supplemented with parr density estimates from other rivers in the Bella Coola system that have similar hydraulic conditions to Clayton Falls Creek (e.g., Nusatsum River, Sawmill River). The magnitude of expected change in the fish population density may be inferred from comparable habitats in neighbouring streams that are unregulated. For example, if current fish abundance in the lower river is statistically similar to that of unregulated streams, it would not be expected that increased flows would result in a significantly large change. However, this baseline has not been established nor has the actual baseflow regime.

Monitoring with the minimum flow treatment will be conducted over a three-year period.

Upon approval of the Clayton Falls Water Use Plan, BC Hydro will develop more detailed terms of reference for monitoring, and will coordinate the work with agency input (Fisheries and Oceans Canada, and Ministry of Water, Land and Air Protection) as required.

Budget

The estimated budget for the monitoring program is $9,525 per annum, for a total cost of $38,100. A breakdown of the budget by labour and expenses is provided below. This estimate assumes training and use of local technicians/biologists. Use of WLAP would also provide considerable savings due to existing equipment and reduced number of trips required. Labour was priced based on typical consultant rates.

Field Labour

Item	Field Rate	Trips	Days	Total Cost
Biologist*	$500	4	4	$8,000
Technician	$300	4	3	$3,600
Technician	$300	4	3	$3,600
Subtotal				*$15,200*

* inclusive of travel time

- Assumes 1 day required to establish sample sites and install sample baskets, 1 day to harvest baskets, and 1 day for fish sampling and habitat measurements

Office Labour

Item	Office Rate	Trips	Days	Total Cost
Biologist	$320		4	$1,280
Technician	$200		4	$800
Subtotal				*$2,080*

Expenses

Item	Units	No. Units	Daily Rate	Trips	Days	Total Cost
Air Fare*		1	$500	5		$2,500
Accommodation	person-days	1	$100	5	2	$1,600
Meals	person-days	1	$50	5	3	$800
Truck	days	1	$100	4	3	$1,200
Fuel	days	1	$50	4	3	$600
Equipment	days	1	$150	4	3	$1,800
Sample Baskets		8	$15			$120
Taxonomic Analysis of Basket Samples		8	$325	4		$10,400
Stomach Content Analysis		10	$25	4		$1,000
Report Production						$800
Subtotal						*$20,820*
Total						**$38,100**

Includes additional flight in Year 1 of monitoring (Trip 1 to train local technicians in placement of sample baskets; Trip 2 harvest of baskets and conduct of fish/habitat sampling)