Consultative Committee Report

May 2004

Prepared on behalf of:

The Consultative Committee for the Walter Hardman Water Use Plan

Walter Hardman Water Use Plan

A Project of BC Hydro

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This report was prepared for and by the Walter Hardman 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 *Walter Hardman 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 this report was gathered solely for the purposes of developing the aforementioned recommendations, and should not be relied upon other than for the purposes intended.

Note: Unless otherwise noted, all photos, figures, tables and text are from BC Hydro.

EXECUTIVE SUMMARY

Water use planning was introduced 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 First Nations, and accepted 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 for a facility using a multi-stakeholder consultative process.

The Walter Hardman water use planning process was initiated in September 2003 and completed in May 2004. 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 Walter Hardman Consultative Committee. It is the basis for the *Walter Hardman Draft Water Use Plan*, which will be submitted to the Comptroller of Water Rights for review and approval.

Walter Hardman Hydroelectric Project

The Walter Hardman Project is located within the Columbia–Shuswap Regional District 25 kilometres (km) south of Revelstoke, B.C. The Walter Hardman Project is part of BC Hydro's integrated generation system and produces approximately 37 gigawatt-hours (GWh) annually, which is enough electricity to serve 3700 homes for one year.

The Walter Hardman Project was originally built by the City of Revelstoke in 1961 and was purchased by BC Hydro in 1972. The original project included Coursier Lake Dam and Reservoir, which stored water during high inflow periods and released it during low inflow periods. In October 2003, Coursier Dam was decommissioned due to dam safety requirements. The Walter Hardman Project now consists of the following: a concrete diversion dam; a diversion channel that takes water from Cranberry Creek to Walter Hardman headpond; flow control structures located in the diversion channel, upstream and downstream saddles dams, the Walter Hardman Dam, the spillway channel, the power intake and the Walter Hardman Generating Station.

Consultative Process

The Walter Hardman Water Use Plan Consultative Committee consisted of representatives (and their designated alternates) from the following organizations:

- BC Hydro
- B.C. Ministry of Water, Land and Air Protection
- Canadian Columbia River Inter-tribal Fisheries Commission (CCRIFC)
- Columbia–Shuswap Regional District

- Fisheries and Oceans Canada
- Okanagan Nation Alliance (ONA)
- Shuswap Nation Fisheries Commission (SNFC)
- an Independent Power Producer

The Consultative Committee and its Fish and Wildlife Technical Subcommittee held a combined total of eight meetings, ultimately reaching agreement on a preferred set of operating constraints and specific monitoring studies.

Issues, Objectives and Performance Measures

The broad issues considered by the Consultative Committee included the influence of operations on: reservoir fish, river fish, reservoir wildlife, riparian effects, recreation, heritage and cultural resources, power revenues and flood protection. Where it was clear that operational alternatives could affect these interests, the Committee developed fundamental objectives:

- Maximize the population of fish in the reservoir.
- Maximize the population of rainbow trout in the river downstream of the dam.
- Maximize the power revenues generated by the Walter Hardman Project.
- Minimize the impacts on wildlife using the area.
- Maximize the recreational quality of the reservoir.

The Committee also articulated specific sub-objectives with associated performance measures (indicators) in each category. The performance measures were used to compare the impacts of various possible operating alternatives across the range of interests expressed.

Creating Operating Alternatives

The Consultative Committee considered the following opportunities to influence operations in the development of operating alternatives:

- Releasing a minimum flow discharge from diversion dam to benefit fish habitat in the lower part of Cranberry Creek.
- Minimum and maximum headpond elevations to benefit fish and reduce spill events down the spillway channel.
- Seasonal headpond operation targets, as well as drafting protocols in the event of very low or zero natural inflows.

The Committee considered nine operating alternatives (different combinations of the three bulleted items above) during their discussions. Through a structured decision-making process that involved the analysis of trade-offs between objectives and alternatives, a consensus agreement was reached on a preferred operating regime that demonstrated a balance across stakeholder values.

Recommended Operating Changes and Physical Works

The operating alternative recommended by the Consultative Committee included operating changes associated with a minimum flow release and headpond levels, and a physical works structure for reliable and efficient provision of minimum flows. These are summarized in Table 1.

Table 1: Recommended Operating Constraints for the Walter Hardman Hydroelectric Facility

Component	Variable	Constraint	When	Water Use Plan Objective
Cranberry Creek	Minimum Discharge	0.1 m^3/s minimum flow into Cranberry Creek	Year round	Maximize habitat for fish in the river.
Walter Hardman Headpond	Maximum Elevation	El. 701.95 (spillway sill)	Year round	Physical constraint of spillway sill elevation.
	Minimum Elevation	El. 698 m	Year round	Physical constraint of penstock intake.
	Target Elevation	El. 701.0 m	16 Nov – 14 Mar	Increase headpond storage for power generation and for oxygen content.
	Target Elevation	El. 700.3 m	15 Mar – 15 Nov	Minimize spill risk.

Target elevation reflects the setting of the headpond controller, which will adjust generation according to headpond elevation changes (inflow changes), however the minimum and maximum headpond elevations remain in effect.

The estimated costs of implementing the Consultative Committee's recommended operating changes and physical works are outlined in Table 3.

Anticipated Benefits of Recommended Operating Alternative

Based on the modelling results used by the Consultative Committee to evaluate and compare the expected outcomes of the alternatives they considered, the anticipated benefits and impacts of the recommended operating alternative are presented in Table 2. These expected benefits are based on the best available information considered at the time of the process. After BC Hydro has been directed to implement operational changes by the Comptroller of Water Rights, BC Hydro will be responsible for meeting the operational parameters, but not for achieving the anticipated benefits. Monitoring studies will be undertaken to assess outcomes.

Table 2: Expected Consequences of Walter Hardman Water Use Plan Recommended Alternative

Water Use Interest		Consequences
Fish in Cranberry Creek	+	Habitat is expected to improve for kokanee and rainbow trout spawning and rearing. Habitat for other species is also expected to improve, but no performance measures were developed.
Fish in Walter Hardman Headpond	∅	Neutral – No significant change is expected due to headpond operations.
Wildlife in Walter Hardman Headpond	∅	Neutral – No significant change is expected for wildlife habitat in or around the headpond.
Wildlife in Lower Cranberry Creek	+	Improvements to aquatic and riparian connectivity are expected as a consequence of the minimum flow and the freshet cycle.
Power Generation	–	Decrease in gross power revenue of approximately $54,000 per year on average over base case.
Recreation	∅	Neutral – No significant change is expected to the opportunity for or quality of recreation in any part of the system.
Heritage and Culture	∅	Neutral – No significant change is expected for heritage and culture. Primary interests were expressed in terms of aquatic and riparian habitat, where gains are expected.

Recommended Monitoring Program

To assess the effectiveness of the recommended operational changes and physical works, and to provide better information to assist future water use decisions, the Consultative Committee discussed a number of monitoring studies. Of the nine studies discussed, the Committee agreed by consensus to recommend six of the studies. Three of the studies were not supported by the BC Hydro representative because it was felt the information would not lead to a change in operation (two riparian studies) or that data collected could not be directly attributed to the change in operations (kokanee spawner enumeration study).

Brief descriptions of the monitoring studies recommended by consensus by the Consultative Committee are as follows:

- **Kokanee Spawning and Incubation, Lower Cranberry Creek:** There is uncertainty regarding the effect of flow changes on spawning and incubation habitat for kokanee. This study is habitat-based rather than population based, and will assess changes in habitat resulting from the provision of a minimum flow. Information will be collected over a one-year period.

- **Rainbow Rearing Habitat and Over-wintering:** There is uncertainty regarding the habitat benefits associated with flows of 0.1 m^3/s and the quantity and quality of rearing habitat for rainbow trout. This proposed study will measure habitat quantity and quality associated with different flow levels at transects in the middle section of Lower Cranberry Creek.

- **Headpond Drawdown Impacts (Fish):** There is uncertainty regarding headpond drawdown and its impacts on physical stranding and dissolved oxygen concentrations, factors that may be affected by drawdown. The proposed study will observe and measure these habitat characteristics in Walter Hardman headpond. The data will be collected within a single year of study. It will be necessary to wait for a year of low inflow during the fall and winter so that extreme conditions can be observed.

- **Temperature Effects:** There is uncertainty around the effects of the minimum flow and its impacts on water temperature. There are concerns that the warm water temperatures during the summer may exceed critical levels for rainbow trout in the upper and middle sections of Lower Cranberry Creek; and that cool water temperatures during the fall and winter in the lower section of Lower Cranberry Creek may affect the rate of kokanee egg incubation. This study will measure temperature in Lower Cranberry Creek. It will involve compiling a database of water temperature over the five years of study and analyzing data concurrent with the results of Studies 1 (kokanee incubation) and 2 (rainbow rearing) in year five.

- **Rainbow Trout Abundance/Biology:** There is an information gap regarding the presence and abundance of rainbow trout in Cranberry Creek. This proposed study will monitor rainbow trout abundance in the middle section of Lower Cranberry Creek and will provide a baseline against which future monitoring studies can measure a response. Specifically, there is an interest in understanding the significance of the rainbow population in Cranberry Creek. Details on population size, age structure and growth rate would provide confidence that any benefits of minimum flow releases identified in Study 2 (rainbow rearing) could be taken advantage of by the resident population. It is emphasized that this is not a study of population effects – changes in abundance detected during this study cannot be inferred as resulting from flow changes.

- **Tailrace Habitat:** There is an information data gap regarding releases from the Walter Hardman powerhouse and its effects on fish habitat in the tailrace channel (in Upper Arrow Lakes Reservoir). There is an interest in determining how kokanee, which use an isolated back channel that is influenced by outflow from Walter Hardman powerhouse, may be affected in the fall by changes in flow releases at the diversion dam. The concern is twofold: shutdowns of the powerhouse may affect kokanee spawning or egg-fry survival by dewatering spawning and incubation habitats, and minimum flow releases at the diversion dam may result in kokanee attraction to powerhouse outflows as a result of minimum flow releases in Cranberry Creek (same source waters).

The expected cost of the studies and operational changes are outlined in Table 3. Recognizing that the hydrology cycle of Cranberry Creek has already changed as a result of the 2003 Coursier Dam decommissioning, the Consultative Committee decided that the studies should not proceed until implementation of the minimum flow using the newly completed flow release structure.

Water Use Plan Review Period

The Consultative Committee recommended that the Water Use Plan be reviewed six years after approval by the Comptroller of Water Rights, with physical works completed by year two.

Implementation Costs

The anticipated costs associated with implementing the operational changes, constructing the physical works, and carrying out the monitoring studies recommended by the Consultative Committee are presented in Table 3 below.

Table 3: Walter Hardman Water Use Plan Summary of Costs

Recommendation	**Annual Costs (in 000's of $/yr)**						**Total Cost (000's of $)**
	1	**2**	**3**	**4**	**5**	**6**	
Operating Changes	**-**	**54**	**54**	**54**	**54**	**54**	**270**
Physical Works	**30**	**240**[1]	**-**	**-**	**-**	**-**	**270**
Monitoring Program	**12.5**	**16.0**	**10.5**	**10.5**	**76.5**		**126**
Kokanee Spawning and Incubation, Lower Cranberry					30		30
Rainbow Rearing Habitat and Over-Wintering					30		30
Headpond Drawdown Impacts (Fish)		5.5					5.5
Temperature Effects	2.5	2.5	2.5	2.5	2.5		12.5
Rainbow Trout Abundance/Biology	6	6	6	6	12		36
Tailrace Habitat	4	2	2	2	2		12

1. Infrastructure changes to provide a minimum flow of 0.1 m^3/s were initially estimated at $200,000. During the trade-off discussions, the Consultative Committee expressed an interest in increasing the capacity of the infrastructure to provide a minimum flow of 0.5 m^3/s for a period of time in the late summer/fall. The Consultative Committee agreed to overbuild the infrastructure if it could be done with a 20 per cent increase in the total cost. The number shown in the table above represents the cost deferential.

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1 INTRODUCTION

Water use planning was introduced by the Minister of Employment and Investment (MEI)[1] and the Minister of Environment, Lands and Parks (MELP)[2] in 1996 as an approach to ensure provincial water management decisions reflect changing public values and environmental priorities. The purpose of water use planning is to understand public values and to develop a preferred operating strategy through a multi-stakeholder consultative process.

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

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

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

The Walter Hardman water use planning process was initiated in September 2003 and completed in February 2004. The purpose of this report is to document the consultative process and present the recommendations of the Walter Hardman Water Use Plan Consultative Committee. The interests and values expressed in this report will be used by BC Hydro to prepare a draft Water Use Plan for the Walter Hardman hydroelectric facilities.

This Consultative Committee Report is a record of the water use issues and interests discussed during the process and the trade-offs between different operating alternatives designed to meet stakeholder objectives. Both the Walter Hardman Consultative Committee Report and BC Hydro's draft Water Use Plan for the Walter Hardman facilities are submitted to the provincial Comptroller of Water Rights for review under the *Water Act*.

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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 THE WALTER HARDMAN PROJECT

This section describes the location of the Walter Hardman hydroelectric facilities, its physical structures, the hydrology of Cranberry Creek and the Walter Hardman basin, the operation of the facility's structures, and the operation and current constraints of the facility.

2.1 Location of Walter Hardman Project

BC Hydro's Walter Hardman Dam and hydroelectric facility is located approximately 25 km south of Revelstoke on Cranberry Creek. A general map of the area and facilities is provided in Figure 2-1.

Walter Hardman hydroelectric facilities are accessible from Highway 23 via three separate roads that provide access to different parts of the system (Figure 2-2). The road running east from Highway 23 South leads to the generating station (powerhouse) that is situated on the west bank of the Arrow Lakes Reservoir. The road running west leads to the Walter Hardman headpond and dam, power intakes, bypass structures and diversion dam structures. Another access road further south leads to the spillway structures west of the highway.

2.2 Hydrology of the Cranberry Creek Watershed

Coursier Dam and Reservoir, located upstream from the diversion dam, has historically diverted water from Upper Cranberry Creek and served as the storage facility for the Walter Hardman hydroelectric system. In 2003, BC Hydro received approval from the BC Utilities Commission and the Provincial Environmental Assessment Office to decommission Coursier Dam. The justification for the decommissioning is based on approximately 30 years of dam safety records, dam safety remedial repairs and the continuing potential for Coursier Dam to fail. The majority of the decommissioning work was completed in summer 2003 and outflows from Coursier Lake have returned to their natural, non-regulated flow patterns. Accordingly, the Walter Hardman Water Use Plan focused on the future operation of the diversion dam and control structures, Walter Hardman headpond, and Walter Hardman Generating Station.

This section describes the hydrology of the Walter Hardman Project, both pre- and post-decommissioning of Coursier Dam. For the purposes of this Water Use Plan, Coursier Dam is excluded as it no longer regulates flows for the Walter Hardman facility.

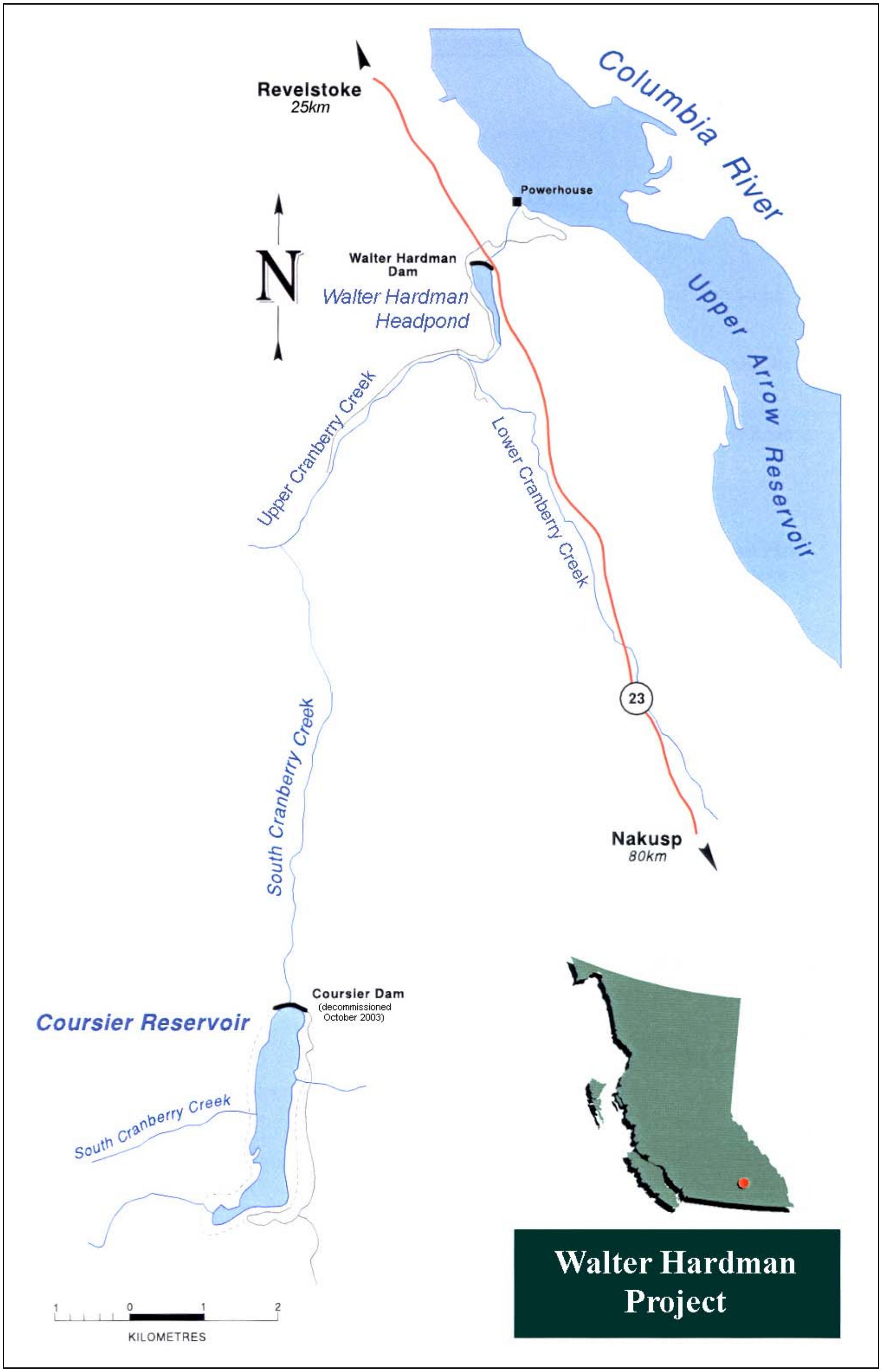

Figure 2-1: General Area Map of Walter Hardman Project

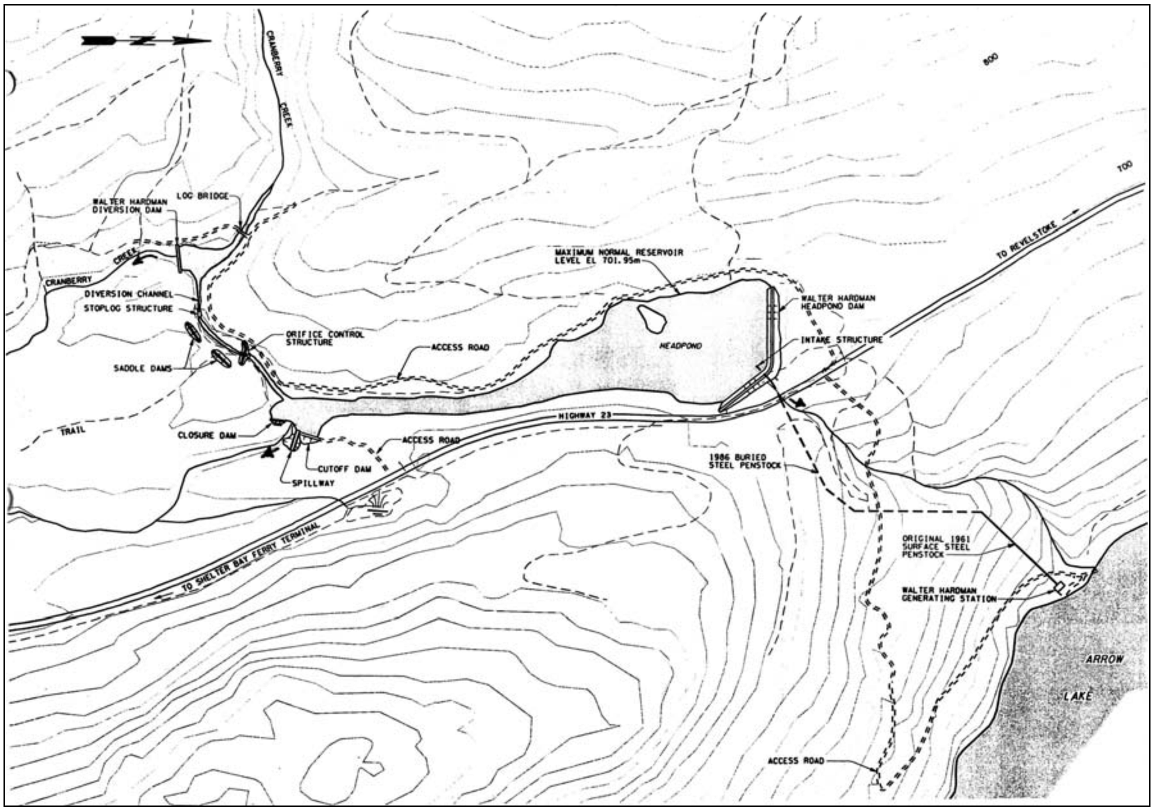

Figure 2-2: Detailed Map of Walter Hardman Headpond and Generating Station

2.2.1 Cranberry Creek Watershed

The drainage area of the entire Cranberry Creek watershed is approximately 145 square kilometres (km^2), of which 100 km^2 lies upstream of the diversion dam. Coursier Lake is fed by South Cranberry Creek, which originates in an ice field six kilometres to the west, and by Westside Creek, which originates four kilometres to the west. Coursier Lake then drains north into South Cranberry Creek (Figure 2-1).

South Cranberry Creek continues in a north-south oriented basin and joins Upper Cranberry Creek approximately seven kilometres downstream of Coursier Lake. Upper Cranberry Creek originates on the east slope of the Monashee Mountains in an alpine area dominated by ice fields and year round snow pack. From the confluence of South Cranberry Creek and Upper Cranberry Creek the main stem flows approximately seventeen kilometres to its mouth on the Upper Arrow Lakes Reservoir (Figure 2-1, Figure 2-2).

2.2.2 Seasonal Flow Patterns

The seasonal flow pattern in Cranberry Creek is typical of the mountain streams in the area. A single-snowmelt peak dominates flow each spring. Secondary rainfall-generated peaks are common throughout the summer and into the fall. Winter and late summer are the low flow periods as most of the precipitation in the upper basin falls as snow.

The former Coursier Lake Reservoir provided partial regulation of inflows to the Walter Hardman hydroelectric facilities, slightly reducing spring and summer flows, and increasing fall and winter flows. However, with the decommissioning, flows will return to "run-of-river" status. Coursier Lake still provides a small amount of natural storage, with higher elevations between April and August as a result of local run-off.

Flow measurements in Cranberry Creek are available from Water Survey of Canada gauge WSC 08NE123, in operation from 1980 to 1986, located just above the diversion dam. As part of a Cranberry Creek fisheries and hydrology study[1] this data was used to estimate flows at different locations along Cranberry Creek under regulated (with Coursier Dam storage) and natural conditions (no upstream storage and no diversion dam). The six years of estimated natural flows were constructed from the recorded, regulated flow data using water balance equations and a series of simplifying assumptions to eliminate the regulating effects of Coursier Dam. Based on a brief review of the annual inflows recorded on other streams in the region, it appears that the period spanning 1980–1986 contains a mix of above and below-average inflow years with the overall average for the period being slightly below the long-term average inflow.

Figure 2-3 through Figure 2-5 show the estimated natural flows in Cranberry Creek (post-Coursier) at various locations. Within the six year period of estimated record, the peak daily inflow above the diversion dam is 48 m^3/s, associated with a July 1983 storm event. On average, the annual peak daily inflow is approximately 21–24 m^3/s, typically occurring between late May or to mid June during freshet. Winter low flows appear to vary between approximately 0.5–2.0 m^3/s, however this portion of the estimated record would be the most sensitive to errors of approximation associated with the simplifying assumptions used to estimate the record.

[1] Summit Environmental Consultants Ltd. (June 2000). *Cranberry Creek Fisheries and Hydrology Study*, Volumes I and II. Vernon, B.C.

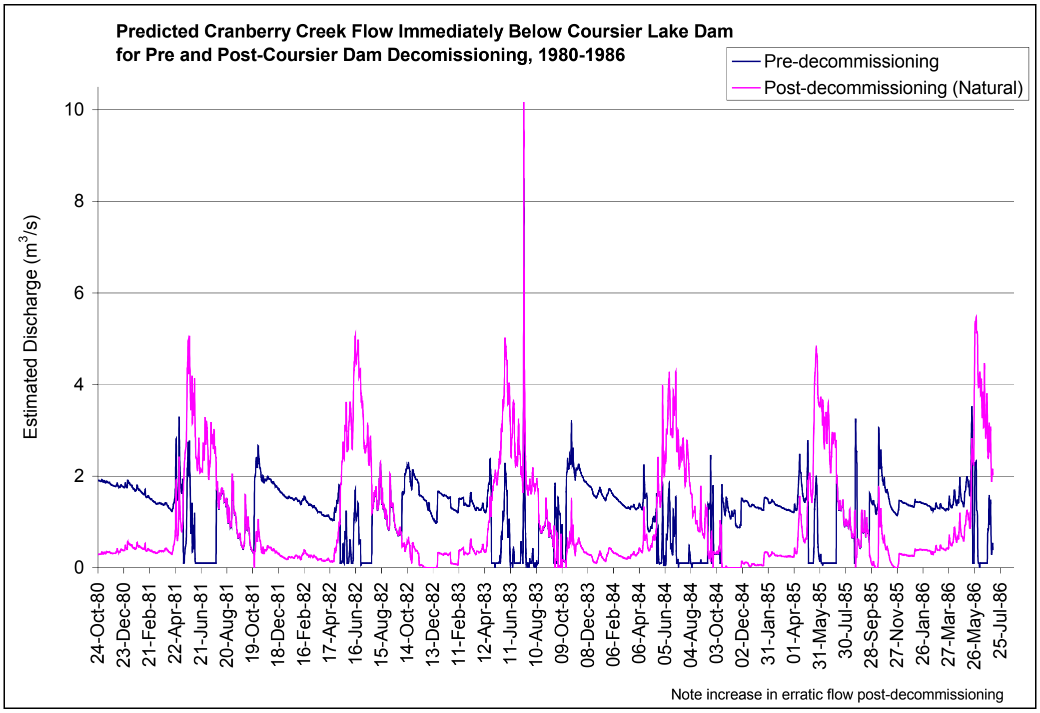

Figure 2-3: Estimated Cranberry Creek Natural Flow below Coursier Dam

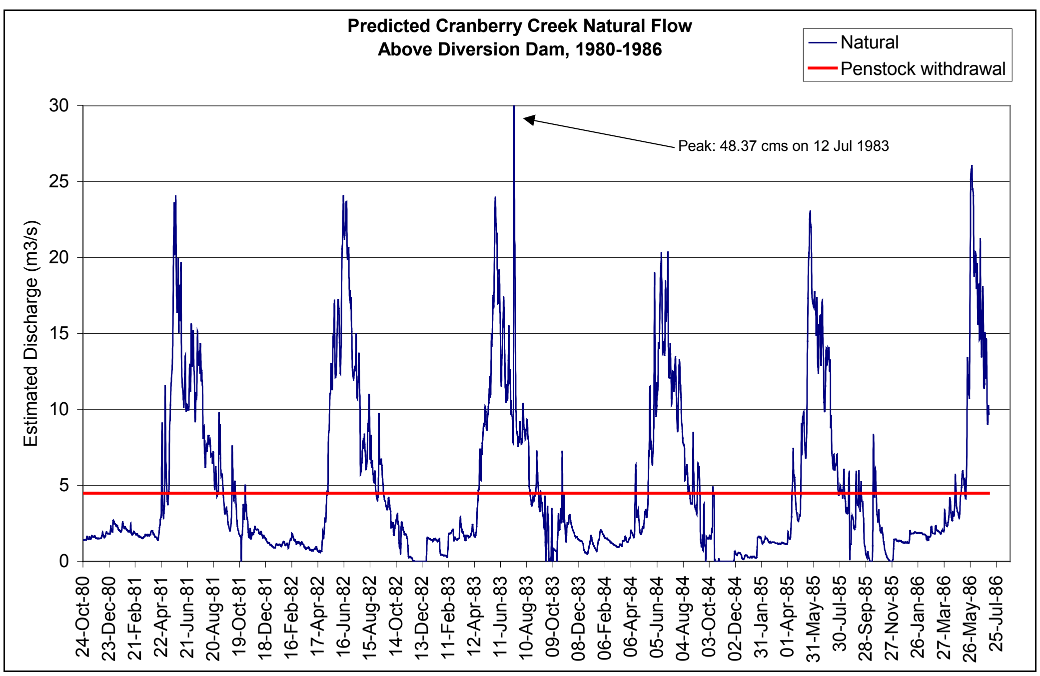

Figure 2-4: Estimated Cranberry Creek Natural Flow above Diversion Dam

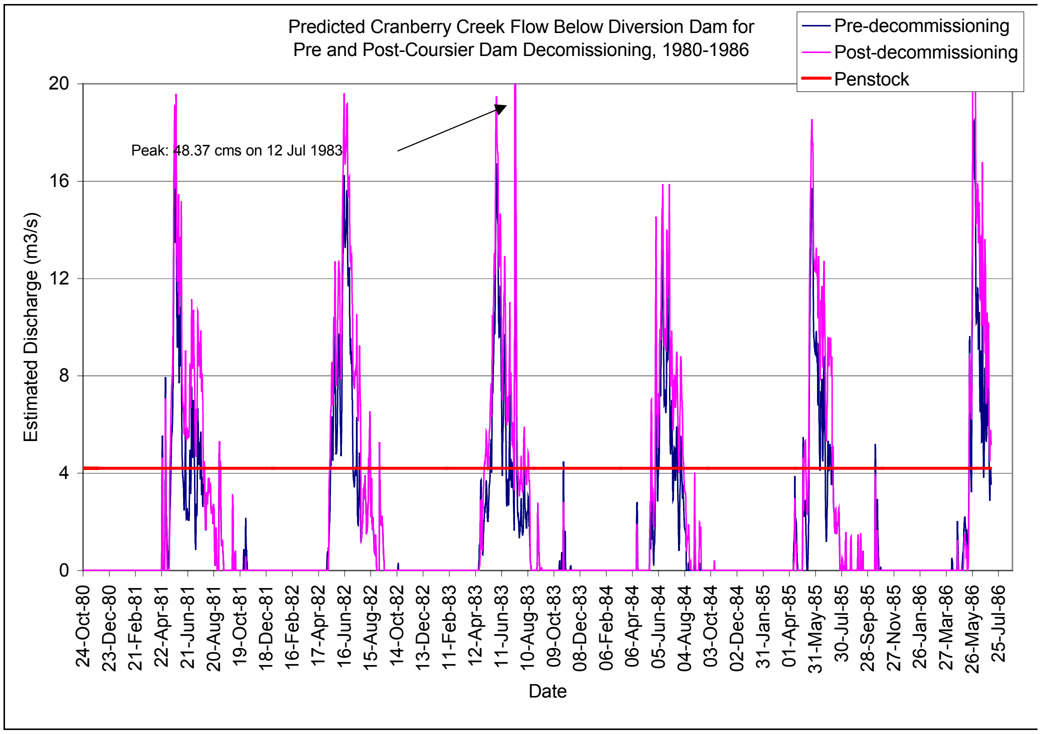

Figure 2-5: Estimated Flow Immediately below Walter Hardman Diversion Dam

Difference between pre (blue) and post (pink) decommissioning of Coursier Dam, assuming flows up to 4.2 m^3/s are diverted to the Walter Hardman headpond.

2.2.3 Cranberry Creek Flow – Pre- and Post-Coursier Dam

Water from Cranberry Creek is diverted into the Walter Hardman headpond by a concrete overflow diversion dam and channel. The diversion dam is located approximately five kilometres downstream of the confluence of South Cranberry Creek and Cranberry Creek. Control structures (stoplogs and orifice) in the diversion channel are used to limit the flow into the headpond to a maximum of 10.5 m^3/s, and to a preferred level of 4.3 m^3/s (plant capacity). The control structures are operated to create a backwater effect such that flows in excess flow over the diversion dam and continue down Cranberry Creek.

The historical Cranberry Creek flow (with Coursier Dam regulation) and the estimated future Cranberry Creek flow (post Coursier Dam decommissioning) are presented in Photo 2-1 and Figure 2-3 through Figure 2-5. The estimated change in flow immediately downstream of Coursier Dam is shown in Figure 2-3. The estimated change in flow immediately upstream of the diversion dam is shown in Figure 2-4. The estimated change in flow immediately downstream of the diversion dam, assuming that flows up to 4.3 m^3/s are diverted to the Walter Hardman headpond, is shown in Figure 2-5.

Photo 2-1: Coursier Dam Decommissioned. A notched channel was cut through the dam structure, and the lake is returning to a natural cycle (October 2003 picture).

2.3 Physical Structures of Walter Hardman Project

There are a number of physical structures comprising the Walter Hardman hydroelectric project. Each of these structures is described in greater detail in this section and marked with corresponding green letters on Figure 2-6.

- **Diversion Dam (A):** This concrete dam is 60 metres (m) long, 1.75 m high and has a crest elevation of El. 711.75 m. This dam diverts water from Cranberry Creek into the diversion channel (Photo 2-2). Under normal operating conditions, flow control structures in the diversion channel limit the maximum diversion to 4.3 m^3/s at El. 701.95 m. Flows in excess of that spill over the diversion dam and continue along Cranberry Creek.

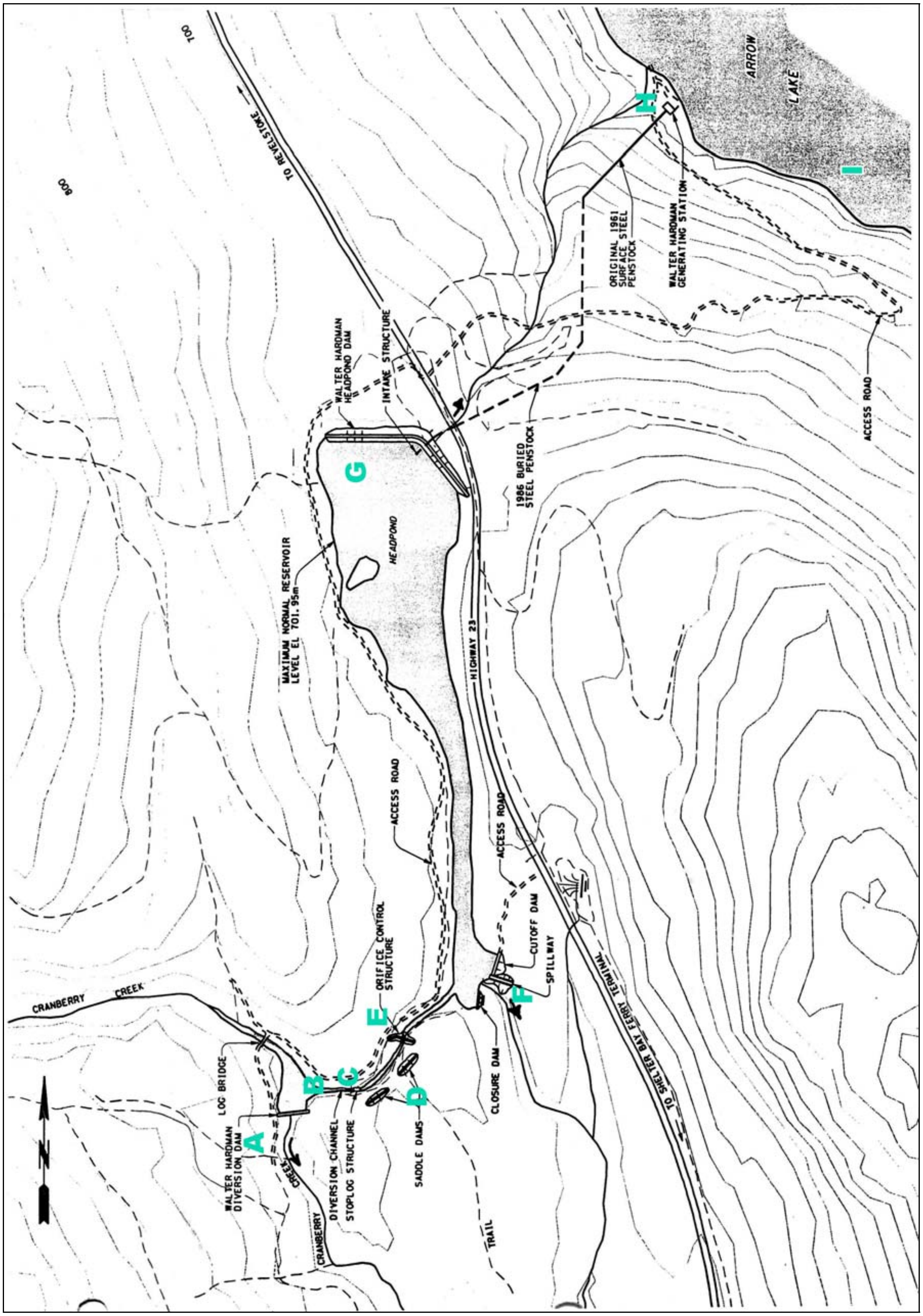

Figure 2-6: Plan of the Walter Hardman Hydroelectric Facilities

Photo 2-2: Diversion Dam, with Freecrest Overflow (left) and No Overflow (right)

- **Diversion Channel (from B to E):** This excavated, unlined channel is 450 m long with a bottom width that varies between 3.0 and 3.7 m. It is designed to facilitate the transfer of water from the diversion dam to the headpond. During flood conditions the channel has a maximum capacity of 10.5 m^3/s.

- **Stoplog Structure (C):** This concrete structure contains stoplog slots under a timber hoist house. It is located in a 3.05 m wide section of the diversion channel, and because of spillway use restrictions, is normally operated as a flow control weir to roughly limit the maximum flow of water to the headpond to 4.3 m^3/s. The stoplog structure can also be used to cut off or reduce the volume of flow diverted to the headpond when required (for example, during maintenance).

- **Upstream and Downstream Saddle Dams in Diversion Channel (D):** These two earthfill dams are made of sand and gravel, and are 73 m and 52 m in length respectively. Both have a crest elevation of El. 713.2 m. They are used for flood relief during extreme inflow events such as the Probable Maximum Flood (PMF). The dams are designed to overtop and fail during extreme inflow events such that all flood inflows are discharged along Cranberry Creek rather than affecting the headpond facilities downstream.

- **Orifice Control Structure in Diversion Channel (E):** This concrete free-overflow spill structure is 0.7 m high, and is located in a section of the diversion channel where the width of the waterway is 2.92 m (Photo 2-4). The crest elevation is El. 710.37 m and the elevation of the top of the structure is El. 713.54 m. The orifice control structure restricts flow into the headpond to a maximum of approximately 10.5 m^3/s[1] regardless of whether the stoplogs are installed in the upstream control structure or not. It is designed so that during extreme inflow events such as the Probable Maximum Flood (PMF), the structure will back water up the diversion channel, flood the area near the saddle dams, and cause their failure. The structure is designed to carry up to approximately 10.5 m^3/s of flow (depending on upstream head) at a channel elevation of El. 713.29 m.

- **Closure Dam:** This earthfill dam is constructed with glacial till. It runs 25 m in length and has a crest elevation of El. 704.1 m. It was originally installed to mitigate against a low point in the headpond, which in turn, prevents water from escaping down Cranberry Creek. Its primary function is to maintain headpond elevation.

Photo 2-3: Stoplog Control Structure
(left, facing downstream in diversion channel)

Photo 2-4: Orifice Control Structure
(right, downstream of stoplogs and facing downstream in diversion channel)

- **Cut-off Dam:** This earthfill dam was constructed with a mixture of glacial till, sand, gravel and rock. It is 60 m long and has a crest elevation of El. 704.1 m. Like the closure dam, the cut-off dam is also designed to maintain headpond elevation.

- **Spillway in Cut-off Dam (F):** This concrete structure, located on the cut-off dam, has an uncontrolled freecrest overflow with a spillway chute and stilling basin (Photo 2-6). It has a crest elevation of El. 701.95 m and can accommodate up to 11.0 m^3/s of flow. Its function is to protect the headpond dam from overtopping during flood inflows (crest elevation of El. 704.15 m). The use of this spillway is avoided under normal operations since spill flows

[1] Actual flow will vary with upstream head, but this is an approximate maximum. May be reported as 11.0 m^3/s in some descriptions.

pass through a highly erodible area approximately 1.0 km downstream of the spillway, resulting in deposits of fine materials in downstream fish habitat.

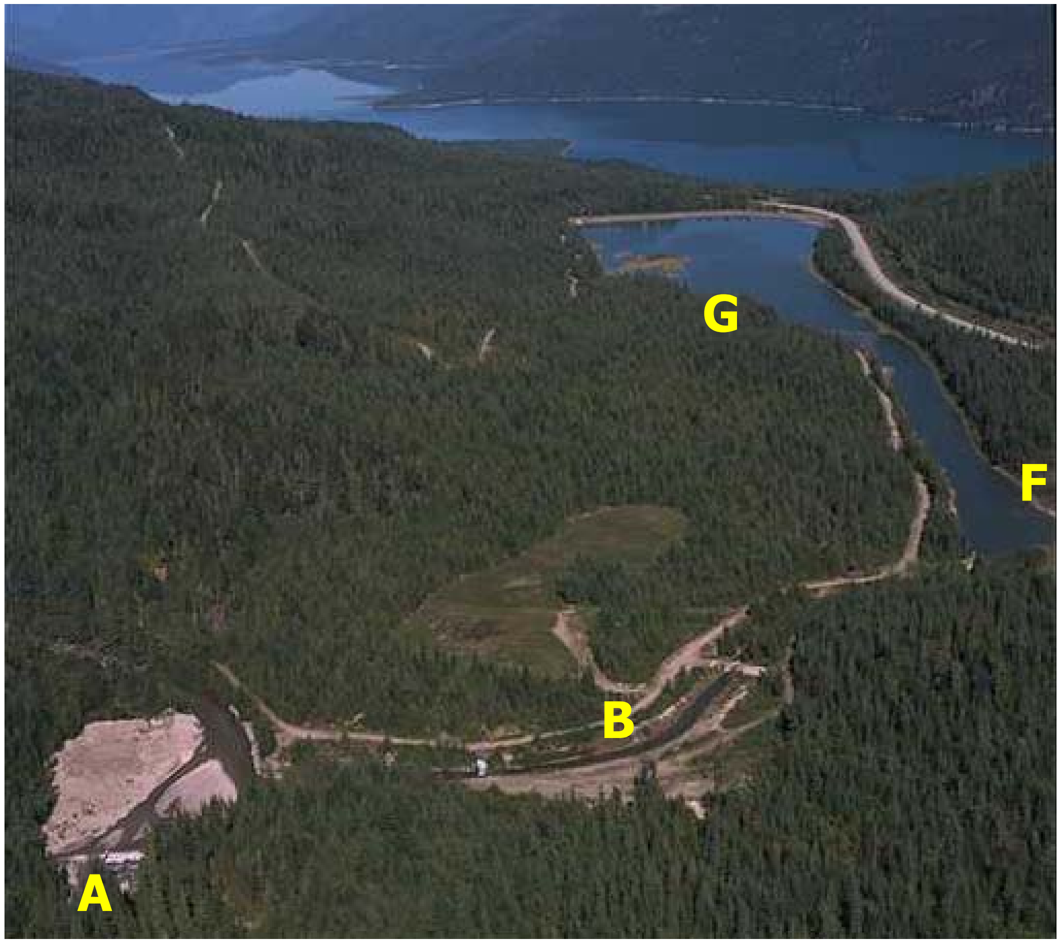

Photo 2-5: Diversion Dam (A), Diversion Channel (B) between the Downstream Orifice and Upstream Stoplog Structures, Spillway (F) and Walter Hardman Headpond (G)

- **Walter Hardman Headpond (G):** The normal operating level of the headpond ranges from a minimum elevation of El. 698.0 m to a maximum elevation of El. 701.95 m. At the maximum normal level: the area of the headpond is 15.8 hectares (ha), the total storage is 700 000 cubic metres (m^3), and the live storage is 330 000 m^3. A headpond elevation controller maintains a constant level in the headpond, and either ramps up or ramps down generation as needed to maintain that targeted level.

- **Walter Hardman Dam (G):** This earthfill dam was constructed with glacial till, sand, gravel and rock. It is 381 m long and its crest elevation is El. 704.1 m. Its function is to maintain storage elevation of the Walter Hardman headpond (Photo 2-7).

Photo 2-6: Spillway on Cut-off Dam at Walter Hardman Headpond

Photo 2-7: Walter Hardman Dam and Headpond (Highway 23 in foreground)

- **Power Intake:** There is a steel water conduit (1.07 m in diameter) running through the base of the dam, spanning the 50 m from the power intake to the penstock valve house. There is a butterfly guard valve (1.07 m in diameter) used as a protection and isolation device in the penstock valve house. The power intake diverts water from the headpond to the penstock that then delivers it to the generating station.

- **Penstock:** A single steel penstock (connected to the power intake) takes the water to the powerhouse once it splits into two sections (each 0.711 m in diameter) each leading to a generating turbine in the generating station.

- **Walter Hardman Generating Station (H):** The Walter Hardman Generating Station contains two Turgo single-jet impulse turbines, each capable of 4.5 megawatts (MW) of output. The combined maximum output of the two units is limited to 8 MW (instead of the potential 9 MW) by the capacity of the penstock. The water leaving the generating turbines discharges into Upper Arrow Lakes Reservoir (Photo 2-8). The generating station (powerhouse) was designed to withstand the worst flood expected over a 200-year period (i.e., the 1:200 year Inflow Design Flood).

- **Dispersion Valve and Discharge (Drawdown) Culvert:** The dispersion valve (in combination with the culverts it discharges into) provides an alternative means of drawing down or emptying the headpond, in the event that the penstock cannot be used. The dispersion valve is fitted with a discharge regulator at the outfall of the headpond and is manually operated. When it is operational, it throws water in the form of droplets to dissipate the energy in the water and prevent damage to the drainage area. The maximum discharge capacity of the valve is 5 m^3/s, but for flood and safety reasons, the discharge must not exceed the capacity of the three downstream culverts located: a) under Highway 23, b) under the Walter Hardman Dam access road, and c) beside the Walter Hardman Dam Generating Station.

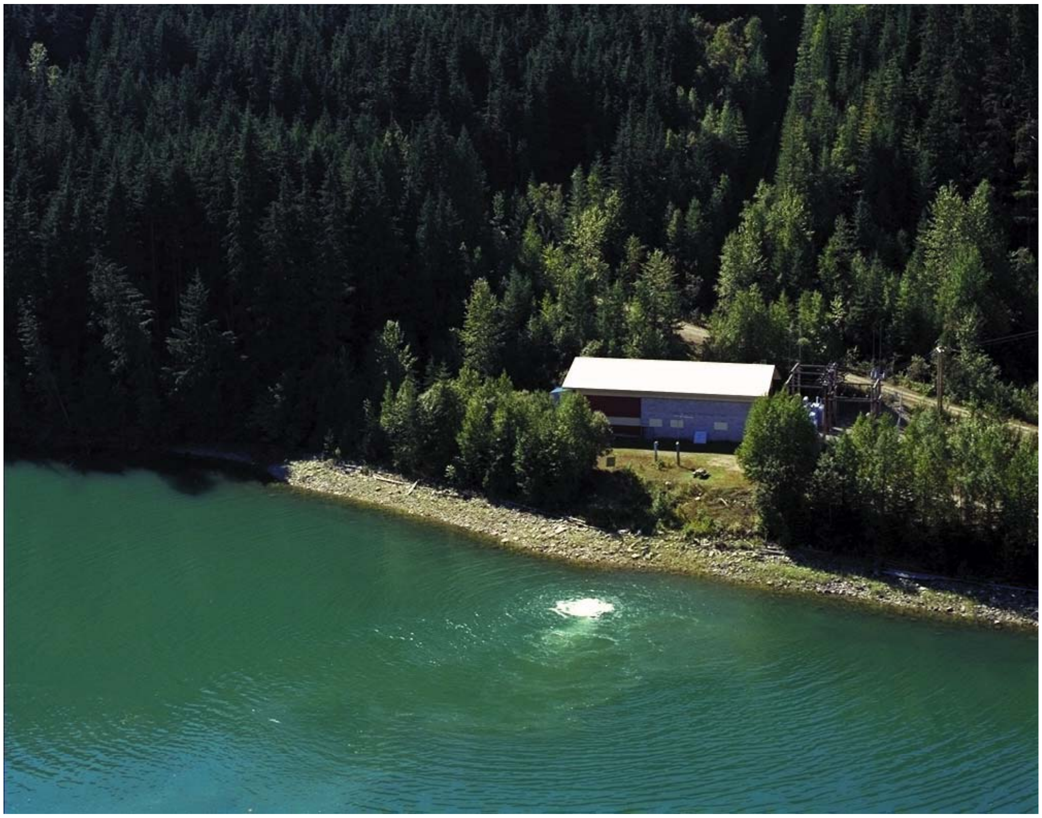

Photo 2-8: Walter Hardman Generating Station on Upper Arrow Lakes Reservoir

- **Debris Booms:** There is a boom located immediately upstream of the spillway to collect debris for disposal.
- **Key Elevations for the Walter Hardman Project:** A summary of the key elevations associated with the operations of the Walter Hardman Project is provided in Table 2-1.

Table 2-1: Summary of Key Elevations for the Walter Hardman Project Facilities

Elevation	Physical Structure
El. 704.10 m	Dam Crest – earthfill dam
El. 701.95 m	Spillway crest
El. 700.30 m	Headpond operating target (in recent years)
El. 698.00 m	Minimum normal elevation (Walter Hardman headpond)
El. 692.35 m	Penstock intake
El. 692.35 m	Low level outlet
El. 711.75 m	Diversion Dam Crest – freecrest weir – concrete gravity overflow structure

2.4 Co-ordinated Operation of the Walter Hardman Project Facilities

The facilities and physical structures described above work together to manage water levels and generate power. The following is a description of how water flows through the system, starting upstream at the diversion dam.

- **Diversion Dam:** The diversion dam re-directs water from Cranberry Creek into the diversion channel and towards the Walter Hardman headpond. Flow control structures in the diversion channel are operated to create a backwater effect such that a portion of the natural inflow is diverted to the Walter Hardman headpond and the remainder of the flow is spilled over the diversion dam and back into the natural Cranberry Creek channel. Under normal operating conditions, inflows of up to 4.3 m^3/s are diverted to the headpond and the remainder of the available inflow passes over the diversion dam to Cranberry Creek.

- **Flow Control Structures in Diversion Channel:** The Walter Hardman Generating Station can only pass up to 4.3 m^3/s of flow through the turbines; flows in excess of that must be spilled or absorbed by the buffering effect of the headpond. To minimize risk of using the Walter Hardman spillway, the stoplog control structure in the diversion channel is used to limit the flow into the headpond to an average of 4.3 m^3/s, however these may vary. The stoplog structure was designed to dewater the diversion channel for maintenance purposes, but in recent years has also been used as a flow control weir. Up to 18 logs can be installed in the structure allowing the crest of the weir to be raised or lowered as required to limit the maximum flow over the weir to the 4.3 m^3/s target. The weir creates a backwater effect such that flows in excess of 4.3 m^3/s will flow over the crest of the diversion dam upstream. As inflows increase during the spring, the stoplogs are installed in stages to limit the diversion flow to 4.3 m^3/s. As inflows decrease in the fall the stoplogs are removed in stages, and are not normally required through the fall and winter low flow period.

  Downstream of the stoplog structure, the diversion channel is contained by the upstream and downstream saddle dams. These structures are designed as "fuse plugs" which will overtop and fail during a probable maximum flood (PMF), or when flows in Cranberry Creek exceed 136 m^3/s. Under extreme flood conditions such as the PMF, failure of these saddle dams will direct floodwaters back into Cranberry Creek and away from the headpond facilities.

  Immediately following the saddle dams lies the orifice control structure. This concrete free overflow spill structure acts as a flow limiting device, and prevents flows greater than approximately 10.5 m^3/s from entering the headpond. Under normal operating conditions, the stoplog structure upstream will be managed to a target flow of approximately 4.3 m^3/s. However, during high inflow storm events, inflows may increase rapidly before manual installation of additional stoplogs. Under these conditions, the orifice control structure acts as an additional control device to limit the diversion to the headpond to the design capacity of the Walter Hardman spillway. The backwater effect caused by the orifice control structure causes flow in excess of 10.5 m^3/s to flow over the crest of the diversion dam and into Cranberry Creek, or as described above under PMF events.

- **Walter Hardman Headpond:** Flows passing the orifice control structure have now entered the Walter Hardman headpond. The active storage in the headpond is less than the volume that can be discharged through the turbines in one day.

  The Walter Hardman headpond is contained by three dam structures: the closure dam and cut-off dam at the southeast corner of the headpond, and the Walter Hardman Dam at the north end of the headpond. The normal operating level of the headpond is kept at El. 700.3 m, approximately 1.65 m lower than the maximum normal operating level. The level is maintained by the unit headpond controller, which adjusts generation to match the inflow. When inflows exceed the units' capacity the headpond level will increase. Keeping the headpond 1.65 m lower assists in the capture of sudden inflow events and acts like a buffer so the spillway channel stays dry except during extreme circumstances. The headpond controller will send out an alarm at El. 701.5 m; workers are dispatched to manually intervene at the stoplog structure when the alarm sounds.

- **Closure Dam, Cut-off Dam, and Spillway:** The closure dam and cut-off dam were constructed at low points in the headpond to permit impoundment of water up to the desired headpond level. This increases the hydraulic head (directly proportional to power production) on the generating unit and provides some additional storage. The cut-off dam also houses the spillway.

  The spillway is designed to allow the free spill of water when the headpond level exceeds El. 701.95 m (crest elevation of the cut-off dam). The spillway design capacity is approximately 11.0 m^3/s at El. 702.8 m. Operations are set to minimize risk of spillway use since spills pass through a highly erodible area approximately 1.0 km downstream of the spillway chute. As described above, the headpond is operated 1.65 m below full pool to allow sufficient time for the installation of stoplogs and minimize use of the spillway. However operation below full pool reduces the gross hydraulic head, decreasing the generating capacity of the facility.

- **Walter Hardman Dam, Power Intake, Discharge Culvert, and Penstock:** The Walter Hardman Dam at the north end of the headpond is the largest of the containment structures and the power intake runs through the base of this dam. The top openings of the intake are protected by trashracks to prevent debris from entering the conduits. The intake feeds both the penstock and the discharge valve/culvert.

The penstock carries water from the headpond to the powerhouse on Upper Arrow Lakes Reservoir. The penstock bifurcates into two separate pipes to deliver water to the two generating turbines. The tailrace of the powerhouse discharges into Upper Arrow Lakes Reservoir. The discharge valve/culvert structures are used to drawdown the headpond as an alternate to the penstock if needed.

2.5 Description of Current Operations and Constraints

The expected current operation of the Walter Hardman Project is outlined below, subsequent to dam decommissioning, yet prior to this water use planning process.

- **Daily Operations:** Due to the limited headpond storage volume, the Walter Hardman Project operates as a run-of-river facility where daily inflow is equal to daily outflow. The headpond level is maintained at constant elevation by the use of a Programmable Logic Controller (PLC) which adjusts the flow through the turbine to match the real time inflow to the headpond. Thus, generation typically follows the real time inflow pattern up to the maximum output of 8 MW. Attempting to maximize the daily generation that occurs in High Load Hours ("peaking") is possible at this plant but is not practical given the limited storage capability of the headpond.

- **Typical Output:** Each generating unit is capable of 4.5 megawatts (MW) of energy generation output when operated on its own, but the water discharge capacity of the single penstock that feeds the two units limits the maximum plant output to 8 MW (4.3 m^3/s) when both units are operating. Under low inflow conditions, only one unit is operated and generation output as low as 0.5 MW is possible (approximately 0.25 m^3/s at a reservoir elevation of El. 698 metres).

- **Bi-annual Maintenance:** Each year, usually in late October, one of the two generating units is taken out of service for approximately two weeks for its bi-annual maintenance. The units are taken out of service in alternating years and the maintenance outage is timed to coincide with a period of low inflow that will not affect generation, but when winter road access to the powerhouse is not a problem.

- **Icing:** Ice problems have been observed in the diversion channel, typically around the orifice control structure. In the past, Coursier Dam's regulating effect allowed a consistent flow through the diversion channel throughout the low flow periods of the year. However, the decommissioning of the dam could exacerbate this problem to the point of freezing up the diversion channel and necessitating shutting down the plant for a period of time.

3 CONSULTATIVE PROCESS

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

Table 3-1: Water Use Planning Process

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

3.1 Initiation and Issues Scoping

In September 2003, BC Hydro began the Initiation Steps for the Walter Hardman Water Use Plan (Step 1). During this time, reference material was gathered to undertake a review of existing documentation regarding operating issues and interests. Provincial and Federal government agencies were also invited to identify representatives to participate in the Walter Hardman water use planning process.

BC Hydro contacted known stakeholders in the area by telephone in September and October 2003, including local and regional government representatives (Mayors and Regional District Directors and local government staff), environmental groups, community groups and property owners. During telephone calls, BC Hydro used a questionnaire survey to document issues and interests associated with the operations of the facility, determine the general use of the Walter Hardman area, solicit the names of other stakeholders in the area, and discuss the interest in participating in the Walter Hardman Water Use Plan consultative process.

Issues scoping and discussion with First Nations is described in Section 3.3.

The stakeholder contact list from the Coursier Dam Decommissioning Project provided a comprehensive initial list of local groups, agencies and individuals who may have an interest in participating. Contacts were made with all of these stakeholders, by phone, e-mail or in person.

The local and regional government representatives were already familiar with the water use planning process, given that the Columbia and Whatshan water use planning processes had already been initiated in the South Interior. Other stakeholders who were not familiar with water use planning were provided with general background information as part of this initial contact. Many of those contacted had already been involved in the Coursier Dam Decommissioning Project and were interested in the progress of the decommissioning work and how it would affect the flows on Cranberry Creek and consequently the water use planning process for Walter Hardman.

On 8 September 2003 BC Hydro sent a letter to the Comptroller of Water Rights formally initiating the Walter Hardman Water Use Plan. A news release was sent out 12 September 2003 that announced the start of the process and the public Open House scheduled for 1 October 2003. Advertisements for the Open House were also placed in the *Revelstoke Times Review* on 17 and 24 September and 1 October 2003 and the *Arrow Lakes News* on 18 and 24 September 2003.

A letter or e-mail was sent to the stakeholders contacted on 19 September 2003, advising of the project initiation and providing information on the upcoming Open House. The notification included the one pending water licence holder on Cranberry Creek, along with stakeholders identified and/or contacted up to that date. A letter was also sent to the Mayor and Council of the City of Revelstoke and the Columbia Shuswap Regional District asking how they would like to be involved in the process. The letter was also sent for information to MLA Wendy McMahon, Columbia River-Revelstoke and MP Jim Abbott, Kootenay West-Columbia.

BC Hydro identified private property owners in the vicinity of the Walter Hardman facilities as part of the Coursier Dam Decommissioning Project. These owners, about five in total, were sent a letter on 19 September 2003 advising of the water use planning process and the opportunity to learn more and get involved.

A complete list of stakeholders that were contacted during the initiation phase of the process is provided in Appendix A.

3.2 Consultative Committee Structure and Process

The Walter Hardman water use planning process provided opportunities for varying levels of participation. Consultative Committee members were committed to attending all meetings and representing their organization's or constituency's interests at the final decision stage. Where possible, each member had a designated Alternate whom could assume the member's role in the event they could not attend a given meeting. Observers attended on a drop-in basis and provided input but did not participate in decision-making. A complete list of members, Alternates and Observers is provided in Appendix A (Photo 3-1).

Nine members (and their designated alternates) actively completed the Walter Hardman water use planning process over a series of four Consultative Committee meetings (Table 3-2).

In addition to the Consultative Committee, participants formed a Fish and Wildlife Technical Subcommittee (see Appendix A for membership) to focus on specific fish and wildlife issues and to provide technical advice to the Committee.

At their first meeting in 2003, the Consultative Committee adopted a Terms of Reference (Appendix B) and a consultation work plan. Both the Terms of Reference and the work plan were included in the *Proposed Consultative Process Report: Walter Hardman Water Use Plan* (BC Hydro, 2002) and submitted to the Comptroller of Water Rights to fulfil Step 3 of the provincial *Water Use Plan Guidelines* (British Columbia, 1998).

Photo 3-1: Consulative Committee Members

The Consultative Committee and the Fish and Wildlife Technical Subcommittee met a number of times between October 2003 and February 2004 (Table 3-2). Three site visits to the Walter Hardman hydroelectric facility were held, 22 July 2003, 25 September 2003, and 18 November 2003. The first two field visits were before the official initiation of the Water Use Plan and included BC Hydro, provincial, federal and First Nation representatives. Other local stakeholders were invited to join the tours as well. The third visit was an overview of the facilities which occurred in conjunction with the first Committee meeting.

Table 3-2: Walter Hardman Water Use Plan Committee Meeting Dates

Group	Meeting Dates
Consultative Committee	Meeting #1 – 18 November 2003
	Meeting #2 – 18 December 2003
	Meeting #3 – 28–30 January 2004
	Meeting #4 – 24 February 2004
Fish and Wildlife Technical Subcommittee	Meeting #1 – 19 November 2003 (Fish Technical Committee)
	Meeting #2 – 10 December 2003 (Fish Technical Committee Conference Call)
	Meeting #3 – 18 December 2003 (joint Consultative Committee/ Fish Technical Committee)
	Meeting #4 – 23 February 2004 (Fish Technical Committee)

Detailed meeting notes recorded the discussions and decisions made at all these meetings. A list of documents (including meeting notes) produced during the Walter Hardman water use planning process is provided in Appendix C.

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

Table 3-3: Walter Hardman Water Use Plan Consultation Process Schedule

Step	Components of Water Use Planning Process	Completion Dates
1	Initiate Water Use Plan.	September 2003
2	Scope water use issues and interests.	September – October 2003
3	Determine consultative process.	October 2003
4	Confirm issues and interests of specific water use objectives.	October 2003
5	Gather additional information.	October 2003 – January 2004
6	Create operating alternatives for regulating water use to meet different interests.	November 2003 – January 2004
7	Assess trade-offs between operating alternatives and document areas of consensus and disagreement.	January 2004
8	Determine monitoring and write Consultative Committee report.	February – May 2004
9	Prepare a draft Water Use Plan and submit to Comptroller of Water Rights for review.	June 2004

3.3 First Nations' Involvement

The Walter Hardman facility is located in traditional territory claimed by the Okanagan Nation Alliance (ONA) and the Shuswap Nation Tribal Council (SNTC). The traditional territory claimed by the Ktunaxa Kinbasket Tribal Council (KKTC) is just to the east of the facility.

The ONA represents seven First Nation bands: Upper Nicola, Okanagan, Westbank, Penticton, Osoyoos, Upper Similkameen and Lower Similkameen. The SNTC represents Adams Lake, Bonaparte, Kamloops, Neskonlith, North Thompson, Skeetchestn, Spallumcheen and Whispering Pines/Clinton bands. The KKTC represents five bands: ?Akisq'nuk, Lower Kootenay, Shuswap, St. Mary's and Tobacco Plains.

The ONA, SNTC and KKTC were first notified about the upcoming Walter Hardman Water Use Plan consultative process by telephone in June 2003 and by letter in September 2003. They were advised of the initiation of the Walter Hardman Water Use Plan and invited to participate. The ONA and the SNTC agreed to participate. The KKTC felt that the facility was outside their traditional territory, but agreed that the participation of the Canadian Columbia River Inter-tribal Fisheries Commission (CCRIFC) would ensure that their interests were brought forward.

In September 2003, the SNTC determined that the Secwepemc Fisheries Commission (SFC) would represent its interests in the water use planning process. Pre-scoping telephone calls were held with ONA, SFC and CCRIFC representatives on 15, 18 and 24 September respectively. Representatives of the ONA, SFC and CCRIFC attended a site visit to inspect the fish habitat on 25 September 2003.

A public Open House was held on 1 October 2003 in Revelstoke. Representatives of the ONA and SFC were unable to attend, but CCRIFC was in attendance. First Nation representatives attended the first Consultative Committee and Fisheries Technical Subcommittee meetings on 18 and 19 November 2003 respectively (ONA was represented on 19 November only) and First Nations had a representative or representatives at each subsequent Consultative and Fish and Wildlife Technical Subcommittee meeting.

First Nations were offered the opportunity for a separate subcommittee to discuss First Nation interests in the Water Hardman water use planning process, but they felt that this was not necessary. BC Hydro also maintained regular contact with First Nation representatives through telephone calls and e-mail throughout the Water Hardman water use planning process.

First Nations interests were primarily in aquatic, riparian, fish and wildlife habitats as affected by operations. Heritage and cultural interests were raised generally, but not developed into a performance measure or operating alternative by First Nations representatives at the table as no sites or area uses were specified.[1]

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

3.4 Community Awareness and Communication

During the Walter Hardman water use planning process, BC Hydro provided information to interested stakeholders to inform them about developments in the process. Information and studies were provided for public review at the Revelstoke Library. On 1 October 2003 a presentation was made to the City of Revelstoke Mayor and Councillors and Columbia Shuswap Regional District Directors.

The BC Hydro Water Use Plan Web site also provided information to those interested in the Walter Hardman planning process as well as those interested in Water Use Plans for other BC Hydro facilities in the province. A newsletter was issued following the process, highlighting discussions and recommendations made by the Consultative Committee.

[1] Upon review of the Draft Consultative Committee Report, the Okanagan Nation Alliance provided the additional comments, "To engage in any elaborate discussions or otherwise on First Nation heritage and cultural issues was beyond the scope of this process as there were no resources or activities dedicated to investigating specific and historical aboriginal use and interest. It should be noted therefore that there remains a data gap in addressing these specific interests and not simply the implication that there are none there."

4 ISSUES, OBJECTIVES AND PERFORMANCE MEASURES

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

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

This section of the report provides a summary of the issues, objectives and performance measures identified and developed for the Walter Hardman Water Use Plan. Each includes a basic description of the issue, states the objective, shows the performance measure calculation (e.g., number of days that the elevation of the headpond falls in a targeted range), the area it applies to (e.g., the headpond or Cranberry Creek) and where applicable, the relevant time of year (e.g., spawning or rearing seasons for specific species of fish). It also summarizes any studies undertaken to inform the development of objectives and performance measures. The order of presentation in this document does not imply any priority or relative importance among the issues. Appendix C provides a list of documents generated by the Walter Hardman water use planning process.

4.1 Power Generation

The Walter Hardman hydroelectric facility is part of BC Hydro's provincial integrated generation system. Power generated at Walter Hardman feeds into the Illecillewaet Substation, which primarily serves local customers. Excess power feeds into the provincial transmission grid, while power shortfalls are augmented from the provincial transmission grid. On average, 37 GWh is produced annually at the Walter Hardman facility, 8 MW maximum instantaneous capacity. The output from the facility can supply the equivalent of approximately 3700 homes. The estimated value of this electricity is approximately $1.9 million per year.

Generation at the facility varies daily and seasonally with the availability of water. BC Hydro currently uses all of the available inflow, within the storage and generation limits of the facilities. Spills occur over the diversion dam when inflows exceed generation or storage capacity.

Coursier Dam and Reservoir no longer regulate flows for BC Hydro's generating facility at Walter Hardman. Future operations will not be augmented by multi-day storage, and the headpond offers limited ability to control flows beyond a few hours.

4.1.1 Issues – Power Generation

Participants in the water use planning process expressed a number of issues and interests related to power generation at the Walter Hardman facility:

- **Generation:** BC Hydro expressed an interest in maximizing the amount and value of power produced thereby making efficient use of available water (i.e., having the flexibility of operation to respond to changes in water supply). Others representing community interests noted their desire to maximize generation to keep electricity rates low and the power supply reliable.

- **Impact on Proposed Independent Power Producer Project Upstream:** An Independent Power Producer (IPP) with a proposed project at the junction of South Cranberry and Cranberry creeks expressed an interest in the water use planning process for Walter Hardman. The IPP project is essentially a run-of-river project with water diverted from and returned to the creek about four kilometres upstream of the diversion dam. Their interest was regarding any change in Walter Hardman operations that could affect their project – from changes in creek flows or the release of sediments which could be directed into Lower Cranberry Creek and affect on-going environmental monitoring or related obligations of the IPP.

4.1.2 Objectives and Performance Measures – Power Generation

The Consultative Committee's defined ***objective*** for power generation at the Walter Hardman facilities is to ***maximize value of electricity to Revelstoke, BC Hydro and the provincial government.***

Two ***performance measures*** (Table 4-1) were used to score each alternative for the power objectives:

1. ***Financial Value of Energy Production:***

    a) The average annual lost dollar value of electricity generated per year.

    b) Mean dollars per year lost plus the stoplog overspill and labour costs ($175,000 per minimum flow alternative).

2. ***Local Operations and Maintenance:***

    a) The total number of plant shut-down days (through all six model years).

    b) The total number of start-up/shut-down events (through all six model years).

For more detailed information on the methodology, assumptions and uncertainties related to the performance measures for power generation, see Appendix D.

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

Objective	Performance Measure	Performance Measure Units	
Maximize value of electricity	Financial value energy production	11a	mean dollars per year lost revenue
		11b	mean dollars per year + stoplog overspill and labour costs ($175,000 per minimum flow alternative)
	Local operations and maintenance	12a	# days plant shut-down over six years modelled
		12b	mean # start-up/shutdown events over six years modelled

4.1.3 Studies – Power Generation

A key precursor to calculating power performance measures (and all the other interests described in this chapter) was to simulate the hydrological response of the Walter Hardman system to a series of proposed operating changes. For each alternative operating scenario – designed to achieve one or more of the water use objectives identified by the Consultative Committee – a computer simulation model calculated the expected daily headpond levels and Cranberry Creek flow levels expected under a range of realistic historical inflow conditions.

The initial hydrology assessment by Summit Environmental Consultants (2000) and subsequent data smoothing were undertaken to provide inflow records for the water use planning process (Section 2.2). Since there was also an interest in exploring minimum flow alternatives for Cranberry Creek, an additional study was completed by Engineering Services to address the use of the stoplogs to provide an overflow minimum flow at the diversion dam. The estimate was intended to represent the “inefficiency” of using the current structures to deliver the minimum flow, vs. building new infrastructure to deliver a minimum flow more efficiently.

Section 5 and Appendix E provide a detailed description of the Power Modelling Studies conducted during the Walter Hardman water use planning process.

4.2 Fisheries

The Cranberry Creek watershed occupies approximately 145 km^2 and flows into Upper Arrow Lakes Reservoir. There is 9.8 km of stream downstream of the diversion dam, with a contributory drainage area of 44.9 km^2. The distance between the diversion dam and the confluence with the spillway channel is 1.11 km. The spillway channel is 1.05 km long.

The reaches downstream of the diversion dam can be subdivided into segments to capture the effects of varying inflows at different locations along the reach. For the purposes of assessment the reach has been divided into two segments bounded by three sample points: the diversion dam (Site 6), Site 5, and the mouth (below the velocity chute). Flows at each site can be estimated using estimated flow data (Section 2.2). The mean annual discharge (MAD) at the diversion dam is 4.85 m^3/s based on a synthesized record from 1980 to 1986 (Summit, 2000). Assuming that the unit runoff is the same downstream, the local inflow would equal 1.51 m^3/s, yielding a MAD of 6.36 m^3/s. This is likely an overestimate given the lower elevation and absence of glaciers in the lower watershed. Moreover, the seasonal timing of run-off likely differs in the lower watershed. Revised estimates of local inflow were calculated using other stations as surrogates.

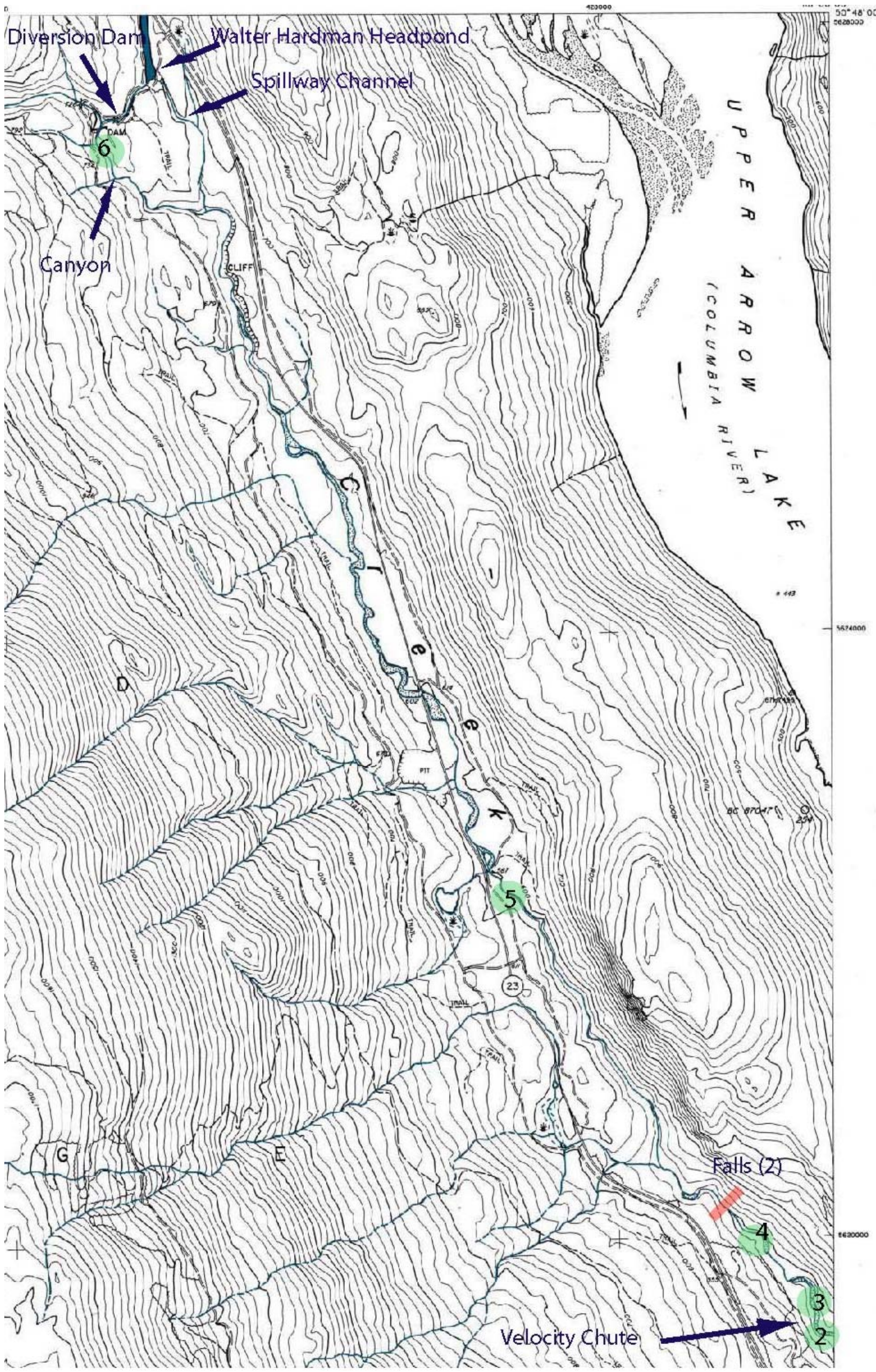

Figure 4-1: Cranberry Creek below the Diversion

Key features with sites studied by Summit Environmental Consultants (2000) shown as highlighted green circles.

Fish and fish habitat were the predominant issues and interests identified by government agencies, First Nations and local groups represented on the Consultative Committee. The related interests and issues are identified below by operating area.

***Diversion Reach**:* The issues with respect to the diversion reach were related to the diversion of water and: 1) the effect on rearing and spawning habitat for rainbow trout and other species; 2) the effect on water temperature on rainbow trout and other species growth and survival; 3) the effect of gravel recruitment into the reach below the diversion dam; and 4) fish stranding from flow changes, particularly during low flow stages.

***Spillway Channel**:* The issues with respect to spillway operations were related to spill events: their frequency, magnitude, duration, and timing. In addition to possible fish entrainment over the spillway, the potential sedimentation and erosion of cutback areas may be detrimental to downstream fish habitat. The impact on rainbow trout stocks was specifically noted. The requirement to undertake fish salvage operations post-spill to deal with possible fish stranding events was also raised.

***Cranberry Creek – Lower Reach Below Diversion Channel**:* The main interest with respect to Lower Cranberry Creek was in exploring minimum flows to improve fish habitat (spawning, incubation, rearing and migration). Such flows may improve over-winter survival of rainbow trout, sculpins and other species.

Similarly there was interest in exploring fish passage from Upper Arrow Lakes Reservoir, and passage above upstream natural barriers (for bull trout and kokanee) associated with a minimum flow into Lower Cranberry Creek. Some stakeholders were interested in critical life stages timing, while others indicated a desire to look at year-round flow benefits.

A concern about low flows affecting water temperature and fish survival was also raised. This concern spanned the seasons, with possible icing effects in the winter and warming impacts in the summer.

Fish species that were specifically mentioned as being of interest included rainbow trout, kokanee, bull trout, whitefish and sculpin. Operations that affect habitat, gravel supply, water temperature, migration barriers or water quality were of concern. Cessation of discharges from the diversion dam or from a spillway event raised a concern about fish stranding and salvage efforts.

Information was brought to the water use planning table about a separate (non-Water Use Plan) proposal being developed for habitat and passage works to enhance fish habitat below the diversion reach and above the "barriers." While outside the scope of the water use planning table, the interests in minimum flows to facilitate such restoration works was discussed by participants.

***Walter Hardman Headpond**:* There was a concern about the status of fish populations in the headpond, and its ability to support fish stocks. There was also some concern about oxygen levels in the headpond under drawdown conditions, when depleted oxygen might harm fish populations. In addition, during drawdown fish may become concentrated near the intake which could lead to increased entrainment.

***Walter Hardman Generating Station**:* The main issue related to the operations of the generating station related to fish entrainment; fish that pass through the turbines and consequently die. At Walter Hardman Generating Station, the Turgo turbines cannot pass whole fish as can occur at other facilities with different turbines.There were questions about how various plant operations or physical structures may be able to minimize fish entrainment.

4.2.1 Issues Pursued by the Consultative Committee – Fish

Of the various issues and interests that were raised, the Consultative Committee agreed to pursue the following issues related to the impact of operations on fish in Cranberry Creek and in the Walter Hardman headpond:

- Habitat for spawning, incubation and rearing (both summer and over-wintering) in Lower Cranberry Creek (rainbow trout and kokanee).
- Conditions for kokanee migration, both up and down Lower Cranberry Creek.
- Stranding and isolation of fish in Cranberry Creek due to flow cessation over the diversion dam.
- Riparian and bankfull flow events.
- Over-wintering habitat in the headpond.

4.2.2 Objectives and Performance Measures – Fish

There were two main ***objectives*** articulated for fish in distinct parts of the Walter Hardman system:

Maximize the production and diversity of fish and fish habitat in Lower Cranberry Creek (below the diversion dam).

Maximize the production and diversity of fish and fish habitat in Walter Hardman headpond.

A number of sub-objectives were developed to clarify what means might be used to achieve this fundamental objective and address the Consultative Committee's specific concerns about potential impacts of operations on fish. Each of the sub-objectives and the performance measures used to track it across alternatives are described below.

The ***sub-objectives and performance measures for fish in Cranberry Creek*** are presented below and summarized in Table 4-2.

- ***Maximize habitat for spawning and incubation:*** The probability of mortality during spawning and incubation is a complex interaction between: 1) individual time of spawning and time of hatch, and 2) various physical habitat conditions including water depth and velocity, as well as the type and porosity of channel substrate. The ***"wetted area and depth for kokanee spawning"*** performance measure defines how physical conditions important to respectively kokanee spawning and incubation are expected to change with river flow. Stream resident rainbow trout populations are not typically limited by spawning habitat. However, members of the Fish and Wildlife Technical Subcommittee expressed concern about that possibility. The ***"depth decrease during rainbow trout incubation"*** performance measure will define how physical conditions important to rainbow trout spawning change with river flow.

- ***Maximize habitat for rearing:*** Rainbow trout populations are typically limited by rearing habitat during the low flow period. In streams in the British Columbia interior, one critical low flow period is during the late summer and early fall, during the rearing season. At this time rainbow trout have reached their maximum size for the calendar year and require the largest territory size, hence habitat space requirements are at a maximum. The ***"wetted area for rainbow trout rearing"*** performance measure will define how physical conditions important to rainbow trout *summer* rearing are expected to change with river flow. Another period of limitation for rainbow trout is during winter, when adequate pool depth may be critical to over-wintering survival. Water depth provides protection from freezing and is correlated with higher dissolved oxygen concentrations. The ***"depth for rainbow trout rearing"*** performance measure will define how physical conditions important to rainbow trout *over-winter* rearing are expected to change with river flow.

- ***Maximize conditions for migration both up and down Cranberry Creek:*** The Fish and Wildlife Technical Subcommittee was concerned about whether or not river flows in Cranberry Creek were adequate for upstream migration. The flows required for passage past specific barriers cannot be predicted without site specific observation. However, migration past less difficult obstacles, such as riffles, rapids, and cascades, will be less difficult with increases with water depth. Accordingly, the ***"depth for upstream migration"*** performance measure was used as a proxy for ease of migration of kokanee and bull trout in Cranberry Creek during the fall.

- ***Maximize fish access to Cranberry Creek tributaries:*** Access to upstream tributaries in Cranberry Creek was not considered a critical issue in this mountain environment, and the Committee decided not to measure associated impact or seek operational changes.

- ***Minimize spillway channel erosion,*** measured by number of spillway events.

- ***Minimize stranding and isolation (Cranberry Creek section):*** Cessation in diversion dam flows has the potential to strand or isolate fish, leading to mortality in Cranberry Creek. The Fish and Wildlife Technical Subcommittee was concerned about the potential for stranding of rainbow trout. The ***"stranding"*** performance measure quantifies the number of dewatering events at the diversion dam on Cranberry Creek, as an indicator of the risk of stranding to fish year-round.

  Note that the above performance measures were originally called "stranding and spillway entrainment." The spillway rarely operates, but when it does, fish may be entrained and transported downstream into the spillway channel. There is no information on the relationship between entrainment and spill volume from Walter Hardman headpond. Based on this lack of data, the power modelling structure, and because use of the spillway is very infrequent, the spillway performance measure was dropped from significant discussions.

The ***sub-objectives and performance measures for fish in the Walter Hardman headpond*** are presented below and summarized in Table 4-2.

- ***Maximize productivity of littoral habitat****:* Littoral productivity refers to the annual production of organisms (i.e., phytoplankton) growing on or near the headpond shoreline, within the area and depth of sunlight penetration and therefore capable of primary production. These littoral organisms, such as algae and macrophytes (weeds) are an important source of food for fish.

  The potential littoral zone in the Walter Hardman headpond is extensive as most of the reservoir bottom may be lit by sunlight during at least part of the year. Annual littoral production is maximized when the reservoir is relatively stable and littoral ecology can develop undisturbed from year-to-year. When water levels fluctuate because of headpond operations, the establishment of algae, macrophytes and associated aquatic communities is limited by the duration that zone is wetted and receives sufficient sunlight during the growing season. Decreases in headpond elevation can dewater extensive areas of littoral habitat, potentially leading to the death of littoral organisms through desiccation (drying out), freezing and predation.

Table 4-2: Performance Measures – Fish in Cranberry Creek and Walter Hardman Headpond

No.	Performance Measure	Units	Location	Timing
1	Wetted area and depth for kokanee spawning	Median wetted area (m^2)	**Cranberry Creek** near the mouth (above the fan)	1 Sep – 31 Oct
2	Wetted area and depth for kokanee incubation	Maximum decrease in depth (m)	**Cranberry Creek** near the mouth (above the fan)	1 Sep – 30 Apr
3a, c, e (broad) 3b, d, f (narrow)	Wetted area for rainbow trout rearing during the critical streamflow period	Habitat area (m^2) (median of 3 areas)	**Cranberry Creek** 3a, b) diversion dam, 3c, d) Site 5 3e, f) near the mouth	1 Jul – 31 Oct (broad window) *and* 1 Sep – 31 Oct (narrow window)
4a, b, c	Depth for rainbow trout rearing over winter	Median depth (m) (3 areas)	**Cranberry Creek** 4a) diversion dam, 4b) Site 5 4c) near the mouth	1 Nov – 31 Mar
5a, b, c	Depth for rainbow trout spawning	Maximum decrease in depth (m) between spawning and incubation flows (3 areas)	**Cranberry Creek** 5a) diversion dam, 5b) Site 5 5c) near the mouth	1 Apr – 15 Jul
6	Depth for upstream migration	Median depth for migration (m)	**Cranberry Creek** near the mouth	1 Aug – 31 Oct (kokanee run timing)
7	Stranding and isolation	Mean # flow cessation events annually	At the **diversion dam**	Year round
8	Riparian habitat wetting (also for wildlife)	Median difference between the channel width and observed wetted width (m)	**Cranberry Creek** at Site 5	1 Apr – 30 Sep
9	Riparian bankfull exceedence days	# Days exceeding bankfull	**Site 5**	
10	Walter Hardman headpond over-wintering	Minimum 30-day average headpond level (m)	**Walter Hardman headpond**	1 Nov – 31 Mar

No performance measure was developed for this objective because initial understanding of normal operations indicated that headpond elevation did not fluctuate often during the growing season. Subsequent discussion suggested more drawdown may occur, thus if future operations draft the headpond more frequently during the growing season, consideration of littoral issues may be warranted.

- ***Maximize over-wintering habitat**:* Dissolved oxygen concentrations during the winter determine the over-winter survival of rainbow trout and may even determine the persistence of the population. Winterkill risk is determined by dissolved oxygen concentration and vegetation decomposition, which in turn is driven by maximum depth and inflow. The Walter Hardman headpond typically receives continuous inflow through the winter. Although the maximum depth is only 11 m, which is shallow enough to elevate the risk of winterkill, the inflow provides dissolved oxygen input and minimizes winterkill risk. Drawdown of the headpond could elevate the risk of winterkill, as could a reduction of inflow. However, the headpond will not be drawn down unless inflows are very low, and headpond level will not increase following a drawdown unless inflows increase.

  Both the duration and magnitude of low flow events are therefore indexed by the occurrence of drawdowns during the winter. For dissolved oxygen concentrations to reach critically low levels, the drawdown will have to be sustained for weeks to allow oxygen to be depleted by biological and chemical processes. Accordingly, the minimum 30-day average headpond level will be used as an indicator of the duration and magnitude of drawdown. A 30-day period is long enough to deplete oxygen to the point of detection, but not so long that drawdowns will be masked by periods of higher headpond level. The ***"headpond over-wintering"*** performance measure provides an index of the risk of mortality in the headpond during the winter ("winterkill") by calculating the minimum 30-day average headpond level from 1 November through 31 March each year.

- ***Minimize total gas pressure (TGP) below the tailrace**:* In areas below a waterfall or below a dam that is spilling, the force of the water carries air with it to depth. This can cause dissolved gas supersaturation in the water (Total Gas Pressure) and is harmful to fish, causing death in extreme cases. No studies of TGP were done at the Walter Hardman hydroelectric project. Based on experience at similar facilities in the province, the Fish and Wildlife Technical Subcommittee agreed the risk of TGP being an issue below the tailrace is low, therefore a TGP performance measure was not developed.

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

4.2.3 Studies – Fish

The Walter Hardman water use planning process was initiated prior to the decision to decommission the Coursier Dam and was suspended until the decommissioning was complete. The second phase, documented in this report, was initiated from Step 1 of the *Water Use Plan Guidelines.* The following studies were conducted related to operational impacts affecting fish in the system.

Summit Environmental Consultants Ltd. (2000). Cranberry Creek Fisheries and Hydrology Study, Volume I (Text) and II (Appendices)

In preparation for the Water Use Plan, this two-volume text provided an overview of aquatic issues and background information, including species inventory and hydrology assessment. The data from this volume was used in the development of objectives and performance measures in all areas of the system, including fish, wildlife and power modelling.

Summit Environmental Consultants Ltd. (2003). Final Report: Fish Habitat Evaluation in Walter Hardman Spillway Channel

Fish habitat along the majority of the natural section of the spillway channel is of high value and the potential for enhancing this habitat by increasing flows is high. There are areas suitable for rainbow trout spawning, pools suitable for over-wintering, abundant cover and a diversity of habitat types. Providing a minimum flow of approximately 0.25 m^3/s to 1.0 m^3/s through this section of the channel would likely benefit a resident fish population in the spillway channel. However, fish habitat in the lower portion of the spillway channel is poor and there is a low potential for enhancing this habitat by increasing flows. Unless a considerable effort is made to stabilize the slopes and channel along Reach 1, providing minimum flows through this portion of the spillway channel would result in the chronic introduction of fine-grained sediment to the spillway channel and Cranberry Creek, which would negatively impact fish habitat downstream. It is also likely that the current upstream progression of channel downcutting would be exacerbated and, in the long-term, much of the higher quality habitat upstream of the nick point would be degraded.

The authors state that increasing flows in Cranberry Creek below the diversion dam will likely result in less benefit in terms of increased habitat availability and value compared to the potential benefits of increasing flow in the upper reach of the spillway channel (Reach 2); however, there is little to no associated risk of erosion and sedimentation (Summit, 2003).

Given the scope of this assessment, the extent of impacts (positive and negative) associated with providing minimum flows (of approximately 0.25 m^3/s to 1.0 m^3/s) in the spillway channel or in Cranberry Creek below the diversion weir cannot be quantified. However, based on this assessment of the spillway channel and Summit's knowledge of Cranberry Creek from previous investigations, it is Summit's professional opinion that providing minimum flows in Cranberry Creek below the diversion dam is the preferred option to providing flows down the spillway channel.

Summit Environmental Consultants Ltd. (2004). Lower Cranberry Creek Ice Study

The assessment found that ice formation is not expected to be a significant problem in all but extremely cold periods lasting about one week or more (for the range of flows 0.25–1.0 m^3/s).

- Relatively mild temperatures in winter along Lower Cranberry Creek (elevations range from 460–720 m).
- Relatively deep snowpack reduces thickness of sheet ice and prevents frazil generation. In addition, as the snowpack thickens, it is thermally "eroded" by flowing water, leaving a sub-ice air gap (which is an excellent insulator).
- Although some pools will freeze at the surface, relatively short flow-through times will prevent complete freeze-up.
- There is likely a significant groundwater contribution along Lower Cranberry Creek (i.e., warm water).
- Risk is greatest from early season cold snaps with little snowpack protection.

Summit advised that flow releases should be managed cautiously:

- In order to minimize frazil generation, turbulence associated with the outlet (of any proposed flow diversion structure) should be minimized.
- In order to prevent break-up associated impacts (e.g., scour), flows should be managed such that they are relatively constant or gradually reduced through the winter (particularly avoiding sudden releases).

4.3 Wildlife

The value of the habitat around the headpond is limited by the presence of a road network surrounding the entire perimeter of the headpond. Highway 23 runs parallel to the east side of the headpond and in some places, little to no vegetation separates the headpond from the highway. The earth-filled dam, located along the northern boundary of the headpond, is devoid of vegetation and provides no habitat value to the resident species. This area is kept cleared of vegetation at all times. A logging road and access road to the spillway is present along the west and south sides of the headpond. The distance from the current waterline to these access roads varies from 5–50 m. The majority of habitat and vegetation assessed is located within this narrow strip between the access road and the headpond. This "island" of habitat is limiting in itself in that some species may not venture into this area.

4.3.1 Issues – Wildlife

Consultative Committee members expressed interests in minimizing the impact of operations on wildlife, particularly in terms of riparian vegetation and habitat along the diversion reach, the lower reach of Cranberry Creek and around the headpond area. A general inquiry was made regarding whether endangered species existed in the area. There was interest in the impact of the Walter Hardman headpond levels on nesting shorebirds. Also, there was a question whether ice conditions occur on the headpond that could then affect wildlife in the area.

4.3.2 Objectives and Performance Measures – Wildlife

The main ***objective*** in considering alternative operations is to ***maximize the abundance and diversity of wildlife habitat in and around Walter Hardman headpond and Lower Cranberry Creek.*** The Committee also identified a key ***sub-objective*** that helped to qualify the main objective based on their primary interest: ***maximize the productivity of riparian in Lower Cranberry Creek.***

The review of issues in and around Walter Hardman headpond did not reveal any significant operational impacts for wildlife with the periodic drawdown events. With the exception of nesting birds, most species are either mobile or not dependent on the headpond for critical habitat. The Committee agreed not to develop a performance measure for wildlife associated with the headpond.

Two related ***performance measures***, described below and in Table 4-3, are ***riparian habitat wetting*** and ***bankfull exceedence.***

The wetting of riparian habitats maintains linkages between riparian and aquatic habitats. The amount of insects dropping and leaf litter falling into wetted habitats increases when the stream channel is full, and mammals and birds can more easily move from cover in the riparian zone to aquatic habitats for foraging. Reductions in flow during the growing season caused by operations can reduce flows, increasing the distance between riparian vegetation and the wetted edge. This can reduce the functional connection between riparian and aquatic systems. Wetted width provides an indicator of the fullness of the stream. The "***riparian habitat wetting"*** performance measure is the difference between the wetted width at bankfull flow and the typical flow and gives a measure of the link between the riparian and aquatic habitats.

Overbank flow has the greatest impact on plant community structure during the growing season, when plants, particularly young individuals, are most sensitive to flooding. Flooding during the growing season inhibits the recruitment of strictly terrestrial plants. Plants typically found in the riparian zone are more tolerant to seasonal flooding and may even require some flooding to successfully recruit, such as cottonwood (several species), however, alder and other deciduous species are also flood tolerant and will benefit from overbank flow. The "***bankfull exceedence"*** performance measure quantifies the duration of bankfull exceedence events, which is expected to correlate with a measure of the function of riparian habitats.

Table 4-3: Objectives and Performance Measures – Wildlife (and Riparian) Habitat in Lower Cranberry Creek

Objectives	Performance Measures & Units	Location & Timing
Maximize the production and diversity of wildlife habitat around Walter Hardman headpond and Lower Cranberry Creek, by maximizing the productivity of riparian and littoral habitat.	**Riparian Habitat Wetting**: The distance (measured in metres) between the channel edge and the wetted edge during the growing season. This is expected to be a measure of the "inter-connectedness" of riparian and aquatic habitats.	Measured at Site 5[1] of Cranberry Creek (roughly half-way downstream in the middle section of Lower Cranberry Creek). Applies in growing season (1 April–30 September).
	Bankfull Exceedence: Annual average duration of bankfull exceedence (i.e., number of days when overbank flows are exceeded), which is expected to correlate with a measure of the function of riparian habitats.	Measured at Site 5 of Cranberry Creek (roughly half-way downstream in the middle section of Lower Cranberry Creek). Applies in growing season (1 April–30 September).

[1] See Figure 4-1.

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

4.3.3 Studies – Wildlife

Summit Environmental Consultants (2003) investigated the possibility of higher and reasonably stable water levels in the headpond on wildlife interests, in the event that the spillway is used to provide a minimum flow. No investigations focused on variable headpond elevations.

To summarize, an initial rise in water levels will permanently flood the shoreline habitat that currently undergoes inundation only a few times a year. Although the current water fluctuations are minor throughout this habitat (i.e., ≤0.63 m, 80 per cent of the time), the proposed fluctuations will even be smaller and therefore have less of an impact on the birds in the shoreline area. Slight increases in the number of nesting individuals are thus a possible outcome of the proposed more stable water level. Browse opportunities for moose and deer will be reduced due to a reduction in the area covered by willow and alder shrubs. This is expected to have negligible effect on ungulates because similar habitats are common within five kilometres of the headpond and that new shrubs will likely establish along the shoreline shortly after the rise in water levels.

It was recommended that, in the event of a permanent increase in headpond elevation, a slow increase in water level be implemented to allow any species in the proposed flood area to relocate to higher ground. Flooding should occur during winter months to avoid the important spring breeding and nesting periods.

4.4 Cultural and Traditional Use

The Walter Hardman facility is located in traditional territory claimed by the Okanagan Nation Alliance (ONA) and the Shuswap Nation Tribal Council (SNTC). The traditional territory claimed by the Ktunaxa Kinbasket Tribal Council (KKTC) is just to the east of the facility.

4.4.1 Issues – Cultural and Traditional Use

No specific interests were raised regarding heritage or cultural sites in the vicinity of Walter Hardman. First Nations Consultative Committee members representatives indicated that they were not aware of any First Nation archaeological sites in the area around Walter Hardman. Provincial records were also searched for documented heritage sites and none were identified.[1]

4.4.2 Objectives and Performance Measures – Cultural and Traditional Use

The Consultative Committee raised no significant issues related to heritage sites, and no objectives or performance measures were developed for this interest.

However, First Nations representatives did voice an interest in the traditional use of the area for hunting and fishing and articulated the following objective: ***maximize abundance and diversity of indigenous fish and wildlife populations to support First Nations' harvesting and associated activities.*** No additional performance measures were developed as indicators for this objective, since the existing fish and wildlife performance measures were considered sufficient (Sections 4.2 and 4.3).

4.4.3 Studies – Cultural and Traditional Use

No related studies were conducted, aside from searching Provincial records for documented heritage sites as mentioned above.

4.5 Recreation

Based on feedback from local groups, there is limited recreation use in the area of the Walter Hardman facilities.

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[1] Upon review of the Draft Consultative Committee Report, the Okanagan Nation Alliance provided the additional comments, "No issues were raised by the ONA as we were not expected to raise these issues – the ONA representatives were not cultural specialists. See comment as above and it is related to section 4.4.3 where no studies were done on cultural issues – care should be taken not to imply that because these issues were not raised in any detail that there are not impacts or concerns."

- **Fishing:** There is some recreational fishing in the headpond, which is said to be good for rainbow trout. Fishing is also known to be popular by the Walter Hardman Generating Station between June and September when the Arrow Lakes Reservoir levels are higher.

- **Aesthetics:** There were comments that the murky water of the headpond and the highway and logging environment makes this area less attractive for recreation.

- **Other Activities:** Some mentioned berry-picking, walking, and spiritual enjoyment in the area adjacent to the diversion dam to the headpond, which would not be affected by operations.

- **Boating and Navigation:** According to local sources, there is little to no canoeing or boating use of the section of Cranberry Creek below the diversion dam. There was a suggestion about the need to maintain navigation and access to lower sections of Cranberry Creek, although low water and natural barriers naturally limit navigation.

- **Motorized Use:** There is some all-terrain vehicle (ATV) and snowmobile use in the area, and there was some concern about ATV recreation use on either the Lower Cranberry Creek or the Upper Arrow Lakes Reservoir drawdown zone, especially during the spring, having a negative impact on fish or fish habitat. These issues are not affected by operations of the Walter Hardman facilities.

4.5.1 Issues – Recreation

Although the community did provide feedback (outlined above) about the current use of the headpond, Cranberry Creek and adjacent areas, no significant concerns were raised about the potential impact of operating changes on recreational activities.

4.5.2 Objectives and Performance Measures – Recreation

The Consultative Committee articulated two recreation objectives: ***maximize the quality of the outdoor recreation experience and minimize the impacts of recreation.*** No performance measures were developed as indicators for these objectives; however, the Committee did agree that once they had developed a preferred operating alternative, they would do a final check to discuss possible impacts to the two recreation objectives.

4.5.3 Studies – Recreation

No related studies were conducted during the Walter Hardman water use planning process.

4.6 Water Quality (Spillway Erosion)

The topic of water quality was raised with respect to the impact of spills in the spillway channel that could then transport sediment to the lower reaches of Cranberry Creek and Arrow Lakes Reservoir, potentially affecting fish or fish habitat and invertebrates. Use of the spillway was considered by the Consultative Committee for provision of a minimum flow into Lower Cranberry Creek.

There was also an interest expressed in the current BC Hydro gravel program at the diversion dam, which transports material downstream in an effort to improve the supply of material to the riverbed. The Consultative Committee did not pursue gravel recruitment through operating alternatives during the process, developing neither related objectives nor performance measures. The Committee did confirm that the gravel removal and recruitment program currently in place should continue as it provides downstream fish benefits.

4.6.1 Spillway Channel Habitat and Erosion Risk Study

Both the spillway channel and the diversion reach channel of Lower Cranberry Creek sites are capable of providing a minimum flow; however, the spillway channel could provide a flow with minimal reconfiguration of the infrastructure and with more year-round reliability. Summit Environmental Consultants completed an assessment of the quantity/quality of potential fish habitat and the erosion risk associated with using each site to provide a minimum fish flow.

The spillway channel has some flowing water from local inflow and isolated pools (depth 0.6–0.7 m) with woody debris cover, so with regular wetting the spillway channel could provide good fish habitat. No fish were observed in the channel, however it is possible that fish would be entrained over the spillway when used. Fish would be unlikely to access the channel from downstream due to a migration barrier.

At the low end of the channel there is an area of continual and potentially significant erosion. The banks are unstable and comprised of fines that would easily be mobilized with even small spillway releases. Sediment loading from the spillway channel to Lower Cranberry Creek from any instream flow release could be detrimental, particularly outside or after freshet. Engineered works or excavations could assist in forming of a proper thalweg channel, although with great difficulty and cost.

Fish habitat below the diversion dam is not high quality habitat, although regular flows would increase the habitat. However, the main benefit of a regular flow is to downstream habitat (from the Highway 23S Bridge and below).

4.7 Flood Management

Flood management has not historically been a concern at the Walter Hardman facility. Since the facility has limited storage capacity in the reservoir and is operated as a run-of-river facility during periods of high inflows, its normal operation does not significantly impact downstream flood risk. For the same reasons, there are no means to modify operations to reduce flood risks.

4.8 Other Issues

Stakeholders contacted during the issues scoping stage of the process commented on a number of issues that fell outside the scope of the Water Use Plan. Foremost of these was the interest in the Coursier Decommissioning Project, especially with respect to how the decommissioning would affect flows, fisheries, environment and invertebrates on Cranberry Creek, plans for monitoring, progress of work, etc. Information on the status of the Coursier Decommissioning Project was provided at the Open House held on 1 October 2003, along with contacts for further information.

5 OPERATING ALTERNATIVES

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

5.1 Specifying Water Use Operating Alternatives

In general, the specifications for the Walter Hardman operating alternatives were relatively simple because Walter Hardman is considered a run-of-river facility. With the decommissioning of Coursier Dam, unregulated natural inflows from South Cranberry Creek and Upper Cranberry Creek are directed into the Walter Hardman headpond and then through to the generating station. The key areas of operating influence include managing inflows and headpond levels.

Managing Inflows:

- Without Coursier Lake Reservoir the Walter Hardman facility has a limited ability to store and control higher water flows. The main flow control point for this system is at the stoplog structure, which can be used to coarsely limit inflows into Walter Hardman headpond. The next downstream control point is the orifice control structure, operationally statically set for dam safety objectives to limit inflows to 10.5 m^3/s, maximum spillway capacity.

- Providing minimum flows over the diversion dam into Lower Cranberry Creek was of interest to a number of Consultative Committee members. This was modelled assuming the stoplog control structure could restrict flow into the headpond, and that the residual inflow would free spill over the diversion dam. An estimate of overspill was also made to reflect the coarseness of the stoplog structure for providing an exact, 100 per cent compliance minimum flow.

- The lower limit of BC Hydro's ability to provide flows into Lower Cranberry Creek is driven by natural variability. Natural inflows range from approximately 0 m^3/s–40 m^3/s, whereas plant capacity is approximately 4.2 m^3/s. There are certain times of year (winter and perhaps fall) when BC Hydro's ability to provide a minimum flow to Lower Cranberry Creek is limited by the upstream inflows.

Managing Headpond Elevations:

- BC Hydro has three main operating options available to manage headpond elevation: 1) upstream control structures (stoplogs and orifice) to limit inflows to headpond 2) spillway to release flows above elevation El. 701.95 m, and 3) two power generating units that are automatically adjusted by the headpond controller (static elevation target).

- For modelling purposes the stoplog structure was assumed to limit flows to the headpond to 4.2 m^3/s. Flows in excess of that amount were assumed as spill over the diversion dam. No spillway discharges were modelled.

- The model assumed that the headpond storage was available for maintaining plant operations at a minimum level (0.25 m^3/s) whenever headpond inflow dropped below 0.25 m^3/s. Using "target" elevations that are achieved operationally with the headpond controller, the model managed the reservoir for a dual purpose: avoid spillway use and maintain plant operation.

5.2 Description of Model and Summary of Constraints

As part of the Walter Hardman water use planning process, BC Hydro's Engineering Services modelled operating alternatives using an Excel spreadsheet developed around constraints, targets and rules. A detailed description of the spreadsheet model and constraints is provided in Appendix E.

Modelling the operating alternatives involved a number of steps. First the modeller used the spreadsheet to simulate operating the hydroelectric facility according to the specifications of each operating alternative. The spreadsheet model optimized power generation subject to operating constraints specified by the Consultative Committee, such as minimum flows or headpond/reservoir constraints. The modeller also considered the physical operating characteristics of the system such as headpond/reservoir storage volume and the discharge capacities of the generating turbines. The hard (cannot be changed) and soft (can be changed) constraints in the spreadsheet model included the following.

Hard Constraints

- Daily inflows (Appendix H).
- Stoplog operation (limits headpond maximum daily inflow to 4.2 m^3/s).
- Maximum turbine flow (4.2 m^3/s).
- Maximum power output (8 MW).
- Value of energy (VOE) average monthly prices (updated March 2002).
- Headpond storage curve.

Soft Constraints

- Minimum fish flow.
- Minimum plant flow to prevent penstock freeze-up.
- Drafting headpond allowed or maintain constant headpond.
- Target headpond levels.
- Minimum headpond level for plant operations.
- Maximum headpond level (during a shutdown) for plant startup to avoid spillway discharges.
- Plant shutdown/startup criteria.
- Plant shutdown/startup costs.

The simulations were done on a daily time step coinciding with the natural, smoothed daily inflows above the diversion dam from October 1980 to July 1986 (BC Hydro, November 2003). Historic inflow data is not available, as Coursier Lake Reservoir has regulated releases into Cranberry Creek since the plant was built.

During the modelling exercise, the minimum flow for fish (set as a first priority unless otherwise stated) was provided at the diversion dam using the stoplogs control structure downstream of the diversion dam such that they always limit the flow into the headpond to a maximum of 4.2 m^3/s (maximum turbine flow). Flow in excess of that which can be diverted to the headpond was modelled as a spill over the diversion dam. There were no headpond spillway discharges in the spreadsheet model.

If the headpond inflow dropped below the minimum plant flow, generation was reduced to the minimum plant flow. If these inflow conditions persisted for more than one day (continuous), the spreadsheet responded as follows: For the drafting headpond case, if the headpond drafted to the minimum operating level, the plant was shut down. For the constant headpond case, if the headpond inflows were below the minimum plant flow for three consecutive days the plant was shut down.

5.2.1 Limitations of Modelling Operating Alternatives

While developing and running the model, some modelling limitations became apparent. Some are model constructs while others are due to hydrology or plant infrastructure constraints. These limitations are outlined below.

Natural inflow reliability for minimum flow requirements: BC Hydro's ability to meet a minimum flow requirement over the diversion dam is currently limited by two factors. In some years natural upstream inflows in late fall or winter may be at or near zero. Furthermore, the manually operated stoplogs are the only infrastructure in place for directing minimum flows away from the headpond, and over the diversion dam into Cranberry Creek. This led the group to discuss BC Hydro's ability to meet requirements for minimum flow, relevant compliance issues and biological issues associated with interrupted minimum flows, either by natural zero inflows or infrastructure limits. This led the group to understand that the model was too "perfect" in delivering minimum flows when available, as natural conditions could result in zero inflows and that the stoplogs are an inefficient mechanism (cost and labour) for minimum flow delivery.

Stoplogs ability to deliver reliable and cost-effective minimum flows: The stoplogs are manually adjusted to control inflows to the headpond, and were not designed as a fine-control device for delivering flows over the diversion dam. The group recognized that the stoplog structure is the only mechanism available at this facility for directing flows over the diversion dam, and that it has not yet been demonstrated as reliable for this purpose. Uncertainty exists as to whether "backed-up flows" will freeze, go sub-surface, form a different channel or flow over the diversion dam as is the intent.

Furthermore, the model assumed that the stoplogs could provide an efficient minimum flow. In reality the stoplogs are an inefficient mechanism for delivery of compliance flows. Assuming a weekly manual stoplog adjustment, the "overspill" results in about 0.3 m^3/s additional flow on average associated with 100 per cent compliance (daily average flow) under various minimum flow scenarios (Table 5-1).

The value of each 0.1 m^3/s flow is approximately $50,000, or about $150,000 per year for 100 per cent compliance of 0.3 m^3/s minimum. To deliver a weekly average minimum flow no greater than the requested minimum flow, one would have to accept absolute compliance only 50 per cent of the time. This would mean that approximately half the time flows would be less and half the time flows would be greater through the week following a stoplog adjustment.

Table 5-1: Estimate of Overspill[1] Using Stoplogs to Deliver Minimum Flow

Average Diversion Flow Estimate (October – March)	Requested Minimum Flow m^3/s				
	0.1	0.2	0.3	0.4	0.5
Per Cent Compliance					
100 per cent	0.43	0.53	0.62	0.71	0.80
95 per cent	0.40	0.50	0.59	0.68	0.77
90 per cent	0.38	0.47	0.57	0.65	0.75
85 per cent	0.34	0.44	0.54	0.62	0.72
80 per cent	0.31	0.41	0.50	0.59	0.69
75 per cent	0.27	0.37	0.46	0.56	0.65
70 per cent	0.24	0.34	0.43	0.53	0.62
50 per cent	0.13	0.23	0.33	0.42	0.51

[1] To determine actual flow over the diversion dam, add the requested minimum flow to the estimated overspill. e.g., at 0.3 m^3/s and 90 per cent compliance flow = 0.87 m^3/s.

Target Reservoir Elevations: Reservoir elevations are a function of inflow and discharge (plant generation). Discharge and elevation are controlled and monitored by the headpond controller, and when reservoir levels rise to El. 701.5 m an alarm sounds in the South Interior Control Centre. Because of the modelling assumptions around these control structures, no spill events were realized in the model. The group recognized that these operating protocols would minimize, but not eliminate, the risk of spill events from the Walter Hardman headpond. Extreme events and forced outages may still result in a spill event.

Reference Case: Since the historic operating regime could not be used as a base or reference case for the Walter Hardman Water Use Plan, due to a small or synthetic data set based on a regulated system and a change in operations as a result of decommissioning, a realistic "power optimal" case was modelled. Alternative 2 reflects the best understanding of how the plant would operate for power optimal interests.

5.3 Creating Operating Alternatives

At the December 2003 Consultative Committee meeting the facilitator and members developed several sets of operational constraints that they felt might meet participants' interests and objectives. For each scenario, a statement of objectives was included so that the Project Team could take the information away and create a suite of operating alternatives based on the Committee input.

The Consultative Committee developed and evaluated a total of nine operating alternatives. The initial set of seven alternatives was presented at the January 2004 meeting, from which two modifications were made and modelled during the meeting. Each of the operating alternatives was designed with a specific objective or set of objectives in mind. Table 5-2 helps to clarify the rationale for each alternative. Each alternative was a combination of one or more constraints on operating the Walter Hardman hydroelectric facility to achieve a suite of water use objectives. Each alternative specified up to six specific constraints (Table 5-3), including:

- Minimum flow delivered at the diversion dam into Lower Cranberry Creek (downstream aquatic and riparian habitat).
- Minimum flow to the plant turbines, achieved through a diversion priority (made largely redundant if headpond drawdown enabled during low inflows).
- Minimum reservoir elevation (the absolute lower limit is a function of facility infrastructure limits).
- Maximum normal reservoir elevation (the absolute upper limit is a function of the sill of the spillway, however during an actual spill event elevation will be higher based on the rate of spill).
- Target reservoir elevation (the headpond controller is set to a target elevation, and generation is accordingly automatically adjusted).

- Headpond drafting (under low inflow conditions the headpond controller or manual operations can opt to draft the headpond below the target to maintain generation and plant operations).

Maintenance outages were not modelled as normal maintenance schedules take only one unit out of service at a time, and plant operations continue.

Alternatives 1 through 7 were developed from the initial Consultative Committee discussion. Alternative 8 was added to provide more information on the "shape" of the minimum flow effects on Lower Cranberry Creek aquatic interests. Alternative 9 was proposed as a modification of Alternatives 1 and 3 during the trade-off process.

Table 5-2: Rationale for Walter Hardman Water Use Plan Operating Alternatives

Alternative No.	Rationale	Mechanism
1	Multi-Fish Seasonal Objectives	Varying minimum flows built around different life stage timing and requirements.
2	Power Max (Base case)	Power optimal alternative.
3	Fish Site 5 and 1, then Power	Minimum flow 0.1 m^3/s year-round.
4	Fish Site 5	Minimum flow 0.2 m^3/s year-round.
5	Kokanee Max	Minimum flow 0.5 m^3/s year-round.
6	Riparian corridor	No plant operations during freshet and into late summer to maximize riparian quantity and duration.
7	Power then Fish	First 0.25 m^3/s available for plant, then minimum fish flow.
8	Fish Site 5 and 1, then Power	Minimum flow 0.05 m^3/s year-round.
9	Variable Min 2 (multi-fish seasonal)	Varying minimum flows built around different life stage timing and requirements (lower flows than Alternative 1).

Table 5-3: Operating Constraints for Walter Hardman Water Use Plan Alternatives

	Alternative								
	1	**2**	**3**	**4**	**5**	**6**[1]	**7**	**8**	**9**
Objective	Multi-Fish Seasonal Objectives	Power Max	Fish Site 5 and 1, then Power	Fish Site 5	Kokanee Max	Riparian corridor	Power then Fish		Multi-Fish Seasonal Objectives
Minimum flow over diversion dam	0.5 m^3/s (15 Aug – 1 Nov) 0.2 m^3/s (2 Nov – 1 May) 0.1 m^3/s (1 Jul – 15 Aug)	0	0.1 m^3/s (min flow all year round)	0.2 m^3/s (min flow all year round)	0.5 m^3/s (min flow all year round)	1 May – 30 Sept (all flow)	#2 – next 0.5 m^3/s to min flow	0.05 m^3/s (min flow all year round)	0.5 m^3/s (15 Aug – 1 Nov) 0.1 m^3/s (2 Nov – 1 May; 1 Jul – 15 Aug)
Minimum flow to headpond	0	0	0	0	0	0	#1 First 0.25 m^3/s to plant #3 rest flow to plant		0
Draft headpond	Yes								
Target headpond level	El. 700.3 m (15 Mar – 15 Nov) El. 701.0 m (16 Nov – 14 Mar)								
Minimum headpond level	El. 698 m								
Maximum headpond level	El. 701.95 m								

[1] First Nations participants were interested in developing an alternative that addressed riparian habitat; however, bankfull exceedence flows were unavailable. With empirical flow data and on-site investigations an alternative could be designed in the future that explores flow impacts to downstream riparian habitat.

5.4 Hydrographs For Operating Alternatives

For each of the operating alternatives considered by the Walter Hardman Water Use Plan Consultative Committee, hydrographs showing the expected total daily flow over the diversion dam into Cranberry Creek were prepared. These hydrographs are superimposed on Figure 5-1 and Figure 5-2 and show the six years of continuous data for Lower Cranberry Creek for each alternative. The headpond operating levels for each alternative is shown in Figure 5-3.

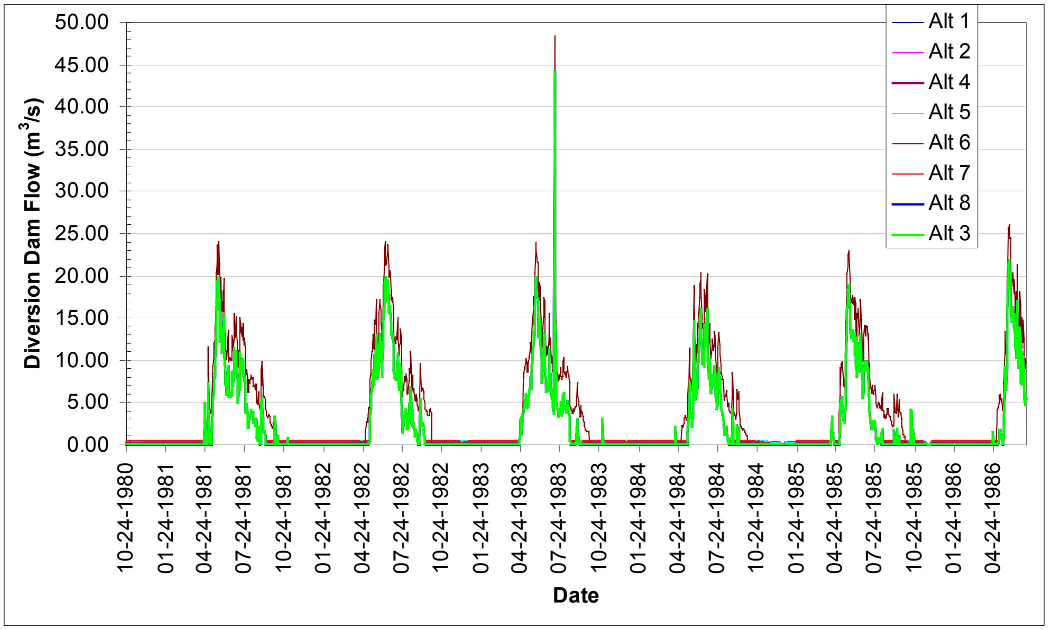

Figure 5-1: Hydrograph for Alternatives 1–8 for Flow Over the Diversion Dam (1980–1986)

Flow differences between Alternatives 3 and 6 are visible. Alternative 6 diverts 100 per cent of flows over the diversion dam between 1 May and 30 September.

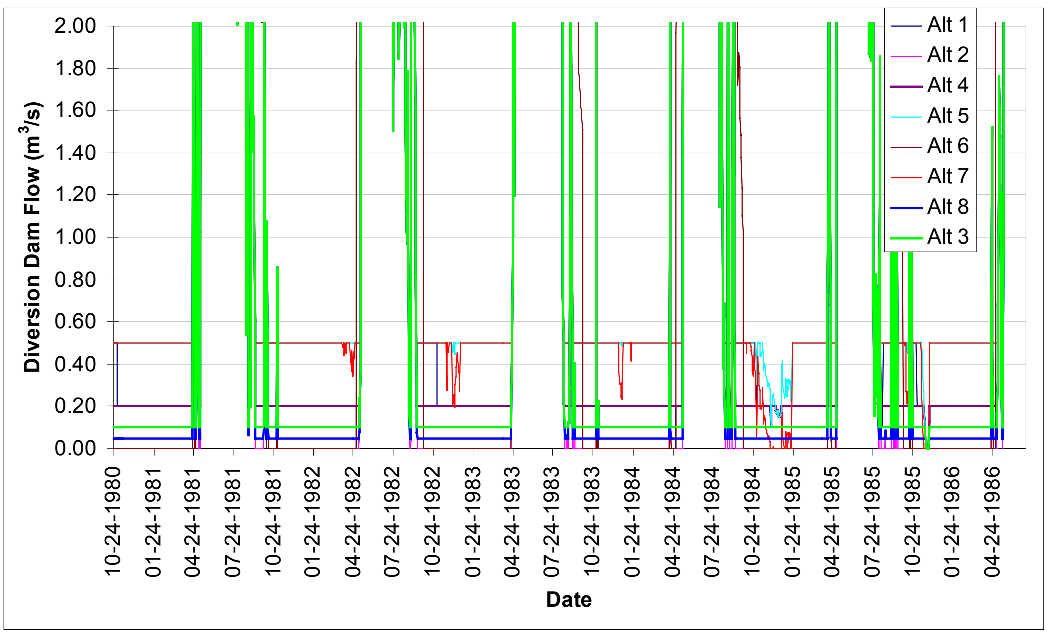

Figure 5-2: "Zoomed" Hydrograph for Alternatives 1–8 for Flow Over the Diversion Dam (1980–1986)

Alternative 3 (bright green) was the final selected alternative.

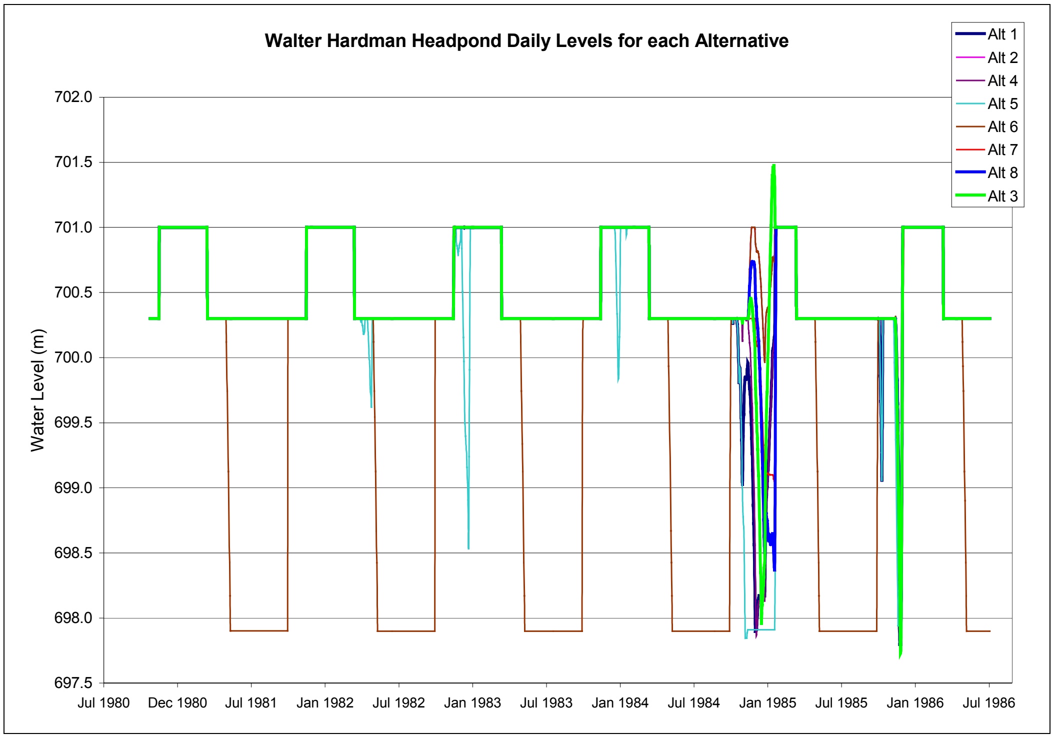

Figure 5-3: BC Hydro Daily Elevation for Walter Hardman Headpond (1999–2003)

6 TRADE-OFF ANALYSIS

During the trade-off discussions, the Consultative Committee compared the outcomes of nine operating alternatives for the Walter Hardman hydroelectric facility. The alternatives considered varied in the benefits they provided and the Committee sought to achieve the best balance amongst the water use objectives defined by the group.

Since the Walter Hardman headpond storage capacity and natural inflows impose limits on how much water is available to satisfy the range of water use objectives, there were trade-offs on what could be achieved with a finite supply of water. For instance, maintaining higher flows for fish habitat in Cranberry Creek means there will be less water available for power generation at some times of year (outside freshet).

As part of the trade-off discussions, the Consultative Committee used the performance measure scores to compare the nine operating alternatives. Selection of the preferred operating alternatives involved the following steps:

- Identify sensitive and meaningful performance measures to carry forward.
- Identify outlier alternatives and narrow down to short-list alternatives.
- Assess degree of Committee consensus on remaining alternatives.
- Select physical works option and include in financial performance measure.
- Select preferred operating alternative and specify operating constraints.
- Define operating protocols associated with recommended alternatives.

This section outlines the trade-off discussion and documents values that Consultative Committee members placed on different water use objectives and alternatives.

6.1 Identifying Key Performance Measures

The Consultative Committee developed 12 performance measure areas, some of which were calculated at multiple sites or times, for a total of 23 performance measures (Section 4). At the beginning of the trade-off discussions, the Committee agreed that some performance measures were not helpful in identifying better performing alternatives. They either appeared to be insensitive across alternatives, or contained too much uncertainty about the results (i.e., the Committee was not confident that the scores provided a true reflection of the impact of operations). Box plots showing the variability of fish and wildlife performance measure scores across the operating alternatives are provided in Appendix I.

Based on the original list of 23 performance measures, the Consultative Committee agreed to reduce the number of key performance measures to those shown in Table 6-1. Where multiple sites were modelled for rainbow trout, the Consultative Committee chose Site 5 because it is the most sensitive to flow changes, is one of the larger stream reaches, and is less influenced by other factors, e.g., elevation of Arrow Lakes Reservoir.

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

No.	Performance Measure	Units	Used in Final Trade-off
1	Wetted area and depth for kokanee spawning	Median wetted area (m^2)	Yes
2	Wetted area and depth for kokanee incubation	Maximum decrease in depth (m)	Yes
3a -f	Wetted area for rainbow trout rearing during the critical streamflow period	Habitat area (m^2) (3 areas)	3d (Site 5 narrow period) 3a–c, 3e, 3f dropped
4a, b, c	Depth for rainbow trout rearing over winter	Median depth (m) (3 areas)	4b (Site 5)
5a, b, c	Depth for rainbow trout spawning	Maximum decrease in depth (m) between spawning and incubation flows (3 areas)	5b (Site 5)
6	Depth for upstream migration	Median depth for migration (m)	Yes
7	Stranding and spillway entrainment	Mean # spill events annually	No
8	Riparian habitat wetting (also for wildlife)	Median difference between the channel width and observed wetted width (m)	Yes
9	Riparian bankfull exceedence days	# days exceeding bankfull	Yes
10	Walter Hardman headpond over-wintering	Minimum 30-day average headpond level (m)	Yes
11a, b	11a Lost revenue – Walter Hardman energy production 11b Lost revenue including overspill and labour	11a Mean dollars per year 11b Mean dollars per year	Yes (11a, 11b)
12a, b	Local Operations and Maintenance	12a # days plant shut-down per year 12b Mean # start-up/shutdown events per year	Yes (12a, 12b)

Note: Some performance measures were largely insensitive as the list of alternatives was reduced, and were not indicated as critical factors during final decision-making.

6.2 Comparing Operating Alternatives and Identifying Better Performing Alternatives

The Consultative Committee used three key tools to assist in interpreting the performance measure results for the nine operating alternatives. Each of these tools is described below. Sections 6.3 through 6.7 outline the Committee's process for eliminating less desirable alternatives using these tools.

- *Minimum significant incremental change* (MSIC) to guide the determination of whether two performance measure scores are meaningfully different.
- An interactive colour-coded *consequence table* to identify trade-offs between alternatives.
- *Direct value ranking* worksheets and results charts.

6.2.1 Minimum Significant Incremental Change for Performance Measures

The Minimum Significant Incremental Change (MSIC) is the minimum difference between performance measure scores before one alternative can be considered to perform meaningfully better (or worse) than the other. A difference between the two scores that is equal to or less than the MSIC means the two alternatives perform reasonably the same on that objective.

For instance, consider two fictitious operating alternatives: Alternative X provides $10.0 million (average annual) power revenue and Alternative Y provides $10.1 million. Based on the power revenue performance measure, it would appear that Alternative Y provides a gain of $100,000 annually in revenue.

The performance measure calculation and modelling include assumptions about the market price of electricity, plant operations and operating rules. Based on these uncertainties, professional judgment determines that the error, or MSIC, associated with this fictitious power revenue performance measure is ± 2 per cent or ± $200,000. So, in the case of Alternatives X and Y where the difference between their scores is less than the MSIC, the Committee should consider the two operating alternatives to have equal power benefits.

The measure of a significant increment of change is determined through professional judgment using the following sources of uncertainty:

- Statistical variation arising from the normal distribution of inflows.
- Modelling variation from actual power operations.
- Modelling error, and measurement error, in the calculation of performance measures.
- Uncertainty in the link between the performance measure and the fundamental objective (the interest that underlies it).
- Measurement error.

The MSIC values determined for each performance measure are shown in Table 6-2. MSICs for the power performance measures were narrower because the modeller adjusted the results against actual data explicitly and the new lost revenue performance measure includes further estimates of model inefficiency. Furthermore, directionally the power performance measures are reliable, and the greatest absolute variability will rest with the future price of energy.

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

No.	Performance Measure (units)	What's best?	MSIC
1	KO wetted area (m^2)	+	15 per cent
2	KO incubation depth (m)	-	10 per cent
3a – 3f	RBT rearing wetted area (m^2)	+	15 per cent
4a – 4c	RBT winter rearing (m)	+	10 per cent
5a – 5c	RBT incubation (m)	-	10 per cent
6	KO migration depth (m)	+	10 per cent
7	# spills (#)	-	10 per cent
8	channel width differential (m)	-	20 per cent
9	bankfull exceed (#)	+	20 per cent
10	minimum 30-day level (m)	+	0.3 m (absolute)
11a	lost revenue ($/yr)	-	1 per cent
11b	lost revenue + overspill ($/yr)	-	1 per cent
12a	shutdown events (#)	-	1 per cent
12b	shutdown days (d)	-	1 per cent

6.2.2 Interactive Colour-Coded Consequence Table

The Consultative Committee used an interactive colour-coded consequence table (Excel spreadsheet) to compare the results using the MSIC for each performance measure (see Table 6-3). Each of the nine columns (the ninth alternative was modelled late in the process) represents one operating alternative while each of the rows represents one performance measure. The cell at the intersection of a column and a row holds the score for a given performance measure for that alternative. In some cases, higher scores indicated better performance (+), in other cases, it is the reverse (-). The colour coding takes this into account, and each performance measure is marked accordingly.

The colour coding indicates how the performance measures compare between alternatives. The column for the highlighted alternative is white, while the scores for all the other alternatives are shown either in green, white or pink. Scores shown in green indicate better performance, based on the MSIC, than the highlighted alternative; white indicates no meaningful difference; pink indicates worse performance.

In summary, the colour coding relative to the highlighted (white) operating alternative used the MSIC:

- Pink: ***Meaningfully worse*** than the highlighted operating alternative.
- White: ***Not meaningfully different*** from the highlighted alternative.
- Green: ***Meaningfully better*** than the highlighted operating alternative.

As an example of the colour coding, Table 6-3 highlights Alternative 3 (0.1 m^3/s minimum flow) for comparison. Looking at the performance measure for Rainbow Rearing (3d) we see the score for Alternative 3 is 38 802 m^2. That is, Alternative 3 provides 38 802 m^2 of habitat for rainbow trout rearing in Site 5 of Cranberry Creek.

One column to the left, Alternative 4 scores 42 032 m^2 but is within ± 15 per cent MSIC[1] of the score for Alternative 3. To indicate there is no significant difference from Alternative 3 the cell for the Rainbow Rearing performance measure under Alternative 8B is coloured *white*.

In contrast, the Rainbow Rearing performance measure for Alternative 5 provides 48 001 m^2 of available habitat and the cell is coloured *green*. The green indicates that the score of 48 001 m^2 is meaningfully more than the 38 802 m^2 score for Alternative 3.

Finally, Alternative 2 scores 8872 m^2 for the Rainbow Rearing performance measure and the cell is coloured *pink*, indicating that Alternative 2 provides meaningfully fewer days of available habitat compared to Alternative 3.

In making choices, the Consultative Committee members sought alternatives that offered more green cells (gains) and fewer pink cells (losses) according to their interests and a balanced decision. Using the spreadsheet, Committee members could highlight any one of the nine alternatives and compare its performance. When changing the highlighted alternative the colour coding automatically adjusted to show the relative gains and losses. Projected onto a screen, the Consultative Committee collectively reviewed, compared and discussed the trade-offs between alternatives.

In the colour-coded matrices that follow in this report, the pink, white and green colour coding patterns may change according to a different highlighted operating alternative.

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

Table 6-3: Comparison of Walter Hardman Water Use Plan Operating Alternatives
(Colour-coding shown in reference to Alternative 3)

	1 Variable Min	2 Power	3 .1 cms	4 .2 cms	5 .5 cms	6 Rip. Max	7 Power then fish	8 .05 cms	9 VARMIN2
1 KO wetted area (m2) (+)	18,859	3,426	15,877	16,854	18,859	10,496	18,809	7,574	17,372
2 KO incubation depth (m) (-)	0.15	0.09	0.06	0.07	0.09	0.24	0.13	0.12	0.12
3d RBT rear wetted area st5 n (m2) (+)	48,001	8,872	38,802	42,032	48,001	28,431	47,821	19,336	43,435
4b RBT winter rear st5 (m) (+)	0.23	0.00	0.21	0.23	0.25	0.00	0.21	0.04	0.21
5b RBT incub. st5(m) (-)	0.17	0.17	0.09	0.08	0.07	0.04	0.07	0.17	0.17
6 KO migration depth (m) (+)	0.31	0.13	0.21	0.24	0.31	0.34	0.31	0.18	0.26
7 # spills (#) (-)	0.00	2.86	0.00	0.00	0.00	1.14	0.00	0.00	0.00
8 channel width differential (m) (-)	2.31	4.91	2.50	2.24	1.74	2.45	1.75	4.91	2.43
9 bankfull exceed (#) (+)	57.6	57.6	57.6	57.6	57.6	86.9	57.6	57.6	57.6
10 Min. 30-day level (m) (+)	700.1	700.5	700.2	700.1	699.9	700.5	700.3	700.1	700.1
11a lost revenue ($/yr) (-)	$138,558	$0,000	$53,700	$106,402	$260,891	$1,160,431	$248,055	$26,793	$104,000
11b lost rev + overspill ($/yr) (-)	$314,558	$0,000	$229,700	$282,402	$436,891	$1,160,431	$424,055	$202,793	$280,000
12a shutdown events (#) (-)	2	0	2	2	2	6	0	1	2
12b shutdown days (d) (-)	56	0	39	54	87	777	0	3	39

6.2.3 Direct Value Ranking Exercises

The direct value ranking worksheet (Appendix J) was used throughout the three days of trade-off discussions as an aid to both the decision analyst/facilitator and the Consultative Committee members. The analyst used the tool to select which alternatives to present for comparison and discussion, as well as to probe the values and preferences of Committee members.

Consultative Committee members were asked to rank alternatives, in order from most preferred (1) to least preferred at several junctures in the process. These results not only clarified for participants where their own values lay, but also for the facilitator the direction of the group as a whole. Two additional visual aids supported the group's understanding of their preferences, both as individuals and as a whole during the trade-off discussions: the pair-wise comparison ranking chart and the cumulative ranking chart (see Appendix K).

6.3 Short-Listing to Preferred Operating Alternatives

The goal of the water use planning process is to reach agreement on a preferred operating alternative. To reduce the initial list of alternatives it was helpful to reduce the number of performance measures being used to compare alternatives. The group eliminated those measures that did not show variation between alternatives or ones that duplicated another performance measure. Next the group narrowed the list of alternatives. The following tests were applied in narrowing the performance measures and alternatives:

- Insensitive performance measures.
- Unreliable, uninformative performance measures.
- Outlier alternatives (extreme for one interest at the exclusion of many other interests).
- Pair-wise comparisons (very close or similar alternatives).

With the exception of Alternative 2, each Alternative had a minimum flow component, varying by either amount and/or timing.

Through the trade-off process, the Consultative Committee reduced the number of operating alternatives from the initial eight to two preferred choices (Alternative 1 and Alternative 3). As the group reviewed the alternatives a modification to Alternative 1 was developed and modelled, creating a new Alternative 9. In order to eliminate an alternative, Committee members had to agree to trading off one water use objective for another. A summary of the Committee's rationale for eliminating alternatives (chronologically) and the trade-offs involved are summarized in Table 6-4.

Table 6-4: Summary of Trade-offs, Revisions and Rationale for Eliminating Operating Alternatives

Alter-native	Rationale for Eliminating and Action
7	Alternative 7 is out-performed by most other alternatives. The intent of Alternative 7 was to ensure a minimum flow of 0.25 m^3/s to the plant first and then a minimum flow of 0.5 m^3/s to Cranberry Creek below the diversion dam. Any water left over would go to the plant. Due to the ability of the headpond for winter drafting, this type of alternative offers limited benefit to operations.
6	Drop Alternative 6 but keep riparian interests consideration. CCRIFC stated an interest in developing a more refined riparian alternative, with additional flows diverted to Cranberry Creek during peak flow periods to inundate the flood plan area for between two and four weeks. Empirical bankfull exceedence data was not available to define such specific model constraints. Most agreed that Alternative 6 as modelled is too expensive, does not provide a year-round minimum flow, and results in more plant shutdowns. In addition, some were interested in retaining consideration of riparian values even though Performance Measure 9 and Performance Measure 10 are not sensitive across the remaining alternatives.
5	The hydrology of the system would not allow for a sustained minimum flow of 0.5 m^3/s through the fall and winter, and it was expensive for the benefits provided compared to Alternative 4.
	Physical Works Decision **(Section 6.4)**
2	Alternative 2 represents power optimal projected future operations. All other alternatives on the table have a minimum flow component. For operating alternatives the group agreed that having some level of minimum flow was likely to provide the greatest increase in aquatic benefits, and therefore dropped Alternative 2 (following the decision for physical works). There remained an interest in discussing the zero flow option in the context of monitoring programs and the need for baseline data.
8	Most felt that if water is going to be released then it should be "enough" to make it worthwhile. The performance measures indicate greater benefits with 0.1 m^3/s.
	Direct Ranking Exercise (Alternatives 3 and 4)
	Alternative 9 Developed, a revision and replacement of Alternative 1
4	Alternatives 3 and 4 are very similar. Alternative 3 offers similar benefits at less cost, based on the performance measures. Consultative Committee discussed elimination of Alternative 4; however, did not eliminate until the agreement was made with the revised Alternative 3.
	Direct Ranking Exercise (Alternatives 3, 4 and 9)
9	The final trade-off involved movement from those who initially blocked Alternative 3 and from those who initially blocked Alternative 9. BC Hydro moved by adding targeted instream monitoring, a five-year review period and a consideration to build (if feasible) works that would enable 0.5 m^3/s flow. First Nations moved by accepting Alternative 3 with the above provisions.[1] Consultative Committee agreed to accept Alternative 3, with the above provisions.

[1] At the subsequent and final meeting, the Okanagan Nation Alliance (ONA) re-framed their level of agreement based on new information regarding the expected cost and feasibility of overbuilding the infrastructure. A six-year review period was decided upon based on the need for one year to conduct the feasibility and construct the flow infrastructure, followed by a desire for five years of minimum flow provision and monitoring period prior to the Water Use Plan Review.

Upon review of the Draft Consultative Committee Report, the Okanagan Nation Alliance representative indicated that "at the time it was felt that it was feasible during this discussion and was part of the basis for the movement by the First Nations. We had all agreed to this upon which the next meeting came where it was later identified that it might not be feasible. Thus on the first day it was the understanding of the participants for the Okanagan that they agreed to this option on the basis that all provisions were met. Not 'if feasible'." Additional comments are noted in Appendix P.

6.3.1 Initial Round of Eliminating Alternatives (7, 6 and 5)

Using an interactive presentation of the consequence table and the results of the initial direct ranking, the Consultative Committee explored and discussed eliminating outlier and less popular alternatives first. In the order dropped, these were Alternatives 7, 6 and 5 (Table 6-5, Figure 6-1 and Figure 6-2).

The intent of Alternative 7 was to ensure a minimum flow of 0.25 m^3/s to the plant first and then a minimum flow of 0.5 m^3/s to Cranberry Creek below the diversion dam. Any water left over would be used for power generation. Due to the ability of the headpond for winter drafting across all modelled alternatives, this type of alternative offers limited benefit to operations.

Most Consultative Committee members agreed that Alternative 6 as modelled is too expensive, does not provide a year round minimum flow, and results in more plant shutdowns. In addition, some were interested in retaining consideration of riparian values through the monitoring discussion, even though Performance Measure 9 and Performance Measure 10 are not sensitive across the remaining alternatives. Subsequently monitoring discussion focused on filling data gaps specific to minimum flows and riparian habitats.

Most Consultative Committee members felt that Alternative 1 offered many of the benefits of Alternative 5 through the late summer and fall, while the hydrology of the system likely does not provide a sustained minimum flow of 0.5 m^3/s through the late fall and winter. Others indicated that it seemed expensive compared to Alternative 4 for minimal added benefit across the non-financial performance measures.

Table 6-5: Consequence Table for Key Performance Measures for Alternatives 1 through 8

	1 Variable Min	2 Power	3 .1 cms	4 .2 cms	5 .5 cms	6 Rip. Max	7 Power then fish	8 .05 cms
1 KO wetted area (m2) (+)	18,859	3,426	15,877	16,854	18,859	10,496	18,809	7,574
2 KO incubation depth (m) (-)	0.15	0.06	0.06	0.07	0.09	0.24	0.13	0.12
3d RBT rear wetted area st5 n (m2) (+)	48,001	8,872	38,802	42,032	48,001	28,431	47,821	19,336
4b RBT winter rear st5 (m) (+)	0.23	0.00	0.21	0.23	0.25	0.00	0.21	0.04
5b RBT incub. st5(m) (-)	0.17	0.17	0.09	0.08	0.07	0.04	0.07	0.17
6 KO migration depth (m) (+)	0.31	0.13	0.21	0.24	0.31	0.34	0.31	0.18
7 # spills (#) (-)	0.00	2.86	0.00	0.00	0.00	1.14	0.00	0.00
8 channel width differential (m) (-)	2.31	4.91	2.50	2.24	1.74	2.45	1.75	4.91
9 bankfull exceed (#) (+)	57.6	57.6	57.6	57.6	57.6	86.9	57.6	57.6
10 Min. 30-day level (m) (+)	700.09	700.46	700.22	700.10	699.88	700.46	700.26	700.14
11a lost revenue ($/yr) (-)	$138,558	$0,000	$53,700	$106,402	$260,891	$1,160,431	$248,055	$26,793
11b lost rev + overspill ($/yr) (-)	$314,558	$0,000	$229,700	$282,402	$436,891	$1,160,431	$424,055	$202,793

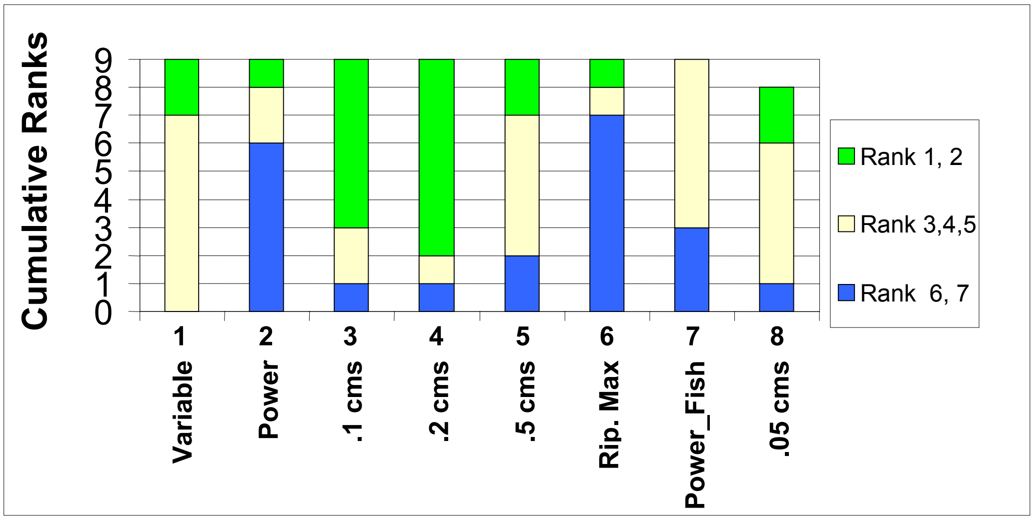

Figure 6-1: Consultative Committee Direct Value Rankings for Alternatives 1, 2, 3, 4, 5, 6, 7 (dropped) and 8

The combined ranking shown in Figure 6-1 illustrates that Alternative 2 and Alternative 6 were less valued than the other alternatives. Alternatives 3 and 4 had high initial support. Eight Committee members picked Alternative 4 as 1st or 2nd choice, one member picked it last.

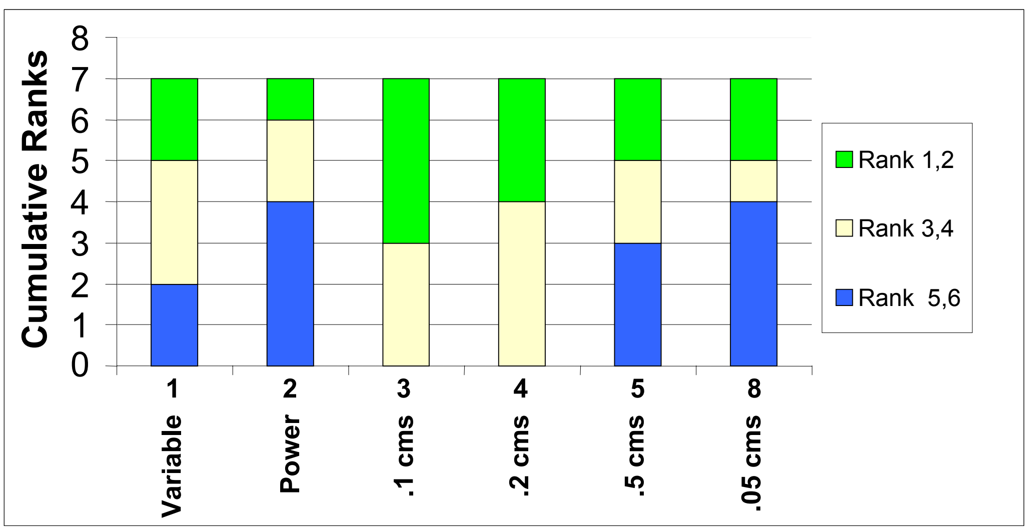

Figure 6-2: Consultative Committee Value Rankings for Alternatives 1, 2, 3, 4, 5 and 8

Ranks 5, 6 are not necessarily a block. Without Alternatives 6 and 7, Alternatives 3 and 4 become the only options without any "lowest ranks." However, ranks 1 and 2 are still present across all remaining alternatives.

6.3.2 Round Two of Eliminating Alternatives (2, 8 and 4)

Alternative 2 represents power optimal projected future operations and it was ranked high by two Committee members (see Figure 6-3). All other alternatives on the table have a minimum flow component. The Consultative Committee agreed that having a minimum flow was likely to provide the greatest increase in aquatic benefits, and therefore eliminated Alternative 2. The decision for physical works (Section 6.4) was also important as without the construction of new infrastructure to provide a minimum flow the financial performance measures are inflated to include the overspill and related stoplog costs. Additionally, for monitoring purposes there remained an interest in discussing the zero flow option in the context of monitoring programs and the need for baseline data.

In discussion about Alternative 8, all Consultative Committee members felt that if water is going to be released then it should be "enough" to make it worthwhile. The performance measures indicated greater benefits with 0.1 m^3/s over 0.05 m^3/s and the choice was made to eliminate Alternative 8 in favour of Alternative 3.

Alternative 4 was compared against other alternatives, such as Alternative 3 (which performed better on the financial value performance measures) and against Alternative 1 (which performed better on some of the environmental performance measures). The Consultative Committee did not actually eliminate Alternative 4 until later however as it appeared to be a possible bridge between the remaining two Alternatives (3 and 1, and later 9).

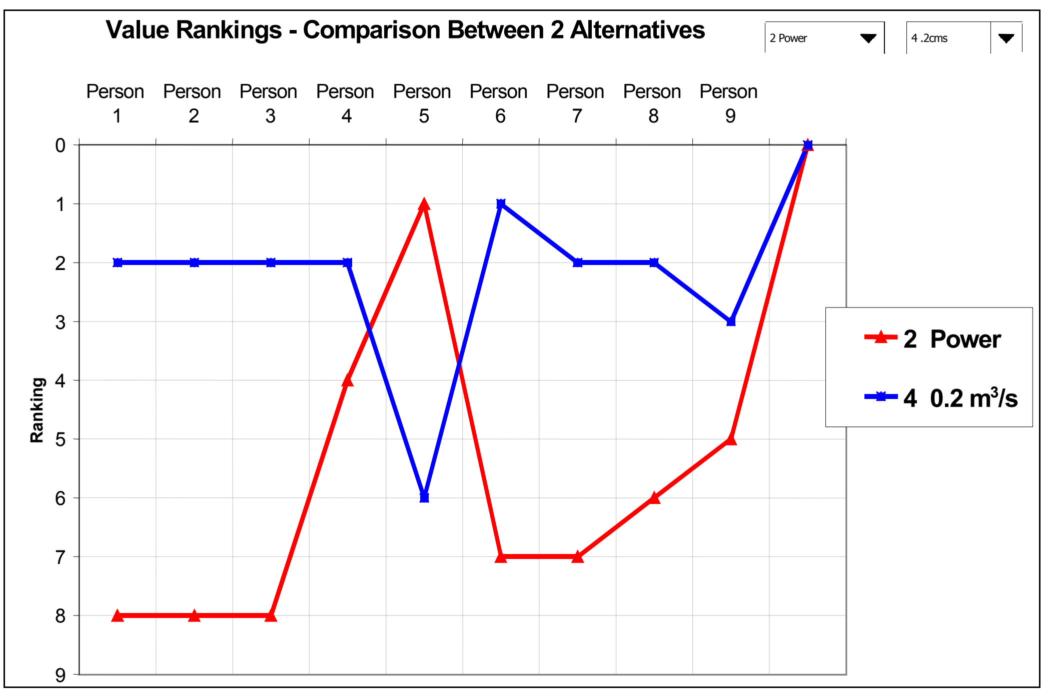

Figure 6-3: Consultative Committee Value Rankings for Alternative 2 Power and Alternative 4 (0.2 m^3/s minimum flow)

6.4 Physical Works Discussion

Part way through the trade-off process all Consultative Committee members agreed that a minimum flow was likely to provide aquatic benefits. However, analysis prepared for the Committee revealed that the current stoplogs were a costly method of providing the flows, due to labour costs and resulting overspill costs.

The Consultative Committee asked the representative from the Water Comptroller's Office: Can works be ordered through the Water Use Plan? The representative indicated that, yes, provided the works are a lesser-cost or more reliable alternative to an operational change. The information provided to the Committee indicated that the physical works option to improve flow provision over the diversion dam into Cranberry Creek, as an example, would cost approximately $21,000/year (including feasibility and design) levellized over 20 years (total $230,000), and would eliminate the overspill costs. Actual design criteria and specifications will be finalized after the Water Use Plan is authorized (Table 6-6).

The Consultative Committee discussed the various options, and decided that providing the infrastructure would improve the reliability of a minimum flow (to 0.1 m^3/s) and is less costly than overspill costs (Table 6-6 PW2). Other comments noted that additional labour costs were of benefit to the larger community, however about two-thirds of the overspill cost (approximately $150,000) is attributable to power generation loss.[1]

At the final Consultative Committee meeting, the cost estimate for infrastructure capable of providing up to 0.5 m^3/s as agreed (an overbuild over the agreed to 0.1 m^3/s minimum) was revised to approximately $450,000 or $42,000/year levellized cost. The Committee considered this new cost, and all but the ONA members determined that the over-construction should only proceed up to $240,000 (20 per cent over the original estimate).

The ONA maintained as their first priority, the construction of infrastructure to capacity 0.5 m^3/s. They stated that they will remain in consensus agreement with the 0.1 m^3/s flow, provided the infrastructure is built to 0.5 m^3/s.[2]

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[1] At this point in the discussion, the Okanagan Nation Alliance (ONA) representative observed there was "consensus made by all parties to have minimum flow with the .5 (m^3/s) option provision." "However, at the last meeting new information was provided about costs that may affect this consensus…"

[2] Upon review of the draft report the ONA indicated that the ONA did not agree to revise its position as it was starting a new process (i.e., back tracking to change one variable in a previous decision physical works cost). Thus we decided we weren't going to comment on what is an appropriate cost without more information and time. The ONA's representatives believe that as the process was completed and if BC Hydro decides not to build, as per the original agreement, it is their decision and thus you would have quite simply have a result that was non-consensus. In addition, we felt that 'throwing out' new cost numbers wasn't part of the process and we weren't comfortable on making a decision based on unreliable percentage estimate provisions (outside of the process).

Table 6-6: Estimated Physical Works Upgrades at the Stoplogs and the Diversion Dam

Option	Benefits	Capital Cost	Levellized Cost over 20 years
PW1 – Diversion Dam Notch	• Measurement point • Directed flows • Reduced sensitivity to confluence pond elevation	YR1 $30,000	$2,620/year
PW2 – Diversion Dam Reliability Upgrade (low level outlet, pumping system, pipe from diversion channel?)	• Controlled outlet size • Directed flows • Reduce sensitivity of diversion dam flows to confluence pond elevation • Reduce risk of frazil ice/temperature on flow reliability • May reduce overspill and labour costs ~$150,000 + $26,000 (depending on design)	YR1 Feasibility and engineering study $30,000 YR2 Upgrade project (up to $200,000)	$2,620/year up to $17,464/year
PW3 – Stoplog upgrade	• Reduce labour costs (~$26,000/yr) • Reduce overspill costs (~$150,000/yr 100 % compliance) • Reduce sensitivity of diversion dam flows to confluence pond elevation	YR1 Feasibility and engineering study $30,000 YR2 Upgrade project $100,000–$200,000	$2,620/year up to $17,464/year
PW – Revised estimate to 0.5 m^3/s	• Future capacity for higher minimum flow	YR1 Feasibility and engineering study $30,000 YR2 As per PW2 cost to $450,000	$2,620/year up to $39,295/year

6.5 Modification of Alternative 1: New Variable Minimum (Alternative 9)

During the trade-off discussion between Alternatives 3 and 1, the Consultative Committee noted the financial benefits associated with Alternative 3, although some Committee members felt the higher flows are critical during the late summer/fall period. The Committee expressed an interest in exploring variations of Alternative 1 with the intent of improving the financial performance of the alternative while maintaining the higher late summer/fall flows.

The result was the development of a new “Variable Minimum” Alternative 9. This new Alternative 9 largely maintains the aquatic benefits of Alternative 1 with one exception: lower fall and winter flows have reduced the kokanee migration depth while increasing the incubation performance measure result (less dewatering from fall flows). While Alternative 1 remained under discussion, Alternatives 9 and 3 were the focus of the final trade-off.

After the initial elimination process, the agreement to consider a physical works upgrade for delivery of the minimum flow, and the modelling of the proposed new alternative (Alternative 9) the Consultative Committee was left considering two viable operating alternatives. Table 6-7 highlights the trade-offs between Alternatives 3 and 9 (Alternative 9 is highlighted for comparison).

Table 6-7: Consequence Table for Key Performance Measures for Alternatives 1, 3 and 9

	1 Variable Min	3 .1 cms	9 VARMIN2
1 KO wetted area (m2) (+)	18,859	15,877	17,372
2 KO incubation depth (m) (-)	0.15	0.06	0.12
3d RBT rear wetted area st5 n (m2) (+)	48,001	38,802	43,435
4b RBT winter rear st5 (m) (+)	0.23	0.21	0.21
5b RBT incub. st5(m) (-)	0.17	0.09	0.17
6 KO migration depth (m) (+)	0.31	0.21	0.26
8 channel width differential (m) (-)	2.31	2.50	2.43
9 bankfull exceed (#) (+)	57.6	57.6	57.6
10 Min. 30-day level (m) (+)	700.09	700.22	700.09
11a lost revenue ($/yr) (-)	$138,558	$53,700	$104,000
11b lost rev + overspill ($/yr) (-)	$314,558	$229,700	$280,000
12a shutdown events (#) (-)	2	2	2
12b shutdown days (d) (-)	56	39	39

Once Alternative 9 was developed, most discussion focused on the difference between Alternative 3 and Alternative 9. With the exception of the migration depth performance measure, all MSIC-based differences indicated that Alternative 3 would be the preferred alternative. Those who preferred Alternative 3 did so for the following reasons:

- Alternative 3 (0.1 m^3/s) allowed for more variation and learning, because natural flow variation would result in flows both at and above the minimum flow level for data collection.
- Without any new data, at this point the performance measures offer the best indication of differences. They were committed to using the performance measures through to the end of the process, and focusing on improvements through monitoring for the next review period.
- The monitoring and a short review period will enable revisions in a reasonably short period of time using better information.
- The infrastructure cost to provide 0.5 m^3/s may be much greater than the current estimate (Section 6.4) and the group did not have that cost estimate.
- The BC Hydro representative stated concerns about the variable flows (of Alternative 9) posing a greater opportunity for operational error and non-compliance, and higher local operating complexity.

However, due to the roughness of the performance measures, and a lack of additional empirical data to develop those performance measures, some Consultative Committee members preferred Alternative 9 on the following grounds:

- Some felt that Alternative 9 allows for variation and learning, while others felt that Alternative 3 (0.1 m^3/s) allowed for more variation and learning.
- Some felt that by starting "higher" it would be easier to go down again, while others felt that it would be difficult to reduce flows in the future regardless of the monitoring results.
- Some felt that the fish performance measures are too rough to be useful in this final trade-off, and elected to use their knowledge and instincts around the higher flow level.
- Some members felt strongly that more water is better in the late summer critical period (for rainbow trout) and that there is more learning potential with Alternative 9.

The Committee members completed a direct value ranking exercise, with Alternatives 3, 4 and 9. Possible declarations were:

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

The results in Figure 6-4 and Table 6-8 showed that Alternatives 9 and 3 had the most endorsements. Alternative 4 was blocked by one member (BC Hydro).

The discussion that followed focused on building a bridge between the alternatives, on clarifying some key monitoring components, and determining the review period. The following section describes the new alternatives that emerged from the discussion.

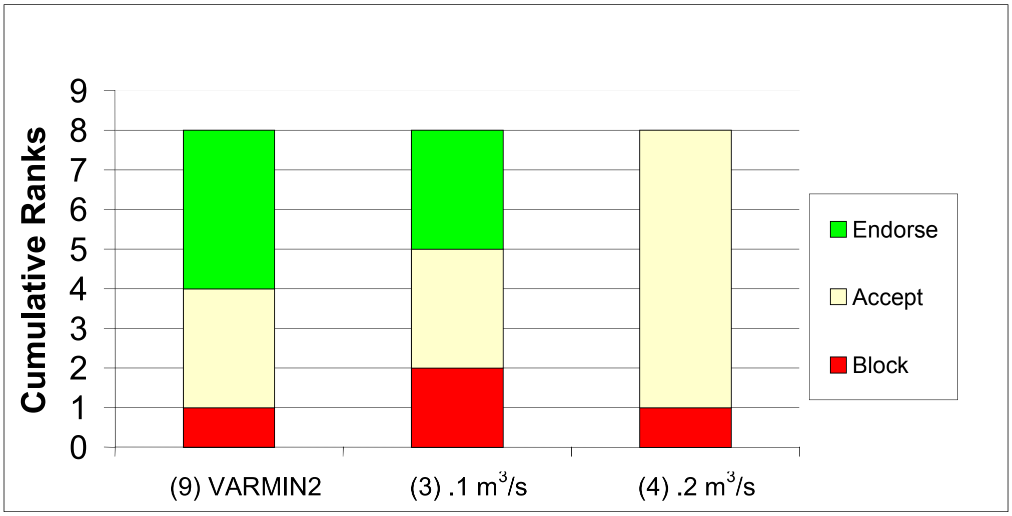

Figure 6-4: Consultative Committee Value Rankings for Alternative 9, Alternative 3 (0.1 m^3/s) and Alternative 4 (0.2 m^3/s)

Table 6-8: Level of Support Regarding Alternative 9, Alternative 3, and Alternative 4

CC Member	9	3	4	Comments
Dan Robinson AES	Accept	Endorse		Monitoring issue is still a concern. Prefer to monitor with 0.1 m^3/s vs. 0.2 m^3/s. Alternative 9 needs more revisions – it makes more sense.
Dave Percell BC Hydro	Block	Accept	Block	Felt that Alternative 1 and 4 were too expensive for the amount of environmental benefit. Capital costs for Alternative 9 are higher than initial physical works estimate (larger pipe needed).[1] Thought that Alternative 9 and Alternative 4 trade-off between species. There are a lot of costs involved in Alternative 9 in operating the facilities with changes. Thought that Alternative 2, power option, with monitoring and a review period was also an alternative. Spend money on monitoring or spend the same amount on the water – leaning toward the water option. Alternative 9 was too expensive and too complex and performance measures were established to provide certainty. Dave preferred a constant to a variable minimum flow because it is easier to provide, and reality is that the more manual changes that need to be made the more risk of error and non-compliance.

1 Upon review of the Draft Consultative Committee Report, the Okanagan Nation Alliance representative indicated, "I believe that at this point in the discussion Dave did not mention the physical works cost, it was more based on that he did not see the benefits of the added flow, of which, I explained my interpretation. This is very important in identifying the process."

Table 6-8: Level of Support Regarding Alternative 9, Alternative 3, and Alternative 4 cont'd

CC Member	9	3	4	Comments
Loni Parker CSRD	Accept	Accept	Accept	Although Alternative 9 may be more complicated to apply, it would be good for the community to train employees. As far as physical works go, may be beneficial to the power side. The monitoring should go along with all three choices, given data limitations. Second choice is Alternative 3 (0.1 m^3/s). Third Choice is Alternative 4 (0.2 m^3/s). Can not endorse any because we're lacking data. Need to monitor to do what's right for the environment and power and not forget about being flexible for the future.
Jayson Kurtz DFO	Endorse	Accept	Endorse	Benefits for late summer rearing are important. Endorsed Alternative 4 also as the 0.2 m^3/s is better for fish interests and costs were in line. Accepted Alternative 3 but felt habitat values were not as good as the others.
Jay Johnson / Howie Wright ONA	Endorse	Block	Block	Greater value in 0.5 m^3/s: more water is important during critical periods, uses realistic species management, balances energy. A little difference in wetted area between 0.2 and 0.1 m^3/s alternatives. Alternative 9 did increase the cost effectiveness over Alternative 1. Need to monitor temperature/flow and relate to habitat with existing transects. Howie provided more context on his block for Alternative 3 and Alternative 4. Considering biological aspects: increased kokanee access, more rearing habitat, more cover, and increased potential to attract bulltrout and whitefish. Think that the $30,000 additional cost is worth the biological gains. He interprets the PMs as showing benefits for fish/habitat.
Mark Tiley CCRIFC	Endorse	Accept	Accept	Endorse Alternative 9 (condition that at 0.1 m^3/s in winter put in a one time habitat structure to increase cover and flow). Mark said his concern with 0.1 m^3/s is with over-wintering survival, and would be interested in putting instream structures, in lieu of the 0.2 m^3/s flows, to provide better over-wintering habitat. Accept Alternative 3 – with instream habitat enhancements in lieu of Alternative 4 0.2 m^3/s flows. Accept Alternative 4 – 1st choice over Alternative 3 because of higher winter flows.
Terry Anderson WLAP	Accept	Endorse	Accept	Would hate to see a non-consensus because people are unwilling to move on their preferences, yet we are not far apart. Sees the biggest bang for buck with Alternative 3. Concern about lack of data for Alternative 9. Terry endorsed Alternative 3, accepted Alternative 9 because he believes most benefits will occur with the base flow, and the performance measures do not increase with the greater flows.
Fred Fortier SFC	Endorse	Block	Block	Alternative 9 gives you more true ecological values – the issue of habitat structures needs to be addressed

Discussion regarding Consensus vs. Non-Consensus – Many Consultative Committee members felt that consensus provides clear direction to the Water Comptroller. The representative from the Comptroller's office indicated that in non-consensus the office reviews the Consultative Committee Report, the performance measure outcomes, and follows the Water Use Plan Steps in assessing the range of values and benefits. The representative indicated that a consensus decision has more weight in their review process. The provincial representative also felt that if a minimum flow is secured, then others might step forward with other habitat enhancements. The representative from Secwepemc felt that a non-consensus outcome makes future discussions with Comptroller, First Nations and the Agencies more challenging. First Nations are proposing a bilateral process for non-consensus Water Use Plans, with government and First Nations.

6.6 Modifying Alternative 3 to New Alternative B

At this point there remained a gap between Consultative Committee members. An earlier suggestion was pursued to bridge the gap between the interests in Alternative 3 and Alternative 9. The Committee developed a new alternative (Alternative B) by enhancing Alternative 3 with a monitoring program probing the flow difference for rainbow habitat, a BC Hydro commitment to build a structure that can deliver 0.5 m^3/s, and a short review of the Water Use Plan (five years). This allows a near-term review of the habitat impacts associated with different flow levels, as well as the ability to provide a larger flow in the future if the next Committee decides the benefits are worthwhile. The BC Hydro representative indicated that he needed to confirm the cost estimate of building the larger capacity infrastructure with senior management at BC Hydro.

In contrast, a longer term would be required for biological-based monitoring, and was framed as Alternative A, requiring 10 years of study, and a base flow of 0.1 m^3/s with infrastructure built to that capacity (not greater). A comparison of Alternative A and Alternative B is provided in Table 6-9.

Table 6-9: Comparison of Alternative A and Alternative B

Component	Alternative A	Alternative B
Minimum Flow	0.1 m^3/s	0.1 m^3/s
Physical Works	Capacity 0.1 m^3/s	Capacity 0.5 m^3/s
Monitoring	Habitat attributes 0.1–0.5 m^3/s RBT rearing habitat ($25,000) RBT biological monitoring ($50,000 x 10 years)	Habitat attributes 0.1–0.5 m^3/s RBT rearing habitat ($25,000)
Review Period	10 year review	5 year review

6.7 Assess Consensus on Alternatives A and B

After group discussion around both alternatives the facilitator requested that each of the Consultative Committee members verbally state their level of support for Alternative B. Possible declarations were:

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

The results show Alternative B did not initially receive unanimous acceptance by the Consultative Committee, as two First Nations members strongly believed in the benefits of the higher late summer flow (Table 6-10). The First Nations members held a private caucus to discuss the options. The outcome of the caucus was that the two members changed their support to "Accept" Alternative B.[1]

Consultative Committee members provided individual rationale for their level of support for each alternative, as well as the change in support, summarized in Table 6-10.

Table 6-10: Summary of Agreement for Alternative B[2] (Alternative 3 amended)

CC Member	Support	Comments
Terry Anderson WLAP	Endorse	
Mark Tiley CCRIFC	Accept	The performance measures do not show a clear differentiation between Alternative 3 and Alternative 9. Prefer to set up monitoring to determine if there is a difference. Recommend future Water Use Plans use a method of cumulative scoring (Fish Index) to compare alternatives. Believe that 0.1 m^3/s will make a big difference compared to zero flows, but that it will not take us where we really want to go.
Jayson Kurtz DFO	Endorse	
Dave Percell BC Hydro	Endorse	
Dan Robinson AES	Endorse	

1 Upon review of the Draft Consultative Committee Report, the Okanagan Nation Alliance representative indicated their support, "was based on the provisions agreed upon including the build to 0.5 m^3/s capacity that was very critical in the decision process."

2 Operating constraints of Alternative 3, year-round minimum flow at diversion dam 0.1 m^3/s, infrastructure/works built to 0.5 m^3/s capacity, rainbow (Site 5) habitat monitoring to assess between 0.1 to 0.5 m^3/s, 5 Year review.

Table 6-10: Summary of Agreement for Alternative B (Alternative 3 amended) cont'd

CC Member	Support	Comments
Loni Parker CSRD	Endorse	Do not feel we are moving forward with a non-consensus Water Use Plan.
Jay Johnson/ Howie Wright ONA	Block	If we include monitoring costs, then Alternative 9 is cheaper. It is not much more money ($30,000/year) to go to 0.5 m^3/s. And BC Hydro will have costs reimbursed. Gut feeling is that there will be long-term benefits of having a 0.5 m^3/s flow 15 August – 10 October.
	Accept (post-caucus)	First Nations caucused and they saw some movement in the group. However, want to underscore their belief that Alternative 9 is the better option, and the difference of $30,000/year is not a large amount. Acknowledge that BC Hydro has moved since the meeting began, therefore ONA will support Alternative B (Alternative 3 + rainbow trout habitat monitoring between flows 0.1 and 0.5 m^3/s and a 5 year review), the caveat that the habitat performance measures we study will be used at the 5 year review, and not population level data (not cost-effective). Howie indicated that from a biological point of view, he feels the extra biological benefits of $30,000/year are worthwhile. However, he accepts Alternative B, with reluctance.[1]
Fred Fortier SFC	Block	Feel similar to Howie/Jay. Still favour Alternative 9.
	Accept (post caucus)	I accept Alternative B, with reluctance. I was interested in "testing" the dispute resolution processes in water use planning in the event of a non-consensus. In the last few Water Use Plans, we came to consensus and did not get all what we wanted, so at the end of the day we hope things work out given the effort we have put into Water Use Plans.

6.8 Select Preferred Operating Alternative

Modelling the operating alternatives demonstrated that the finite supply of water in the Walter Hardman system could not optimally satisfy all the water use objectives. This became apparent during the final comparison of Alternatives 3 (revised to Alternatives A and B) and 9. Possible gains in fish resources in the river were contrasted with losses to financial revenue from power generation.

Ultimately, in choosing the preferred alternative, the Consultative Committee had to build in some comfort level around future decision-making, including monitoring results, the flow infrastructure, and the timing of when the minimum flow decision can be revisited. Most Committee members stated uncertainty around performance measures as a key factor in their reluctance to shift their preference between the two final alternatives. In the end, it came down to choosing between: 1) uncertain benefits for rainbow trout habitat, and 2) certain

[1] In review of the Draft Consultative Committee Report, the Okanagan Nation Alliance representative indicated that the requirement to build to 0.5 m^3/s capacity was important in the decision process.

benefits for power. Bridging that gap was possible through addressing the uncertainty for the next decision-makers at the six year Water Use Plan review[1].

The Consultative Committee also discussed the possibility of an adaptive approach to selecting a preferred operating alternative. Perhaps selecting one alternative as the preferred operating alternative but releasing test flows for monitoring and study. The studies as proposed however can be conducted under any operating alternative, as they do not require year-round flows, and natural flow variability can be utilized to collect data. The Committee in the end decided to focus on monitoring studies without an adaptive flow approach, keeping the operations and studies separate until the next Water Use Plan review.

In the end, the Secwepemc and ONA Consultative Committee members agreed to proceed with Alternative B even though they maintained doubt about the performance measure results as affected by the higher late summer flows. All Committee members agreed that most aquatic habitat benefits are likely to occur with the change from no minimum flow to the 0.1 m^3/s minimum flow.

The Consultative Committee agreed to recommend Alternative B (modified from Alternative 3) as the preferred operating alternative.[2]

An additional meeting was required as the Consultative Committee ran out of time at the trade-off meeting. The final meeting was necessary to discuss and decide upon a monitoring program, review period and other minor operational details.

During the final meeting, new information indicated that the physical characteristics and topography around the diversion channel and dam may result

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[1] A six-year review period was decided upon based on the need for one year to conduct the feasibility and construct the flow infrastructure, followed by a desire for five years of minimum flow provision and monitoring period prior to the Water Use Plan review.

[2] During the review of the Draft Consultative Committee Report, the Okanagan Nation Alliance representative indicated that, "The ONA felt uncomfortable at this point in the process because:

1) No other options were on the table to be discussed even though with this significant change in the two options of costs.
2) Decisions were based on physical structure costs and percentages outside of the process that we just went through.
3) We feel that if this was known earlier in the process there would have been a different outcome.
4) We did recommend re-looking at changes to the maintenance flows from August to Nov ranging between .2 m^3/s to .5 m^3/s in addition to putting more research into being more confident in physical structure costs. However, this was not an option.
5) In the end, we just ended up with minimum flows, a most likely requirement for BC Hydro under the *Fisheries Act*.
6) We stood with the original decision as it was a well thought out process until the end and feel that it is BC Hydro's decision whether to build or not to build – which would be a determining factor into whether the WUP was a consensus or not."

in a doubling of the cost to construct flow capacity from 0.1 m^3/s to 0.5 m^3/s. Further, such a design may not be feasible. With the exception of ONA, all members agreed that overbuilding the infrastructure (to 0.5 m^3/s) was now only desirable up to within 20 per cent of the original budget estimate ($200,000 + $40,000). If this cost could not be achieved then all but ONA agreed that the infrastructure should be built to 0.1 m^3/s.

It was recognized that a future Water Use Plan Consultative Committee will review the flow study results, and may recommend a minimum flow greater than 0.1 m^3/s, or greater than the physical works.

The ONA member stated that he still agreed to the original decision that includes infrastructure to 0.5 m^3/s, and abstained from the new decision. ONA's primary interest is in future capacity for 0.5 m^3/s, and ONA will remove their original agreement (with Alternative B) if either feasibility or budget considerations result in a decision not to overbuild the infrastructure.

6.9 Additional Operating Protocols

Additional operating protocols were developed to accompany the operating recommendations. These served to clarify current operating procedures in light of new operations or Water Use Plan outcomes.

6.9.1 Spillway Protocol

Operation of the spillway at Walter Hardman headpond poses downstream environmental impacts, from erosion, fish stranding and fish entrainment. BC Hydro has historically operated in a manner that minimizes spill risk by limiting inflows to the headpond using upstream facilities, operating the headpond to a maximum target level lower than full pool, and by responding with crew dispatch to make adjustments according to inflow changes.

The Consultative Committee agreed that these operational mechanisms have been demonstrably effective at minimizing spill risk. In optimizing operations across interests, the Committee agreed to the following headpond elevation constraints, recognizing that little or no increase in spill risk will result:

a) Maximum headpond target El. 701.0 m from 16 November – 14 March.

b) Maximum headpond target El. 700.3 m from 15 March – 15 November (no change).

c) Allow headpond drafting through full range: El. 701.95 to 698 m (no change).

d) Headpond alarm and crew dispatch El. 701.5 m (no change).

The targets determine the headpond controller setting, and the generation is adjusted accordingly, however full pool remains at El. 701.95 m.

6.9.2 Fish Stranding Protocol

The Consultative Committee agreed that there are five fish stranding risks associated with the Walter Hardman facilities:

1. **Minimum flow over the diversion dam going to zero:** The Consultative Committee agreed that a minimum flow adequately addresses stranding issues in Cranberry Creek. The remaining stranding risk relates to the inadequacy of existing facilities to control a minimum flow (the stoplogs), however the current minimum flow proposal includes a facility upgrade component. With the provision of a minimum flow, stranding in the mainstem downstream of the diversion dam will be the result of natural inflows and is acceptable. The various instream monitoring programs may add new information in the future.

2. **Spillway risk and spillway entrainment:** The Consultative Committee agreed that historic operation at or below headpond elevation targets, combined with crew dispatch for stoplog adjustment if higher headpond levels occur, has proven to effectively buffer the spillway risk. Nothing in the final preferred operating Alternative 3 would change this risk. The proposed headpond elevation 16 November – 14 March (El. 701.0 m) is not expected to increase the risk because sudden flash inflow events are unlikely to occur during this winter period.

   In the event of a spill at the spillway, BC Hydro will stop the spill event at the earliest moment according to dam safety criteria, and will implement fish salvage as practicable below the spillway structure. Local provincial and federal fisheries agencies will be notified.

3. **Headpond drawdown:** Under proposed operating alternatives the Walter Hardman headpond is allowed to draft, and is likely to do so when inflows to the headpond are limited (less than 0.25 m^3/s). Performance measure 10 reveals this occurrence with lower headpond levels associated with higher minimum flows. During a drawdown event generation will continue at a minimum (0.25 m^3/s), effectively minimizing the drawdown rate while keeping the power plant running. Under the extreme case, the headpond may draft from El. 701.0–698.0 m over a period of approximately 14–18 days.

4. **Dewatering of the diversion channel:** Dewatering of the diversion channel could occur as a result of low inflows or maintenance activity. No salvage action is needed for low inflow events, but salvage is recommended for maintenance activities.

5. **Dewatering of the diversion dam stream area/headpond:** Dewatering of the diversion dam headpond area could occur as a result of low inflows or maintenance activity (i.e., gravel excavation). No action is needed for low inflows, but salvage is recommended for maintenance.

6.9.3 Gravel Removal/Recruitment

BC Hydro currently has an agreement to physically move gravel from the diversion dam headpond over the dam into Cranberry Creek. Following an annual request to Water Land and Air Protection (Revelstoke), each year BC Hydro removes the annual gravel accumulated, plus ten per cent of the annual load from the gravel stockpile. The annual cost of the gravel removal and placement program to BC Hydro is approximately $15,000.

Consultative Committee members expressed an interest in including this program under the Water Use Plan, as it would reduce annual paperwork for all agencies. The Committee agreed to approve the annual placement of gravel into Cranberry Creek from the diversion dam headpond area according to best management practices recommended by the federal and provincial regulatory agencies and specific regulations set by the Province.

The following guidelines and practices are to be observed during the gravel excavation and recruitment work. Of note is that the work was previously done without a minimum flow into Cranberry Creek, while future work will be done while a minimum flow is being provided downstream. The installed works should be designed to minimize sediment delivery to Cranberry Creek. Instream works should be conducted in a manner and time window that minimizes the risk of sedimentation to downstream habitat and life stages.

Contact information and procedures are current as of May 2001.

- Only existing gravel located upstream of the diversion dam and within the high water mark of Cranberry Creek should be excavated. This material should be placed immediately downstream of the diversion dam, within the high water channel but outside the wetted channel at time of excavation. The volume of material excavated should not exceed the volume of material deposited in the previous year. In addition, ten per cent of the excavated volume may be taken from the existing gravel stockpile adjacent to Cranberry Creek and similarly deposited downstream. The total volume of material placed downstream of the diversion dam should not exceed 5000 cubic metres annually.

- Practicable mitigation measures should be taken during all phases of the work to prevent sediment or debris from entering fish bearing waters. Sediment control structures such as silt fences, straw bale dikes, settling basins, ditch blocks, or filter cloth may be employed. However, sediment control is generally best achieved through isolating the work site from water flow. Please refer to Section 41, Protection of Water Quality, and Section 44(x), Authorization for Changes In and About a Stream, in the Water Regulation for information related to the engineering requirements for stream diversions (i.e., isolation of work site). Appropriate fish salvage must be conducted prior to diverting flows around the work site. If diversion of water is required to isolate the work site, proponents must salvage all fish within the area where water will be removed. A "Scientific Collection Permit" is required to salvage fish. Please contact the Ministry of Water, Land and Air Protection in Nelson at (250) 489-8540 for information on obtaining a permit. A copy of the Scientific Collection Permit application form can be found on the Internet at: http://srmwww.gov.bc.ca/kor/fsh/main/contents/permits/scientificpermit.htm.

- Work should be suspended if the sediment control measures are ineffective. In the event of uncontrolled sediment release, proponents are directed to stabilize and correct the uncontrolled sediment release as soon as possible and to notify the Ecosystem Section of the Ministry of Water, Land and Air Protection and Fisheries and Oceans Canada.

- During periods of heavy or persistent precipitation work should stop if it will result in additional sediment delivery to the stream. Measures should be taken to minimize the risk of sediment delivery to the stream during the shutdown period.

- Machinery should be free of deleterious substances such as oil, grease, mud, silt, soil, or any substance that may be harmful to fish or fish habitat.

- Fuelling and servicing of vehicles and equipment should occur away from the streams and any spills must be properly cleaned up and reported as required by the Spill Reporting Regulation (B.C. Reg. 263/90). Every effort should be made to contain the spill and prevent adverse impacts to the environment. An unofficial electronic version of the regulation can be found on the Internet at: http://www.qp.gov.bc.ca/statreg/reg/W/WasteMgmt/263_90.htm.

- Machinery should work in the dry (e.g., from the stream bank) and not from within the wetted portion of the stream channel. One fording of Cranberry Creek (i.e., over and back in the wet) is allowed.

- Damage above the high water mark to values such as banks and streamside (riparian) vegetation in the vicinity of the work area should be minimized. Unavoidable damage that occurs must be remedied. Soils exposed as a result of work activities that have the potential for sediment delivery to the stream must be promptly re-vegetated. All disturbed soils adjacent to the stream should be re-vegetated with a suitable grass mix as soon as works are completed or as soon as site conditions are conducive to growth.

- The preferred timing for the excavation work is at a time that minimizes the risk of sedimentation to downstream habitat and life stages. Following regulatory review and trial run with the new infrastructure the preferred time can be confirmed.

6.9.4 Additional Discussion Regarding Proposed Habitat Structures on Cranberry Creek

Consultative Committee members agreed to recommend that future non-Water Use Plan projects in Lower Cranberry Creek, such as a currently proposed habitat structure initiative, be complementary to the objectives, flow decisions and monitoring studies for this Water Use Plan.

6.10 Summary of Recommended Operations

The Walter Hardman Water Use Plan Consultative Committee recommends the Walter Hardman hydroelectric facility be operated subject to the operating constraints summarized in Table 6-11. These constraints include those in the modelled Alternative 3, as well as some additional operating protocols recommended by the Consultative Committee to efficiently address other key objectives (spill protocol, fish stranding protocol and gravel recruitment).

Some constraints apply to operations affecting the creek flows (minimum discharge) while others apply to headpond level regulation.

The automated headpond controller will adjust generation according to elevation targets as specified. As discussed by the Consultative Committee and modelled across all operating alternatives, reservoir elevation may fluctuate within the entire range (El. 698.0–701.95 m) depending on inflows and operations.

Table 6-11: Recommended Operating Constraints for the Walter Hardman Hydroelectric Facility

Component	Variable	Constraint	When	Water Use Plan Objective
Cranberry Creek	Minimum discharge	0.1 m^3/s minimum flow into Cranberry Creek	Year round	Maximize habitat for fish in the river.
Walter Hardman Headpond	Maximum Elevation	El. 701.95 (spillway sill)	Year round	Physical constraint of spillway sill elevation.
	Minimum Elevation	El. 698.0 m	Year round	Physical constraint of penstock intake.
	Target Elevation	El. 701.0 m	16 Nov – 14 Mar	Increase headpond storage for power generation and for oxygen content.
	Target Elevation	El. 700.3 m	15 Mar – 15 Nov	Minimize spill risk.

Target elevation reflects the setting of the headpond controller, which will adjust generation according to headpond elevation changes (inflow changes).

6.10.1 Expected Consequences of Recommended Operating Alternative

Alternative 3[1] is expected to provide numerous benefits, and some losses, over the modelled Power Optimal Alternative 2, summarized in Table 6-12. The consequences of Alternative 3 are described in relative terms: "neutral (∅)" if they were not notably different from the power optimal; "increase (+)" if a benefit or improvement over the base case is expected; and "decrease (–)" if a loss is expected. The magnitude of losses and benefits remains to be confirmed based on the results of recommended monitoring studies (Section 7).

Consequences in the neutral category include fish and wildlife habitat in Walter Hardman headpond, recreation, heritage and culture.

Benefits are expected in Cranberry Creek for spawning and rearing habitat for rainbow trout (primarily in the reach associated with Site 5) and for kokanee spawning and rearing at the mouth.

Losses are anticipated for power generation revenues, attributable primarily to the diversion of 0.1 m^3/s during periods when inflows are already at or below plant capacity (4.2 m^3/s). When inflows are greater than plant capacity (i.e., during freshet), the minimum flow does not divert water from generation purposes.

Table 6-12: Expected Consequences of Walter Hardman Water Use Plan Recommended Alternative

Water Use Interest	Consequences	
Fish in Cranberry Creek	+	Habitat is expected to improve for kokanee and rainbow trout spawning and rearing. Habitat for other species is also expected to improve, but no performance measures were developed.
Fish in Walter Hardman Headpond	∅	Neutral – No significant change is expected due to headpond operations.
Wildlife in Walter Hardman Headpond	∅	Neutral – No significant change is expected for wildlife habitat in or around the headpond.
Wildlife in Lower Cranberry Creek	+	Improvements to aquatic and riparian connectivity are expected as a consequence of the minimum flow and the freshet cycle.
Power Generation	–	Decrease in gross power revenue of approximately $54,000 per year on average over base case.
Recreation	∅	Neutral – No significant change is expected to the opportunity for or quality of recreation in any part of the system.
Heritage and Culture	∅	Neutral – No significant change is expected for heritage and culture. Primary interests were expressed in terms of aquatic and riparian habitat, where gains are expected.

[1] The recommended alternative was called B, and included the operating constraints of Alternative 3 plus specific monitoring and review elements.

6.10.2 Hydrographs for Cranberry Creek and Walter Hardman Headpond under the Recommended Operating Alternative

The recommended operating alternative will result in a minimum flow into Lower Cranberry Creek and a regime of headpond elevations on Walter Hardman headpond that sees periodic drawdowns when natural inflows are limited.

The hydrographs for the river and reservoir for all of the operating alternatives considered by the Walter Hardman Water Use Plan Consultative Committee are shown in Section 5.4, Figure 5-1 and Figure 5-3.

7 MONITORING PROGRAMS

In addition to recommending a preferred operating alternative for the Walter Hardman hydroelectric facility, the Consultative Committee recommended a monitoring program designed to address key uncertainties and answer specific questions that may change future operating decisions.

In the Walter Hardman water use planning process, the Consultative Committee chose their preferred operating alternative based on the currently available information about fish, wildlife and vegetation. On most issues, there was limited specific data for the development of the indicators linking water use objectives to operating alternatives. As a result, the Committee struggled with these uncertainties while moving ahead with their decision making.

For example, there was no data on the headpond level and links to either oxygenation or risk of stranding, however high level performance measures were developed to provide an indication of the risks of these impacts. The results of the monitoring program will provide better data for future decision making and reduce the uncertainty around the impacts of different operating regimes.

This section describes the criteria used to evaluate monitoring studies under the Water Use Plan, and the Walter Hardman Water Use Plan monitoring program recommended by the Consultative Committee.

7.1 Criteria for Water Use Plan Monitoring Studies

The Water Use Plan Management Committee developed province-wide principles and criteria for screening monitoring programs and the component studies. In the face of uncertainty about the relationship between changes in operation and habitat or biological response in the Cranberry Creek system, and in the interests of timeliness and cost-effectiveness, ***the monitoring program assesses the impacts associated with different operational changes for the Walter Hardman hydroelectric facility relative to habitat-based water use objectives.***

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

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

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

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

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

The criteria can be summarized as: 1) *efficacy*, 2) *sensitivity*, 3) *timeliness* and 4) *cost effectiveness*. Monitoring programs that meet these criteria are eligible under the Walter Hardman Water Use Plan. See Appendix L for more details.

7.2 Walter Hardman Water Use Plan Monitoring Studies

During the last two meetings the Consultative Committee discussed a variety of potential studies as part of the monitoring program (see Appendix M, Table M-1 for the initial list). The Fisheries Technical Subcommittee and the Consultative Committee evaluated these studies using the Eligibility Criteria for Water Use Plan Monitoring Studies described in Section 7.1 above and in Appendices L and M. In some cases studies were revised and some combined to form new studies.

Based on their evaluation, the Walter Hardman Water Use Plan Consultative Committee reached consensus recommendations on a monitoring program consisting of six monitoring studies that meet the principles or evaluation criteria for monitoring studies under the water use planning program. Two additional studies (#3 and #4) had a “block” from the BC Hydro representative, on the basis that future operations would be unlikely to change based on the information collected under these studies. Study #9 had one “abstain” from the BC Hydro representative, although others shared the concern that it was unclear whether conclusions could be drawn between the study outcomes and BC Hydro operations, thus future decisions based on this information would be unlikely. Table 7-1 below summarizes the Committee’s level of support for all final proposed studies.

As consensus was not reached for three of the proposed studies, BC Hydro will submit their final recommendation regarding the monitoring program in the Water Use Plan. The Water Comptroller will review the entire Water Use Plan according to the *Water Use Plan Guidelines* (British Columbia, 1999).

Table 7-2 summarizes the proposed cost and recommended schedules for each of the monitoring program studies. Appendix N includes more detailed discussion of the recommended studies and the Committee’s evaluation.

Table 7-1: Summary of Support for All Proposed Studies

CC Member	Level of Support (E=Endorse, A=Accept, B=Block)								
Old #	**1/2**	**3/4**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
New #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Mark Tiley	A	E	E	E	A	E	E	E	A
Jayson Kurtz	E	E	A	A	E	E	A	E	A
Loni Parker	A	A	A	A	A	A	A	A	A
Dave Percell	A	A	**B**	**B**	A	A	A	A	**Abstain**
Jay Johnson and Howie Wright	E	E	E	A	A	E	E	A	E
Dan Robinson	A	A	A	A	A	A	A	A	A
Terry Anderson	E	E	A	A	E	E	A	E	E
Fred Fortier	E	E	E	A	A	A	A	E	A

Table 7-2: Summary of Costs and Schedule for Walter Hardman Monitoring Studies

Study No.	Study Name	Cost per Year YR 1	YR 2	YR 3	YR 4	YR 5	Total	6 YR LAC[1, 2]
#1	Kokanee Spawning and Incubation					$30,000	$30,000	$4,417
#2	Rainbow Rearing and Over-wintering					$30,000	$30,000	$4,417
#3[4]	Riparian PFC Study[3]	$10,000					$10,000	$2,003
#4[4]	Bankfull Exceedence Estimate					$5,000	$5,000	$736
#5	Headpond Drawdown Fish Impacts		$5,500				$5,500	$1,020
#6	Temperature Effects	$2,500	$2,500	$2,500	$2,500	$2,500	$12,500	$2,159
#7	Rainbow Trout Abundance/Biology	$6,000	$6,000	$6,000	$6,000	$12,000	$36,000	$6,065
#8	Tailrace Habitat	$4,000	$2,000	$2,000	$2,000	$2,000	$12,000	$2,128
#9[4]	Kokanee Spawner Enumeration	$7,000	$7,000	$7,000	$7,000	$7,000	$35,000	$6,046
	Total	$29,500	$23,000	$17,500	$17,500	$88,500	$176,000	$28,991

[1] Net Present Value (NPV): Total Cost Schedule discounted at 8 per cent per year to Year 1.

[2] Levellized Annual Cost: NPV translated into a stream of six equal payments at 8 per cent interest, according to the six-year Water Use Plan review period.

[3] PFC = "proper functioning condition," Appendix N.

[4] Not consensus agreement, Table 7-1.

These costs are estimated assuming external consultants will be retained and that each study will be implemented on an individual basis. Costs may be reduced by: using BC Hydro staff, implementing more than one of the related studies simultaneously or combining work with other environmental monitoring activities in the area.

Typically a monitoring program is designed to provide a before and after comparison of alternative operating regimes. A period of initial data collection would establish a baseline condition, and the effects of the new operating regime (treatment) are then monitored. The before and after comparison demonstrates whether the new operating regime performed better than the old regime.

At Walter Hardman the Coursier Dam decommissioning complicates this approach. First, 2003–2004 operations differ from historical operations due to the decommissioning of the Coursier Dam. The downstream hydrograph will be different, regardless of the implementation of any Water Use Plan alternative. Second, "before" data would be collected during a biological and channel structure transition period, so comparative results would be confounded between the baseline, the transition and the treatment.

Given this, and the propensity of the Committee to confidently support the adoption of a minimum flow, the studies are set up to either a) focus on the difference between minimum flow levels, rather than the difference from the original operation (since it no longer exists), or b) fill a data gap and build better performance measures and alternatives for the next Water Use Plan review.

7.3 Development of Detailed Terms of Reference for Monitoring Studies

Once the operational changes approved under the final Walter Hardman Water Use Plan are implemented, BC Hydro will: 1) develop detailed terms of reference for the monitoring studies; and 2) initiate the monitoring program on a schedule amenable to delivering results for the next review period.

Appendix N provides more detail about the evaluation of the study proposals, as well as specific study components and considerations for developing terms of reference.

7.4 Communication of Monitoring Program Results

The Consultative Committee recommended that results of all the monitoring studies be sent to interested current parties by BC Hydro on an annual basis, or as information is available. The Walter Hardman Consultative Committee will no longer be in place but the intent was to provide information to appropriate governments, organizations and interested individuals.

8 IMPLEMENTATION OF RECOMMENDATIONS

The Consultative Committee agreed to begin implementation of the year round, minimum flow of 0.1 m^3/s into Cranberry Creek immediately following construction of the infrastructure recommended and approved under the Walter Hardman Water Use Plan. Provision of that flow prior to the infrastructure would incur high overspill costs as demonstrated in the previous chapters.

The entire package of recommendations, including infrastructure, monitoring and minimum flow provision will be implemented according to the specified timeline following submission of the Consultative Committee Report and approval of the Water Use Plan by the Comptroller of Water Rights:

- **Approval of the Water Use Plan:** As described in Step 10 of the *Water Use Plan Guidelines*, the Comptroller of Water Rights will review and issue a decision on the Walter Hardman draft 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, First Nations, and holders of water licences who might be affected by the changes.

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

- **Implement Operational Changes:** Once the Comptroller of Water Rights has approved the Walter Hardman Water Use Plan and provided BC Hydro with direction, BC Hydro will implement the approved changes as specified. Construction will follow the feasibility and design of the physical works, and provision of the minimum flow will follow upon completion of the works.

- **Initiate Monitoring Program:** Once the operational changes approved under the final Walter Hardman Water Use Plan are implemented, BC Hydro will: 1) develop detailed terms of reference for the approved monitoring studies; and 2) start monitoring studies, data collection, analysis and reporting on a schedule that will ensure results are available for the next review of the Water Use Plan. Annual reporting to interested parties was agreed to by the Consultative Committee as an appropriate method to communicate activities and/or results of monitoring throughout the six-year period.

- **Review Water Use Plan:** Six years after the implementation of the Walter Hardman Water Use Plan, with the results of all the approved monitoring studies, representatives of appropriate federal, provincial, municipal and First Nations governments will meet to initiate the review of the Walter Hardman Water Use Plan (Section 9).

9 REVIEW PERIOD

The Consultative Committee was requested to define an appropriate review period for the Walter Hardman Water Use Plan. The timing of the review should: 1) ensure there is enough time to collect the information that will set them up to make better decisions (including time required to collect baseline data for monitoring studies), 2) accommodate the time needed to build physical works (e.g., conduct feasibility study in Year 1 and build in Year 2), and 3) provide a reasonable period of operational certainty for BC Hydro.

The Consultative Committee agreed by consensus to recommend that the Water Use Plan for the Walter Hardman Project be reviewed six years after implementation. This would allow construction of the physical works followed by five years of minimum flow operations, and sufficient data collection on the multi-year monitoring studies (Study #7, rainbow trout abundance/biology study).

10 REFERENCES

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11 ACRONYMS AND ABBREVIATIONS

CCRIFC	Canadian Columbia River Inter-tribal Fisheries Commission
cm	centimetre
m3/s	cubic metres per second (also abbreviated as cms)
DFO	Fisheries and Oceans Canada
FWTC	Fish and Wildlife Technical Subcommittee
GHG	Greenhouse Gas
GWh	Gigawatt-hour (of energy)
ha	area in hectares (1 ha = 10 000 m^2)
K$	thousands of dollars
km	kilometre
km^2	square kilometre
m	metre
m^2	square metre
m^3/s	discharge or flow rate in cubic metres per second (also abbreviated as m3/s)
Mm^3	millions of cubic metres (volume of water)
MSIC	Minimum Significant Incremental Change
MWLAP	Ministry of Water Land and Air Protection
ONA	Okanagan Nation Alliance
PFC	Proper Functioning Condition
PM	Performance Measure
SFC	Secwepemc Fisheries Commission
t CO_2e	tonnes of carbon dioxide equivalent (unit for greenhouse gas emissions)
WUP	Water Use Plan
~	approximately

APPENDIX A: WALTER HARDMAN WATER USE PLAN PARTICIPANTS

The consultative process for the Walter Hardman Water Use Plan will adopt the consultation objectives and principles presented in the *Water Use Plan Guidelines*. The process will seek to be inclusive and representative; strive for meaningful discussion and dialogue; be transparent; and be based on two-way communication and mutual respect.

The consultation process will include the following key components:

- Open House(s) held at key points through the process.
- Telephone Surveys and Questionnaires to assist in issues identification.
- Site tour of the facilities and area.
- Consultative Committee (CC) meetings.
- Subcommittee meetings.
- On-going communications throughout the process by a variety of means: email, project updates, news releases, telephone calls, website updates, and presentations.

The following organizations and members of the public were contacted during the initial stages of this Water Use Plan in September 2003, prior to the Open House and First Consultative Committee meeting.

Table A-1: Walter Hardman Water Use Plan Consultative Committee

Committee Members	Organization	Primary Interest
Dan Robinson	Advanced Energy Systems	Process, Power (IPP)
David Percell	BC Hydro	Power
Fred Fortier	Secwepemc Fisheries Commission (SFC)	First Nations, Fish, Wildlife, Culture, Heritage
Jayson Kurtz	Fisheries and Oceans Canada	Fish
Mark Tiley	Canadian Columbia River Inter-tribal Fisheries Commission (CCRIFC)	Fish, Wildlife
Loni Parker	Columbia-Shuswap Regional District	Community
Terry Anderson	Water, Land and Air Protection	Fish, Wildlife
Jay Johnson/ Howie Wright	Okanagan Nation Alliance	First Nations, Fish, Wildlife, Culture, Heritage
Technical Advisors		
Shawn Clough	Secwepemc Fisheries Commission (SFC)	Fish, Wildlife
Leloni Needlay	Canadian Columbia River Inter-tribal Fisheries Commission (CCRIFC)	

Table A-2: Walter Hardman Water Use Plan Fish and Wildlife Technical Subcommittee (FWTC)

Committee Members	Organization	Primary Interest
David Percell	BC Hydro	Power
Jayson Kurtz	Fisheries and Oceans Canada	Fish
Mark Tiley	Canadian Columbia River Inter-tribal Fisheries Commission (CCRIFC)	Fish, Wildlife
Terry Anderson	Water, Land and Air Protection	Fish, Wildlife
Howie Wright	Okanagan Nation Alliance	First Nations, Fish, Wildlife, Culture, Heritage
Shawn Clough	Secwepemc Fisheries Commission (SFC)	Fish, Wildlife
Leloni Needlay	Canadian Columbia River Inter-tribal Fisheries Commission (CCRIFC)	
Bob Westcott	BC Hydro – Columbia Region	

Table A-3: Walter Hardman Water Use Plan Observers

Observers	Organization
Bob Westcott	BC Hydro, Environment
Ted White	Water Comptroller's Office

Table A-4: Walter Hardman Project Team Members

BC Hydro Project Team	
Vesta Filipchuk	BC Hydro, Project Manager
Adam Lewis	Ecofish Ltd., Environmental Task Manager
Mary Algar	BC Hydro, Community Relations
Faizal Yusuf	BC Hydro, Engineering and Power Modelling
Siobhan Jackson	BC Hydro, Facilitator & Resource Valuation Task Manager
David Percell	BC Hydro, Power Facilities Task Manager

Table A-5: List of Stakeholders Contacted Prior to First Consultative Committee Meeting

Name	Affiliation
Chris Beers	Columbia Kootenay Fisheries Renewal Program
Colin MacRae	Revelstoke Rod and Gun Club
Cory Legebocow	Ministry of Water, Land and Air Protection
Councillor Clayton Brooks and Administrator Esther Ewings	Village of Nakusp
Director Loni Parker and Administrator Alan Kuroyama	Columbia Shuswap Regional District
Frances Maltby	Canoe Club
Fred Fortier/Shawn Clough	Secwepemc Fisheries Commission (Shuswap Nation Tribal Council)
Grant Dowdy/Tom Dickson	Revelstoke Snowmobile Club
Jackie Morris	Columbia Mountains Institute of Applied Ecology
Jay Johnson/Deana Machin/Howie Wright	Okanagan Nation Alliance
Jayson Kurtz	Fisheries and Oceans Canada
John Mackie	Fisheries and Oceans Canada
Kindy Gosal	Columbia Basin Trust
Mark Tiley/Bill Green	Canadian Columbia River Inter-tribal Fisheries Commission (CCRIFC)
Maureen Weddell	Friends of Mt. Revelstoke and Glacier
Mayor Mark McKee, Council and Administrator Don DeGagne	City of Revelstoke
Neil Hodgson	Revelstoke Flyfishers
Norma Wilson/Mark Angelo	BC Outdoor Recreation Council
Pat Dunn	North Columbia Environmental Society
Property Owners & Residents	In vicinity of Walter Hardman facilities Or who expressed an interest in Coursier Decommissioning Project
Ron LaRoy/Al Obrivewitsch	Revelstoke ATV Club
Scott Rookes	Kootenay Zone – Recreational Canoeing Association of BC
Terry Anderson	Ministry of Water, Land and Air Protection
Tony Johnston	Illecillewaet Greenbelt Society
Ward Kemerer	Revelstoke Rowing Club
Water Licence Holder	Advanced Energy Systems

APPENDIX B: WALTER HARDMAN WATER USE PLAN CONSULTATIVE COMMITTEE TERMS OF REFERENCE

INTRODUCTION

The purpose of the Terms of Reference is to ensure that participants of the Walter Hardman water use planning process have a clear understanding of their purpose and responsibilities, to provide assurance that public values will be integrated into resource management decisions, and enhance the smooth functioning of the Committee work.

CONSULTATIVE COMMITTEE PURPOSE

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

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

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

CODE OF CONDUCT

All participants of the Walter Hardman Water Use Plan will endeavour to:

- Support an open and inclusive process.
- Treat others with courtesy and respect.
- Listen attentively with an aim to understand.

- Be concise in making your point.
- Speak in terms of interests instead of positions.
- Be open to outcomes, not attached to outcomes.
- Challenge ideas, not people.
- Let opposing views co-exist.
- Avoid disruption of meetings (e.g., cell phones, caucusing at the table, etc.).
- Use the "parking lot" for issues that fall outside the day's agenda.
- Aim to achieve consensus on issues being addressed.

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

PROCESS

Committee Tasks

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

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

Procedure in the Event of Disagreement

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

- Define the issue.
- Identify interests.
- Brainstorm options.

- Evaluate options.
- Choose an option.

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

Deliverable

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

The target date for the delivery of this report is Spring 2004.

Water Use Plan Preparation, Review, and Approval

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

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

The target date for the delivery of this report is Spring 2004.

MEMBERSHIP

Committee Membership

The Walter Hardman Water Use Plan Consultative Committee has been established in accordance with Steps 2 and 3 of the *Water Use Plan Guidelines*. Committee Members represent a broad range of interests affected by the operations of the Walter Hardman facilities.

Alternates

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

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

New Members

Individuals or organizations may apply to become Consultative Committee Members by:

- Submitting a request for Committee Membership to the BC Hydro process co-ordinator. The process co-ordinator will then schedule the membership request as an agenda topic for the next Committee meeting.
- Applicants must be present at the meeting where the application is considered and be prepared to describe the interests they represent and the reasons why they believe those interests are not adequately represented in the process
- Committee Members will consider new applications based on the principle of a fair, open and inclusive process.

New Committee Members will be required to:

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

Observers and Guests

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

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

Observers and guests will not participate in making Committee decisions.

ROLES AND RESPONSIBILITIES

Committee Members

In addition to following the code of conduct, participants of the Walter Hardman Water Use Plan are responsible for:

- Attending and openly participating in Walter Hardman Consultative Committee meetings. Committee Members who miss **more than one** meeting, without providing an Alternate, may be moved into the Observer role.
- Articulating their interests with respect to water use; reviewing relevant information and coming to meetings prepared.
- Making recommendations concerning study/research work.
- Exploring the implications of a range of operating alternatives.
- Seeking areas of agreement.
- Ensuring continuity in representation, through the use of a designated Alternate and/or provision of advance comments or information to the facilitator in the event of an expected absence.
- Being accountable to constituents, other Committee Members and the general public.
- Keeping constituents current on progress and decisions of the Committee.
- Signing off on the final *Walter Hardman Consultative Committee Report* provided it is a true and accurate record of the Walter Hardman Water Use Plan Committee process, documenting decisions and all areas of agreement and disagreement.

Facilitator

In addition to following the code of conduct, the Facilitator for the Walter Hardman water use planning process is responsible for:

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

BC Hydro Project Team

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

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

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

- Arranging meetings.
- Preparing and distributing the meeting minutes of Committee meetings or any subcommittee, working table or technical work group meetings. Meeting minutes shall focus on content, not people. All such notes will be distributed directly to each Committee Member, designated Alternates and observers and guests. Committee Members may distribute minutes and materials to their constituents.
- Arranging for facilitation services (as necessary).
- Maintaining a database of interested parties who are to receive copies of meeting notes and other written materials.
- Distributing meeting notes and supporting materials.
- Developing and maintaining communication links with interested parties.
- Producing and issuing all communications materials.
- Supporting report and document preparation and copying.
- Assisting with preparation and presentation of the *Walter Hardman Consultative Committee Report*.
- Presenting the Draft Water Use Plan to the Consultative Committee.

Working Groups

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

Working groups will:

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

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

PUBLIC COMMUNICATION

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

- Committee meetings will be open to the public and the media.
- Newsletters, press releases or media updates describing the water use planning process and its progress will be prepared on a periodic basis by BC Hydro.
- Committee Members will describe their points of view as interests rather than positions and will not criticize or discredit the process or the views of others when communicating with the broader public with respect to the process.
- Where needed, the Committee will select an appropriate spokesperson, such as the facilitator or BC Hydro communications, to represent the Committee.

APPENDIX C: LIST OF DOCUMENTS GENERATED BY THE WALTER HARDMAN WATER USE PLANNING PROCESS

This appendix outlines the documents prepared for or used in the 2003/04 Walter Hardman water use planning process.

Pre-Reading Packages and Meeting Notes

Pre-reading packages were distributed to the Consultative Committee or the Fish and Wildlife Technical Committee in preparation for upcoming meetings. They included meeting minutes, presentations and reports, and background working material. In most cases, draft minutes were circulated for review followed by a revised version marked "final." Meeting material was distributed via email with digital files attached, followed by hard copies available at meetings.

Reports and Memos Produced for Walter Hardman Water Use Planning Process

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

BC Hydro Inter-Office Memo. (16 December 2003). Walter Hardman Water Use Plan: Power Study – Spreadsheet Model Assumptions. F. Yusuf, Engineering Services. File WHNWUP C510.

BC Hydro Inter-Office Memo. (3 November 2003). Walter Hardman Water Use Plan: Power Studies Modelling, Inflow Data. F. Yusuf, Engineering Services. File WHNWUP C510.

BC Hydro Inter-Office Memo. (29 September 2003). Walter Hardman Water Use Plan Operations Primer. Kelly Galway, Engineering Services. File WHNWUP A100.

BC Hydro Inter-Office Memo. (September 2003). Walter Hardman Water Use Plan Hydrology Primer. Kelly Galway, Engineering Services. File WHNWUP A100.

Summit Environmental Consultants Ltd. (2004). Lower Cranberry Creek Ice Study. Vernon, B.C.

Summit Environmental Consultants Ltd. (2003a). Final Report: Assessment of Wildlife Issues at the Walter Hardman headpond. Vernon, B.C.

Summit Environmental Consultants Ltd. (2003b). Final Report: Fish Habitat Evaluation in Walter Hardman Spillway Channel. Vernon, B.C.

APPENDIX D: DETAILED INFORMATION SHEET ON POWER GENERATION PERFORMANCE MEASURE FOR WALTER HARDMAN WATER USE PLAN

What is the performance measure for power generation at Walter Hardman?

The performance measures for power generation at the Walter Hardman hydroelectric facility are 11a, b) change in average annual revenue (from power optimal), and 12a, b) local operations and maintenance. The first set is the total gross revenue that the province would forego from the energy produced at the Walter Hardman hydroelectric plant on an annual basis under each proposed operating alternative. The second performance measure represents the cost to local plant operations of interrupted generation.

The total annual energy produced at Walter Hardman Generating Station is a simple measure of the Gigawatt-hours (GW/h) produced by the simulated model. The model has been calibrated against actual generation years to ensure it reasonably represents the amount of generation that would be produced under the various inflow years.

The financial value of the energy produced (VOE) is a function of both the generation and the timing of the generation. Across all of the Water Use Plan processes, a proprietary formula has been applied to reflect the seasonal variation in the price of electricity. In a plant with limited storage ability, the VOE may track exactly with energy produced (GW/h).

Table D-1: Summary of Power Performance Measures

11a	Change in financial value of Walter Hardman facility energy production (cost of water only)	Lost revenue over power optimal alternative, mean dollars per year
11b	Change in financial value of Walter Hardman facility energy production (cost of water only plus stoplog inefficiency)	Lost revenue (power losses, overspill and labour), mean dollars per year
12a, 12b	Local Operations and Maintenance	12a # days plant shutdown per year 12b mean # start-up/shutdown events per year

Why is it important?

The Walter Hardman hydroelectric facility is part of BC Hydro's provincial integrated generation system. The value of energy produced at the facility changes depending on the time of day, week and year based on peaks in demand. Not a peaking plant, local operations seek to produce energy continually at the least cost. The performance measure for local operations and maintenance reflects the inconvenience and cost of interrupted operations due to the unavailability of inflows to the generating station.

How does it affect the objective?

The power objective for the Walter Hardman Water Use Plan is to maximize the value of power produced. These performance measures provide a direct indicator of the impact on the financial value of power from the facility under each proposed operating alternative, as well as the impact on local plant operations of interrupted generation.

How can it be affected by operational changes?

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

The Local Operations and Maintenance performance measures will show a higher number of shutdown days and events under operating scenarios that reduce available inflows to the headpond through the winter period.

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

The key assumption is that a change in operation at the Walter Hardman facility is not expected to have an impact on operation of the overall BC Hydro system.

Another assumption is related to the start-up and shutdown cycle. In reality these decisions are driven by judgment calls based on weather forecasts and real-time inflows. For modelling purposes assumptions were made based on inflow level increases representing a temperature warming trend.

A key uncertainty is the future price (value) of electricity. For the purpose of comparing different operating alternatives during the Walter Hardman Water Use Plan consultative process, the same set of Value of Energy (VOE) values was applied for all alternatives evaluated.

Another source of uncertainty was with the model itself. The Financial Value Performance Measure (power revenues) is calculated based on the energy production modelled from the facility. Within the model there was an assumption that the stoplogs are capable of providing an efficient minimum flow. In reality the use of the stoplogs is an inefficient mechanism for delivery of compliance flows. Engineering estimates of labour and “overspill” have resulted in the following additional costs associated with compliance under various minimum flows:

Table D-2: Average Diversion Flow using Stoplog Adjustments, by Compliance Requirement

Average Diversion Flow Estimate (October – March)	Requested Minimum Flow				
Per Cent Compliance	0.1 m^3/s	0.2 m^3/s	0.3 m^3/s	0.4 m^3/s	0.5 m^3/s
100%	0.43	0.53	0.62	0.71	0.80
95%	0.40	0.50	0.59	0.68	0.77
90%	0.38	0.47	0.57	0.65	0.75
85%	0.34	0.44	0.54	0.62	0.72
80%	0.31	0.41	0.50	0.59	0.69
75%	0.27	0.37	0.46	0.56	0.65
70%	0.24	0.34	0.43	0.53	0.62
50%	0.13	0.23	0.33	0.42	0.51

This analysis means that compliance level is a simple cost calculation (Table 2). For example, using the manual stoplogs, providing a 100 per cent compliance minimum flow will result in range 0.3 to 0.33 m^3/s overspill above the minimum flow. So if 0.1 m^3/s is requested, average actual flows would be 0.43 m^3/s. The approximate additional lost power revenue is $50,000 per 0.1 m^3/s, or about $150,000 per year for 100 per cent compliance. To deliver a *weekly average* actual minimum flow close to the requested minimum flow, one would have to accept approximately 50 per cent compliance with the targeted minimum flow. This makes sense, in that approximately half the time flows would be less and half the time flows would be greater than the "target" through the week after a stoplog adjustment.

How is this performance measure calculated?

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

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

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

Local Operations and Maintenance: To calculate the impact of operational constraints on local operations, the number of events and the cumulative number of days that the operating alternative results in zero generation from the generating station are counted.

Is adequate information available to calculate this performance measure?

In addition to the seasonally-variable value of energy (VOE), calculating this performance measure requires two key sets of data associated with each proposed operating alternative:

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

Both sets of data are available from the modelling output.

References

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

APPENDIX E: POWER STUDY – SPREADSHEET MODEL ASSUMPTIONS

Inter-office memo

ENGINEERING

TO:	Siobhan Jackson	DATE:	16 December 2003
FROM:	Faizal Yusuf	FILE:	File: WHNWUP C510
SUBJECT:	Walter Hardman Water Use Plan Power Study – Spreadsheet Model Assumptions		

As part of the Water Use Planning (WUP) Program, the WUP Process Team has requested the services of Engineering for conducting the Power Studies Modelling for the Walter Hardman WUP. The various Power Study scenarios will be evaluated with an Excel spreadsheet which will be developed based on the constraints, targets and rules described in this memo.

Summary of Model Constraints

The hard (cannot be changed) and soft (can be changed) constraints in the spreadsheet model are summarized below and are explained in more detail in the next section.

Hard Constraints

- daily inflows
- stoplog operation (limits headpond maximum daily inflow to 4.2 m^3/s)
- maximum turbine flow (4.2 m^3/s)
- maximum power output (8 MW)
- value of energy (VOE) average monthly prices (March 2002)
- headpond storage curve

Soft Constraints

- minimum fish flow
- minimum plant flow to prevent penstock freeze-up
- drafting headpond allowed or maintain constant headpond

- target headpond levels
- minimum headpond level for plant operations
- maximum headpond level (during a shutdown) for plant startup to avoid spillway discharges
- plant shutdown/startup criteria
- plant shutdown/startup costs

Description of Spreadsheet Model

The spreadsheet calculations will be done on a daily time step coinciding with the natural, smoothed daily inflows above the Walter Hardman diversion dam from October 1980 to July 1986 described in a memo from F. Yusuf to V. Filipchuk dated 3 November 2003.

The minimum flow for fish (first priority) will be provided at the diversion dam and the stoplogs in the control structure downstream of the diversion dam will be modeled such that they always limit the flow into the Headpond to a maximum of 4.2 m^3/s, which is the maximum turbine flow. Flow in excess of that which can be diverted to the Headpond will be modelled as spill over the diversion dam. There will not be any spillway discharges from the Headpond spillway in the spreadsheet model.

The minimum plant flow to prevent penstock freeze-up will be a user-defined value (currently set at 0.2 m^3/s).

The day-ending Headpond level will be calculated based on the Headpond storage curves and daily change in storage (daily inflow minus outflow). The spreadsheet will mimic the Headpond Controller and adjust daily flows to the powerhouse (between the minimum and maximum values) as required to maintain the target Headpond levels. A constant target Headpond level (currently set to 700.3 m) will be used year round except for scenarios which specifically identify periods of time where drafting the Headpond is to be modelled. When drafting the Headpond is to be modelled, a higher target Headpond level (currently set to 701.0 m) will be used to potentially minimize plant shutdown/startup costs due to low inflows.

If the Headpond inflow drops below the minimum plant flow, generation will be reduced to the minimum plant flow. If these inflow conditions persist for more than one day (continuous), the spreadsheet will respond as follows: For the drafting Headpond case, if the Headpond is drafted to the minimum operating level, the plant will be shutdown. For the constant Headpond case, if the Headpond inflows are below the minimum plant flow for three consecutive days the plant will be shutdown.

In the event of a plant shutdown, plant startup will take place once the five-day moving average of Headpond inflows has reached at least 0.1 m^3/s greater than the required minimum continuous plant discharge. If the plant is shutdown and the Headpond rises above a user-defined elevation (currently set at 701.5 m), the plant will startup to avoid spillway discharges.

Since the gross head at this plant is very high (>250 m), the relatively minor fluctuations in Headpond level will not be considered in calculating daily generation. A constant h/k value (8 MW / 4.2 m^3/s = 1.905) will be used to convert the spreadsheet computed daily power flows into daily MW. The Value of Energy average monthly figures will then be used to calculate the average annual revenue for each scenario considered.

The spreadsheet model will respond perfectly to day to day changes in local inflow whereas in reality, operation cannot be quite so perfect. Thus, the model is likely to slightly overestimate the amount of generation that could be attributed to a particular scenario. The spreadsheet calculations can be checked by comparing the computed GWh with actual generation records, which go back to 1984. Until recently, generation at Walter Hardman was influenced by the storage effects of Coursier Dam. Regulated flows just above the diversion dam were measured at a Water Survey Canada station from October 1980 to July 1986. The measured, regulated flows for 1984 and 1985 (the only complete years of regulated flow data for which there are also generation records) were entered into the spreadsheet model and the computed annual GWh (assuming a constant Headpond level of 700.3 m was maintained) were compared with the actual generation. To avoid overstating the benefits, the calculated daily MWh had to be reduced by a constant factor (0.876) to match the computed GWh for 1984 and 1985 with actual records. This factor will be applied to all the power and fish flow alternatives that will be based on the natural inflows above the diversion dam.

APPENDIX F: DETAILED INFORMATION SHEET ON FISH PERFORMANCE MEASURES FOR WALTER HARDMAN WATER USE PLAN

Performance measures were developed for the Walter Hardman Water Use Plan Consultative Committee to assess the impact of various operating alternatives on key fish and aquatic interests. These are summarized in Table F-1 and described in greater detail in the following pages.

Table F-1: Summary of Fish Performance Measures

No.	Description	Units	Location	Timing
1a, 1b	Wetted area and depth for kokanee spawning	Median wetted area (m^2)	Cranberry Creek near the mouth (above the fan)	1 Sep – 31 Oct
2	Wetted area and depth for kokanee incubation	Maximum decrease in depth (m)	Cranberry Creek near the mouth (above the fan)	1 Sep – 30 Apr
3a,b,c (broad) **3d,e,f (narrow)**	Wetted area for rainbow trout rearing during the critical streamflow period	Habitat area (m^2) (median of 3 areas)	Cranberry Creek 3a) diversion dam, 3b) Site 5 3c) near the mouth	1 Jul – 31 Oct (broad window) *and* 1 Sep – 31 Oct (narrow window)
4a,b,c	Depth for rainbow trout rearing over winter	Median depth (m) (3 areas)	Cranberry Creek 4a) diversion dam, 4b) Site 5 4c) near the mouth	1 Nov – 31 Mar
5	Depth for rainbow trout spawning	Maximum decrease in depth (m) between spawning and incubation flows (3 areas)	Cranberry Creek 4a) diversion dam, 4b) Site 5 4c) near the mouth	1 Apr – 15 Jul
6	Depth for upstream migration	Median depth for migration (m)	Cranberry Creek near the mouth	1 Aug – 31 Oct (kokanee run timing)
7	Stranding and spillway entrainment	Mean # spill events annually	At the Walter Hardman spillway	Year round
8	Riparian habitat wetting (also for wildlife)	Median difference between the channel width and observed wetted width (m)	Cranberry Creek Site 5	1 Apr – 30 Sep
9	Riparian bankfull exceedence days	# days exceeding bankfull	Site 5	
10	Walter Hardman headpond over-wintering	Minimum 30-day average headpond level (m)	Walter Hardman headpond	1 Nov – 31 Mar

Of the performance measures developed, seven were used by the Walter Hardman Water Use Plan Consultative Committee to assess the impact of various operating alternatives on key fish objectives for Cranberry Creek and the Walter Hardman headpond. These included the following:

1. Wetted area (1A) and depth (1B) for kokanee spawning habitat in Lower Cranberry Creek during the fall and winter.
2. Wetted area for rainbow trout rearing habitat in Cranberry Creek during the growing season.
3. Depth for rainbow trout rearing in Cranberry Creek over the winter.
4. Depth decrease during rainbow trout in Cranberry Creek during egg incubation.
5. Depth for upstream migration of kokanee and bull trout in Cranberry Creek during the fall.
6. Stranding of all species, but rainbow trout in particular, in Cranberry Creek year-round.
7. Headpond over-wintering – an index of winterkill risk in the headpond during the winter.

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

1. Wetted Area and Depth for Kokanee Spawning (#1A and #1B)

What is this performance measure?

This performance measure measures habitat in units of wetted area and depth, both physical variables considered important to kokanee spawning.

For what locations and timing is this performance measure relevant?

The performance measure is calculated for the lower section of Lower Cranberry Creek, from Upper Arrow Lakes upstream 2.26 kilometres (km) to the impassable falls. This is the area that kokanee are found within Cranberry Creek. The performance measure applies during the fall, winter, and early spring.

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

These spawning and incubation habitat performance measures assume a linkage between physical habitat and flows, and between habitat and spawning success and egg-fry survival. Changes in flow will change wetted width, which in turn will alter the area of wetted habitat for spawning. Changes in flow will also alter depth, which may affect egg-fry survival of kokanee. Increasing spawning habitat through flow management is expected to increase spawning area and egg-fry survival.

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

One of the Walter Hardman Water Use Plan Consultative Committee's key objectives was to maximize the production and diversity of fish in Cranberry Creek. The Committee developed a sub-objective of maximizing habitat for spawning which is directly addressed by this performance measure. Maximizing spawning habitat is expected to maximize the production of kokanee.

How is the kokanee spawning performance measure calculated?

Summit Environmental Consultants (2000) collected physical habitat information in Lower Cranberry Creek by measuring wetted width, depth, and velocity at whole-river transects. Summit summarized the data to develop hydrometric relationships that linked wetted width and depth to river flow. These relationships are used to calculate the wetted width and depth at a given flow. The wetted width was multiplied by the length of the reach to calculate the wetted area. The depth performance measure represents the change in depth between spawning and the time the eggs hatch.

The ***wetted area performance measure*** calculates the wetted area on each day of spawning. The ***depth performance measure*** calculates 1) the depth on each day of spawning and averages this over the spawning period each year (1 September to 31 October) and 2) the minimum depth of each day of the incubation period (1 September to 30 April) each year. The difference between the average spawning depth and minimum incubation depth is then calculated.

Once these two metrics are calculated for each day of spawning, the average over the entire spawning period (for wetted area) and the incubation period (depth) is summarized for each year. The minimum, average, and maximum values over the range of yearly averages are tabulated for each alternative.[1]

What are the key assumptions and uncertainties associated with the impact of operations on kokanee spawning?

The key assumptions are: 1) the information collected by Summit Environmental Consultants accurately represents the wetted width and depth vs. flow relationships; 2) wetted area measures the quantity and quality of habitat available for spawning;

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[1] The statistical measures used for most performance measures are 10th percentile, median, and 90th percentile. Minimum, median, and maximum were used for Walter Hardman environmental performance measures because there were only seven years of flow data and therefore only seven annual values to summarize.

3) spawning habitat for kokanee is limited in Cranberry Creek; 4) changes in depth affect egg-fry survival. Although in reality spawning habitat will increase up to a maximum level after which it will decrease, spawning habitat will likely only increase as flows increase up to the greatest minimum expected to be contemplated for the Walter Hardman water use planning process (1.0 m^3/s)[1]. Egg survival depends on a complex interaction between depth, velocity, substrate and substrate porosity, and varies with individual time of spawning and time of hatch – the performance measure used here greatly simplifies this interaction.

Is adequate information available to calculate this performance measure?

The assumptions noted above limit the confidence in the performance measure results. While not as sensitive as the effective spawning habitat performance typically used in other water use planning processes around the province, the “decrease in depth” performance measure (#4 in this appendix) should provide a reliable index of the performance of different flow alternatives. The Consultative Committee was informed of these limitations before using the results to develop any recommendations about operating alternatives.

References

None.

2. Wetted Area for Rainbow Trout Rearing during the Growing Season

What is this performance measure?

This performance measure measures habitat in units of wetted area, a physical variable considered important to rainbow trout rearing.

For what locations and timing is this performance measure relevant?

The performance measure is calculated for the middle section of Lower Cranberry Creek, from the impassable falls (located 2.26 kilometres (km) upstream of Upper Arrow Lake) upstream for 5.47 km to the confluence with a tributary (located 7.73 km upstream of Upper Arrow Lake). This is a key area of rainbow trout habitat in Cranberry Creek, inhabited by a resident population. The performance measure applies during the growing season.

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[1] Local inflows during September are typically 0.7 m^3/s between the mouth and the diversion dam. Added to the maximum of 1 m^3/s expected across operating alternatives, a flow of 1.7 m^3/s is 28 per cent of Mean Annual Discharge (MAD) (6.11 m^3/s at the mouth). Spawning habitat would be expected to be maximized at the Cranberry Creek mouth at approximately 4.89 m^3/s based on Provincial standards.

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

The rearing habitat performance measure assumes a linkage between physical habitat and flow. Changes in flow will change wetted width, which in turn will alter the area of rearing habitat, as well as habitat for invertebrates that rainbow trout feed on.

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

One of the Walter Hardman Water Use Plan Consultative Committee's key objectives was to maximize the production and diversity of fish in Cranberry Creek. The Committee developed a sub-objective of maximizing habitat for rearing which is directly addressed by this performance. Maximizing rearing habitat is expected to maximize the production of rainbow trout.

How is the rainbow rearing (growing season) performance measure calculated?

Summit Environmental Consultants (2000) collected physical habitat information in Cranberry Creek by measuring wetted width, depth, and velocity at whole-river transects. Summit summarized the data to develop hydrometric relationships that linked wetted width and depth to river flow. The relationship collected from transects at Site 5 was used to calculate the wetted width at a given flow. The wetted width was multiplied by the length of the section (x m) to calculate the wetted area.

The "wetted area" performance measure calculates the wetted area on each day during the critical period of stream flow within the growing season (1 September to 31 October). Once this metric has been calculated for each day of rearing, the average over the entire rearing period is summarized for each year. The minimum, average, and maximum values over the range of yearly averages are tabulated for each alternative.

What are the key assumptions and uncertainties associated with the impact of operations on rainbow rearing (growing season)?

The key uncertainties are: 1) the information collected by Summit accurately represents the wetted width and flow relationship in this section; 2) area measures the quantity and quality of habitat available for rearing; 3) rainbow trout are limited by the quantity or quality of rearing habitat in Cranberry Creek. Rainbow trout populations are typically limited by rearing habitat during the low flow period. In interior streams, one critical period is during the late summer and early fall, within the growing season. At this time rainbow trout have reached their maximum size for the calendar year and require the largest territory size, hence habitat space requirements are at a maximum.

Is adequate information available to calculate this performance measure?

The assumptions noted above limit the confidence in the performance measure results. While not as sensitive as weighted usable area calculations typically used in water use planning processes throughout the province, wetted area should provide a reliable index of the performance of different flow alternatives over the range of minimum flows considered. The Consultative Committee was informed of these limitations before using the results to develop any recommendations about operating alternatives.

References

Summit Environmental Consultants Ltd. (June 2000). *Cranberry Creek Fisheries and Hydrology Study, Volumes I and II*. Vernon, B.C.

3. Depth for Rainbow Trout Rearing Over Winter

What is this performance measure?

This performance measure indexes habitat in units of depth, a physical variable considered important to rainbow trout rearing during the winter.

For what locations and timing is this performance measure relevant?

The performance measure is calculated for the middle section of Lower Cranberry Creek, from the impassable falls upstream for 5.47 km to the confluence with a tributary (2.26– 7.73 kilometres (km) upstream of Upper Arrow Lake). This is a key area of rainbow trout habitat in Cranberry Creek, inhabited by a resident population. The performance measure applies during the late fall and winter.

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

The rearing habitat performance measure assumes a linkage between physical habitat and flow. Changes in flow will change depth, which in turn will alter the area of rearing habitat, as well as habitat for invertebrates that rainbow trout feed on.

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

One of the Walter Hardman Water Use Plan Consultative Committee's key objectives was to maximize the production and diversity of fish in Cranberry Creek. The Committee developed a sub-objective of maximizing habitat for rearing which is directly addressed by this performance measure. Maximizing winter rearing habitat is expected to maximize the production of rainbow trout.

How is the rainbow rearing (winter) performance measure calculated?

Summit Environmental Consultants (2000) collected physical habitat information in Cranberry Creek by measuring wetted width, depth, and velocity at whole-river transects. Summit summarized the data to develop hydrometric relationships that linked and depth to river flow. The relationship collected from transects at Site 5 was used to calculate the depth at a given flow.

The wetted area performance measure calculates the depth on each day during the winter (1 November to 31 March). Once this metric has been calculated for each day of rearing in the winter, the average over the entire winter rearing period is summarized for each year. The minimum, average, and maximum values over the range of yearly averages are tabulated for each alternative.

What are the key assumptions and uncertainties associated with the impact of operations on rainbow rearing over winter?

The key uncertainties are: 1) the information collected by Summit accurately represents the depth versus flow relationship in this section; 2) depth indexes the quantity and quality of habitat available for rearing over winter; 3) rainbow trout are limited by the quantity or quality of rearing habitat over winter in Cranberry Creek.

Is adequate information available to calculate this performance measure?

The assumptions noted above limit the confidence in the performance measure results. While not as sensitive as weighted usable area calculations typically used in water use planning processes throughout the province, depth should provide a reliable index of the performance of different flow alternatives. The Consultative Committee was informed of these limitations before using the results to develop any recommendations about operating alternatives.

References

Summit Environmental Consultants Ltd. (June 2000). *Cranberry Creek Fisheries and Hydrology Study, Volumes I and II*. Vernon, B.C.

4. Depth Decrease During Rainbow Trout Incubation

What is this performance measure?

This performance measure quantifies the change in water depth during egg incubation, which is a physical variable considered important to rainbow trout egg-fry survival.

For what locations and timing is this performance measure relevant?

The performance measure is calculated for the middle section of Lower Cranberry Creek, from the impassable falls upstream for 5.47 km to the confluence with a tributary (2.26–7.73 kilometres (km) upstream of Upper Arrow Lake). This is a key area of rainbow trout habitat in Cranberry Creek, inhabited by a resident population. The performance measure applies during the period of rainbow trout incubation in the late spring and early summer.

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

The incubation habitat performance measure assumes a linkage between physical habitat and flows, and between incubation habitat and egg-fry survival. Changes in flow will change depth, which in turn will affect the wetting of and intragravel velocity within spawning habitats, potentially affecting egg-fry survival of rainbow trout. Maintaining depths through flow management is expected to increase egg-fry survival.

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

One of the Walter Hardman Water Use Plan Consultative Committee's key objectives was to maximize the production and diversity of fish in Cranberry Creek. The Committee developed a sub-objective of maximizing habitat for incubation which is directly addressed by this performance measure. Maximizing incubation habitat is expected to maximize the production of rainbow trout.

How is the rainbow trout incubation performance measure calculated?

Summit Environmental Consultants (2000) collected physical habitat information in Lower Cranberry Creek by measuring wetted width, depth, and velocity at whole-river transects. Summit summarized the data to develop hydrometric relationships that linked depth to river flow. This relationship is used to calculate the depth at a given flow. The depth performance measure represents the change in depth between spawning and the time the eggs hatch.

The depth performance measure calculates 1) the depth on each day of spawning and averages this over the spawning period each year (1 April to 7 June), and 2) the minimum depth of each day of the incubation period each year (1 April to 15 July). The difference between the average spawning depth and minimum incubation depth is then calculated to yield the decrease in depth in meters.

Once this metric is calculated for each day of spawning, the average over the entire spawning period (for wetted area) and the incubation period (depth) is summarized for each year. The minimum, average, and maximum values over the range of yearly averages are tabulated for each alternative.

What are the key assumptions and uncertainties associated with the impact of operations on rainbow trout incubation?

The key uncertainties are: 1) the information collected by Summit accurately represents the wetted width and depth vs. flow relationships; 2) wetted area measures the quantity and quality of habitat available for spawning; 3) spawning habitat for rainbow trout is limited in Cranberry Creek; 4) changes in depth affect egg-fry survival. Egg survival depends on a complex interaction between depth, velocity, substrate and substrate porosity, and varies with individual time of spawning and time of hatch – the performance measure used here greatly simplifies this interaction. Stream resident rainbow trout populations are not typically limited by spawning habitat. However, members of the Fish and Wildlife Technical Subcommittee expressed an interest in this performance measure and so it was calculated.

Although it is possible that the reduction in flow post spawning may dewater eggs, the rainbow trout spawn during freshet when the channel is fully wetted, possibly at considerable depths where egg dewatering post spawning is unlikely. We can't accurately predict where in the channel they will spawn and whether their eggs will be dewatered.

Is adequate information available to calculate this performance measure?

The assumptions noted above limit the confidence in the performance measure results. While not as sensitive as the effective spawning habitat performance measure typically used in water use planning processes throughout the province, the incubation depth performance measure should provide a reliable index of the performance of different flow alternatives. The Consultative Committee was informed of these limitations before using the results to develop any recommendations about operating alternatives.

References

Summit Environmental Consultants Ltd. (June 2000). *Cranberry Creek Fisheries and Hydrology Study, Volumes I and II*. Vernon, B.C.

5. Depth for Upstream Migration

What is this performance measure?

This performance measure quantifies river depth, which is a physical variable considered important to kokanee and bull trout during upstream migration.

For what locations and timing is this performance measure relevant?

The performance measure is calculated for the lower section of Lower Cranberry Creek, from Upper Arrow Lakes upstream 2.26 kilometres (km) to the impassable falls. This is the area that kokanee and bull trout are found within Cranberry Creek. The performance measure applies during the migration period of August and September.

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

River flow during upstream migration is a general concern to the Fish and Wildlife Technical Subcommittee. The flows required for passage past specific barriers cannot be predicted without site specific observation. However, migration past less difficult obstacles, such as riffles, rapids, and cascades, will be less difficult with increases with water depth. Accordingly, depth will be used as a proxy for ease of migration.

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

One of the Walter Hardman Water Use Plan Consultative Committee's key objectives was to maximize the production and diversity of fish in Cranberry Creek. The Committee developed a sub-objective of maximizing conditions for migration (up and down), which is directly addressed by this performance measure.

How is the depth for upstream migration performance measure calculated?

Summit Environmental Consultants (2000) collected physical habitat information in Lower Cranberry Creek by measuring wetted width, depth, and velocity at whole-river transects. Summit summarized the data to develop hydrometric relationships that linked depth to river flow. This relationship is used to calculate the depth at a given flow. The depth performance measure represents the depth during migration.

The depth performance measure calculates the depth on each day of the migration season each year (1 August to 31 October). Once this metric is calculated for each day of migration, the average over the entire migration period is summarized for each year. The minimum, average, and maximum values over the range of yearly averages are tabulated for each alternative.

What are the key assumptions and uncertainties associated with the impact of operations on depth for upstream migration?

The key uncertainty is the whether migration is an important factor to migrating kokanee and bull trout during the migration season. Observations of Cranberry Creek have not identified this as an issue, other than at known barriers. On the other hand, the low flow conditions typical during August and September suggest that migration could be impeded at a number of locations.

Based on Provincial standards, migration is typically easiest at 50 to 200 per cent of Mean Annual Discharge (MAD). At present Cranberry Creek provides these flows during rainbow trout migration, so obstruction at minor obstacles is unlikely under the current or any anticipated alternatives. Bull trout generally migrate from 1 May to 30 August; however, in smaller streams such as Cranberry Creek they are expected to migrate closer to spawning time, during August. Kokanee migrate during September and spawn in September and October.

The performance measures score higher flows better in a continuous fashion. In reality, there may a threshold flow below which migration depths become limiting and above which additional increases in depth give no greater benefit.

Is adequate information available to calculate this performance measure?

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

References

Summit Environmental Consultants Ltd. (June 2000). *Cranberry Creek Fisheries and Hydrology Study, Volumes I and II*. Vernon, B.C.

6. Fish Stranding

What is this performance measure?

This performance measure quantifies the number of dewaterings at the diversion dam on Cranberry Creek, which may index the risk of stranding to fish. Note that this performance measure was originally called "stranding and spillway entrainment." However, because use of the spillway will be very infrequent and was not possible to model for the Walter Hardman Water Use Plan, the spillway component of the performance measure was dropped.

For what locations and timing is this performance measure relevant?

The performance measure is calculated at the diversion dam. The measure applies to all of Cranberry Creek downstream of the diversion dam; however, local inflow will moderate the effects of dewaterings and therefore the measure will be most appropriate for the section of Cranberry Creek immediately downstream of the diversion dam. The performance measure applies year-round.

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

Reductions in flow to zero have the potential to strand or isolate fish, leading to mortality. Changes in flow at the diversion dam include reductions to zero flow.

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

One of the Walter Hardman Water Use Plan Consultative Committee's key objectives was to maximize the production and diversity of fish in Cranberry Creek. The Committee developed a sub-objective of minimizing stranding and predation, which is directly addressed by this performance measure.

How is the stranding performance measure calculated?

Each time flows are reduced to zero at the diversion dam, the stream channel downstream is dewatered and habitats become isolated, possibly leading to stranding and mortality. Daily flow time series modelled for the Water Use Plan are analyzed and the number of times flow is reduced to zero was summed within each year. The minimum, average, and maximum values over the range of yearly averages are tabulated for each alternative.

What are the key assumptions and uncertainties associated with the impact of operations on stranding?

The key uncertainty is whether fluctuations in flow (distinct from reductions to zero flow) cause stranding in Cranberry Creek. The "stranding" performance measure does not deal with stranding at those flow levels. A Stranding Protocol has been developed for Cranberry Creek to address the uncertainty associated with this issue.

Is adequate information available to calculate this performance measure?

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

References

None.

7. Walter Hardman Headpond Over-wintering

What is this performance measure?

This performance measure quantifies the elevation of the headpond during the winter months, a physical measure that is expected to correlate with the dissolved oxygen concentration in the headpond (which in turn, is expected to correlate with fish surviving the winter season).

For what locations and timing is this performance measure relevant?

The performance measure is calculated for the Walter Hardman headpond during the winter.

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

Over-winter dissolved oxygen concentrations affect the over-winter survival of rainbow trout and determine the risk of winterkill in lakes. Under anticipated operating protocols, headpond levels will only be drawn down when inflows are low. Dissolved oxygen concentrations will be the lowest during the winter when ice cover prevents oxygen exchange with the air, and when headpond levels decrease as inflows to the headpond decline. Under these conditions, the low inflow and declining volume of the headpond may accelerate the rate of oxygen depletion, reducing dissolved oxygen concentrations in the headpond to levels harmful to fish. By reducing headpond levels during winter, operations may reduce dissolved oxygen in the headpond and increase fish mortality.

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

One of the Walter Hardman Water Use Plan Consultative Committee's key objectives was to maximize the production and diversity of fish stocks in the Walter Hardman headpond. Winterkill in the headpond could lower the production of rainbow trout.

How is the headpond over-wintering performance measure calculated?

The daily average elevation of the headpond over a 30-day period is calculated as a running average for the period during the late fall and winter (1 November to 31 March). The minimum 30-day running average within this period is selected for each year. The minimum, average, and maximum values over the range of yearly averages are tabulated for each alternative.

What are the key assumptions and uncertainties associated with the impact of operations on headpond over-wintering?

The key uncertainty is whether dissolved oxygen concentrations drop to levels of concern for the over-winter survival of rainbow trout. The Walter Hardman headpond has a maximum depth of only 11 metres (m), which is shallow enough to elevate the risk of winterkill, based on measurements in other British Columbia lakes (Lirette and Chapman, 1993). Compensating for this, inflows from Cranberry Creek throughout the late fall and winter transport water of high dissolved oxygen levels into the headpond, thereby reducing the risk of "winter kill." Turbid water conditions during the growing season limit primary production in the headpond, which in turn limits biological oxygen demand and the scope for oxygen depletion over winter.

Considering this, it seems unlikely that oxygen levels drop low enough over winter to harm fish, but we have no data with which to assess this.

Another key uncertainty is the duration of low headpond level that would effect a reduction in dissolved oxygen sufficient to significantly increase winterkill risk. The drawdown will have to be sustained for weeks for biological and chemical processes to deplete oxygen concentrations. A minimum 30-day average was selected as an indicator of the duration and magnitude of drawdown, however, there is no data to support this selection. The 30-day period was selected as a balance between a longer period, that would allow significant oxygen depletion, and a shorter period, that would allow the measurement of significant differences in headpond level between operating alternatives.

Is adequate information available to calculate this performance measure?

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

References

Lirette, M.G. and Chapman, B.B. 1993. *Winter limnological survey of selected lakes in central British Columbia, an assessment of winter kill risk*. B.C. Ministry of Environment, Regional Fisheries Report No. CA 935. 21 p.

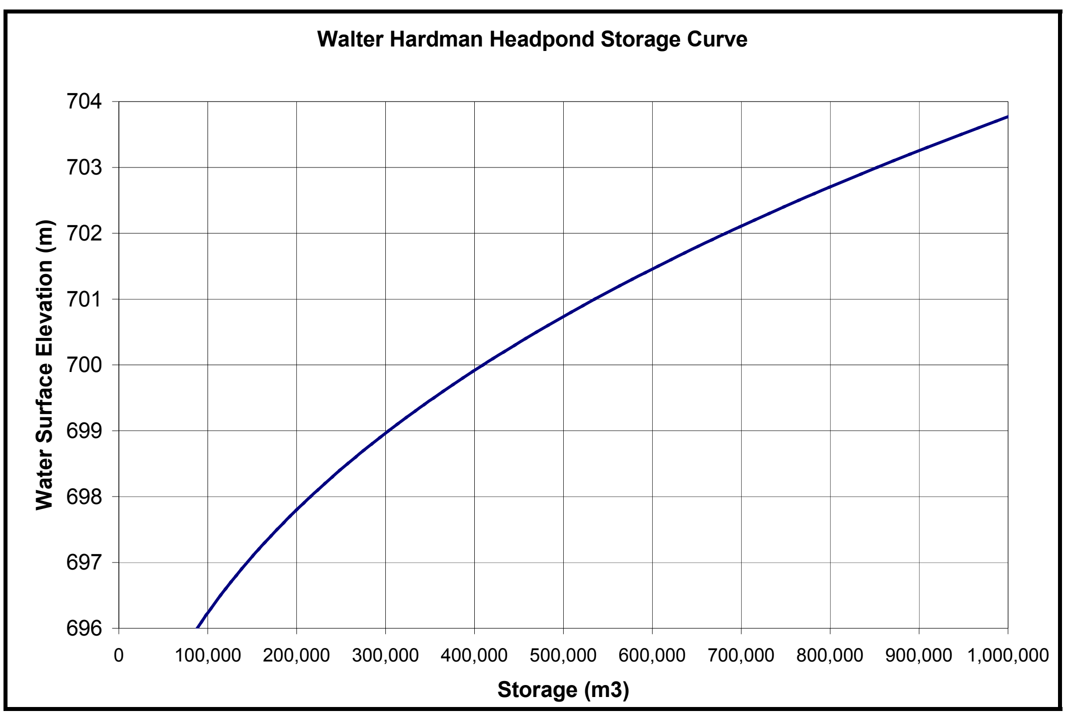


Figure F-1: Walter Hardman Headpond Storage Curve

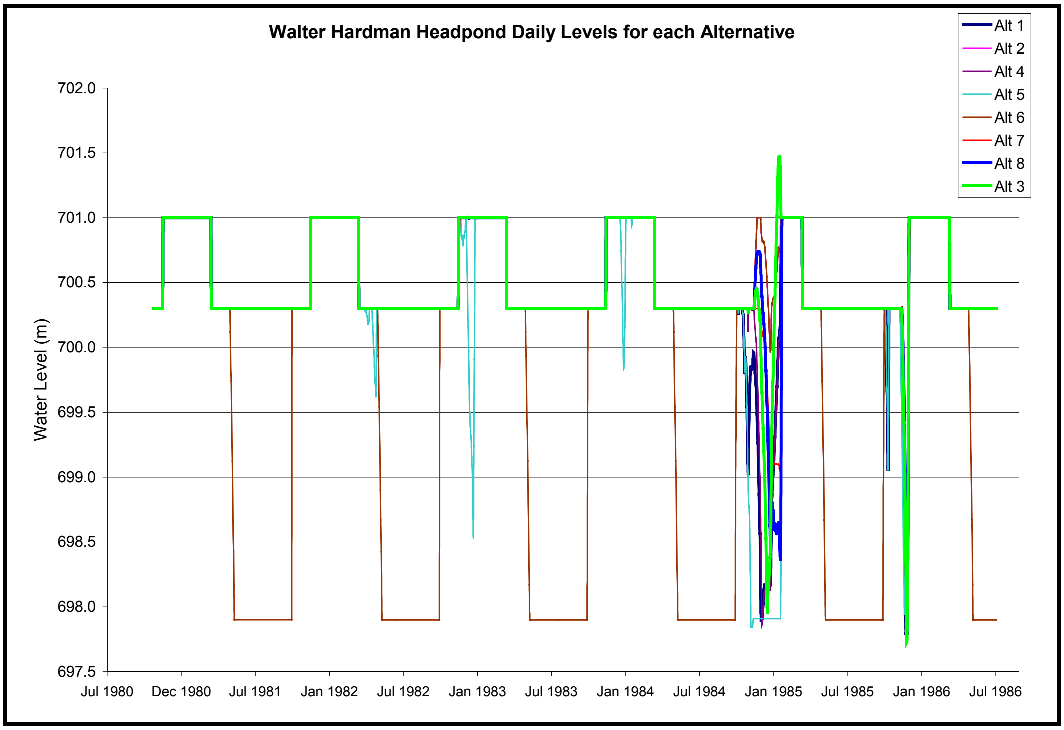


Figure F-2: BC Hydro Daily Elevation for Walter Hardman Headpond, Alternatives 1–8

APPENDIX G: DETAILED INFORMATION SHEET ON WILDLIFE PERFORMANCE MEASURES FOR WALTER HARDMAN WATER USE PLAN

There were two performance measures developed by the Walter Hardman Water Use Plan Consultative Committee to assess the impact of various operating alternatives on wildlife objectives for Cranberry Creek and the Walter Hardman headpond. They included:

- **Riparian Habitat Wetting** along Cranberry Creek during the growing season.
- **Bankfull Exceedance** of riparian habitat long Cranberry Creek during the growing season.

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

1. Riparian Habitat Wetting

What is this performance measure?

This performance measure calculates the distance between the channel edge and the wetted edge during the growing season, which is expected to be a measure of the "interconnectedness" of riparian and aquatic habitats.

For what locations and timing is this performance measure relevant?

The performance measure is calculated at Site 5, roughly mid-way between in the middle section of Lower Cranberry Creek. Riparian vegetation in this area is suspected to be of highest quality along Cranberry Creek. The performance measure applies during the growing season.

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

The wetting of riparian habitats maintains linkages between riparian and aquatic habitats. Insect drop and leaf litter fall into wetted habitats are increased when the stream channel is full, and mammals and birds can more easily move from cover in the riparian zone to aquatic habitats.

Reductions in flow during the growing season caused by operations can reduce flows, increasing the distance between riparian vegetation and the wetted edge. This can reduce connectivity and the functional connection between riparian and aquatic systems.

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

One of the Walter Hardman Water Use Plan Consultative Committee's key objectives was to maximize the production and diversity of wildlife along Cranberry Creek. The Committee identified riparian habitat as an issue for evaluation.

How is the riparian wetting performance measure calculated?

Summit Environmental Consultants (2000) collected physical habitat information in Cranberry Creek by measuring wetted width, depth, and velocity at whole-river transects. Summit summarized the data to develop hydrometric relationships that linked wetted width to river flow. The relationship collected from transects at Site 5 was used to calculate the wetted width at a given flow and from this to calculate the distance between the channel edge and the wetted edge. It was assumed that the channel was fully wetted at two times the mean annual discharge (= 11.6 m^3/s at Site 5).

The riparian habit wetting performance measure calculates the difference between the channel width and the wetted width on each day during the growing season (1 April to 30 September). Once this metric has been calculated for each day of growing season, the average over the entire period is summarized for each year. The minimum, average, and maximum values over the range of yearly averages are tabulated for each alternative.

What are the key assumptions and uncertainties associated with the impact of operations on riparian wetting?

The key uncertainty is whether the distance between the channel edge and the wetted edge is important to riparian processes or riparian-aquatic connections. The performance measure scores zero at two times mean annual discharge (MAD) and higher levels of flow, hence this performance measure is not sensitive to the magnitude or duration of riparian zone flooding. However, we do expect this performance measure to be correlated with the magnitude and duration of riparian zone flooding. Accordingly, this performance measure is an index for riparian zone wetting.

Is adequate information available to calculate this performance measure?

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

References

Summit Environmental Consultants Ltd. (June 2000). *Cranberry Creek Fisheries and Hydrology Study, Volumes I and II*. Vernon, B.C.

2. Bankfull Exceedance

What is this performance measure?

This performance quantifies the duration of bankfull exceedence, which is expected to correlate with a measure of the function of riparian habitats.

For what locations and timing is this performance measure relevant?

The performance measure is calculated at Site 5, roughly mid-way between in the middle section of Lower Cranberry Creek. Riparian vegetation in this area is suspected to be of highest quality along Cranberry Creek. The performance measure applies during the growing season.

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

The wetting of riparian habitats maintains community structure and ecological function by limiting the survival of some species and enhancing the survival of others. Overbank flow has the greatest impact on plant community structure during the growing season, when plants, particularly young individuals, are most sensitive to flooding. Flooding during the growing season inhibits the recruitment of strictly terrestrial plants. Plants typically found in the riparian zone are more tolerant to this seasonal flooding and may even require some flooding to successfully recruit. A well-known example of this is the cottonwood (several species), however, alder and other deciduous species are more flood tolerant than many coniferous species and will benefit from overbank flow.

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

One of the Walter Hardman Water Use Plan Consultative Committee's key objectives was to maximize the production and diversity of wildlife along Cranberry Creek. The Committee identified riparian habitat as an issue for evaluation, and overbank flow is suspected to be important to the community structure of the riparian zone.

How is the bankfull exceedence performance measure calculated?

Summit Environmental Consultants (2000) collected physical habitat information in Cranberry Creek by measuring wetted width, depth, and velocity at whole-river transects. Summit summarized the data to develop hydrometric relationships that linked wetted width to river flow. The relationship collected from transects at Site 5 was used to calculate the wetted width at a given flow and from this to calculate the distance between the channel edge and the wetted edge. It was assumed that overbank flow was achieved at two times the mean annual discharge (which is 11.6 m^3/s at Site 5) for modelling purposes. Near the end of the Walter Hardman water use planning process, an analysis was completed that estimated overbank flow at 38.9 m^3/s (Summit, 2004b), however, this flow is exceeded on only one day in the modelled flows, providing no sensitivity to discriminate among alternatives. Accordingly, the lower estimate of flow was used for modelling purposes.

The overbank flow performance measure calculates the number of days when overbank flows are exceeded during the growing season (1 April to 30 September). Once this metric has been calculated for all exceedences throughout growing season, the average over the entire period is summarized for each year. The minimum, average, and maximum values over the range of yearly values averages are tabulated for each alternative.

What are the key assumptions and uncertainties associated with the impact of operations on bankfull exceedence?

The key uncertainty is whether riparian habitat exists in sufficient quantity along Cranberry Creek to be important to wildlife or fish species, even at a local level. Secondly, the role of flow in maintaining community structure along Cranberry Creek is unknown, and may be limited, given the high gradient and moderate confinement of the channel. The third uncertainty is whether changes in overbank flow duration and frequency will occur under potential operating scenarios which will affect community structure. This last uncertainty relates to the minimum significant increment of change (MSIC) value, of which we are more uncertain than for other performance measures.

Is adequate information available to calculate this performance measure?

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

References

Summit Environmental Consultants Ltd. (June 2000). *Cranberry Creek Fisheries and Hydrology Study, Volumes I and II.* Vernon, B.C.

Summit Environmental Consultants Ltd. (2004). *Lower Cranberry Creek Ice Study*. Vernon, B.C.

APPENDIX H: POWER STUDIES MODELLING – INFLOW DATA

Inter-office memo

ENGINEERING

TO:	Vesta Filipchuk	DATE:	3 November 2003
FROM:	Faizal Yusuf	FILE:	File: WHNWUP C510
SUBJECT:	Walter Hardman Water Use Plan Power Studies Modelling – Inflow Data		

The power study for the Walter Hardman Water Use Plan (WUP) will be based on a daily time-step spreadsheet simulation which routes flow through the project assuming no net change in storage. Historically the flows in Cranberry Creek above the diversion dam were regulated by the Coursier Lake Reservoir Dam, which stored water from Upper Cranberry Creek during high inflow periods and released water during lower inflow periods. However, Coursier Dam was decommissioned in summer / fall 2003, with outflows from Coursier Lake to returning to the natural, unregulated flow pattern. Since the focus of the Water Hardman WUP is on the future operation of the diversion dam, flow control structures, Headpond and Generating Station, the power study requires daily inflows which are representative of the current flow regime without the storage effects of Coursier Lake Reservoir Dam as model input.

Natural Flow Record

Flow measurements in Cranberry Creek are available from a Water Survey of Canada gauge (WSC 08NE123, A=100 km^2), in operation from 1980 to 1986, located just above the diversion dam. As part of a Cranberry Creek fisheries and hydrology study[1] this measured data was used to estimate flows at different locations along Cranberry Creek under regulated and natural conditions. The estimated natural flows were reconstructed from the recorded, regulated flow data using water balance equations and a series of simplifying assumptions to eliminate the regulating effects of Coursier Dam. Based on a brief review of the annual inflows recorded on other streams in the region, it appears that the 1980–1986 period contains a mix of above and below-average inflow years with the overall average for the period being slightly below the long term average inflow.

[1] Summit Environmental Consultants Ltd. (June 2000). *Cranberry Creek Fisheries and Hydrology Study, Volumes I and II.*

Figure 1 shows the estimated post-Coursier Decommissioning natural flows in Cranberry Creek immediately above the diversion dam. Within the six-year period of estimated record, the peak daily inflow is 48 m^3/s associated with a storm event in July 1983. On average, the annual peak daily inflow is approximately 21–24 m^3/s, typically occurring in late May or early to mid-June during the freshet. Winter low flows appear to vary between approximately 0.5 m^3/s and 2.0 m^3/s, however, this portion of the estimated record would be the most sensitive to any errors and approximations associated with the simplifying assumptions that were used to estimate the record.

The possibility of extending the short period of natural Cranberry Creek flow record was investigated by comparing the Cranberry flow data above the diversion dam with flows measured at a Water Survey of Canada gauge located at Lower Kuskanax Creek (WSC 08NE006, A=337km^2). Lower Kuskanax Creek was the reference stream used to develop a synthetic hydrograph for Coursier. The flow per unit area hydrographs for both Cranberry Creek and Lower Kuskanax Creek are plotted in Figure 2. While the hydrographs generally compare reasonably well, the flows in the late summer at the lower Kuskanax station are consistently lower than the natural Cranberry Creek flows. This difference is likely due to more glaciation in the Cranberry watershed. Since a longer period of record would not necessarily add additional value to the power study in terms of accuracy and the existing record does not appear to have any extreme hydrological years, it was decided not to extend the inflow record.

Quality Assurance

Before using the six-year natural inflow record as input for the power study spreadsheet model the daily flows were smoothed to eliminate any anomalous values. Flows were only modified in the fall/winter season to eliminate obvious erroneous upward or downward spikes or questionable periods of no flow. Spring and summer flows were not considered for smoothing since they are generally above the 4.5 m^3/s limit of the flow diversion control structures and would therefore have no effect on the power study calculations. Flows measured at the Lower Kuskanax Creek gauge (WSC 08NE006) were used to help smooth the anomalous data. The smoothed daily natural inflows for Cranberry Creek above the diversion dam are plotted in Figure 3 along with the "unsmoothed" flows for comparison.

APPENDIX I: BOX PLOTS SHOWING VARIABILITY OF FISH AND WILDLIFE PERFORMANCE MEASURE SCORES FOR WALTER HARDMAN HYDROELECTRIC FACILITY

The following pages contain box plots showing the range of scores for each fish performance measure across the nine operating alternatives considered by the Walter Hardman Water Use Plan Consultative Committee (Figure I-1 to Figure I-11).

Interpreting Box Plots

The main performance measure metric used is the mean (average) value modelled over 33 years of simulated operation of the Walter Hardman hydroelectric facility. This means that for a given alternative, the value of that performance measure is the average over the six years of modelled output. The mean values are shown as hollow circles (O).

The box plots also show two other metrics that can be interpreted as follows:

- **Minimum values**: The minimum value of the performance measure over the six year modelling period.

- **Maximum values**: The maximum value of the performance measure over the six year modelling period.

The minimum and maximum values are shown as dashes at the end of a bar connecting the two values to the median circle.

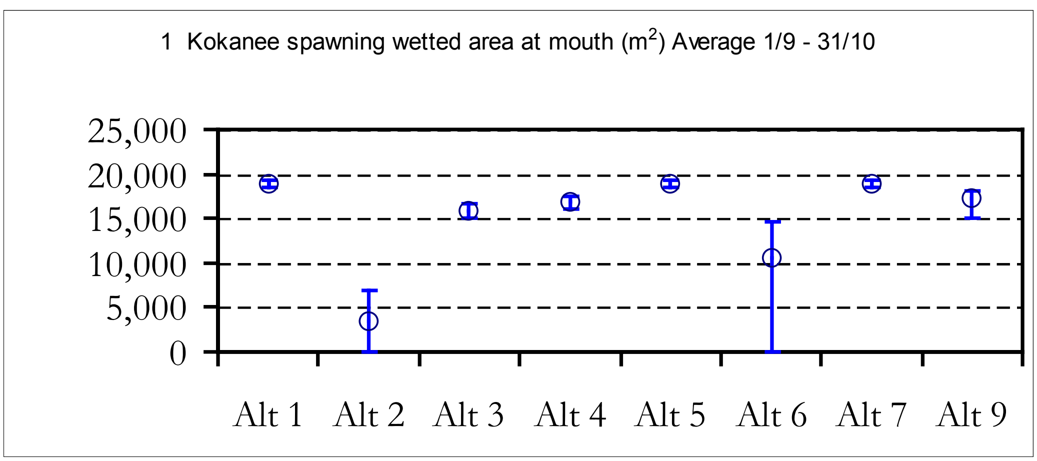


Figure I-1: PM 1 Kokanee Spawning Wetted Area at Mouth (m^2) Average

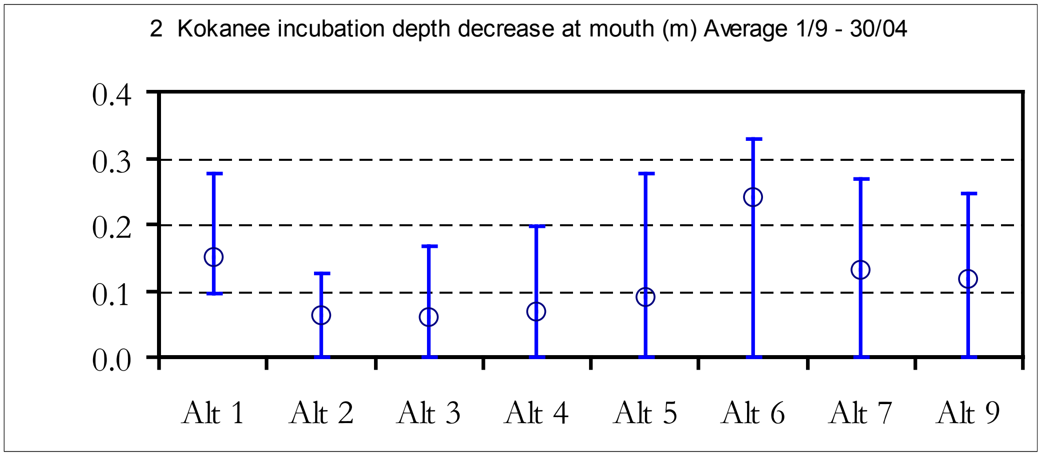
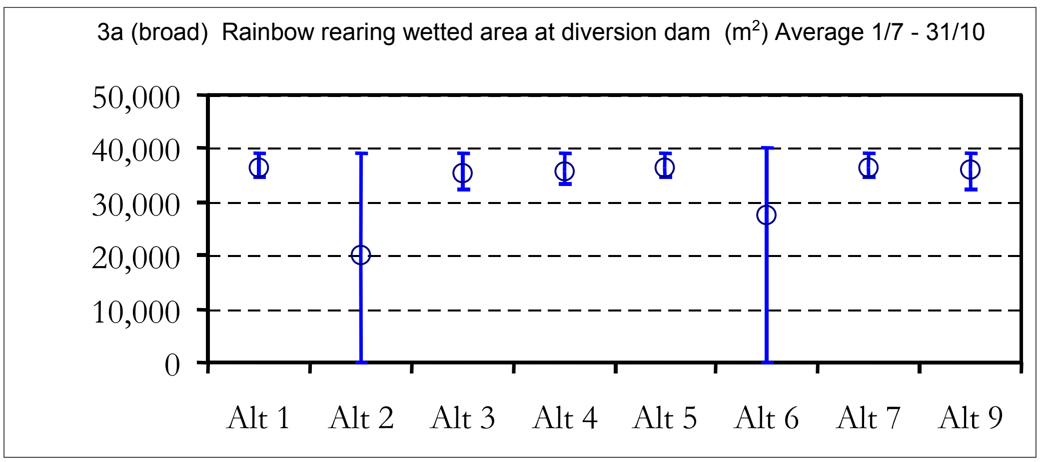


Figure I-2: PM 2 Kokanee Incubation Depth Decrease at Mouth (m) Average



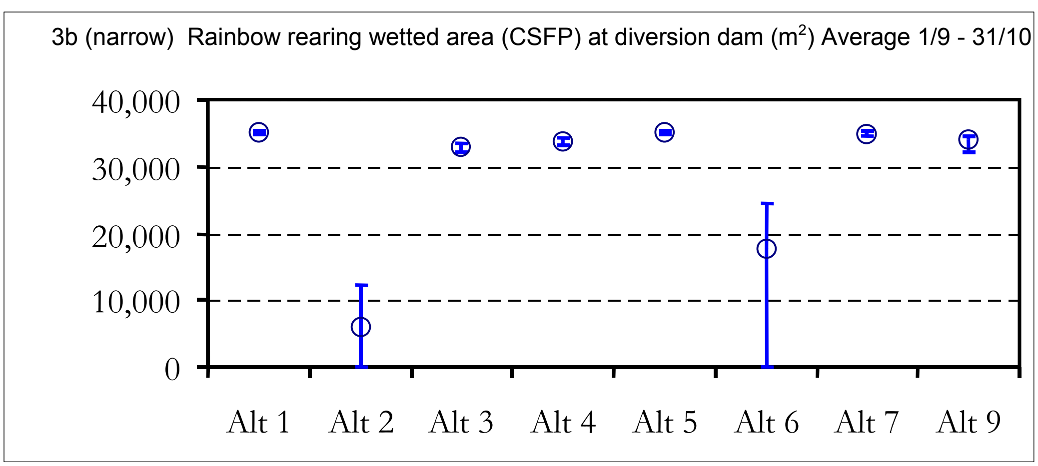
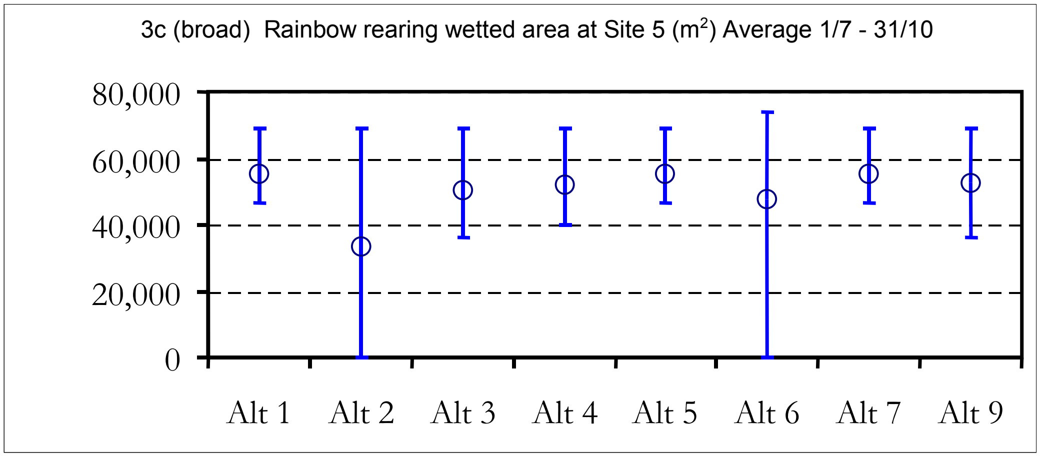


Figure I-3: PM 3a, b Rainbow Rearing Wetted Area at Diversion Dam (m^2) Average
a) Broad b) Narrow

Not selected as a final trade-off performance measure, only Site 5 – narrow selected.



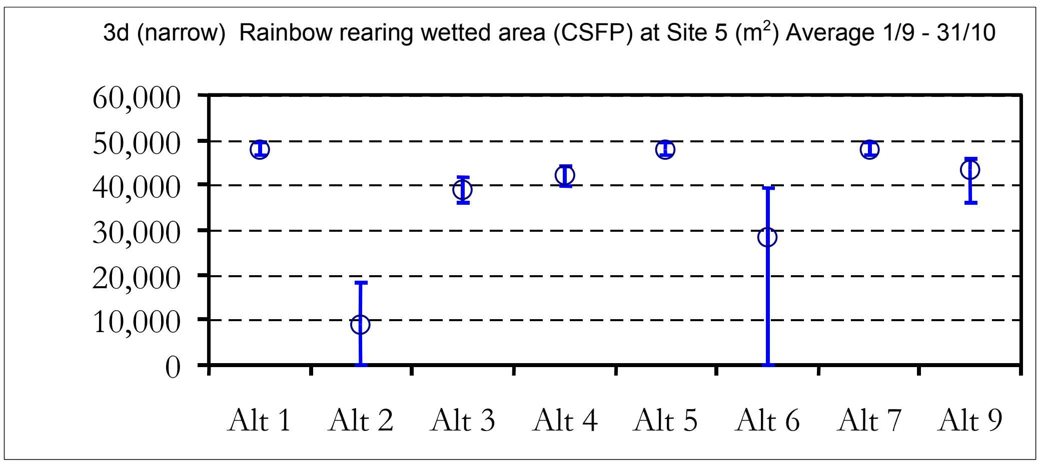
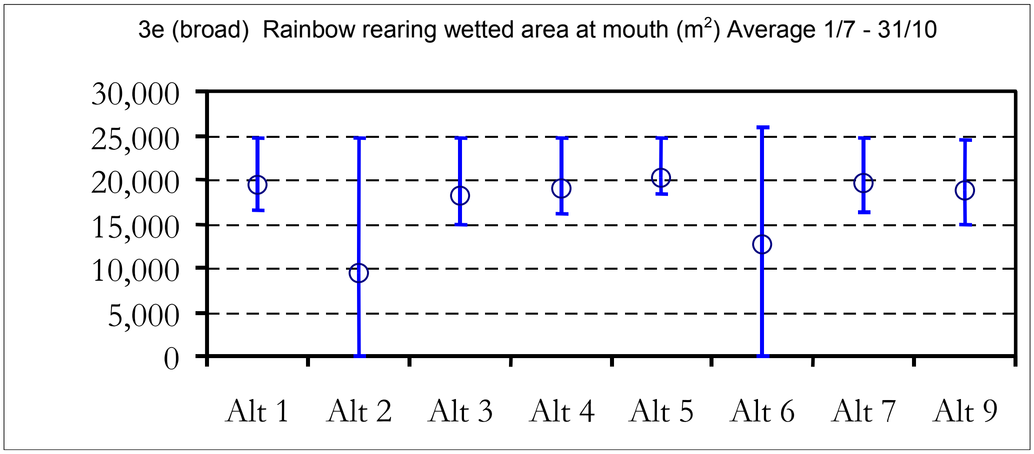


Figure I-4: PM 3c, d Rainbow Rearing Wetted Area at Site 5 (m^2) Average c) Broad d) Narrow

3d selected as a final trade-off performance measure for all rainbow rearing habitat.



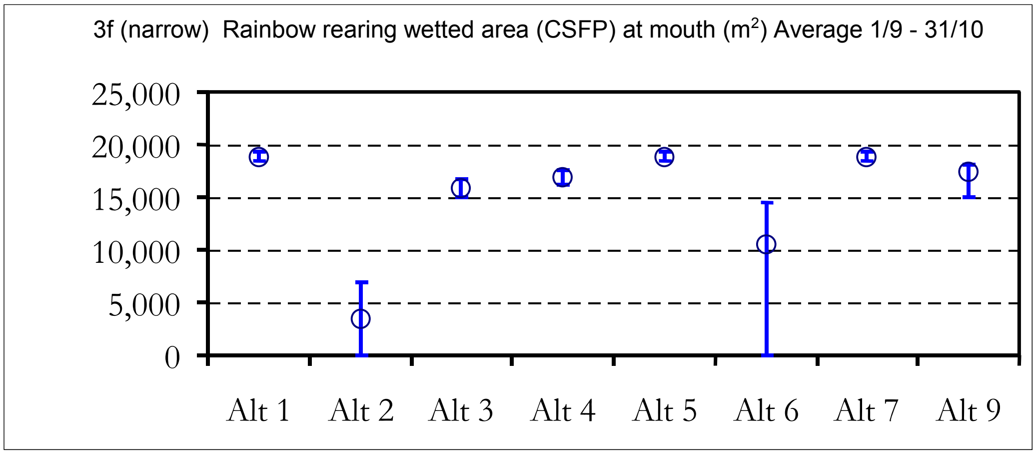
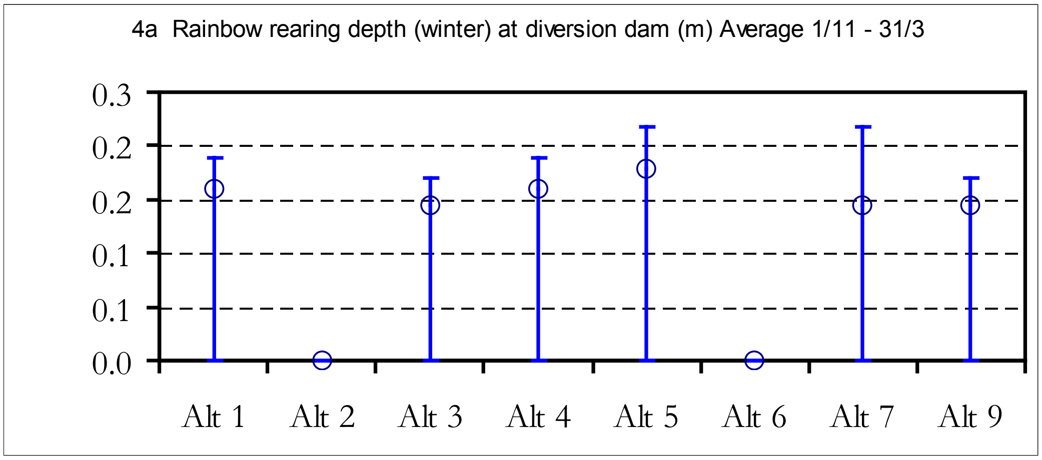
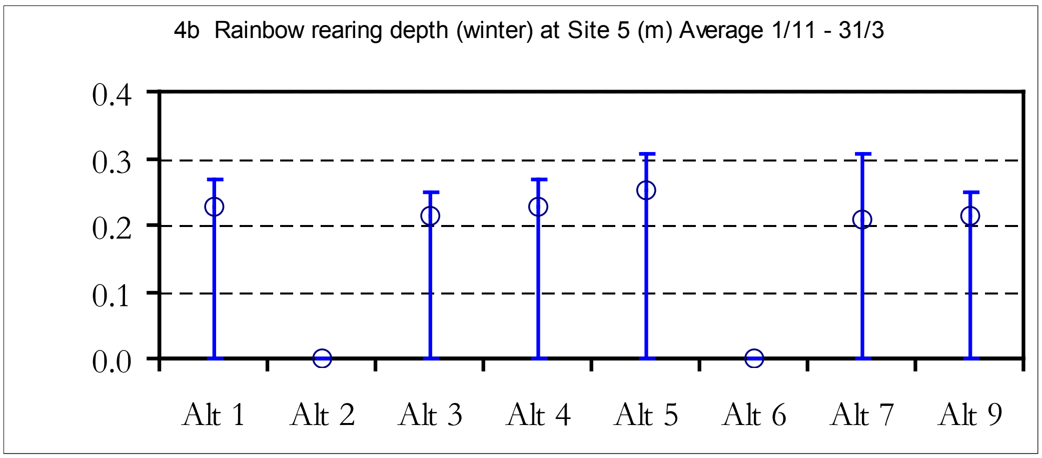


Figure I-5: PM 3e, f Rainbow Rearing Wetted Area at Mouth (m^2) Average e) Broad f) Narrow

Not selected as a final trade-off performance measure, only Site 5 - narrow selected.





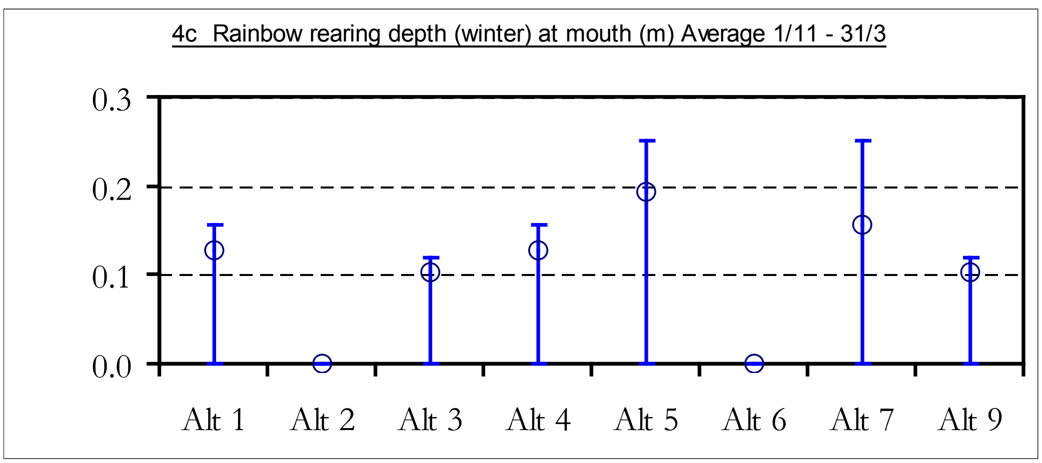


Figure I-6: PM 4a, b, c Rainbow Rearing Depth (Winter) (m) Average, at a) Diversion Dam, b) Site 5 and c) the Mouth

Only Site 5 selected as a final performance measure.

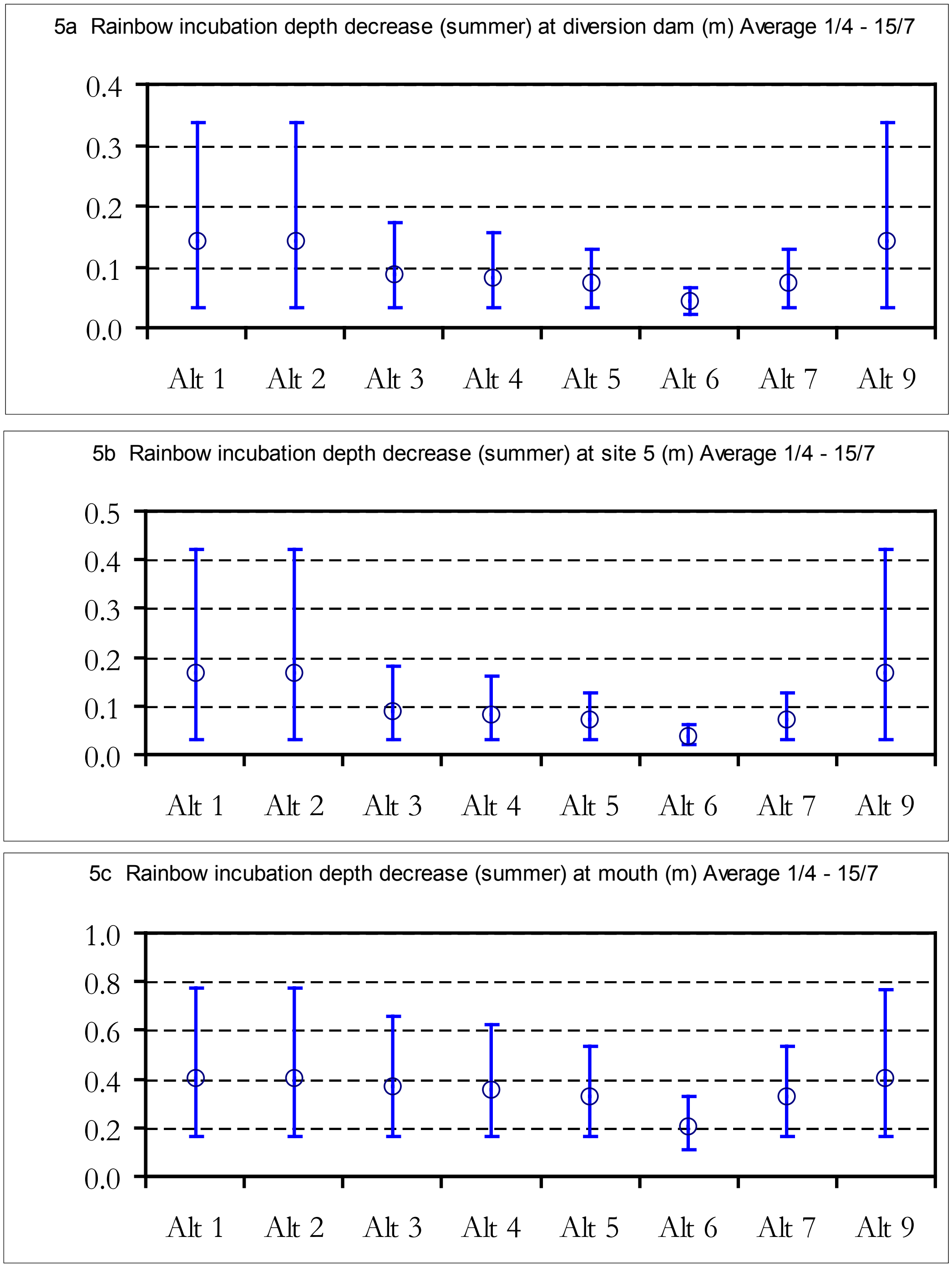


Figure I-7: PM 5a, b, c Rainbow Incubation Depth Decrease (Summer) (m) Average, at a) Diversion Dam, b) Site 5 and c) the Mouth

Only Site 5 selected as a final performance measure.

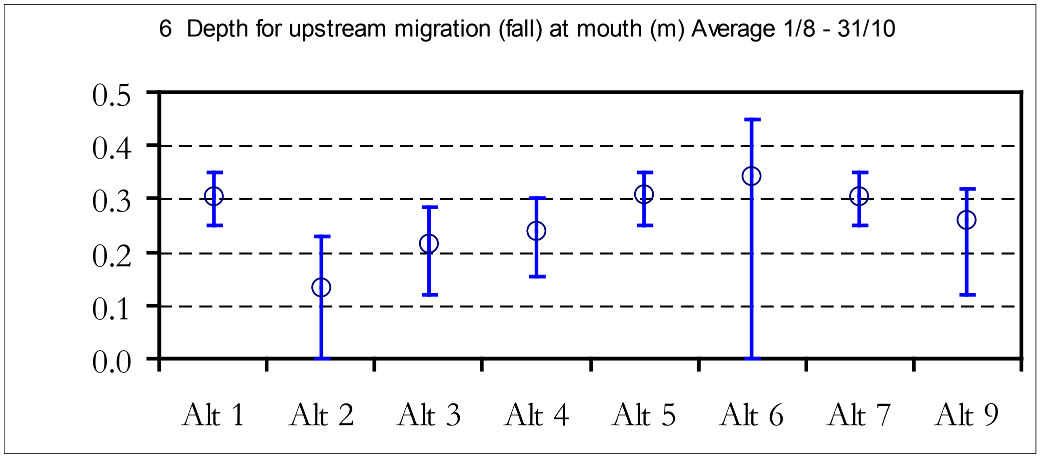


Figure I-8: PM 6 Depth for Upstream Migration (Fall) at Mouth (m) Average

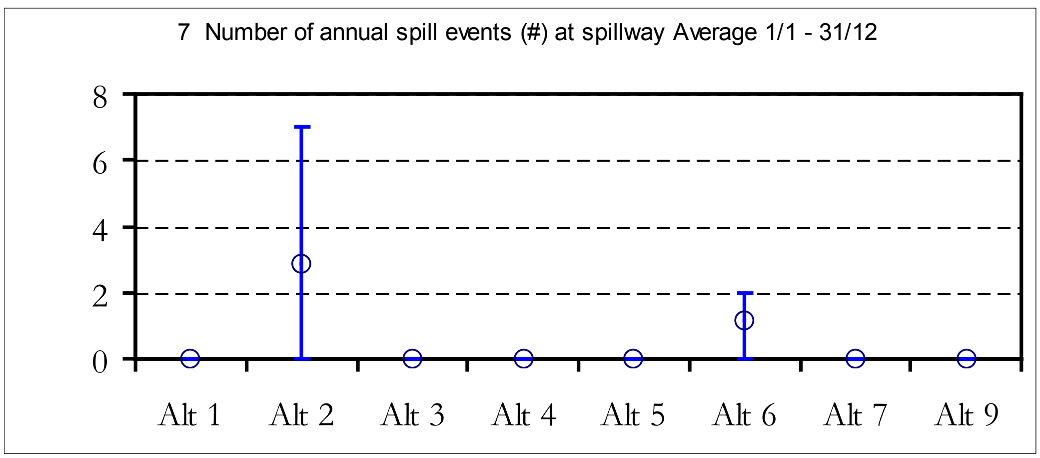


Figure I-9: PM 7 Number of Annual Spill Events (#) at Spillway Average

Not selected as a final trade-off performance measure, insensitive across alternatives.

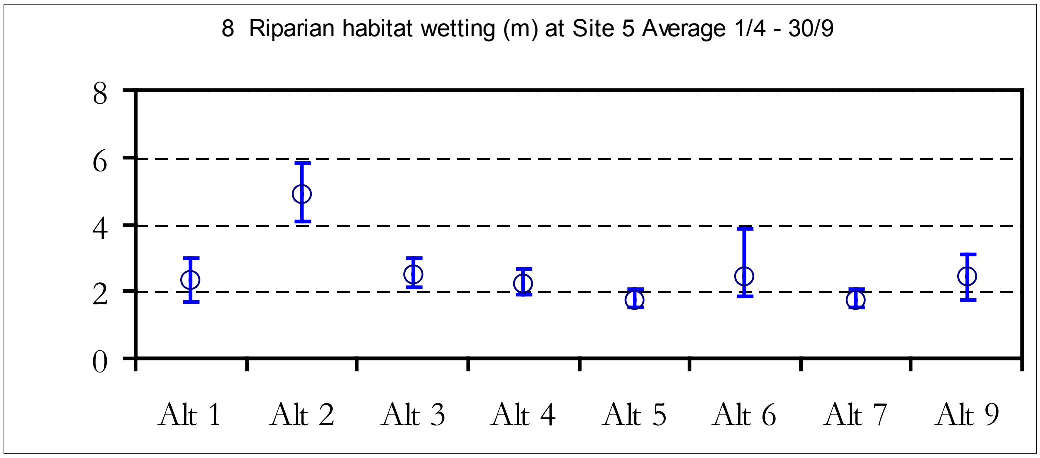


Figure I-10: PM 8 Riparian Habitat Wetting (m) at Site 5 Average

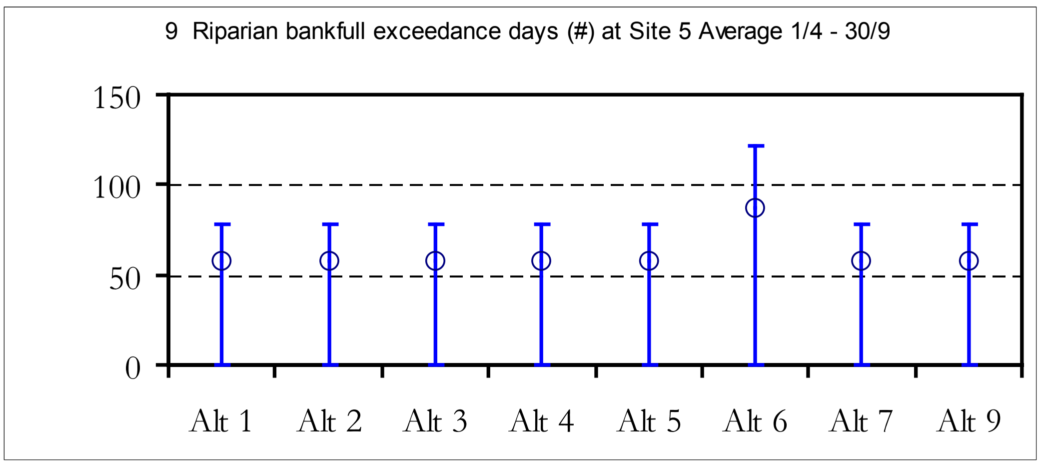


Figure I-11: PM 9 Riparian Bankfull Exceedence Days (#) at Site 5 Average

Not selected as a final trade-off performance measure, insensitive across all except Alternative 6.

APPENDIX J: DIRECT RANKING EXERCISE WORKSHEET

The direct ranking exercise was used during the trade-off discussions to help the Consultative Committee identify preferences and articulate values. The exercise involved two steps to completing the worksheet.

Step 1: Consider the trade-offs between the alternatives. None is perfect, but several may perform better overall than other alternatives. Assign a rank of #1 to your first choice. Ties are allowed.

Step 2: Indicate if you Endorse, Accept or Block each Alternative. Please comment on why. "Accept with Reservations" is also an option – and an opportunity to express a specific concern.

#	Alternative	Rank	Endorse Accept Block	Comment
1	**Variable Minimum**			
2	**Power**			
3	**0.1 m^3/s**			
4	**0.2 m^3/s**			
5	**0.5 m^3/s**			
6	**Rip. Max.**			
7	**Power_Fish**			
8	**0.05 m^3/s**			
9	**(Alternative 9)**			

APPENDIX K: VISUAL DECISION AIDS FOR TRADE-OFF PROCESS

Three visual tools were used throughout the trade-off discussion process. These included:

- Value Rankings: Pair-wise comparison of alternatives according to individual ranks.
- Cumulative Ranking Chart: Comparing the relative scoring ranks for each alternative.
- Interactive Consequence Table: Highlighting differences between alternatives using the Minimum Significant Increment of Change (MSIC) score.

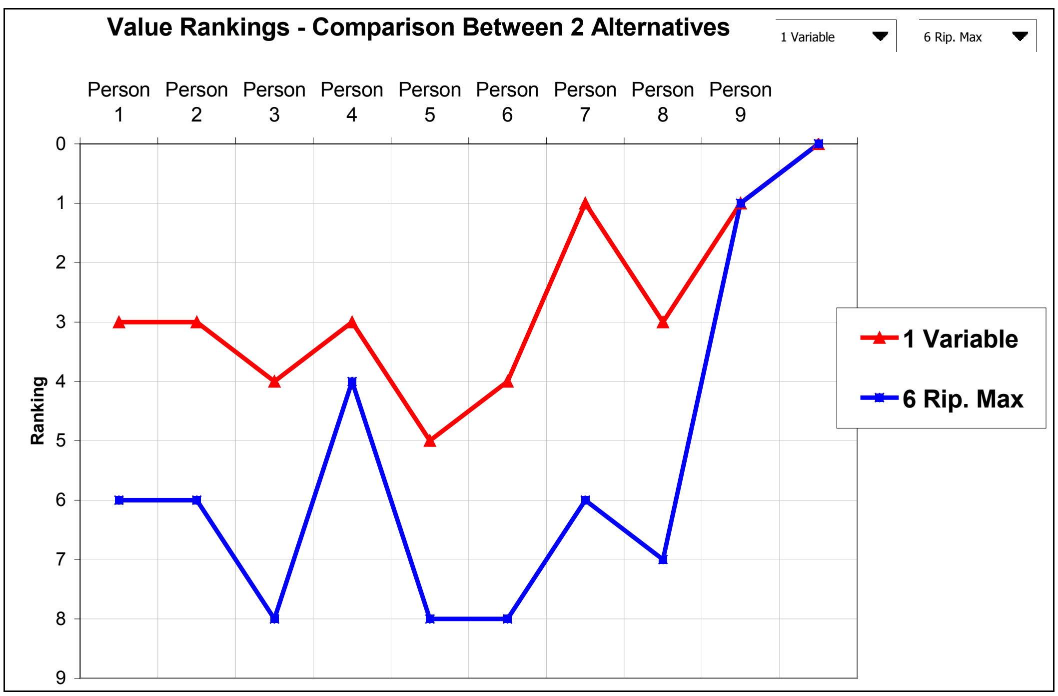


Figure K-1: Value Rankings for Alt 1 and Alt 6

As shown in Figure K-1, all other alternatives were more preferred than Alt 6 by all Consultative Committee members except one, who tied it for first place with Alt 1.

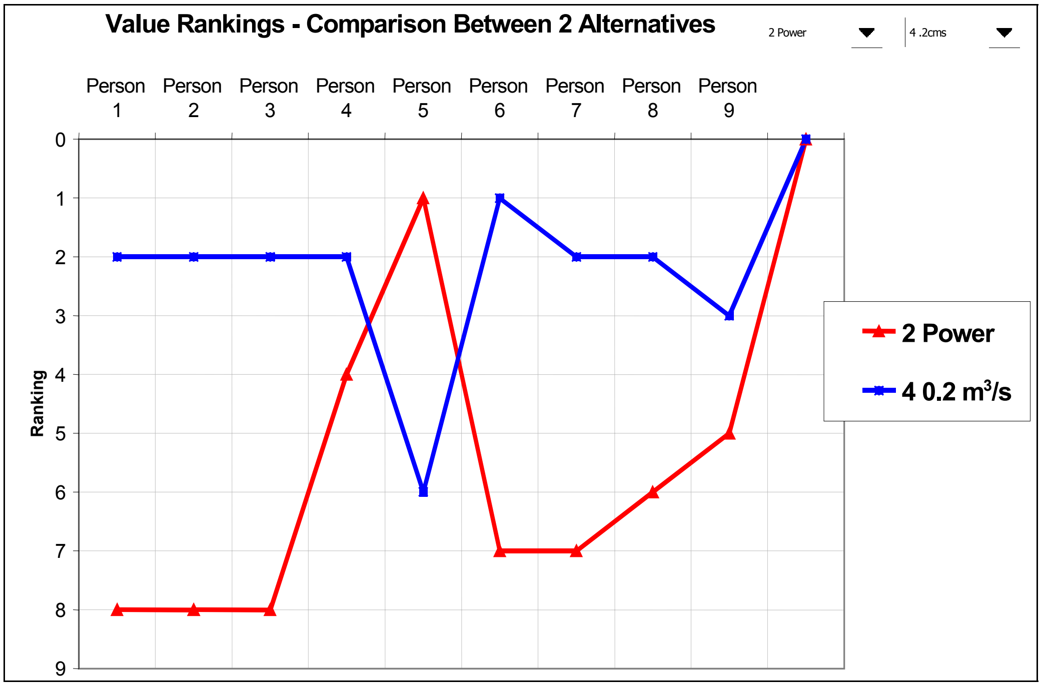


Figure K-2: Value Rankings for Alt 2 and Alt 4

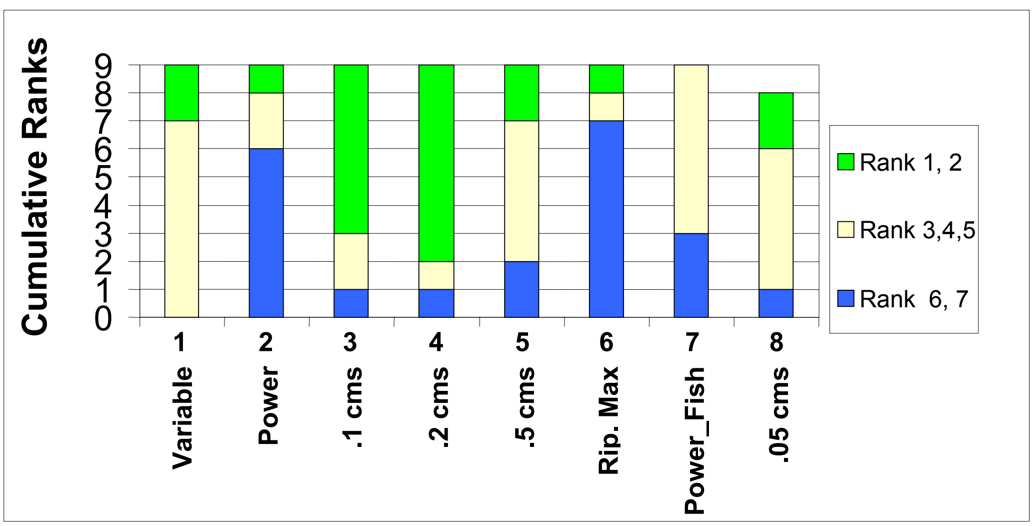


Figure K-3: Direct Value Rankings for Alt 1, 2, 3, 4, 5, 6, 7 (dropped) and 8

Combined ranking shows that Alt 2 and Alt 6 were less valued by Consultative Committee members than other alternatives. Alt 3 and 4 had high initial support. Alt 4 was selected by eight Committee members as 1st or 2nd choice, one member picked it last. The BC Hydro representative did not prefer Alt 3 or 4 because he stated he did not see clear benefits for a minimum flow yet. Other members felt that a minimum flow will substantially increase fish habitat.

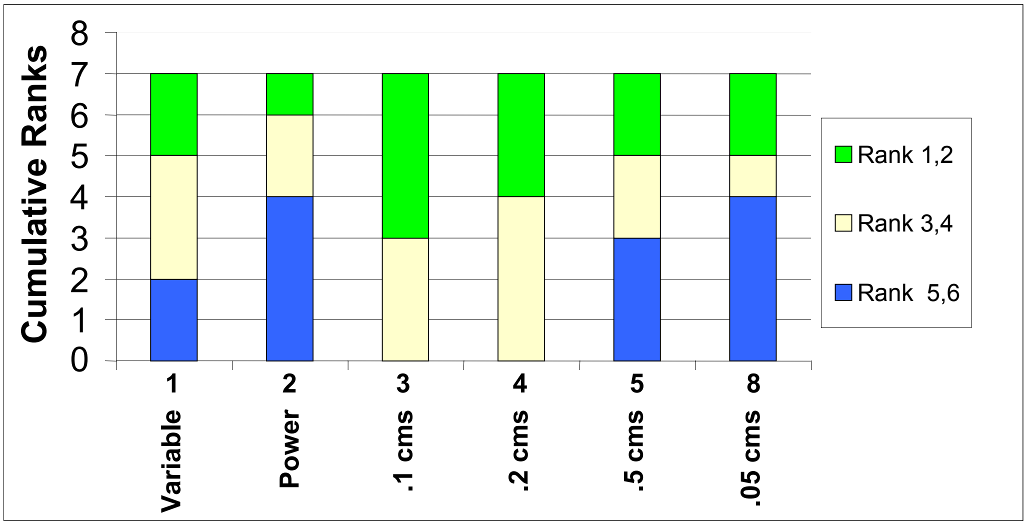


Figure K-4: Value Rankings for Alt 1, 2, 3, 4, 5 and 8

Table K-1: Initial Level of Support between Alt 9, 3 and 4

	Alt 9 (0.1–0.5 m^3/s variable)	**Alt 3 (min 0.1 m^3/s)**	**Alt 4 (min 0.2 m^3/s)**	**Comments**
Dan	Accept	Endorse		Monitoring issue is still a concern. Prefer monitor with 0.1 m^3/s vs. 0.2 m^3/s. Alt 9 needs more revisions – it makes more sense.
Dave	Block	Accept	Block	Felt that Alt 1 and 4 were too expensive for the amount of environmental benefit. Capital costs for the Alt 9 were higher than what we was initially said. Target 10 % MAD - which is close to 0.1 m^3/s. Thought that Alt 9 and Alt 4 was a trade-off between species. There are a lot of costs involved in Alt 9 in operating the facilities with changes. Thought that Alt 2, power option, with a monitoring and review period was also an alternative. Spend money on monitoring or spend the same amount on the water – leaning toward the water option. Alt 9 was too expensive and too complex and performance measures were established to provide certainty. Trade-off between species.

	Alt 9 (0.1–0.5 m^3/s variable)	**Alt 3 (min 0.1 m^3/s)**	**Alt 4 (min 0.2 m^3/s)**	**Comments**
Loni	Accept	Accept	Accept	Although Alt 9 may be more complicated to apply, it would be good for the community to train employees. As far as physical works go, may be beneficial to the power side. The monitoring should go along with all three choices, given data limitations. Second choice is Alt 3 (0.1 m^3/s). Third Choice is Alt 4 (0.2 m^3/s). Can't endorse any because we're lacking data. Need to monitor to do what's right for the environment and power and not forget about being flexible for the future.
Jayson	Endorse	Accept	Endorse	Benefits for late summer rearing and this is important. Endorsed Alt 4, 0.2 m^3/s, as performance measures better for fish interests and costs were in line with the program. Accepted Alt 3 but felt habitat values weren't as good as the others.
Jay/ Howie	Endorse	Block	Block	Value in 0.5 m^3/s as more water is important. During critical periods. Does use realistic management of species and values of interests. Balances energy and need. A little difference in wetted area between 0.2 and 0.1 m^3/s alternatives. Alt 9 did increase the cost effectiveness. Looking to see if variations provide benefits. Need to monitor temp and flow and relate to habitat with transects already in place.
Mark	Endorse	Accept	Accept	Endorse Alt 9 (condition that at 0.1 m^3/s in winter put in a one time habitat structure to increase cover and flow). Accept Alt 3 – with habitat conditions. Accept Alt 4 – 1st choice over Alt 3 with winter cover. Will include habitat conditions.
Terry	Endorse	Accept	Accept	Terry, would hate to see us have a non-consensus because people are unwilling to move on their preferences. In many cases we are not far apart. Get biggest bang for buck with Alt 3. Concern about lack of data for Alt 9.
Fred	Endorse	Block	Block	Alt 9 gives you more true ecological values – the issue of habitat structures needs to be addressed.

	3 .1 m^3/s	4 .2 m^3/s	9 VARMIN2
1 KO wetted area (m2) (+)	15,877	16,854	17,372
2 KO incubation depth (m) (-)	0.06	0.07	0.12
3d RBT rear wetted area st5 n (m2) (+)	38,802	42,032	43,435
4b RBT winter rear st5 (m) (+)	0.21	0.23	0.21
5b RBT incub. st5(m) (-)	0.09	0.08	0.17
6 KO migration depth (m) (+)	0.21	0.24	0.26
11a lost revenue ($/yr) (-)	$74,700	$127,402	$104,000

Figure K-5: Round Table Regarding Alt 9, Alt 3 Alt 4

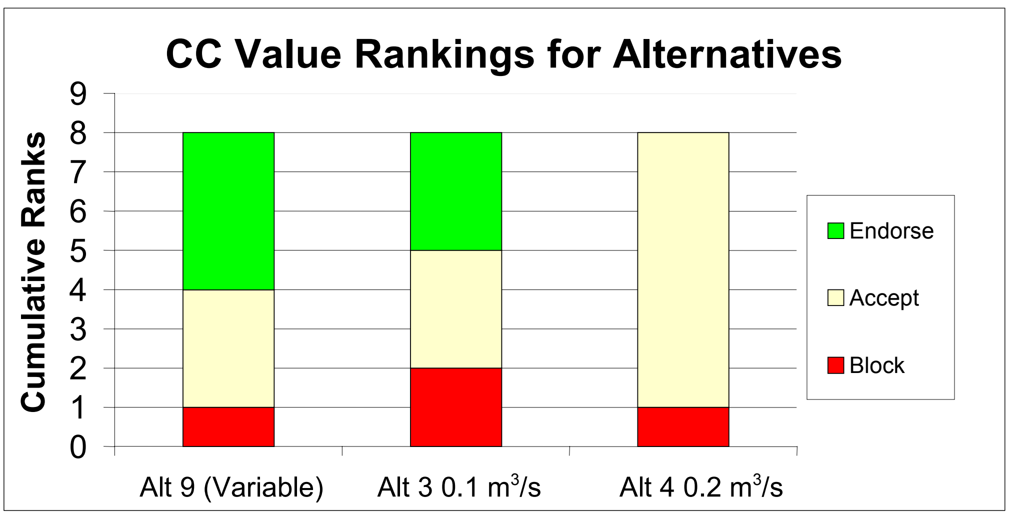


Figure K-6: Value Rankings Alt 9, Alt 3 and Alt 4

APPENDIX L: ELIGIBILITY CRITERIA FOR WATER USE MONITORING STUDIES

The Water Use Plans for the BC Hydro facilities will contain recommended operational changes that are designed to address issues identified during the development of the Water Use Plans. However, a significant degree of uncertainty may exist regarding the effectiveness of the recommended operational changes. This uncertainty is largely due to the difficulty in drawing scientifically defensible conclusions with limited information. In some cases, there will be a need to verify the effectiveness of the recommendations put forward by the Water Use Plan Consultative Committees. These specific Water Use Plans will include recommendations for a monitoring program that will provide additional data designed to measure results/effectiveness of the operational changes specified by the Comptroller of Water Rights for each of the facilities.

Monitoring Program Elements

The primary objectives of the post-implementation Water Use Plan Monitoring Program will be to assess whether the operational changes, as specified in the Water Use Plan, provide the expected results (in terms of the performance measures and/or the fundamental objectives), or whether the operations need further adjustment (which could include adjustment back to the Reference Case operations).

Principles

The individual Water Use Plan Consultative Committees will be responsible for defining and prioritizing the recommended post-implementation monitoring studies. The recommendations for monitoring studies will be included in the Consultative Committee Report and the Water Use Plan presented to the Comptroller of Water Rights. Each monitoring study will be designed to meet the following principles:

- An expected result from each study must have the potential to change the way water is used at BC Hydro facilities.
- Each study must have the ability to distinguish between competing hypotheses. This can be assessed using a range of techniques, from a calculation of statistical power to professional judgment around the weight of evidence.
- Each study must be able to show results in a timely manner (e.g., by the next scheduled Water Use Plan review period).
- Each study must show cost effectiveness by demonstrating that it is the least expensive way to generate that level of learning both within that Water Use Plan and across other Water Use Plan Monitoring Programs.

In order to ensure that the above principles are met, requests for monitoring studies should be described in sufficient detail to allow the evaluation of objectives, methodologies, deliverables, and estimated costs. This information was collected by the Fish Technical

Subcommittee and then the Consultative Committee fill out the “Information Matrix for Water Use Plan Monitoring Requests” found later in this section (Table L-1).

Decision Tree for Evaluating Water Use Plan Monitoring Requests

The following decision tree embodies the principles of monitoring laid out by the Water Use Planning Inter-Agency Committee developing monitoring protocol. This tree is to be used in conjunction with input from the Water Use Planning Management Committee (MC), Resource Valuation Advisory Team (RVAT) and Fisheries Advisory Team (FAT), and will be used by the facilitator to assist Subcommittees and the Consultative Committee in assessing monitoring requests. Step 1 starts at the Subcommittee levels and this process is carried out for each proposed study (Figure L-1).

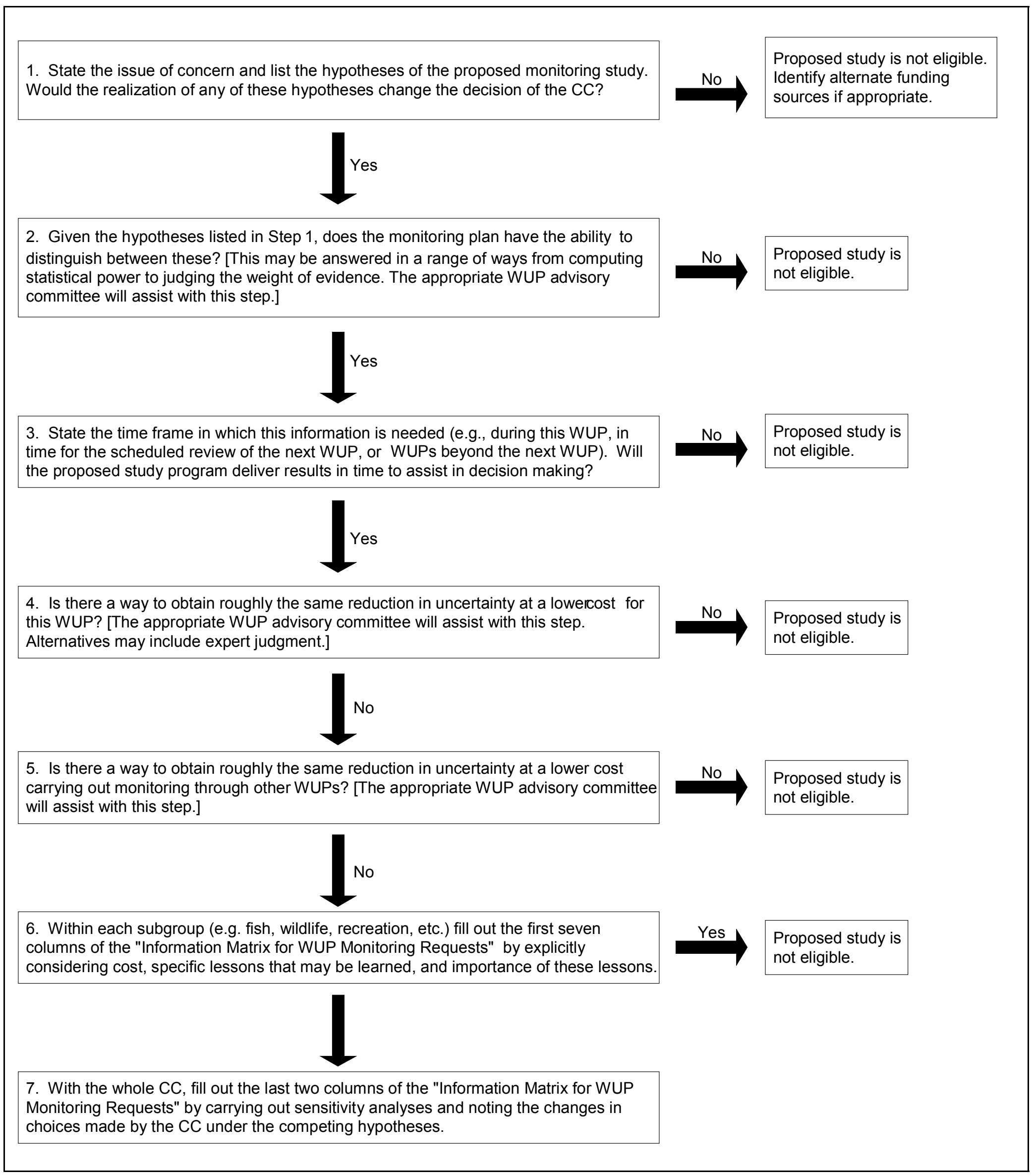


Figure L-1: Decision Tree for Evaluating Water Use Plan Monitoring Requests

Table L-1: Information Matrix for Water Use Plan Monitoring Requests

Study	Description	Data Gap Addressed	Learning	Duration	Time Frame	Cost	Willingness to change operations	Overall Rating
Location of Water Use Plan, Title of Study, Interest Area.	*Describe the scope and methodology for the study.*	*List the issue, the competing hypotheses and the estimates of the probability of these competing hypotheses being true.*	*Assess the amount of learning expected through monitoring (high, medium, low).*	*Estimate the duration of study program.*	*State the time frame in which the information will be used (before, during or after the next Water Use Plan review).*	*Estimate the cost of the study (including any losses of power revenue).*	*State the willingness of the Consultative Committee to change water allocation (high, medium or low).*	*State the overall rating/priority of the study given the information in all the other columns.*

Filling out the Information Matrix

The Subgroups can fill out the first seven columns, and the last two are filled out by the Consultative Committee.

"Willingness to Change Water Allocation" Scale Explained

These scales will be developed once the final choice of the Consultative Committee (CC) has been made. At that time, key uncertainties about the performance measures and/or their link to fundamental objectives can be tested through sensitivity analyses, and the change in the support from the CC for the various alternatives considered can be observed.

High Importance: It is *clear* that the CC will change its final choice if one of the alternative hypotheses prevails. This change includes a shift in support *away* from the original choice made and the convergence of the CC's support on another, *existing* alternative.

Medium Importance: A large shift in support away from the final choice of the CC takes place under one of the competing hypotheses. This shift in support may include some people preferring to block the original choice of the CC. However, *it is not clear* that another, *existing* alternative would be chosen by the CC under this competing hypothesis.

Low Importance: A shift in support away from the final choice of the CC may occur. However, *it is clear* that the final choice of the CC will not be changed to another, existing alternative. This decision may be a non-consensus Water Use Plan.

"Learning" Scale Explained

High – monitoring study will definitely lead to quantitative discrimination among all of the competing hypotheses.

Medium – monitoring study will likely lead to the ability to discriminate quantitatively among some of the competing hypotheses.

Low – likely to allow only qualitative comparisons among a few competing hypotheses.

"Overall Rating of Study" Scale Explained

High Importance – There is a consensus (or close) agreement that this monitoring program should be included as a request within the consultative report.

Medium Importance – There is no clear consensus as to whether this monitoring program should be included as a request within the consultative report.

Low Importance – There is a consensus (or close) agreement that this monitoring plan should not be included as a request within the consultative report.

APPENDIX M: EVALUATION OF POTENTIAL WALTER HARDMAN WATER USE PLAN MONITORING STUDIES

Potential Monitoring Studies for Walter Hardman Water Use Plan

A preliminary list of potential monitoring studies was prepared for the January and February meetings, with opportunities for Committee members to provide input between meetings. All of the proposed studies related to an issue data gap or to uncertainty associated with key performance measures (Table M-1).

Water Use Plan Principles for Evaluating Monitoring Studies

The Walter Hardman Water Use Plan Consultative Committee was responsible for defining and prioritising the recommended Water Use Plan monitoring studies to address uncertainty. The recommendations for monitoring studies will be included in the Water Use Plan presented to the Water Comptroller for approval. Each monitoring study should be designed to meet the following principles or screening criteria:

- **Efficacy** – the study will provide results that could change the way water is used at the Walter Hardman facility.

  Test: Could the results from the study change the Committee's recommendations?

- **Sensitivity** – the study will distinguish between competing hypotheses or assumptions.

  Test: If the Committee's recommendations are based on more than one hypothesis or assumption, can the proposed monitoring study isolate the impact of each hypothesis or assumption?

- **Timeliness** – the study must be able to show results in a timely manner.

  Test: Will the proposed study program deliver results in time to assist in decision making during the next Water Use Plan Review?

- **Cost Effectiveness** – the study is the least expensive way to generate the learning both within that Water Use Plan and across other Water Use Plan monitoring plans.

  Test: Is there a way to obtain roughly the same reduction in uncertainty at a lower cost for this Water Use Plan?

An additional consideration that is not addressed for each of the proposed monitoring interests concerns impacts of the preferred alternative on the power interest. If the preferred alternative has insignificant cost to the power interest, there may be less interest in monitoring its effectiveness, since there would be no economic impact on operations.

Table M-1: Initial Monitoring Studies, Walter Hardman WUP CC Meeting February 23/24, 2004

Study	Location	Underlying Hypothesis / Data Gap	Methods	Intensity	Estimated Annual Cost	Experimental Design (phases and duration)
Kokanee spawning	Lower Cranberry	Changes in spawning flow will affect quantity and quality of spawning habitat.	Survey spawning gravel, depth, and velocity: model changes in habitat with flow.	15 transects	$25,000	One year
Kokanee incubation	Lower Cranberry	Changes in incubation flow will affect egg-fry survival.	Monitor changes in water depth over kokanee redds.	30 redd sites	$15,000	One year
Rainbow rearing habitat	Site 5	Changes in flow during the CSFP will affect rainbow trout rearing habitat.	Habitat studies: measure wetted width, depth, velocity at transects. (Existing Summit data could be re-analyzed and may provide additional transects and/or reduce cost).	15 transects	$25,000	One year
Rainbow over-wintering habitat	Site 5 (diversion dam to falls)	Over-winter habitat for rainbow trout is adequate under existing flows.	Inventory rainbow trout over-wintering habitat; quantify use, assess adequacy. FHAP methodology?	Continuous	$7,500	One year
Rainbow incubation habitat	Site 5	Rainbow trout redds are dewatered by changes in flow.	Identify spawning sites for rainbow trout, survey, monitor depths over redds through incubation.	30 redd sites	$15,000	One year
Migration depth (kokanee and bull trout)	Lower Cranberry (falls to mouth)	Upstream migration by kokanee and bull trout is impeded at low flows.	Foot survey to identify locations of difficult upstream passage; measure depths over redds.	Continuous	$5,000	One year
Spills	Lower Cranberry	Spill events can strand and isolate fish.	NA – handle with stranding protocol.			
Riparian wetted differential	Site 5 (may include downstream areas)	1. Changes in freshet flows will alter riparian community: 2. Changes in freshet flows will affect off-channel habitats for fish and amphibians.	1. Survey riparian habitat in Cranberry Cr. 2. Survey off channel habitats for fish and amphibians in Cranberry Cr. 3. Monitor 9 years post project to assess changes.	5 sites, with five transects with 10 plots each	$20,000 / YEAR	
Number of bankfull exceedence events	Site 5	Duration of bankfull inundation determines community structure.	Survey to identify level of bankfull flow. Survey key areas of riparian vegetation to allow estimate of duration of inundation.	5 sites, same as for PM 8	$5,000	One year

Screening Potential Monitoring Studies for Walter Hardman

Next, the Consultative Committee reviewed its initial list of potential monitoring studies and evaluated them against the principles and requirements for Water Use Plan monitoring studies (see section above).

Table M-2 lists each monitoring interest discussed by the Consultative Committee and evaluates whether it meets each of the four Water Use Plan monitoring principles. Typically, that can be assessed as “yes” or “no.” For some interests, it was less clear whether they would meet a given principle, and this is indicated as a “maybe.”

The key principle is efficacy or effectiveness: to qualify, a monitoring study must have the potential to lead to a change in the Consultative Committee’s water allocation recommendations. For example, the ability to affect habitat for rainbow trout through various life stages is a driver behind the some of the minimum flow operating alternatives considered by the Committee. The performance measures are critical to the interpretation and design of these alternatives. If monitoring of this performance measure showed that habitat is not affected by flow changes, then the preferred alternative might change.

Sensitivity is another key principle. If an issue is poorly understood or if natural variation so high that monitoring is unlikely to yield useful new information (i.e., an ability to discriminate between alternatives), then monitoring would not qualify.

Timeliness is important for those performance measures where long term monitoring is required: very long programs may not meet the Water Use Plan review period time frame.

Cost effectiveness is important because monitoring proposals are considered with reference to BC Hydro’s Water Use Planning program as a whole. Proposals for individual Water Use Plan at specific facilities (like the Walter Hardman Water Use Plan) will be compared across all Water Use Plans, and those individual proposals that provide the most learning per cost for the system as a whole will be favoured. Of course, there are some monitoring results that would only be relevant to Walter Hardman (e.g., the location of barriers to migration).

Potentially Qualifying Monitoring Studies

Based on the assessment of how well each potential monitoring study meets the water use planning monitoring principles (Table M-2), the monitoring studies were evaluated by the Fisheries Technical Committee and considered by the Consultative Committee. Monitoring interests that appeared to qualify and were recommended by the Committee are described in Appendix M.

Table M-2: Evaluation of Proposed Walter Hardman Water Use Plan Monitoring Studies against Provincial Water Use Planning Monitoring Principles

Final Study No.	Title	Learning Value?	Effective?	Sensitive?	Timely?	Cost Effective?
1	Kokanee Spawning and Incubation	Medium/High.	Yes (adjust minimum flow)	High	Yes	Yes
2	Rainbow Rearing and Over-wintering	High.	Yes (adjust minimum flow)	High	Yes	Yes
-	Rainbow Trout Incubation	Low – Will be challenging or unfeasible to find redds. NOT RECOMMENDED BY FTC.	-	-	-	-
-	Fish Passage	Low – Passage not a data gap (e.g., see Rick Olmstead study). NOT RECOMMENDED BY FTC.	-	-	-	-
3	Riparian Proper Function and Condition Assessment	Does increase or extend freshet affect riparian community? PFC method is qualitative expert judgment, not quantitative. Note: not testing the impact of flows.	Yes (augment freshet flow), but expensive	Data gap (rather than hypothesis testing)	Yes	Yes (less than quantitative alternative)
4	Bankfull Estimate	High (will provide quantitative data to help with development of performance measure).	Yes (augment freshet flows)	High	Yes	Yes
5	Headpond Drawdown Fish Impacts (oxygen, habitat)	High – helps to answer the question: is this an issue? Would not provide data needed to frame or model a better operational alternative.	Yes – haven't modelled any to date, but could consider some at next Water Use Plan review	Data gap (rather than hypothesis testing)	Yes	Yes
6	Temperature Effects	High.	Yes	Yes – could develop a sensitive temperature PM for next Consultative Committee	Yes	Yes
7	Rainbow Abundance and Biology	Value will be in providing next Consultative Committee with ability to make decisions with more confidence based on performance measures #3 and 4.	N/A – designed to collect presence/ absence and life stage data.	Data gap (rather than hypothesis testing)	Yes	Yes
8	Tailrace Habitat	High value in confirming whether this is an issue/risk (scope fish activity and see whether there is any redd dewatering when tailrace flow is zero and Arrow is at low pool.	N/A – adds to information about minimum flow impacts on Cranberry	Data gap (rather than hypothesis testing)	Yes	Yes
9	Kokanee Spawner Enumeration	Longer study needed to relate flow to enumeration result.	-	-	-	-

APPENDIX N: WALTER HARDMAN WATER USE PLAN RECOMMENDED MONITORING PROGRAM

The Walter Hardman Water Use Plan Consultative Committee recommended by consensus a monitoring program consisting of six monitoring studies that appear to meet the principles or evaluation criteria for monitoring studies under the water use planning program. Three other studies were also supported at the table but it was felt by the BC Hydro representative they did not meet the criteria for water use planning or would not lead to a change in operations in the future (Studies 3, 4 and 9).

STUDY 1 – KOKANEE SPAWNING AND INCUBATION, LOWER CRANBERRY

The primary management question for this monitoring study is: Does flow affect spawning and incubation habitat for kokanee? Given this management question the primary hypothesis is:

> H_o: changes in spawning and incubation flow will affect quantity and quality of spawning and incubation habitat. Note that egg-fry survival is inferred to be related to the quality of egg incubation habitat.

The key water use decision affected is the minimum flow provided to Cranberry Creek at the diversion dam. Water used to provide this minimum flow could otherwise be used for generation.

The proposed study meets all four principles of water use planning. BC Hydro has the ability to influence total discharge levels in all months, though in some years local inflows are insufficient to operate the plant and flows below the diversion dam will be the same as natural inflows.

This proposed study, like many of the other studies proposed for this Water Use Plan, is a habitat-based study rather than a population study. This means that the study will measure changes in habitat but will not address uncertainty about the fundamental question: will these changes in flows benefit fish? Although population studies directly address the fundamental questions, they are expensive and time consuming. On the other hand, habitat-based studies also have the advantage of being easier to interpret accurately, since they are not prone to be influenced by confounding factors the way that population-based studies are. Furthermore, habitat studies tend to be highly sensitive to operational changes that directly affect the physical variables that define habitat. Accordingly, the sensitivity of this monitoring study is high.

The proposed monitoring study will quantify habitat by measuring physical conditions over a range of flow levels in the lower section of Lower Cranberry Creek.

The study will consist of the following tasks:

- Identify mesohabitat units in the study area, which is defined as the lower section of Lower Cranberry Creek, from Upper Arrow Lakes upstream 2.26 km to the impassable falls. This is the area that kokanee are found within Cranberry Creek. The habitat units will be defined during a foot survey.

- Establish 15 transects in this section and identify 30 kokanee redd sites, focusing on areas of known kokanee spawning. Survey the elevation and measure the depth, velocity and substrate along each transect and at each redd site. Measure elevation, depth and velocity over a range of flows by repeating the measurements to provide three sets of data. The potential effects of increased glacial till and compacted gravels may be addressed by examining the substrate and qualitatively assessing changes in composition.

- Simulate habitat availability at each transect using a habitat suitability index developed from the measurements collected at each redd site. Calculate weighted usable area of spawning and incubation habitat and quantify frequency and occurrence of drawdowns.

- Analyze data and interpret effects of flow regime changes.

The cost of the monitoring study is expected to be $30,000 that will be expended in a single year of study. This cost is based on three trips during a single spawning season, likely between September and November. The study does not have to be conducted in the first year, however, all the work should be conducted within a single spawning season to avoid the effects of changes in river bed structure that may occur during freshets. To ensure that a large range in flows is described, it will be important to monitor river flows each year and select the appropriate year.

STUDY 2 – RAINBOW REARING HABITAT – GROWING SEASON AND OVER-WINTER

The primary management question for this monitoring study is: Do increases in minimum flow increase the effective rearing habitat for rainbow trout during the growing season or winter? Given this management question, the primary hypothesis is:

> H_o: The existing flows maximize the quantity and quality of rearing habitat.

The key water use affected is the minimum flow provided to Cranberry Creek at the diversion dam, alternatively that water could be used for power generation.

The proposed study meets all four principles of water use planning. The sensitivity of this monitoring program is high: habitat measures have been selected for monitoring and these are expected to be highly sensitive to changes in flow.

The proposed monitoring study will measure habitat quantity and quality at transects in the middle section of Lower Cranberry Creek.

The study will consist of the following tasks:

- Identify mesohabitat units in the study area, which lies between the impassable falls (located 2.26 km upstream of Upper Arrow Lake) upstream for 5.47 km to the confluence with a tributary (located 7.73 km upstream of Upper Arrow Lake). This is a key area of rainbow trout habitat in Cranberry Creek, inhabited by a resident population. The habitat units can be defined during a foot survey using FHAP (Fish Habitat Assessment Procedure methodology).

- Establish 15 transects in this section. Survey the elevation and measure the depth, velocity, substrate and cover along each transect. Measure elevation, depth and velocity over a range of flows by repeating the measurements to provide three sets of data. Identify how access to winter habitat refuges (cover) changes with flow.

- Simulate habitat availability at each transect using a habitat suitability index using Provincial HSI criteria. Calculate weighted usable area of rearing habitat in summer and winter and quantify habitat.

- Analyze data and interpret effects of flow regime changes.

The data can be collected within a single year of study. However, to capture a natural contrast in flows during the year of study it will be important to select the appropriate year for sampling so that these variations are captured.

The cost of the monitoring study is expected to be $30,000 over a single year of study that may be undertaken sometime within the five-year period. An advantage of scheduling this study for later in the program is that the results of other monitoring studies (particularly Study 7, rainbow trout abundance and biology), will help identify the sites used by rainbow trout and most appropriate for study.

STUDY 3 – RIPARIAN PROPER FUNCTIONING CONDITION (PFC)

The primary management question for this monitoring study is: Can changes in operations affect riparian habitat function along Cranberry Creek? Given this management question, the primary hypothesis is:

> H_o: The existing operating regime provides adequate riparian function.

The key water use decision affected is flow (particularly higher levels of flow that can connect to and wet riparian areas) to Cranberry Creek at the diversion dam. Water used to provide these flows could otherwise be used for generation.

The proposed study meets a data gap in this consultative process. The proposed study will document riparian habitat quantity and quality along the middle section of Lower Cranberry Creek, where riparian habitat values are suspected to be the highest.

The study will consist of the following tasks:

- Identify riparian habitats along the middle section of Lower Cranberry Creek, which lies between the impassable falls (located 2.26 km upstream of Upper Arrow Lake) upstream for 5.47 km to the confluence with a tributary (located 7.73 km upstream of Upper Arrow Lake). This is the area where riparian habitat values are expected to be the highest. Five sites will be established in this area. The focus will be on the riparian community and off-channel habitats for fish and amphibians.

- Riparian function will be evaluated with the techniques identified in the Riparian Assessment and Prescription Procedures (1999, Watershed Restoration Technical Circular No. 6, C.W. Koning ed.). Appendix 2 of that document provides questions adapted from the proper functioning condition (PFC) checklist-style assessment of the U.S. Bureau of Land Management (Prichard *et al.* 1998a)[1]. The answering of these questions will form the basis of an analysis of those aspects of riparian function likely to be affected by changes in flow.

- Based on this assessment and professional judgment, the role of the present flow regime in maintaining riparian function will be identified, along with the potential benefits of operationally feasible flow regime alternatives.

The data can be collected within a single year of study, however, the study must be repeated twice during the Water Use Plan, once at the beginning to establish a baseline, and again near the end to evaluate what, if any, changes there have been in riparian habitat. To maximize the probability of detecting changes in riparian conditions, the riparian studies will take place in years one and nine.

The expected cost of the monitoring study is $10,000 each year, total cost $20,000.

STUDY 4 – BANKFULL EXCEEDENCE

The primary management question for this monitoring study is: Can changes in operations increase the frequency and duration of bankfull flows along Cranberry Creek and significantly affect riparian habitat function? Given this management question, the primary hypothesis is:

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[1] Prichard, D., H. Barrett, J. Cagney, R. Clark, J. Fogg, K. Gebhardt, P.L. Hanson, B. Mitchell, D. Tippy. 1998a. Riparian area management: process for assessing proper functioning condition. U.S. Dept. Int., Bur. Land Manage., Denver, CO. TR1737-9.

H_o: The existing operating regime provides adequate bankfull exceedence for riparian habitats.

The key water use decision affected are high flows (high enough to overtop banks) released to Cranberry Creek at the diversion dam. Water used to provide these flows could otherwise be used for generation.

The proposed study meets a data gap in the Water Use Plan. The proposed monitoring study will document flow magnitude required to exceed bankfull levels along the middle section of Lower Cranberry Creek, where riparian habitat values are suspected to be highest.

The study will consist of the following tasks:

- Using sites of important riparian habitat identified along middle section of Lower Cranberry Creek during Study 3, collect elevation data by survey to allow the effect of flow changes and overbank flow to be quantitatively described. Survey methods and sites may also be linked to Study 2, which will survey the middle section of Lower Cranberry Creek extensively. However, the survey sites for the study of overbank flow must cover sites with important riparian vegetation.

- Using an instream flow model, link areas of important riparian habitat that require overbank flow to maintain function, to the flow regime of Cranberry Creek. Model the daily flow regime of Cranberry Creek, including local inflow, and calculate the water surface elevation at riparian sites. Tabulate the magnitude of overbank flow (depth overtop bank in m) as well as the frequency (number of events per year) and duration (days). Interpret these statistics in conjunction with the riparian study (Study 3).

The data can be collected within a single year of study. The cost of the measuring bankfull exceedance is expected to be $5,000 over a single year. This study should be undertaken concurrent with Study 2, which also requires surveying, to increase study efficiency. However, this study must also be linked to Study 3 (Riparian PFC) so that the areas of important riparian habitat are studied. Therefore, Study 3 should take place before Study 4.

STUDY 5 – HEADPOND DRAWDOWN IMPACTS (FISH)

The primary management question for this monitoring study is: Do reductions in the operating elevation of the Walter Hardman headpond affect fish habitat and survival? Given this management question, the primary hypothesis is:

H_o: Reductions to minimum operating levels maximize habitat and survival of fish.

The key water use decision affected is the operating level of the Walter Hardman headpond.

The proposed study meets all four principles of water use planning. The sensitivity of this monitoring study will be high since it will rely on physical habitat observations and measurements that are closely linked to fish survival. Specifically, there is concern about physical stranding and dissolved oxygen concentrations, factors may be affected by drawdown. The proposed monitoring study will observe and measure these habitat characteristics in Walter Hardman headpond.

The study will consist of the following tasks:

- A foot survey will be undertaken to look for potential areas of fish stranding in the headpond. The survey will be timed with a period of low inflow when the headpond is drawn down during the fall (this must be an ice-free period when dewatered habitats can be observed). A drawdown event may have to be scheduled to provide these conditions. Observations will be documented with field notes and photographs, with special attention to the inlet of the headpond, where bathymetry may be conducive to dewatering. Potential sites of dewatering will be surveyed and tied to benchmarks to create a link with reservoir elevations.

- Water quality will be measured during a period of low inflow when the headpond is drawn down during the winter (January to March). These are conditions when the dissolved oxygen concentrations will be lowest. A dissolved oxygen profile will be measured at two locations: at the upper and lower ends of the headpond.

- Analyze data and interpret effects of drawdown on fish stranding and dissolved oxygen concentrations.

The data can be collected within a single year of study. It may be necessary to wait for a year of low inflow during the fall and winter so that extreme conditions can be observed.

The cost of the monitoring study is expected to be $5,500 over a single year.

STUDY 6 – TEMPERATURE EFFECTS

The primary management question for this monitoring study is: Do increases in minimum flow affect water temperatures for fish in Cranberry Creek (warm temperatures during summer and fall and cold temperatures over winter)? Given this management question, the primary hypothesis is:

> H_o: The existing flows provide temperatures within ranges suitable for rainbow trout rearing and kokanee egg incubation.

The key water use decision affected is the minimum flow provided to Cranberry Creek at the diversion dam. Water used to provide this minimum flow could otherwise be used for generation.

The proposed study meets all four principles of water use planning. The sensitivity of this monitoring study will be high because water temperature can be accurately and precisely measured. The extensive literature on water temperature and salmonids will allow us to evaluate the potential effects of water temperature changes. We are concerned with: 1) warm water temperatures during the summer that may exceed critical levels for rainbow trout in the upper and middle sections of Lower Cranberry Creek; and 2) with cool water temperatures during the fall and winter in the lower section of Lower Cranberry Creek that may affect the rate of kokanee egg incubation.

The proposed monitoring study will measure temperature in Lower Cranberry Creek.

The study will consist of the following tasks:

- Install continuous temperature monitors at three sites in Lower Cranberry Creek: Sites 6, 5 and 2 as used in earlier studies (Summit, 2000). Install two monitors at each site to reduce the risk of data loss. Download the data annually each spring, prior to the freshet when high flows may damage the monitors.

- Compile a database of water temperature over the five years of study and analyze concurrent with the analysis of results of Studies 1 (kokanee incubation) and 2 (rainbow rearing) in year five. Identify how potential changes to flow may affect temperature and kokanee incubation and rainbow rearing.

The data will be collected over the five years of study to capture annual variation in temperature and flow.

The cost of the monitoring study is expected to be $2,500 per year, which includes $1,200 in the first year for the temperature monitors.

STUDY 7 – RAINBOW TROUT ABUNDANCE/BIOLOGY

This study aids in filling a data gap for the interpretation of Study 2 (rainbow rearing). The primary management question addressed by this monitoring study concerns how increases in minimum flow affect rainbow trout populations. The key water use decision affected is the minimum flow provided to Cranberry Creek at the diversion dam. Water used to provide this minimum flow could otherwise be used for generation.

However, the proposed study does not meet all four principles of water use planning monitoring and is designed to address a data gap. The sensitivity of this monitoring program would be insufficient to detect changes in rainbow trout abundance. The study will be unable to separate the impacts of Coursier Dam decommissioning from the impacts of operational changes. However, the monitoring will provide a rainbow trout abundance baseline against which future monitoring studies can measure a response.

We are interested in understanding the significance of the rainbow population in Cranberry Creek. Details on population size, age structure and growth rate would provide confidence that any benefits of minimum flow releases identified in Study 2 (rainbow rearing) could be taken advantage of by the resident population. It is emphasized that this is not a study of population effects – changes in abundance detected during this study cannot be inferred as resulting from flow changes.

The proposed monitoring study will monitor rainbow trout abundance in the middle section of Lower Cranberry Creek.

The study will consist of the following tasks:

- Study abundance of rainbow trout in the middle section of Lower Cranberry Creek, which lies between the impassable falls (located 2.26 km upstream of Upper Arrow Lake) upstream for 5.47 km to the confluence with a tributary (located 7.73 km upstream of Upper Arrow Lake). This is a key area of rainbow trout habitat in Cranberry Creek, inhabited by a resident population. The study site overlaps with those sites used by in an earlier study (Summit, 2000).

- Conduct presence/absence electrofishing throughout the reach. Collect specimens and measure body length and weight, assess sexual maturity and collect scales for age determination. Snorkel surveys will overlap with the electrofishing to provide a second method of assessment. The snorkel surveys will provide qualitative information on how access to winter habitat refuges (cover) changes with flow, complementing Study 2 (rainbow rearing).

- Analyze data and assess population size and age structure.

The data will be collected in each year of the study. The study will document the population over a natural contrast in flows over the years of study.

The cost of the monitoring study is expected to be $6,000 per year over five years, plus an additional $6,000 in year five for analysis and write-up, for a total cost of $36,000.

STUDY 8 – TAILRACE HABITAT

This is a data gap study. The primary management question addressed by this monitoring study is: How do releases from the Walter Hardman powerhouse affect fish habitat in the tailrace channel (in Upper Arrow Lakes Reservoir)? The key water use decision affected is the timing of powerhouse operations.

An information gap identified during the Water Use Plan was how kokanee, which use an isolated back channel that is influenced by outflow from Walter Hardman powerhouse, may be affected in the fall by changes in flow releases from the powerhouse. The concern is that shut downs of the powerhouse may affect kokanee spawning or egg-fry survival by dewatering spawning and incubation habitats.

The proposed study does not meet all four principles of water use planning, as it has been designed to address a data gap.

The proposed monitoring study will identify the use of the tailrace and back channel by kokanee and show whether kokanee are attracted to powerhouse outflows. The latter is of concern once a minimum flow is implemented because the homing of kokanee may be influenced by the release of water from the diversion dam (under current operations this rarely happens during kokanee spawning and incubation, thus attractions are unlikely to be an issue).

The study will consist of the following tasks:

- Observe fish activity in the tailrace during the kokanee spawning season in September and October. Obtain a visual estimate of fish abundance in the tailrace. Time observations to coincide with zero flow events. Pay particular attention to the possibility of attraction to powerhouse outflows by comparing escapements to the tailrace to those in Lower Cranberry Creek.

- Observe the tailrace during low flow conditions and reservoir elevation conditions during mid-winter in a single year. Determine whether redds are dewatered when the tailrace flow is zero by timing the site visits to coincide with a shutdown event.

The data will be collected in each year of the study for Task 1 and in year one only for Task 2. Annual monitoring is required for Task 1 to capture variation in operating conditions and to capture natural variation in kokanee escapements and behaviour.

The cost of the monitoring study is expected to be $4,000 in the first year, and $2,000 per year over the remaining four years, for a total of $12,000.

STUDY 9 – KOKANEE SPAWNER ENUMERATION

This study aids in filling a data gap for the interpretation of Study 1 (kokanee spawning and incubation). The primary management question addressed by this monitoring study concerns how increases in minimum flow affect kokanee populations. The key water use decision affected is the minimum flow provided to Cranberry Creek at the diversion dam. Water used to provide this minimum flow could otherwise be used for generation.

The proposed study does not meet all four principles of water use planning and has been designed to address a data gap. The sensitivity of this monitoring program would be insufficient to detect changes in kokanee abundance because reservoir-wide effects drive kokanee production such that the returns of adult kokanee are more likely to reflect events during lake life history than during spawning and incubation. The interpretation of trends in kokanee abundance would require the monitoring of control streams to isolate the effects specific to Cranberry Creek. This study will be unable to separate the impacts of Coursier decommissioning from the impacts of operational changes. However, the monitoring will provide a larger picture of kokanee abundance that will assist in making decisions using the results of Study 1 (kokanee spawning and incubation).

The proposed monitoring study will monitor kokanee abundance in lower section of Lower Cranberry Creek each year.

The study will consist of the following tasks:

- Conduct overflights of the lower section of Lower Cranberry Creek each year during September and October. The study site and methods are the same as those used by BC Hydro to monitor kokanee populations since the mid-1990s.
- Time surveys to correspond to start, peak and end of each of the two runs in Cranberry Creek (September and October runs).

The data will be collected in each year of the study. The study will document the population over a natural contrast in flows over the years of study.

The cost of the monitoring study is expected to be $7,000 per year over five years, for a total of $35,000.

APPENDIX O: CONFIRMATION OF ACCEPTANCE OF WALTER HARDMAN WATER USE PLAN CONSULTATIVE COMMITTEE REPORT FINAL DRAFT

This report records the deliberation of the Walter Hardman Water Use Plan Consultative Committee and provides the context for the committee's recommendations for the future operations of the Walter Hardman hydroelectric facilities. The undersigned confirm that this report accurately captures the water use interests, objectives and associated values expressed by the Consultative Committee members during the process.

Name & Organization	*Signature*
Mark Tiley Canadian Columbia River Inter-tribal Fisheries Commission	See footnote [1]
Jayson Kurtz Fisheries and Oceans Canada	
Loni Parker Columbia-Shuswap Regional District	
Dave Percell BC Hydro	
Jay Johnson & Howie Wright Okanagan Nation Alliance	See Appendix P
Dan Robinson Advanced Energy Systems	
Terry Anderson Water, Land and Air Protection	
Fred Fortier Secwepemc Fisheries Commission	

1. The Canadian Columbia River Inter-tribal Fisheries Commission participated on behalf of First Nations. Their comments have been incorporated into the Consultative Committee Report.

APPENDIX P: OKANAGAN NATION ALLIANCE GENERAL COMMENTS ON THE CONSULTATIVE COMMITTEE REPORT FOR THE WALTER HARDMAN WATER USE PLAN

Okanagan Nation Alliance

Without prejudice to Aboriginal Title and Rights

June 18, 2004

General Comments on the Consultative Committee Report for the Walter Hardman Water Use Plan

The ONA welcomed the invitation to participate in this process influencing land and resource decisions on our traditional territory. The ONA representatives were generally impressed with this process, however, felt pressured to ensure that the final decisions were not going to be a non-consensus result. The facilitator was very knowledgeable about the issues and many of the technical merits of the project operations, but her status as an employee of BC Hydro was evident throughout the process as often discussions were softly directed back to what appeared to be BC Hydro interests, occasionally when the group had even moved past an issue. Having a BC Hydro employee facilitating the group resulted in a perception of bias that could easily be eliminated through the future use of independent yet knowledgeable facilitators with BC Hydro present as resource staff, as necessary.

Please note that staff remained professional and courteous in performing their duties as best they saw fit and the important recommendations made about staff deployment is not intended as personal criticism but rather a procedural one.

Some Specific Final Report Issues

Section 3.3 – page 3-5 4th paragraph down. Heritage and cultural interests were raised generally during the process, but were not developed into a performance measure or operating alternative by First Nation representatives at the table, as no sites or area uses were specified. To engage in any elaborate discussions or otherwise on First Nation heritage and cultural issues was beyond the scope of this process as there were no resources or activities dedicated to investigating specific and historical aboriginal use and interest. It should be noted therefore that there remains a data gap in addressing these specific interests and not simply the implication that there are none there.

Section 4.4.1 page 4-14.

No issues were raised by the ONA as we were not expected to raise these issues- the ONA representatives were not cultural specialists. See comment as above and it is related to section 4.4.3 where no studies were done on cultural issues- care should be taken not to imply that because these issues were not raised in any detail that there are not impacts or concerns.

Page 6-8 Table 6-4 Alternative eliminated. After the word to build is "(if feasible)" in brackets of which at the time it was felt that it was feasible during this discussion and was part of the basis for the movement by the First Nations. We had all agreed to this upon which the next meeting came where it was later identified that it might not be feasible. Thus on the first day it was the understanding of the participants for the Okanagan that they agreed to this option on the basis that all provisions were met. Not 'if feasible'.

Through the water use planning process the ONA representatives were asked to make decisions based on the available information at the time and some agreed to assumptions, if these assumptions or information data changes then that change would naturally affect the basis for how a decision was made and why other options may have been eliminated. This change in baseline information would affect the rationale for a specific operating decision by the ONA, such as the dramatic change in the costs of an agreed to alteration to the facilities (that would allow for increased flow to benefit fish, if later studies indicate that it would be necessary) as part of an operational decision. The ONA would then feel uncomfortable about making an operational decision concerning what is an appropriate level of additional construction cost (to accommodate increased flows for fish), for the project to bare without additional economic and operational information and a mandate from BC Hydro. (Most participants at the table are, frankly, unqualified to make those decisions at the time – without more information and context.) Our view is that if a decision is made to support a specific option based upon a reasonable cost of building additional facilities, then later these costs are seen to be too high then all other previous options must be reviewed in light of this new information on costs to see if a similar intention can occur in another manner, rather than simply not building the addition to the facility under the same option because of new, but vague, cost information.

Page 6-12 section 6.4 Physical works discussion. Between paragraphs 3 and 4 there should be a statement that at this point, there was consensus made by all parties to have minimum flow with the .5 option provision. Then stating in the next paragraph, "However, at the last meeting new information was provided about costs that may affect this consensus…

Page 6-12 section 6.4. The ONA did not agree to revise its position as it was starting a new process (i.e. back tracking to change one variable in a pervious decision physical works cost). Thus we decided we weren't going to comment on what is an appropriate cost without more information and time. The ONA's representatives believe that as the process was completed and if BC Hydro decides not to build, as per the original agreement, it is their decision and thus you would have quite simply have a result that was non-consensus. In addition, we felt that 'throwing out' new cost numbers wasn't part of the process and we weren't comfortable on making a decision based on unreliable percentage estimate provisions (outside of the process).

Page 6-17 Table 6-6. I believe that at this point in the discussion Dave did not mention the physical works cost, it was more based on that he did not see the benefits of the added flow, of which, I explained my interpretation. This is very important in identifying the process.

Page 6-19 section 6.7 second to last paragraph. At the end it should state: " Note – this was based on the provisions agreed upon including the build to .5cms capacity that was very critical in the decision process.

Page 6-20 table 6-8. Once again, there was also the requirement to build to .5 which was important in the decision process.

Page 6-22 section 6.8 second paragraph. The ONA felt uncomfortable at this point in the process because:

1) No other options were on the table to be discussed even though with this significant change in the two options of costs.

2) Decisions were based on physical structure costs and percentages outside of the process that we just went through.

3) We feel that if this was known earlier in the process there would have been a different outcome.

4) We did recommend re-looking at changes to the maintenance flows from August to Nov ranging between .2cms to .5cms in addition to putting more research into being more confident in physical structure costs. However, this was not an option.

5) In the end, we just ended up with minimum flows, a most likely requirement for BC Hydro under the Fisheries Act.

6) We stood with the original decision as it was a well thought out process until the end and feel that it is BC Hydro's decision whether to build or not to build – which would be a determining factor into whether the WUP was a consensus or not.

Additional Comments

As mentioned before, we support the process, with the recommended future changes toward using an independent facilitator and ensuring that corporate to First Nations communications (non-committee table) occur directly. We are comfortable with the final decision – acknowledging that if BC Hydro decides against building the recommended infrastructure, for what ever reason – including cost, this WUP would then be a non-consensus WUP, as the ONA would not support this change to the final result, as it would alter the agreement. However, we would then recommend further discussion among the committee to seek a compromise if the infrastructure built to its maximum as agreed upon by committee members would not happen, i.e. a conference call to move to consensus.

Further, we would encourage BC Hydro to keep ensuring that local communities and First Nations continue to be intimately involved in these positive and collaborative processes.

We would like to formally request a meeting with the BC Hydro aboriginal manager to discuss monitoring programs and potential professional Okanagan opportunities and studies. We would also like to discuss directly with BC Hydro how they intend to specifically fulfill their consultative requirements on other WUPs that were conducted and still be conducted in Okanagan territory.

We would like to thank all the participants and staff who put great professional effort into this important process.