Coquitlam-Buntzen Water Use Plan: Report of the Consultative Committee

June 2002

Prepared on behalf of:

The Consultative Committee for the Coquitlam-Buntzen Water Use Plan

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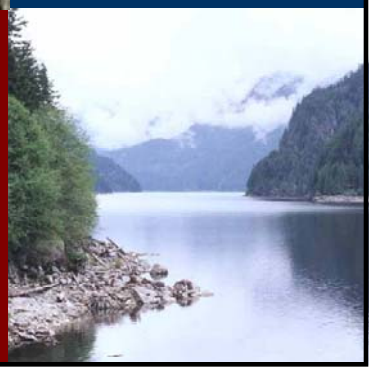
Coquitlam-Buntzen Water Use Plan
A Project of BC Hydro



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This report was prepared for and by the Coquitlam/Buntzen 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 Coquitlam/Buntzen Water Use Plan that will be submitted to the Comptroller of Water Rights for review under the *Water Act*.

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

Tribute to Al Grist

The Coquitlam Buntzen Water Use Plan is dedicated to the memory of Al Grist 1936 - 2000.

The Consultative Committee wish to acknowledge the commitment of Al Grist, a local resident, who for over 30 years was an advocate active in pursuing the health of the Coquitlam River.

Al, a member of the Port Coquitlam & District Hunting & Fishing Club, was a valued member and active participant on the Coquitlam Buntzen Water Use Plan Consultative Committee until he passed away on November 20, 2000.

Al would be very pleased to know that a consensus agreement was reached which ensures higher flows into the Coquitlam River for fish habitat enhancement.

Note to Readers: This report documents the deliberations and recommendations of the Coquitlam Buntzen Water Use Planning Consultative Committee between November 1999 and March 2002.

List of Acronyms*

2FVC	2 Fish Valves always open with the GVRD current agreement (an operating alternative)
4FVN	4 Fish Valves New (Optimized) with GVRD proposed agreement (an operating alternative)
ATU	Accumulated thermal units
CBWUP	Coquitlam-Buntzen Water Use Plan
CC	Consultative Committee
cfs	Cubic feet per second
cms or m3/s	Cubic meters per second
DCP	Data collection platform
DFO	Department of Fisheries and Oceans (now known as Fisheries and Oceans Canada)
ELZ	Effective Littoral Zone
ESOR	BC Hydro's Electric Systems Operations Review – completed in 1994
FFF	Fish Friendly Flow
FTC	Fish Technical Committee – subcommittee of the Consultative Committee.
GVRD	Greater Vancouver Regional District
GVWD	Greater Vancouver Water District; a subsidiary of GVRD.
HSI	Hydraulic Suitability Index
IFN	In Stream Flow Needs Assessment
LB1/LB2	Buntzen Generating Stations No. 1 and 2
LLO	Low Level Outlet
MAD	Mean annual discharge
MSRM	Ministry of Sustainable Resource Management
PM	Performance measure
SQM	Square metres
STP#4 - #5	Sharing the Pain #4 and Sharing the Pain #5 (operating alternatives)
TGP	Total Gas Pressure
VOE	Value of Energy
WLAP	Ministry of Water Land and Air Protection
WSC	Water Survey Canada
WUA	Weighted Usable Area
WUP	Water use plan

*For definitions see glossary in Appendix I.

EXECUTIVE SUMMARY

Overview

Water Use Planning was announced in 1996 to ensure provincial water management decisions reflect changing public values and environmental priorities. A Water Use Plan (WUP) is a technical document that, once approved by the provincial Comptroller of Water Rights, defines how water control facilities will be operated. The purpose of a Water Use Planning process is to develop recommendations defining a preferred operating strategy using a public participatory process.

The Coquitlam-Buntzen hydroelectric development is located approximately 24 km east of Vancouver on the shores of Indian Arm. The system is the oldest hydroelectric facility in the Lower Mainland, and contributes just over 7 percent of regional generating capacity for the Lower Mainland/Coastal/Fraser Region (about 0.4 percent of BC Hydro's total capacity). Water for the Coquitlam-Buntzen system originates in the **Coquitlam River,** which flows from the Lower Mainland coastal mountains south to the Fraser River via the **Coquitlam Reservoir**. Tunnels divert water from the Coquitlam Reservoir to the Greater Vancouver Regional District (**GVRD)** for domestic water and to **Buntzen Lake Reservoir** where the intakes are located for the two **powerhouses** situated on the shore of **Indian Arm**.[1]

Coquitlam Reservoir is closed to the public and has no fish access other than for resident species. It is one of three Lower Mainland drinking water sources for the GVRD. Buntzen Reservoir and the Coquitlam River (downstream of the dam) are widely used for recreation. Buntzen Reservoir is artificially stocked with fish and also supports some wild resident species. The Coquitlam River is an important environment for fish and wildlife and has received a great deal of attention from local and provincial interest groups over the years. The area encompasses provincial, regional, and municipal parks as well as extensive urban development. There are also a number of gravel operations adjacent to the river. Since construction of the hydroelectric facilities in 1903, access by anadromous fish to the river is restricted to 17-18 km from the Fraser River to the dam. Serious concern about the decline of salmonid populations in the Coquitlam River has been expressed since the early 1980's. In response, several enhancement and conservation initiatives were introduced, including escalation of minimum flow releases, hatchery production, and off-channel habitat creation. The Coquitlam Reservoir provides significant downstream flood control benefits to municipalities and to the Kwikwetlem First Nations reserves, IR#1 and IR#2, both located adjacent to the river. The Coquitlam- Buntzen hydroelectric system is in the asserted traditional use areas of five First Nations: Kwikwetlem First Nation, Tsleil-Waututh First Nation, Katzie First Nation, Squamish First Nation and Musqueam First Nation. It is also within the asserted traditional territory claimed by Sto:lo Nation.

The Consultative Committee

The structure of the Consultative Committee (CC) was inclusive with two levels of involvement, active and observer status. Active participants attended most CC meetings and were directly involved in making decisions, whereas observer status enabled members to attend meetings to observe the proceedings and to receive meeting minutes. The Consultative Committee began with 37 active members and 18 observers (December 1999) but some active members changed to observer status as the process advanced. Others

[1] GVRD (Greater Vancouver Regional District) is meant to refer to both the geographical area of the GVRD and the services provided by the GVRD and its drinking water supply utility (Greater Vancouver Water District, GVWD).

were replaced by different people from their organization or left the process because others represented their interests on the CC. At the end of the process, there were 26 CC members of whom 22 were on the original committee.[2] In addition, 36 people received Consultative Committee minutes (see Appendix C for a complete listing of who received the minutes).

The Consultative Committee as a whole met 22 times, from November 8, 1999 to March 11, 2002 to move through steps outlined in the provincial *Water Use Plan Guidelines*. During this time there were also 65 additional subcommittee meetings held to aid the CC's work: involving First Nations, technical committees, and other working groups.

Objectives

The committee explored issues and interests that could be affected by facility operations and from this a list of objectives was drawn up for the Coquitlam-Buntzen Water Use Plan (see Table ES 1 below). The CC then established performance measures that determined the degree to which each objective would be achieved by changes to the facilities' operations. Where possible, performance measures were modelled quantitatively. In other cases, impacts were described qualitatively.

Table ES 1: Objectives for the Coquitlam-Buntzen Water Use Plan

Archaeological, Cultural & Historical	• Maximize access for First Nations traditional uses • Maximize access for recovery of artifacts/inventory of sites • Maximize protection of sites from erosion, pot hunting, flooding
Domestic Water	• Maximize reliability of access to water supply • Minimize cost
Fish (Coquitlam River)	• Mimic natural hydrograph • Maximize the availability of suitable (fish) habitat • Optimize secondary (invertebrate) productivity
Fish (Coquitlam Reservoir)	• Optimize secondary productivity
Flood Control (Coquitlam River)	• Minimize adverse effects of flood damage & public safety
Hydroelectricity	• Maximize the financial value of power generation • Minimize the loss of generating capability in the Lower Mainland
Industry (Coquitlam River)	• Improve gravel industry storm management through sediment dilution
Recreation (Coquitlam River)	• Maximize opportunities for recreation on Coquitlam River • Maximize quality of recreation • Maximize public safety
Wildlife/Environment	• Maximize the area & suitability of aquatic & riparian habitat for indigenous wildlife, including species at risk and organisms not captured by fish objectives.

[2] This tally includes neither the First Nations representatives nor representatives from the Ministry of Sustainable Resource Management and the City of Coquitlam whose status changed from member to observer near the end of the consultation period. It also excludes one of the DFO representatives on the Committee who left for maternity leave before the final trade-off meeting.

Throughout the process, the CC removed several objectives and associated performance measures from further consideration because they did not aid in decision making between the alternatives or it was recognized that changes in operations had an insignificant affect on the performance measure. These are listed below with a short rationale.

- Archaeological, Cultural and Historical objectives: only archeological sites were affected by BC Hydro operations and the CC accepted Kwikwetlem First Nation's recommendation that these should be addressed directly with BC Hydro, GVRD and First Nations.

- Flood Control: BC Hydro's current operations, which lowers the reservoir elevation before the fall storm season, and the use of a 1 meter flood buffer was applied to each alternative. Acceptance of these operational procedures by the CC addressed their concerns regarding concerns related to public safety and property damage.

- Fish (Coquitlam Reservoir): the changes to this objective from the final set of alternatives were considered insignificant.

- Industry: a current minimum in-stream flow (.65 cms) was established so that changes from alternatives were considered marginally beneficial to industry storm water management.

- Recreation (Coquitlam River): a current minimum in-stream flow (.65 cms) was established so that changes from alternatives were considered marginally beneficial.

- Wildlife/Environment: due to the maintenance of the current minimum in-stream flow (.65 cms) in all alternatives, concerns about adverse impacts to the low bench ecosystem were addressed and therefore, given the range of alternatives considered by the CC, the performance measures for this objective did not significantly change.

The CC also developed objectives for Buntzen Reservoir and Indian Arm. Issues at Buntzen Reservoir were addressed through recommended reservoir elevations in the summer, and issues at Indian Arm were not pursued by the CC as preliminary analysis suggested water use plan alternatives would have little or no effect.

Fish in Coquitlam River, Domestic Water and Hydroelectric Power objectives experienced significant change resulting from the final alternatives considered by the CC.

Alternatives

Based on the objectives adopted for each interest, different operating changes were suggested and evaluated by the Consultative Committee. The changes fell into three categories, each of which was separately evaluated:

- Flow alternatives each consisting of target monthly flow nominations to GVRD and the Coquitlam River;
- Flushing flows (also referred to as system maintenance flows) to improve the quality of habitat in the Coquitlam River, downstream of the dam;[3]
- Operating protocols and procedures which would be applied to every operating alternative:

[3] Operating alternatives were evaluated without incorporating the effects of flushing flows primarily because of the high degree of uncertainty associated with trying to quantify fish benefits for this Water Use Plan.

- Satisfy recreation & public safety objectives on Buntzen Reservoir; and
- Address issues related to specific flooding, domestic water, fish, and emergency power situations.[4]

During the WUP process, over 24 operating alternatives were considered and these were eventually narrowed and combined to six flow alternatives. One opportunistic flushing flow experiment was also recommended. In addition, numerous operating protocols were adopted (mostly from current operating procedures) and carried forward into the operating alternatives considered. From the final six alternatives, two alternatives formed the basis for the recommendations adopted by the consultative committee at the last decision making meeting (Oct 2001) and these (as well as the base case) are briefly described below:

***Reference Base Case* (2FVC):** 2 Fish Valves always open with the GVRD current agreement: this alternative reflects the current situation under existing agreements (although the GVRD does not typically use all their water allocations at present as allowed under their current agreement).

(4FVN): 4 Fish Valves New (Optimized) with GVRD proposed agreement: this alternative is equivalent to a doubling of current river flows through the existing 2 fish valves and includes the GVRD water nominations described in their proposed agreement. River flows are optimized on a monthly basis according to fish requirements.

(STP#5): "Sharing the Pain" (STP) alternatives were designed to provide a target flow nomination to both the river and GVRD on a monthly basis. The "Share the Pain" idea is to try and accommodate both domestic water objectives and in-stream flow objectives more equitably during dry water years and therefore 'share the pain'. The STP#5 alternative (like other STP alternatives considered) varies according to target flows, seasonal priorities and yearly rainfall between domestic water, water for fish down the Coquitlam River, and water for power. The prioritization is operationalized according to target reservoir elevations. For example, BC Hydro diversion from Coquitlam Reservoir is the first to be restricted when the reservoir elevation drops by approximately 1 metre below target levels. When the reservoir elevation drops further (approximately 2 m below target elevation) depending on the priority of the water user, nominations are gradually reduced to the minimum targets for both/either GVRD and river flows.

All alternatives included a flood buffer (1 metre) and minimum in-stream flow (.65 cms). The minimum in stream flow includes up to .25cms discharge into Grant's Tomb pond, currently delivered through GVRD's intake and piping facilities.

Trade-offs

Among the alternatives considered at the final CC meeting, domestic water, fish and hydroelectric objectives experienced the greatest change. The CC focused on alternatives that first attempted to satisfy domestic water and fish objectives. However, during dry years none of the alternatives could provide the minimum water needs to satisfy both domestic water and fish requirements during the summer months, excluding hydroelectric power production altogether. Facing these trade-offs, two alternatives emerged as the final "frontrunners": 4FVN and STP#5, as described in the previous section. The key trade-offs between these two alternatives, using indicator performance measures, are described below and highlighted in Table ES2.

[4] Emergencies include those required to address dam safety, actual or potential loss of power supply to customers, dam breach or potential dam breach, extreme flood flows, fire or explosion, environmental incidents, major equipment failure, or threat to employee or public safety.

- For domestic water, the performance measure shown in Table ES2 reflects the annualized cost savings associated with developing an alternative water source later than would be required, based on the GVRD satisfying their future use nominations of water from the Coquitlam reservoir in their proposed agreement. The annualized cost saving to the GVRD and ratepayers is $3.7 million for 4FVN and $1.8 million for STP#5 (a difference of $1.9 million annually)5.
- For hydroelectric power, the performance measure shown below is the average annual revenue to BC Hydro (including VOE and GVRD payments), which is $8.0 million for 4FVN and $7.2 million for STP#5 (a difference of $800,000 annually; revenue under current operations is $9.4 million).
- For fish in the Coquitlam River, rearing habitat is one of the key limiting factors. Table ES2 highlights the difference in expected rearing habitat using the weighted useable area (referred to as WUA and is calculated by weighting habitat quality considerations for different sections of the river) for steelhead parr, which is considered the most sensitive species and therefore a good indicator of all rearing habitat. Projected habitat gains (over current operations) are 8,500 m^2 for 4FVN and 16,100m^2 for STP#5 (difference of 7,600m^2). However, this habitat measure was criticized as not sufficiently sensitive, particularly considering the importance of flows during the summer months. Therefore, CC members often cited a flow threshold performance measure which indicated the frequency with which river flows did not meet minimum rearing requirements (based on 20% of the mean annual discharge) for steelhead during August, also shown in Table ES2. Under the 4FVN alternative, these minimum flows are not met 87% of the time while under STP#5 they are not met 58% of the time (a difference of 29%).

Table ES 2: Impacts to Objectives using Key Performance Measures

Objective (performance measure)	4FVN	STP#5
Domestic Water: (GVRD annualized capital costs savings for development of a new water source compared with current agreement and operations) (millions)	$3.7	$1.8
Hydroelectric Power: (BC Hydro annual average revenue losses from current operations) (millions)	$1.4	$2.2
Fish: Steelhead Parr rearing (increase in habitat – weighted usable area in sq. metres – over current operations)	8,500	16,100
Fish: Steelhead Parr (Flows less than 5.4cms at PoCo gauge in August)	87%	58%

Significant uncertainty also played an important role in assessing trade-offs, especially regarding how fish would respond to increased flows. This uncertainty was largely attributed to (1) incomplete field studies resulting from a lack of water for flow trials during the WUP timeframe, (2) how fish habitat areas would improve with increased base flows given the poor condition (high embeddedness) of the substrate, and (3) how fish habitat areas would improve with the use of opportunistic flushing flows (described in detail in Section 6.4). Also weighing into the trade-off discussions was the certainty that the GVRD was looking for in order to make long term planning and development decisions. It was recognized that in the short

[5] GVRD estimated the following annualized capital costs associated with having to raise Seymour Dam *earlier* than would be necessary if GVRD secured the proposed water allocation agreement from Coquitlam Reservoir: current agreement (2FVC): $6.3 million; 4FVN: $2.6 million; STP5: $4.5 million. Thus cost savings associated with going from 2FVC to 4FVN are $3.7 million ($6.3 million less $2.6 million) and cost saving associated with going from 2 FVC to STP5 are $1.8 million ($6.3 million less $4.5 million).

term they might not immediately need their proposed nominations for domestic supply (but may depending on their other supply reservoirs). Similarly, BC Hydro expressed the importance of operating certainty regarding hydropower planning and operations.

Value-Based Trade-offs

The importance of these technical trade-offs was captured through formal value-based analysis and discussion at the final decision making meeting held in October 2001. This analysis indicated that value-based thresholds limited the opportunity for consensus on a single alternative. The 4FVN alternative was "Blocked"[6] by nine CC members including the provincial fish representative, NGO representatives and local citizens. In addition, three others expressed major reservations with this alternative including the representative from the Department of Fisheries and Oceans and two local NGO representatives. They consistently cited a lack of flow for fish, particularly during the summer months, as their primary reason for blocking the 4FVN alternative.

GVRD and BC Hydro representatives blocked the STP#5 alternative. The GVRD representatives indicated that fish benefits beyond 4FVN did not appear to warrant the trade-off with domestic water, a value judgement that was compounded by the significant uncertainty surrounding the potential benefits to fish objectives. Furthermore, the GVRD representatives stated that they did not have a mandate from their board to support anything beyond the 4FVN alternative and the GVRD board would require a sufficiently strong case for fish benefits to support any flow alternatives greater than 4FVN. BC Hydro representatives cited the uncertainty regarding fish benefits, in terms of fish response to increased flow levels and in regards to other factors, such as substrate quality, as not justifying the trade-off with power and domestic water values.

One local resident initially blocked both alternatives because he could not support any alternative that provided additional water to the GVRD, which would support regional population growth, but expressed support for providing additional flows to the Coquitlam River for fish and to BC Hydro for power.[7]

In summary, the two most significant reasons for a lack of consensus to a single flow alternative were: 1) the uncertainty associated with the fish performance measures; and, 2) the need for operating certainty for BC Hydro and GVRD. Therefore, the CC generated a new adaptive management alternative at the final meeting to address these issues and arrive at a consensus recommendation.[8]

Recommendations

The consensus recommendation from the CC identifies an operating plan that incorporates an adaptive management program (flow testing and monitoring) to help address uncertainty and make more informed recommendations within fifteen years. At the core of the consensus agreement are flow and time parameters. The agreed upon adaptive management program consists of two flow trials: the first is the operating alternative 4FVN and would continue for 6 years; the second, a higher flow alternative, is STP5 (or slightly less depending on the results from the still to be completed In-stream Flow Needs Assessment) and would also continue for 6 years. The entire adaptive management program was

[6] Defined as one or more CC members who would not accept the alternative.
[7] In the end, this CC member (an area resident) expressed strong reservations about the agreement but accepted the group's decision and arriving at consensus (see following footnote).
[8] Consensus is defined as all CC members who attended the October 22, 2001 CC meeting supporting the Consultative Committee's final recommendations.

recommended to be complete within a 15 year time period[9] (starting from October 2001). It was further agreed that any future WUP operating regimes be constrained (in terms of volume of water allocation down the Coquitlam River) between 4FVN and STP5; this provided the GVRD with the certainty they required for their future planning and capital works decisions and fish interests with an increased minimum in-stream flow level.

The CC also accepted the FTC's recommendation to perform an opportunistic flushing flow test[10]. However upon further review (after the October 2001 CC meeting), the FTC recommended to not implement opportunistic flushing flow experiment within the review period of this WUP (depending on the results of the statistical power analysis, described below), as it may confound the results from the adaptive management program.

Table ES3 is a summary of the operating recommendations agreed to at the October 22nd, 2001 CC meeting.

Table ES 3: Summary of CBWUP Operating Recommendations[11]

Operating Recommendations	Comments
Instream Flow Needs (IFN) Assessment	• Complete the IFN study (that began with this WUP) as soon as possible (anticipated to be within the next 2 years) and this information is to be used to finalize the second test flow (STP5) parameters
Change one low level (LLO) outlet at Coquitlam Dam to permit 4FVN & STP5 flows	• Both flow regimes (4FVN & STP5) will require the same infrastructure change, allowing regulated and variable flows through one of the LLOs (expected to be complete within 2-3 years)
<u>Adaptive Management Program</u> Implement and monitor 2 flow trials: • Test flow #1: 4FVN and • Test flow #2: STP5 or less	• Part of adaptive management program to test fish benefits from increased flows to Coquitlam River • 10-12 years to better understand benefits to fish from higher dam flow releases to the Coq. River to inform review • Test flow #1 will be tested first • Test flow #2 to be selected after due consideration of IFN results • Both test flows will be complete within 15 years of Oct 2001 • Develop a monitoring plan with clear design measures (by the FTC)
Recommend that a Monitoring Committee be formed	• For duration of review period to oversee implementation of the adaptive management program & to ensure that there is sufficient information in place by the end of the review period to determine the fish benefits of both test flows & to enable a better understanding of trade-offs between fish, domestic water & power generation. • Agreed that results from the committee be made available to the community through an information session to be held annually.
After monitoring, recommend and implement "final" flow alternative between 4FVN & STP5	• To follow 10-12 year flow testing program • Agreed that future flow regimes to the river will not be less than 4FVN, will not exceed STP5, and that all water allocations within the 4FVN & STP#5 will be on the table for review at that time. • To be done within 15 years or less from October 22, 2001

[9] This timeframe was selected to coincide with the GVRD's future planning needs to clarify water allocations in the Coquitlam reservoir

[10] The opportunistic flushing flow test is dependent on coordinating flows in Or Creek; as a result the timing is unpredictable.

[11] "4FVN" represents approximately a doubling of the present fish flows to the river, an increase in flows to GVRD, and a reduction in flows to the power generating station. "STP5" represents higher flows to the river and lower flows to GVRD and power than "4FVN". A more detailed explanation of these operating alternatives is found in Chapter 5 ("Operating Alternatives").

Operating Recommendations	Comments
Implement and monitor opportunistic flushing flow experiment as recommended by FTC and subject to monitoring program design[12]	• To be incorporated into adaptive management program design • In coordination with the FTC's recommendations, the CC supported the testing of an opportunistic flushing flow experiment with the monitoring program • Fish and other impacts to be monitored • Incorporate continued investigation of other possible options for substrate maintenance.
Operationalizing target flow rates for the flow trials	• Target flow releases from Coquitlam dam would be modified once per week and only if the release is outside of +/- 10% range of the target, except for July and September when –10% becomes a hard constraint.

Finally, there were a number of recommendations and/or acknowledgements, which were made during the course of this WUP which were accepted by the CC and are summarized below:

Operations:

- BC Hydro system emergency situations would take precedence over the Water Use Plan alternatives. Historically these events are very rare and of a short-term nature (normally hours). Emergencies include those required to address dam safety, actual or potential loss of power supply to customers, dam breach or potential dam breach, extreme flood flows, fire or explosion, environmental incidents, major equipment failure, or threat to employee or public safety.
- Ramping rates at Buntzen #1 and #2—no restrictions apply
- Diversion tunnel between Coquitlam and Buntzen reservoirs—no restrictions apply
- Ramping rates at Coquitlam dam—these are considered a *work-in-progress* and no ramping rates were agreed to. This item is to be finalized as a part of the monitoring program. However, the CC agreed to target ramping rates based on DFO's suggested maximum water level changes in the river of 5 centimeters per hour. In the interim (until an accurate stage/flow relationship is established) the following three-step ramping rate protocol is proposed as a starting point:
    - Above 7.1cms, ramp down at 9.5cms (cubic metres per second/hour)
    - Below 7.1cms, ramp down at 0.71cms per every half hour
    - Below 2.8cms, ramp down at 0.42cms per every half hour
    - Ramping up rates are currently at 9.5cms/hour
- The CC recommended the following reservoir target elevations for the Buntzen Reservoir[13]:
    - Restrict minimal operating level to 122.2m between 15 May to 1 October during daylight hours

[12] The FTC has subsequently recommended that opportunistic flushing flows (OFFs) be postponed until after the review period and flow trials have been conducted so as to not confound the monitoring results. There may be an opportunity to carryout OFFs if the flow trials are completed earlier than expected (i.e. if preliminary flow trials show conclusive results and/or their duration reduced), or if there is a weak correlation between increased flows and habitat improvements.
[13] Operating levels specified in the plan were implemented by BC Hydro in June 2001 prior to final CC approval of the plan in January 2002.

- At other times the operating range is 120.09-122.9 m[14]
- When emergency drawdowns below this point are required, the Buntzen Reservoir Warden will be contacted. A procedure is being developed for employing additional staff and placing additional signage to advise the public of the increased hazard when such drawdowns do occur.

◆ The operational and maintenance requirements at Grant's Tomb (a tripartite agreement between DFO, BC Hydro, and GVRD) were not addressed within this WUP. However, the allocation of water (up to 9 cubic feet per second) was included in the operating alternatives.

Other issues and recommendations (outside the scope of this Water Use Plan):

◆ First Nations access to the Coquitlam Reservoir is best addressed through direct consultation between First Nations and GVRD.

◆ The development of an Archeological Management Plan between BC Hydro, First Nations, and GVRD was acknowledged to be First Nations' preferred approach to address archaeological issues.

◆ The CC supported the idea for the Kwikwetlem First Nations' desire to restore sockeye to the Coquitlam Reservoir.[15] However, this issue was considered beyond the scope of this water use plan, but was to be addressed through the Bridge Coastal Restoration program[16]. It was recommended by the CC that if efforts are undertaken to return sockeye to the Coquitlam reservoir, that this should trigger the re-opening of the WUP. The GVRD indicated that they would support the return of sockeye assuming it would not significantly impair drinking water quality.

◆ Tower Creek (located just upstream of the Coquitlam Dam) is now being wholly diverted into the Coquitlam River. Committee members expressed a concern that the creek is being diverted directly into the river only when it is turbid. GVRD representatives indicated that this occurs only during the winter months and agreed to look into the issue, but pointed out that this is a larger issue would need to involve other agencies and would need to be resolved outside this WUP.

Expected Impacts from the Adaptive Management Program

The impacts from the adaptive management program (aside from addressing the high level of uncertainty associated with fish impacts and benefits) according to each of the principal trade-off objectives—domestic water, fish and power—are summarized in Table ES4 below. These impacts are based on comparisons to current operations and referred to as the ***reference base case*** (2FVC). Some of these impacts are uncertain and are designed to be addressed as a part of the adaptive management program.

[14] Although the operating range is not being changed, the way in which BC Hydro operates the reservoir during part of the year is being changed. Reservoir elevation below 120.09 m can cause vortexing at the intake; above 122.9 m creates an unacceptable risk of spilling.
[15] This WUP dealt with access issues for all salmonids from the mouth of the Coquitlam River to the dam.
[16] A feasibility study was conducted on the Coquitlam River system and concluded that it is not a strong candidate for salmon passage initiatives because of technical uncertainties around smolt screening during out migration.

Table ES 4: Expected Impacts of the Recommended Package

Objective	Flow Trial #1 - 4FVN	Flow Trial #2 - STP5
Domestic Water (values supplied by GVRD)	• Increases regional water supply capacity on average by 4.0 cms[17] (from 7.88cms to 11.88cms) • Delay raising Seymour dam by about 23 years (2030 to 2053) • Delay flooding 390 ha of valley floor ecosystem at Seymour by 23 years • Save GVRD ratepayers approx. $59 million by delaying costs for raising Seymour by 23 yrs (annualized costs of approx. $3.7 million per year)	• Increases regional water supply capacity on average by 2.6 cms (from 7.88cms to 10.48cms) • Delay raising Seymour dam by about 15 years (2030 to 2045) • Delay flooding 390 ha of valley floor ecosystem at Seymour by 15 years • Save GVRD ratepayers approx. $29 million by delaying costs for raising Seymour by 15 yrs (annualized costs of approx. $1.8 million per year)
Fish	• Steelhead spawning habitats increase by 7700m^2 (50% change) • Steelhead parr habitats increase by 8600m^2 (10% change) • Invertebrate habitats increase by 11,500m^2 (12% change) • August short-term survival flows are provided at all times for a major portion of the river (61% improvement from current) • 25% improvement in spawning flow provisions for Steelhead • Yearly average base flows doubled: spawning and rearing habitat increase substantially over current operations	• Chinook spawning habitats increase by 4100m^2 (24% change) • Steelhead spawning habitats increase by 11,000m^2 (69% change) • Steelhead parr habitats increase by 16,100m^2 (18% change) • Invertebrate habitats increase by 22,700m^2 (24% change) • Short-term survival flows are provided year round every year (16-61% improvements over current) • Rearing flows provided 43% more often than current flows • Yearly average target base flows are almost 4 times the current flow agreement: spawning and rearing habitat for all species are improved considerably
Power	• Annual total power production is reduced by 65 GWh on average (from 125 to 60 GWh) • Total value of power production and GVRD payments is reduced by $1.37 million per year (from $9.4 to $8.03 million) • Capital cost for modifications to one low level outlet = $310,000	• Annual total power production is reduced by 77 GWh on average (from 125 to 48 GWh) • Total value of power production and GVRD payments is reduced by $2.18 million per year (from $9.4 to $7.22 million) • Capital cost for modifications to one low level outlet = $310,000

[17] Cubic metres per second (cms)

Monitoring Program

The purpose of the monitoring program (as defined by the CC) was to ensure that there would be sufficient information in place by the end of the review period to address the uncertainty of fisheries benefits and therefore provide a future committee with improved information to make better decisions. To achieve this objective, the FTC developed a comprehensive monitoring program to be used in conjunction with the two flow trials. Initially consisting of 17 components, the monitoring program was screened[18] by the FTC and reduced in scope to include 8 items, which are summarized in Table ES 5 below (for a complete listing of all the components considered for the monitoring program, refer to *Appendix L Detailed Monitoring Program Summary*).

Table ES 5: Monitoring Plan Components and Uncertainties

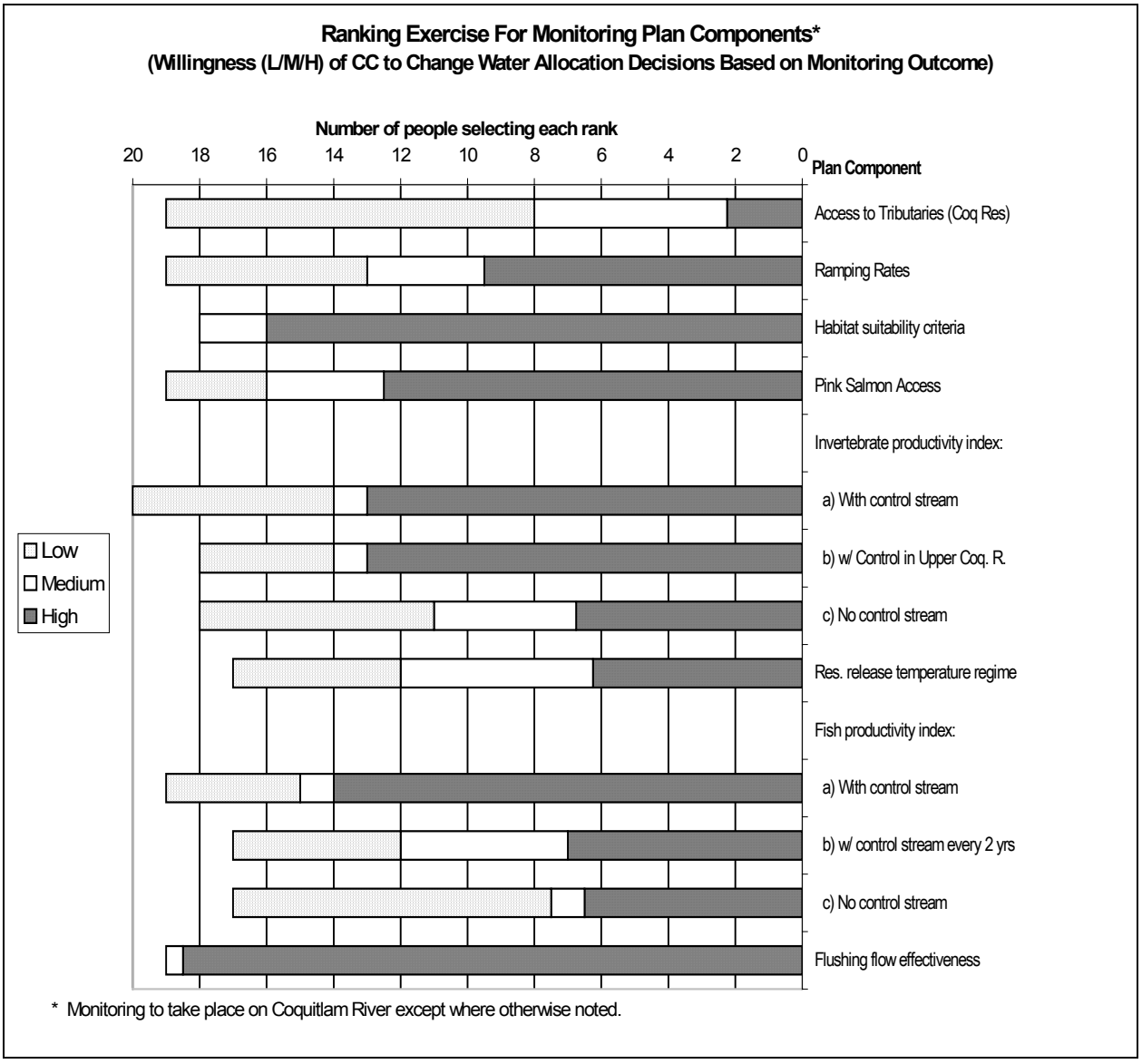
Site	Monitoring Aspect:	Uncertainty being Addressed:
Reser-voir	*Access to Tributaries*	Complete database of streams which have access issues associated with reservoir operations, and determine the fish use of those affected streams.
River	*Ramping Rates*	Need to identify the stranding and dewatering impacts associated with operational changes at the dam. Previous assessments lacked field validation.
	Habitat Suitability Criteria	Refine available species habitat use data by collecting in-situ data at varying flow, mesohabitat and seasonal conditions
	Pink Salmon Access to Mainstem	Access issues for pink salmon will be evaluated during lower September flows, to augment previous assessments which did not include pink salmon.
	Invertebrate Productivity Index	Determine the productive response of invertebrates to flow changes in the Coquitlam River. Invertebrate response is expected to be more immediate than for fish, and will therefore be valuable where fish responses are not detected.
	Reservoir Release Temperature Regime	The operational influence on release temperatures needs to be better understood.
	Fish Productivity Index	Determine the productive response of fish to flow changes in the Coquitlam River. A control stream will help to eliminate variables contributing to production outside of operational control.
	Flushing Flow Effectiveness	Determine the effectiveness of flushing flows in improving the quality of Coquitlam River fish habitat for evaluation of future water planning initiatives.

[18] The FTC screening process reviewed: (a) the data gap being addressed (competing hypotheses), (b) the value of information (or amount of learning) that the study would produce, (c) duration of the study to produce meaningful results (as compared to the flow trial durations), (d) timeframe that the information would be used, and (e) the study costs.

Consultative Committee Evaluation of the Monitoring Plan

At the Final CC Meeting on March 11, 2002, the Consultative Committee was asked to evaluate the monitoring program developed by the FTC (for specific member comments and more detail see Section 7.0 and the minutes of final meeting included in Appendix K). CC members were asked to rank each component of the proposed monitoring program on a scale of high, medium, or low based on the impact they expect its outcome to have on their own water allocation choices. Of the 23 CC members at the meeting, 20 filled out evaluation forms although some completed them only partially. Rankings for each monitoring plan components are summarized below:

Figure ES 1: Ranking Exercise for Monitoring Plan Components



The estimated annual costs (over the review period) associated with the 8 components of the monitoring program are outlined in Table ES6 below:

Table ES 6: Monitoring Program Costs ($ in thousands)

Site	Monitoring Aspect:	Start-Up Yr 1-3	*Treatment A: Four Fish Valves Optimized* Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	*Treatment B: "Share the Pain 5" or Less* Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15
Reser-voir	*Access to Tributaries*	15	10											
River	*Ramping Rates*	3	12											
	Pink Salmon Access	2		4		4		4		4		4		7
	Habitat Suitability Criteria	15	15						15					
	Invert. Productivity Index													
	w/ control stream	86	40	40	40	40	40	45	40	40	40	40	40	45
	w/ U.Coq.R. ctrl strm	71	30	30	30	30	30	40	30	30	30	30	30	40
	w/o ctrl strm	46	20	20	20	20	20	25	20	20	20	20	20	25
	Reservoir Release TemperatureRegime	5	10	5										
	Fish Productivity Index													
	w/ control stream	595	190	190	190	190	190	205	190	190	190	190	190	205
	w/ ltd ctrl strm	505	100	190	100	190	100	205	100	190	100	190	100	205
	w/o ctrl strm	415	100	100	100	100	100	115	100	100	100	100	100	115
	Flushing Flow Effectiveness	30				30						30		10
Totals (without control stream):		***531***	***167***	***129***	***120***	***154***	***120***	***144***	***135***	***124***	***120***	***154***	***120***	***157***

Conclusion

In summary, the Coquitlam-Buntzen Water Use Plan Consultative Committee succeeded in achieving a consensus on an operating strategy that will enable more informed decisions to be made on a preferred operating flow regime within fifteen years. The process was complicated by large uncertainties related to anticipated fish benefits and this was addressed through the adoption of an adaptive management program.

This document is to forward these recommendations to BC Hydro and the Provincial Comptroller of Water Rights. The consultation process provided a framework to share information and learn, promote understanding between parties and interests, explore alternative ways to operate the facilities, evaluate impacts in a structured way and thus allow each participant to make clear choices based on explicit trade-offs between technical and value-based information. Through this interest-based process, a consensus decision was reached whereby fish, domestic water, industry, and recreation interests will be all improved over current operations.

Important Final Note on Report Submission and Monitoring Plan Implementation

At the final meeting held on March 11, 2002, it was brought to the attention of the Consultative Committee that there is a possibility that the two recommended flow trials might not yield meaningful results: In other words, the information gathered through monitoring may not clearly distinguish between the two flow trials and, therefore, not adequately inform a future Consultative Committee. To determine this possibility, BC Hydro is undertaking a statistical power analysis to gain insight into the effectiveness of the monitoring plan. In light of this information, the Consultative Committee agreed to submit this report to the Comptroller of Water Rights along with BC Hydro's Water Use Plan with the understanding that the report is subject to the following two conditions:

1. An effective monitoring plan can and will be implemented. "Effective" is defined as being cost effective and having sufficient statistical power to distinguish between the two flow trials as documented in this Consultative Committee Report. Modification to the proposed monitoring plan can be made (i.e. based on a review by the Fisheries Advisory Team) but the Coquitlam-Buntzen Fish Technical Committee will determine effectiveness. Any recommended changes to the monitoring plan will be submitted to the Comptroller of Water Rights and the Consultative Committee will be informed of the result.

2. If an effective monitoring plan cannot be implemented (again, subject to review and agreement by the Coquitlam-Buntzen Fish Technical Committee), the Consultative Committee will be reconvened for one final meeting to discuss alternatives and perhaps change recommendations. The results of this meeting will be submitted to the Comptroller of Water Rights.

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1 INTRODUCTION . . .

1.1 What is a WUP?

The Province of British Columbia (BC Ministry of Sustainable Resource Management[19]) introduced a new water use planning process in 1998. A Water Use Plan (WUP) is a technical document that defines detailed operating parameters for managers of hydroelectric power and other water control facilities in their day-to-day decisions. Plans are intended to clarify how rights to provincial water resources should be exercised, and to take account of the multiple uses for those resources.

Water Use Plans (WUPs) address both power and non-power objectives that can be addressed by rules and procedures adopted in the operation of hydroelectric facilities. These operating rules and procedures include changes to water levels in reservoirs and to water flows out of reservoirs.

Water use planning does not address issues pertaining to original construction and/or inundation that cannot be mitigated through changes in water flow and reservoir levels. For example, treaty entitlements and historic grievances are considered outside the scope of water use planning. WUPs are not equivalent to the comprehensive watershed management plans that are being produced through other processes in the province.

1.2 What is this Report?

Provincial *Water Use Plan Guidelines (December 1998)* stipulate that proponents of water use licenses (in this case, BC Hydro), in consultation with the Comptroller of Water Rights, will set up a process for involving government agencies, First Nations, key interested parties, and the general public in water use plan development.

The purpose of this report is to document the consultation process, conclusions and recommendations of the Consultative Committee (CC) of the Coquitlam-Buntzen Water Use Plan (CBWUP). It describes consultative techniques, water use interests and objectives, technical information, operating alternatives, impact and trade-off assessments, discussions, and areas of consensus and disagreement.

Figure 2 provides an overview of how the CBWUP Consultative Committee covered steps 1-8 of a 13-step water use planning process described in the provincial *Water Use Plan Guidelines (1998).*[20] As per Figure 2, and as required by the Guidelines, the committee identified:

- issues and objectives related to system operation;
- "measures" for assessing how well objectives are achieved with different operating rules;
- a range of operating procedures that address objectives;
- trade-offs between different operating alternatives; and
- degrees of support for different alternatives.

[19] Formerly the Ministry of Environment, Lands, and Parks
[20] Summary of WUP Guidelines is included in Appendix A of this report.

The recommendations of this report will be considered by BC Hydro as input for a Water Use Plan. Both reports are submitted to the Provincial Comptroller of Water Rights for review and approval of the Water Use Plan. (Step 9 of the WUP Guidelines). The Federal Department of Fisheries and Oceans (DFO) also reviews the Water Use Plan for regulatory and policy implications before it is implemented.

This report is structured as follows (Steps refer to the Provincial WUP Guidelines):

Chapter 2 describes the consultation process, including process initiation, schedule, committee participants, and committee structure (steps 1& 3).

Chapter 3 starts with documentation of issues that were raised during initial stages of issue identification and objective elicitation (steps 2 and 4). These include a list of over-arching values captured by the WUP objectives, concerns raised during the process in relation to objectives, and issues for resolution outside the WUP process. Chapter 3 then describes the process used for determining which issues and objectives could be addressed as part of the WUP process. Finally, Chapter 3 provides an explanation of the CBWUP objectives and performance measures (step 4).

Information gaps identified by the CC and studies undertaken to address these gaps are explained in Chapter 4 (step 5).

Chapter 5 describes operating alternatives considered by the CC to meet different interests along with the criteria used for creating these alternatives (step 6).

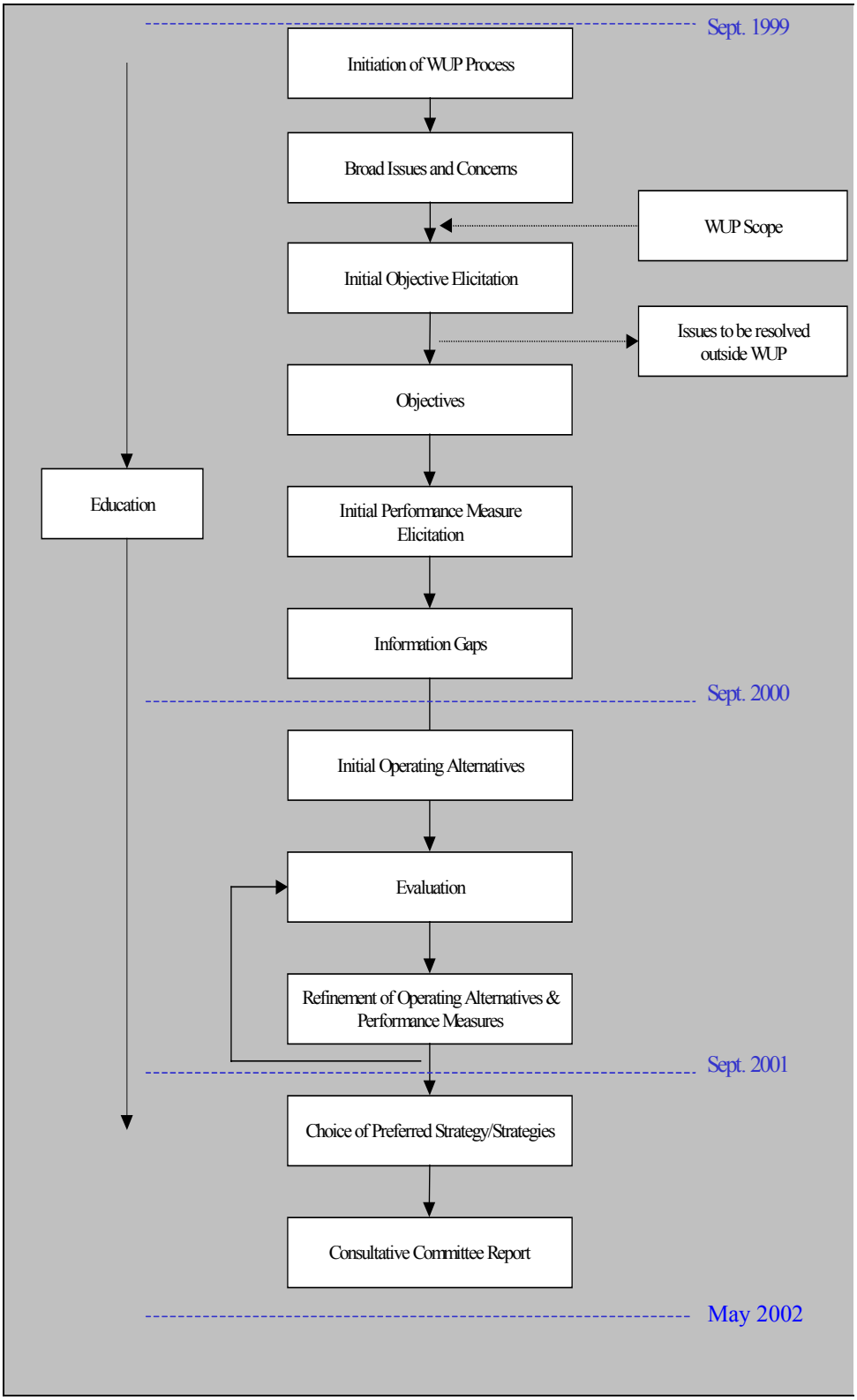
Chapter 6 describes trade-offs between operating alternatives and areas of agreement and disagreement about different operating alternatives (step 7). It also summarizes the agreed upon operating strategy and other recommendations made by the Consultative Committee. Flushing flows and a Management Plan for Buntzen Reservoir are discussed at the end of this chapter.

Chapter 7 explains monitoring recommendations of the committee.

Chapter 8 highlights the review period for this WUP.

Chapter 9 addresses the timing/implementation of the CBWUP recommendations.

Figure 2: CBWUP Process Overview

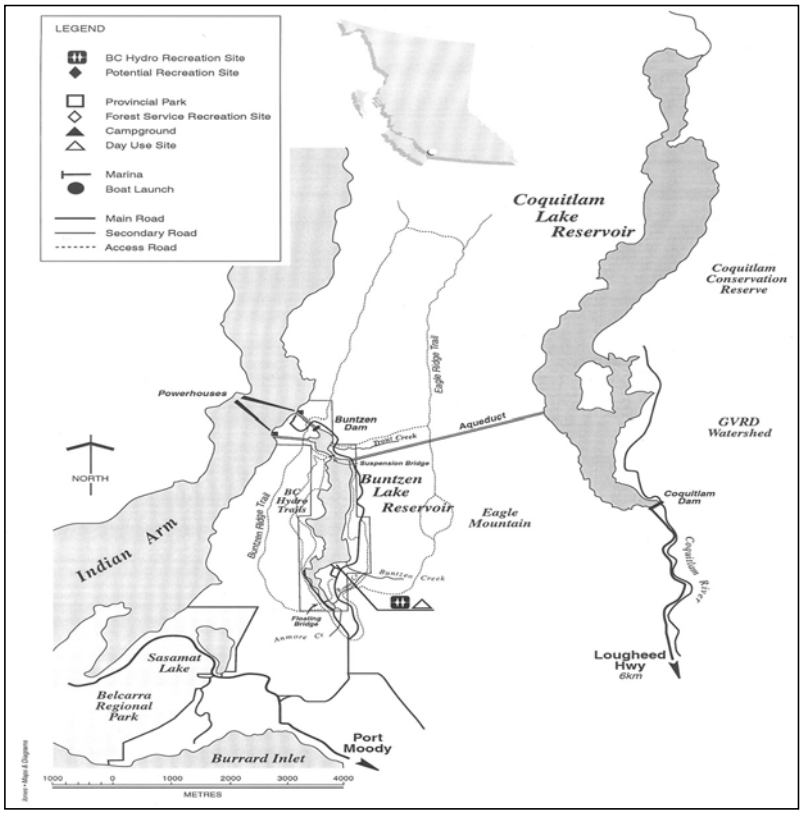


1.3 The Coquitlam-Buntzen System

Water for the Coquitlam-Buntzen system originates in the headwaters of the **Coquitlam River**, which flows from Lower Mainland coastal mountains south to the Fraser River via the **Coquitlam Reservoir**. The Coquitlam Reservoir lies within the GVRD watershed about 10 km north of the Lougheed Highway in Coquitlam. Tunnels divert water from the Coquitlam Reservoir to the **Greater Vancouver Regional District** (GVRD) for domestic water and to **Buntzen Lake Reservoir** where the intakes are located for the two **powerhouses** situated on the shore of **Indian Arm**[22]. Buntzen Reservoir is situated just north of the Village of Anmore, approximately 30 km east of downtown Vancouver. The Coquitlam-Buntzen hydroelectric system is in the traditional use area of five First Nations**,** including Kwikwetlem First Nation, Tsleil-Waututh First Nation, Katzie First Nation, Squamish First Nation and Musqueam First Nation. It is also within the traditional territory claimed by Sto:lo Nation.

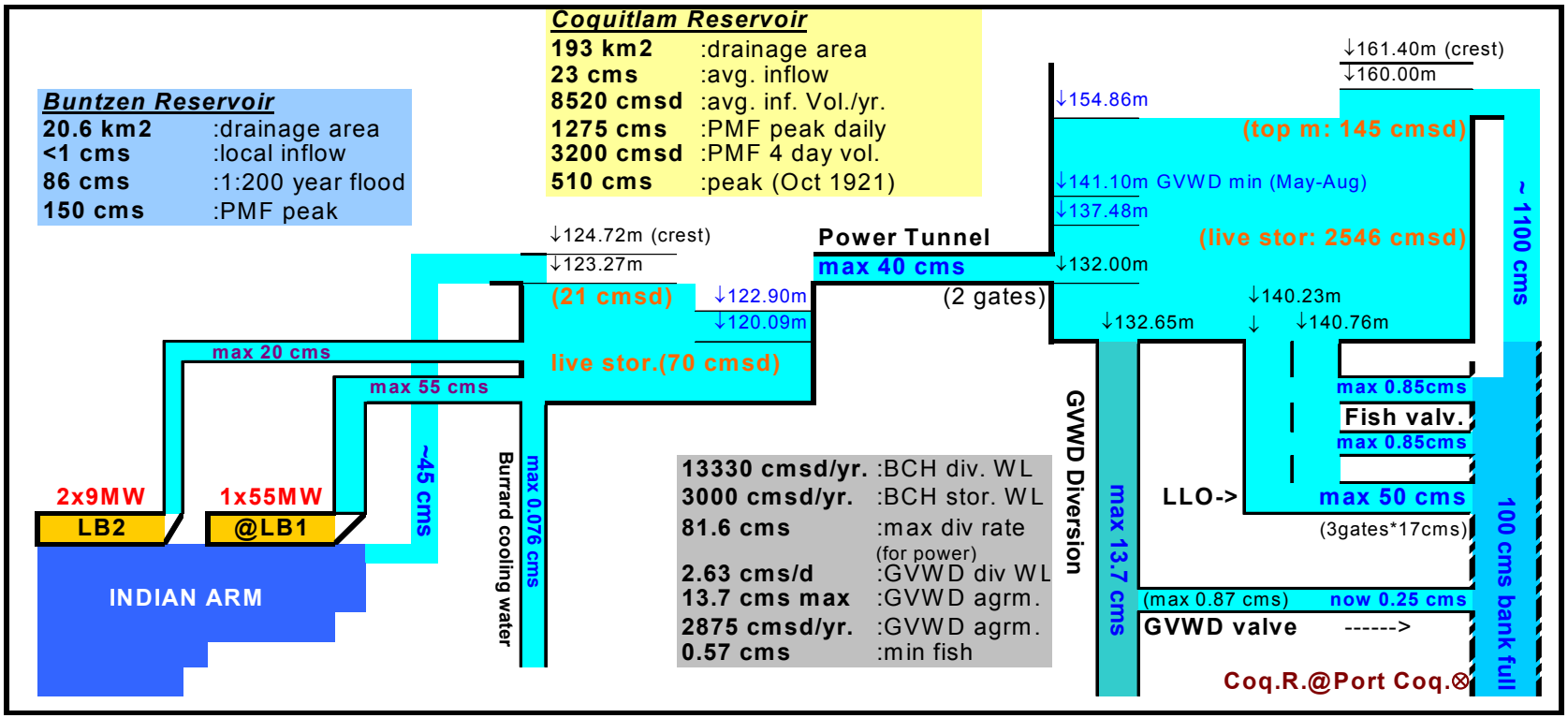
A map of the system is shown below and a schematic of the operational features of the system are described in Figure 3.

Figure 3: Coquitlam-Buntzen system map



[22] GVRD (Greater Vancouver Regional District) is meant to refer to both the geographical area of the GVRD and the services provided by the GVRD and its drinking water supply utility (Greater Vancouver Water District, GVWD).

Figure 4: Coquitlam-Buntzen System Operating Parameters



Coquitlam Reservoir

The Coquitlam Reservoir is part of the GVRD Watershed and is closed to the public. The reservoir supports a resident fish population, but there is no fish access from the Coquitlam River, downstream of the dam. The reservoir contains archaeological sites.

Buntzen Reservoir

Buntzen Reservoir is heavily used for recreation (swimming, boating, fishing, and walking). Normal operating elevations for the reservoir at the start of the CBWUP were between 122.09 m and 122.90 m with daily elevations fluctuating to give BC Hydro flexibility (load factoring) in operating its powerhouses (LB1 and LB2). Buntzen Reservoir is stocked with fish and supports resident fish and wildlife.

Buntzen Powerhouse & Outflow to Indian Arm

The Coquitlam-Buntzen hydroelectric facility has been in operation since 1903, making it the oldest in the Lower Mainland. The facility is part of BC Hydro's Bridge River/Coastal Area. The Buntzen generating stations (LB1 and LB2) are able to produce about 200 gigawatt hours of electricity each year-- enough to provide electricity for 18,000 homes. It represents approximately 7.1 percent of BC Hydro's generating capacity in the Lower Mainland/Coastal/Fraser Region and about 0.4 percent of BC Hydro's total power generating capacity. It also provides BC Hydro with emergency capabilities for its system[23]. Diversion of the Coquitlam River via BC Hydro's system results in freshwater outflows to Indian Arm that would otherwise not occur.

GVRD Diversion

Since 1987, there has been an agreement between BC Hydro and the Greater Vancouver Regional District (GVRD), approved by the Comptroller of Water Rights, for supply of water for municipal use. Discussions between BC Hydro and the GVRD on an expansion to this agreement began in 1995 and continued until the CBWUP consultation process began. At the request of CBWUP Consultative Committee members, finalization of the agreement between BC Hydro and GVRD was deferred until completion of the water use planning process.[24]

The existing BC Hydro/GVRD agreement identifies the maximum amount of water that may be diverted from the Coquitlam Reservoir to municipal water supply. The GVRD presently uses less than its maximum nomination. With full use of the current agreement with BC Hydro the GVRD allocation of Coquitlam Reservoir water would increase to a maximum of 7.88 cms on an annual basis. This represents about 34 percent of the average annual reservoir inflow of 23.3 cms.

[23] For example, one emergency situation involves starting generation in a total black out situation. Black start capability requires use of the Buntzen plants and water in the Buntzen Reservoir. It was also mentioned that black start situations are extremely rare and of a short duration (normally in hours).

[24] BC Hydro confirmed at a Consultative Committee meeting (Nov 8, 1999) that their priority is to conduct water use plans as a means of addressing competing water use interests and that the proposed agreement would not prejudice water use planning.

Coquitlam Dam and Coquitlam River (downstream of dam)

Land along the river downstream of the dam is located in a variety of holdings, including GVRD, private property (including gravel operations), and provincial, regional, and municipal parks. There is extensive urban development in the area, gravel operations adjacent to the river, and two Kwikwetlem First Nation reserves (IR#1 and IR#2) located on the banks of the Coquitlam River downstream of the Coquitlam Dam.

Release facilities at the Coquitlam Dam at the southern end of the Coquitlam Reservoir provide significant downstream flood control benefits and facilitate regulation of inflows such that the river's water can be allocated for power generation, domestic water supply, fish and wildlife habitat, storm water management for industry, and recreation.

There are seven formal recreation areas (GVRD and City of Coquitlam) along and in the region of the Coquitlam River. As well, there are many informal open spaces and trails along most of the Coquitlam River corridor and these are in use year round for hiking and cycling. There are numerous plans and recommendations for enhancing recreation potential in this area and water releases from the Coquitlam Dam are therefore of increasing consequence to recreation interests, including safety.

The Coquitlam River is also the location of fish and wildlife interests. According to CC Members, concern among residents in the area regarding the decline of salmonid populations in the Coquitlam River began with the destruction of the sockeye when the dam went in at the beginning of the century, followed by the decline of pink salmon in the late 1950s followed by more widespread concern since the early 1980's. In response, several enhancement and conservation initiatives were introduced, including escalation of minimum flow agreements, hatchery production, and off-channel habitat creation. Recent fish flow agreements in 1993 and 1999 resulted in the construction of 2 fish valves and, as of 1999, minimum flow release to the river from the Coquitlam Reservoir is approximately 0.65 cms of which 0.57 cms is released from the dam through the 2 fish valves (now 100% open all year) and 0.08 cms is released via the GVRD pipeline (Grant's Tomb/Swoboda Channel). Note that a maximum of 1.70cms (60cfs) and 0.25cms (9cfs) is released via the two fish valves and the GVRD pipeline respectively when the reservoir is full.

2 THE CONSULTATION PROCESS . . .

The Coquitlam-Buntzen WUP consultation process followed the steps outlined in the provincial *Water Use Plan Guidelines* (Province of British Columbia, 1998). These steps, shown in the adjacent Box, represent a structured approach to decision making; some steps were undertaken in an iterative manner (the Consultative Committee was involved in the blue highlighted steps).

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

2.1 Process Initiation and Schedule

Public involvement in the development of the Coquitlam-Buntzen WUP began with a mail out to over 70 organizations; in addition two publicly advertised open houses and information sessions were held in September and October of 1999. All interested parties were invited by BC Hydro to be part of the CBWUP Consultative Committee. The first meeting of interested parties was held in November 1999.

The Consultative Committee as a whole met 22 times, from November 8, 1999 to March 11, 2002 to move through the process steps.[25] During this time there were also 65 additional subcommittee meetings held to aid the CC's work: involving First Nations, technical committees, and other working groups. Table 1 highlights main activities, their timeframe, and associated process steps. Meeting dates are provided in Appendix B.

[25] The first meeting facilitated by outside consultants took place on December 13, 1999 (third CC meeting).

Table 1: Consultation Milestones

WUP Guidelines	Main Activities	Timeframe
Step 1: Initiate WUP Process	**Initiate WUP Process** • Public open house & information sessions	Sep-Oct 1999
Step 2: Scope water issues & interests	**Scope broad issues & concerns**	Nov 1999–Jan 2000
Step 3: Determine consultative process	**Determine consultative process & committee structure** • Identify & confirm interested parties for consultative committee • Form working groups[26] • Review CC size and structure • Form Fish Technical Committee (FTC)	Nov-Dec 1999 Feb-Apr 2000 Apr 2000 Jul 2000
Step 4: Set Objectives & performance measures	**Initial objective elicitation**	Jan 2000
Step 4 cont.	**Establish WUP objectives & issues for resolution outside WUP**	Jan-Apr 2000
Step 4 cont.	**Develop Initial performance measures (PMs)**	Apr-Jul 2000

Step 5: Collect data on water use impacts	**Identify information gaps & study requirements**
	• Information gaps & studies except those listed below
	  ○ Proposed atlas/historical study
	  ○ Decision to use modelled fish PMs as an interim tool for trade-off analysis because of insufficient field data on instream flow needs
	Collect data & review study results
	• Non-fish studies
	• Fish IFN study
	• Other fish studies
		Apr-Jul 2000
		Sep-Dec 2000
		Feb 2001
		
		Jan 2000-May 2001
		Jul 2000-ongoing[27]
		Dec 2000-Jul 2001

Step 6: Create operating alternatives **Step 7:** Assess trade-offs between alternatives	**Create & evaluate *initial* operating alternatives** • Coquitlam River flow regimes, excluding flushing flows • Coquitlam River: 200 cms flushing flows • Buntzen Reservoir management plan	Oct – Dec 2000 Mar - Jun 2001 Aug 2001
Step 4 cont.	**Refine performance measures[28]**	Dec 2000-Oct 2001
Step 6/7 cont.	**Create & evaluate *refined* operating alternatives** • Coquitlam River flow regimes, excluding flushing flows • Coquitlam River interim flushing flow options	Feb-Mar 2001 & Jun-Oct 2001 Jun-Jul 2001
Step 7 cont **Step 8:** Determine & document areas of consensus & disagreement	**Determine preferred operating strategy** • All except details of fish monitoring plan • FTC develop monitoring recommendations	October 2001 Nov 2001
Step 8 cont	**Review & sign-off on consultation report**	January - June 2002

2.2 Participants

The structure of the Consultative Committee (CC) was inclusive with two levels of involvement, active and observer status. Active participants attended most CC meetings and were directly involved in making decisions, whereas observer status enabled members to attend meetings to observe the proceedings and to receive meeting minutes. The Consultative Committee began with 37 active members and 18 observers

[26] These were sub-groups of the CC that refined objectives and recommended performance measures, information gaps & study requirements.
[27] Data collection not completed during WUP process due to unusually low rainfall. Data collection is ongoing and IFN study to be completed over the next 2 years.
[28] Revision of PMs occurred throughout the WUP process as study results became available and operating alternatives were refined.

(December 1999) but some active members changed to observer status as the process advanced. Others were replaced by different people from their organization or left the process because others represented their interests on the CC. At the end of the process, there were 26 CC members of whom 22 were on the original committee.[29] In addition, 36 people received Consultative Committee minutes.

Consultative Committee members included representatives of community organizations (such as environmental and recreation groups), First Nations, industry, and government agencies (local, regional, provincial, federal) as well as local residents. (Detail in Appendix C) First Nations, the City of Coquitlam, and the Ministry of Sustainable Resource Management (MSRM) made notable changes in the status of their participation. First Nations representation is discussed under a separate heading below.

MSRM was a full member of the Consultative Committee until the summer 2001. Then, in view of government re-organization and responsibility changes, a change was made to observer status as of the October 22, 2001 CC meeting.

The City of Coquitlam was a full member of the CC until May 2001. After that, the City decided to change its delegate to the CC. While deciding whom to delegate, it sent observers in the interim from May to July 2001. A new delegate was provided to the CC in August 2001 at which time there were only two more CC meetings planned – one to carry out a final evaluation of operating alternatives and a second to review and sign-off on the final consultation report. In view of the late stage of the process, the CC decided that the new delegate from the City of Coquitlam should attend the final CC meetings as an active observer rather than as a full member. The CC also decided that the City of Coquitlam would be invited to sign-off on the final consultative committee report in recognition of its active role as a CC member throughout most of the CBWUP process.

In addition to the CC, BC Hydro provided broader public consultation through web based updates, attendance at community events, newspaper inserts/advertisements, etc. See Appendix D for details.

2.3 First Nations Involvement

The Coquitlam-Buntzen hydroelectric system is in the asserted traditional use area of five First Nations, including Kwikwetlem First Nation, Tsleil-Waututh First Nation, Katzie First Nation, Squamish First Nation and Musqueam First Nation. It is also within the asserted traditional territory claimed by Sto:lo Nation.

Kwikwetlem First Nation has two reserves, Coquitlam IR#1 and Coquitlam IR#2, located on the banks of the Coquitlam River downstream of the Coquitlam Dam.

An introductory meeting was held with representatives from each of the five First Nations and Sto:lo Nation in July 1999.

- Kwikwetlem First Nation, Katzie First Nation, Tsleil-Waututh First Nation and Sto:lo Nation committed to participate in the Coquitlam-Buntzen Water Use Planning process.

[29] This tally includes neither the First Nations representatives nor representatives from MSRM and the City of Coquitlam whose status changed from member to observer near the end of the consultation period. It also excludes one of the DFO representatives on the Committee who left for maternity leave before the final trade-off meeting.

- Squamish Nation advised BC Hydro that they would not be participating in this WUP because their interests were more directly with the WUP being undertaking on the Cheakamus River.
- Musqueam First Nation indicated interest in the process and a representative attended meetings to January 2000. Musqueam First Nation was sent periodic updates on the process and offers were made to meet to discuss the process or any concerns directly. Copies of all CC meeting minutes were provided to Musqueam's representative.

Early in the process the First Nations requested a separate consultation process and First Nation meetings were held in parallel with meetings of the Consultative Committee. The First Nations reserved and exercised the right to participate at the multi-party table as well as the First Nation table.

To promote better understanding by the Consultative Committee of the context and concerns of First Nations people involved in the WUP process, a cross-cultural session was given by BC Hydro in cooperation with the representatives from Kwikwetlem, Katzie, Musqueam, Tsleil-Waututh First Nations and Sto:lo Nation.

The First Nation representatives were explicit that their participation in the WUP process was based on the understanding that Aboriginal rights and title to all lands and resources within the Coquitlam-Buntzen watershed are unextinguished and, therefore, that the WUP process is without prejudice to Aboriginal rights and title in all aspects of BC Hydro facility operations. The First Nations representatives stated an interest in maximizing consideration of Aboriginal rights and title in all aspects of BC Hydro facility operations and these were considered when developing alternatives.

On October 10, 2000 it was clearly articulated at the Consultative Committee that individual First Nation representatives represented their respective First Nations directly at the Consultative Committee Table. No further meetings of the First Nation table were held. However, meetings were held with Kwikwetlem First Nation to discuss their interests in relation to objectives (e.g. archaeology, fish, environment/wildlife, flooding) and to ensure that these interests were covered by the CBWUP performance measures.

Meetings were also held with the First Nation representatives that focused on the Archaeological, Heritage and History objectives, performance measures and study requirements. Each of the three First Nations and Sto:lo Nation participated directly in the commission and implementation of the Heritage/Archaeological Resources Overview for the CBWUP.

Kwikwetlem First Nation participated in meetings of the Consultative Committee through 2000 and early in 2001. In May and June 2001, however, Kwikwetlem First Nation advised the Consultative Committee that because BC Hydro was refusing to deal with them directly about the return of sockeye to Coquitlam Lake Reservoir, they were withdrawing their participation in the CBWUP.

In February 2001, Sto:lo Nation sent a letter to BC Hydro advising that their "involvement in the Coquitlam-Buntzen WUP was to gather information and to help with the work of the Kwikwetlem Band and other First Nation interests". On June 19th, 2001, Sto:lo Nation advised BC Hydro by letter that because Kwikwetlem First Nation was no longer participating in the WUP there was no further point to continuing Sto:lo Nation involvement. They continued to be informed after this date through receiving meeting minutes (and briefing materials sent to the CC).

Tsleil-Waututh First Nation participated in meetings of both the First Nations table and the Consultative Committee main table up until October 2000. They continued to be informed after this date through receiving meeting minutes (and briefing materials sent to the CC).

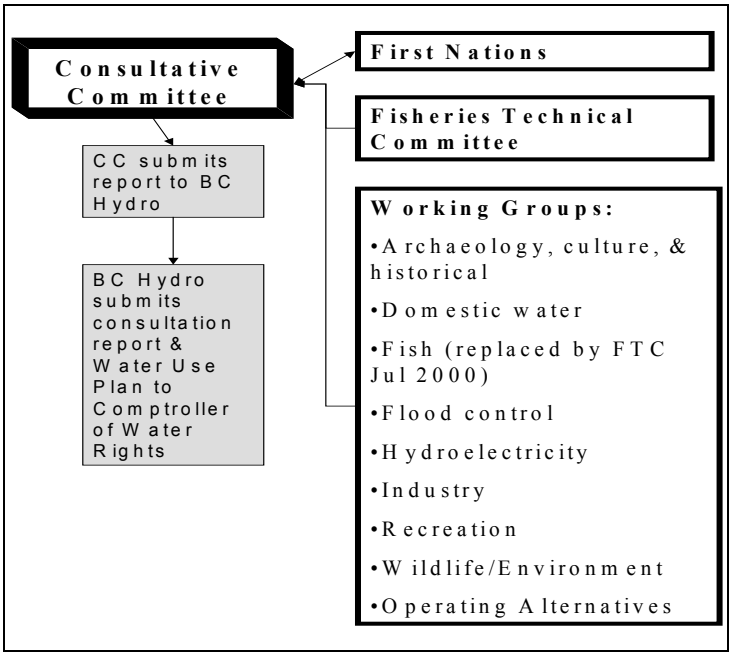
Katzie First Nation participated in meetings of both the First Nations table and the Consultative Committee main table up until March 2001. They continued to be informed after this date through receiving meeting minutes (and briefing materials sent to the CC). A representative from Katzie First Nation attended the meeting of the Consultative Committee on October 22nd, 2001.

2.4 Committee Structure

Committee and reporting structure for the CBWUP consultation process is summarized in Figure 5.

In addition to the main table of the Consultative Committee (CC), First Nations were consulted separately on issues related to all the CBWUP objectives. The First Nations table reported at their discretion to the CC.

Figure 5: Consultative Committee Structure



The CC made extensive use of working groups that met as needed from February 2000 to February 2001 to refine objectives, recommend and refine performance measures, identify information gaps and study requirements, and report on study findings. CC members were free to join any working group, provided that they were prepared to make the necessary time commitment required for full participation.

A fish working group was formed along with other working groups during the early stages of the process but was later replaced by a Fish Technical Committee composed of CC members, BC Hydro technical staff and two fish biologists from the Ministry of Water, Air and Land Protection (formerly part of the Ministry of Environment). The FTC first met in August 2000 and continued meeting throughout the remainder of the consultation process.

An additional working group was formed in July 2001 to try and develop new alternatives which would better meet objectives and likely enable the CC members to reach consensus. This group was represented by members from the CC: BC Hydro, GVRD, the Ministry of Water, Land, and Air Protection (formerly

MELP), Ministry of Sustainable Resource Management, Watershed Watch Salmon Society (occasional), Habitat Conservation & Stewardship Program, and DFO (occasional).

The FTC and working groups were delegated tasks by the CC and brought recommendations back to the Main Table. All decisions and recommendations of the consultation process were made at the main table of the CC.

Facilitation

Composition of the facilitation team changed during the course of the process. BC Hydro facilitated initial WUP consultation meetings (Sept-Nov 1999). Consultants took over facilitation of the CC from BC Hydro in December 1999. Part of the consulting team changed in February 2000. William Trousdale of EcoPlan International, Inc. and Maria Harris shared the facilitation role after this point.

3 ISSUES, OBJECTIVES, AND PERFORMANCE MEASURES . . .

In Step 4 of the water use planning process, the consultative committee (CC) took the issues and interests (Appendix A) confirmed by the group and expressed them in terms of specific objectives and performance measures. In defining the objectives, the participants articulated what they were seeking to achieve through a change in operations. The performance measures developed by the CC provide the tools to assess the degree to which alternative operating regimes achieve the objectives.

This section summarizes objectives and corresponding performance measures for the Coquitlam-Buntzen WUP. A more detailed description of the interests, objectives and performance measures and how they were calculated can be found in the associated appendices.

3.1 Issues

The consultative committee met for approximately one year developing issues, objectives, and performance measures which were summarized in an Issues Paper (EcoPlan International/Maria Harris, November 2000, see Appendix A). The Issues Paper was also placed on the web site and used at community events as a handout. It provided an interim summary of:

- WUP objectives along with over-arching values and related concerns;
- Issues for resolution outside WUP;
- Initial performance measures; and
- Information gaps & CBWUP studies.

Key issues identified in the Issues Paper related to the following areas:

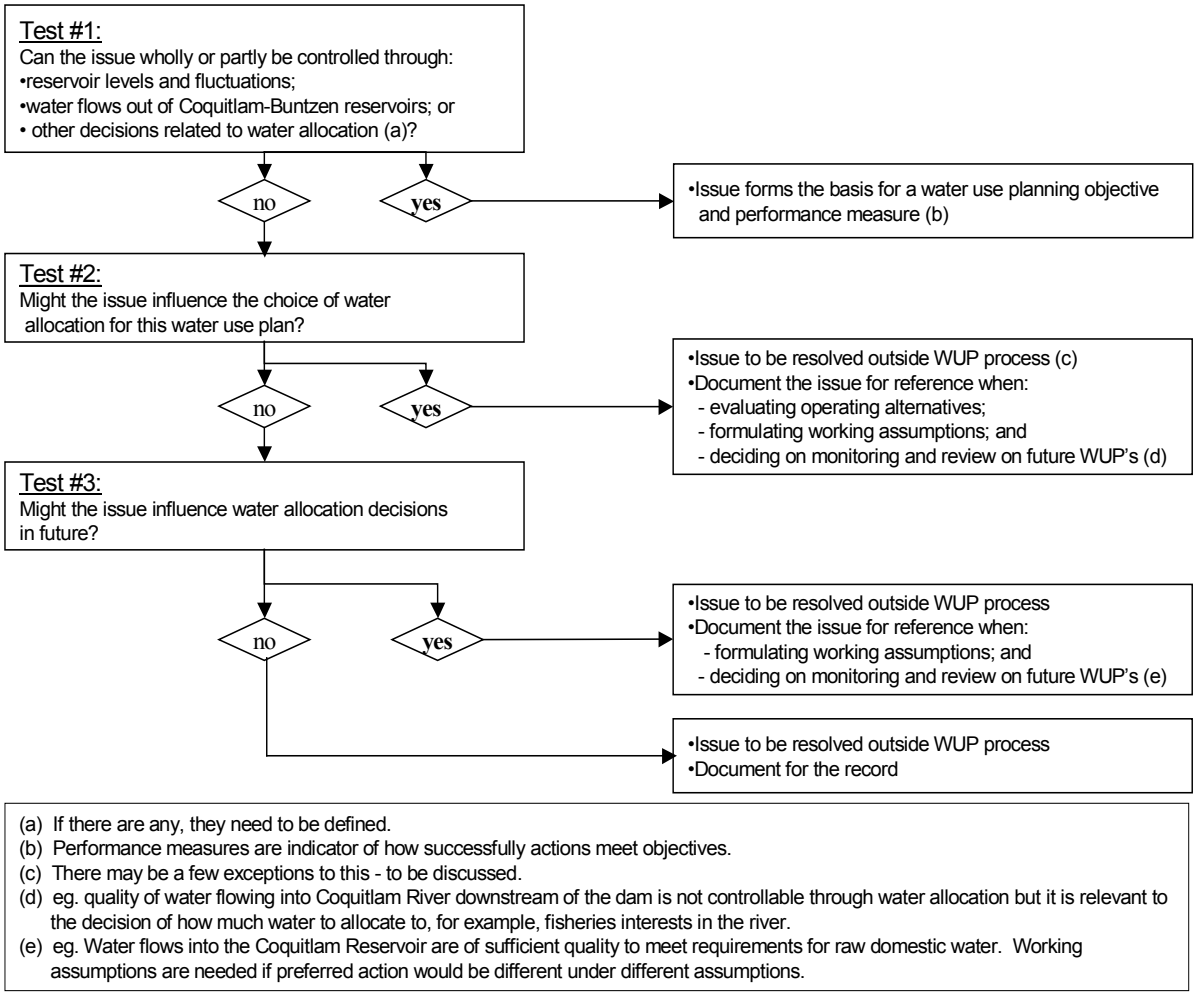
- Archaeology, Culture and History
- Domestic Water
- Fish
- Flood Control
- Power
- Industry and Economic Development
- Recreation
- Wildlife and Environment

In addition, suspended sediment (turbidity) was raised as an issue of concern throughout the Coquitlam-Buntzen WUP planning process, both at the working group level (Recreation, Flood, Fish, Industry) and the Consultative Committee level. An overview of suspended sediment (turbidity) concerns is provided in Section 3.3 of this chapter.

Issues raised by the CC were assessed through an analytical framework (see Figure 6) to determine their relevance to the water use planning process.[30] This framework was developed to help decide whether issues could be resolved within the water use planning process and whether, as a consequence, they could be reflected in WUP objectives.

[30] Subsequently (Spring 2001), the inter-agency WUP Management Committee provided all WUP tables with another framework for reviewing issues and operating alternatives. This did not alter the original classification of CBWUP issues.

Figure 6: Analytical Framework For Reviewing CBWUP Issues



Only the issues that passed Test #1 in Figure 6 were developed into objectives for the WUP. For example, the issue of fish habitat is directly influenced by water allocation decisions (Test #1), and therefore forms the basis for a WUP objective and performance measure.

Tests #2 and #3 of the analytical framework in Figure 6 were intended to help clarify the relevance of some issues to the water use planning process even if they could not be resolved within the process. For example, urban riparian development (land use zoning) is not influenced by Coquitlam Reservoir water allocation (Test #1) and therefore does not form the basis of a WUP objective. However, it might influence the choice of water allocation (e.g. by reducing potential wildlife and fish habitat -- from dyking and low bench loss -- made possible by increased flows) for this WUP (Test #2) and can be documented as an issue outside the scope of the WUP. This issue may also influence water allocation decisions in the future if future land use decisions were to affect habitat (Test #3).

The screening of issues through these tests to determine whether they fell within the scope of water use planning or not, resulted in some issues not being explicitly addressed as a part of this WUP. Efforts were made to redirect non-WUP issues and they are documented for reference in Appendix G of this report.

Two notable exceptions which could not be entirely dealt with are **Fish Access to the Coquitlam Reservoir** and **Channel Forming Flushing Flows: 200cms** (see summary boxes below) designed to adequately clean poor substrate used by fish.

Fish Access to Coquitlam Reservoir

The Coquitlam River supported a sockeye population until construction of the Coquitlam Dam in the early 1900's. Since then there has been no fish access from the lower Coquitlam River to the Coquitlam Reservoir and sockeye no longer return to the river. Many CC members placed high value on the return of sockeye to the river and the CC spent considerable time during the first six months of the WUP process deliberating whether issues related to fish access can be considered as part of WUP.

In June 2000, the issue was temporarily set aside to await results of a study, coordinated by BC Hydro as part of the Bridge Coastal Restoration Program. The Bridge River Coastal Passage Study was a scoping exercise to determine feasibility of salmonid passage at Bridge River Coastal hydroelectric facilities.

In late spring 2001 (shortly prior to completion of the Bridge River Coastal Passage Report), the Kwikwetlem First Nation notified the Consultative Committee that they would not participate in the WUP process until the Sockeye issue is satisfactorily resolved. The CC supported the idea for the Kwikwetlem First Nations' desire to restore sockeye to the Coquitlam Reservoir. The issue was considered beyond the scope of this water use plan, but was to be addressed through the Bridge Coastal Restoration program. It was recommended by the CC that if efforts are undertaken to return sockeye to the Coquitlam Reservoir, that this should trigger re-opening of the WUP. The GVRD indicated that they would support the return of sockeye assuming it would not significantly impair drinking water quality.

In July 2001, the CC received notice that the study report was finalized. The report concluded that Coquitlam's design prevented it from being a strong candidate for salmon passage initiatives because technical uncertainties around smolt screening during out migration are a concern. In the analysis done for this report, the Coquitlam-Buntzen system along with any others that involve an interbasin transfer of water (i.e. diversion of water away from a river) were given a lower priority than run of the river facilities.

Channel Forming Flushing Flows: 200cms

Substrate quality is one of the most significant limiting factors for fish productivity in the Coquitlam River. Due to this, the CC spent a great deal of effort reviewing options for substrate maintenance flows, referred to by the CC as "flushing flows". These flows were recommended by the FTC to clean substrate downstream of the Coquitlam dam for the benefit of fish and benthic invertebrates. Based on a study by Northwest Hydraulics, the FTC initially recommended a 200 cms release from the dam for 8 hours every 2-5 years to achieve maximum fish benefits. The Consultative Committee evaluated the costs, benefits and risks associated with this flow in detail and it became clear that several downstream issues need to be addressed before a 200 cms flow could proceed. Consequently, and as an interim measure until a 200 cms flushing flow can be safely achieved, the FTC evaluated other substrate maintenance flows and recommended an opportunistic flushing flow release from the dam which attempts to maximize the benefits, given the constraints (See Section 6.0 for more details). There was no agreement regarding the implementation of a 200cms flushing flow in the future, there was only agreement that this issue would be re-evaluated once the down stream issues were resolved.

3.2 Objectives & Performance Measures

An influence diagram, or framework, was developed for each area of concern and each set of issues as a tool for generating and reviewing objectives. These influence diagrams provide a visual means to explore how actions will influence outcomes based on identified objectives (see the Issues Paper in Appendix A for an example).

The CBWUP objectives are summarized in Table 2. Through the use of influence diagrams, the consultative committee made explicit not only the WUP objectives but also their relation to over-arching values and concerns raised by CC members in relation to objectives. Over-arching values were expressed by CC members as values that are to be addressed in the WUP process through use of selected objectives. Over-arching values and concerns raised in relation to the CBWUP objectives are provided in Appendix A of this report.

To be meaningful, objectives must be measurable. A performance measure is used to measure the degree to which an objective is achieved. Therefore, the ability to measure the degree to which an objective is achieved is critical to evaluating water allocation decisions. Performance measures must:

- Be clearly linked to the objective they are measuring
- Provide a way to refine discussions of objectives
- Provide a way to identify progress in meeting objectives
- Provide a way to develop alternatives and understand trade-offs being made between alternatives
- Provide a way to select the preferred alternative(s)

Developing specific objectives and performance measures of this nature was an iterative process that required a great deal of discussion about how water allocation decisions may or may not affect an issue and what component of an issue could be effectively measured within the constraints of time, budget and available technology. For each objective, performance measures were identified and approved by the Consultative Committee. Then, the CC identified information gaps and study requirements. Finally, on the basis of study results and preliminary evaluations of operating alternatives, the committee revised its performance measures to include those best suited for comparing and evaluating operating alternatives. Table 3 (at the end of this section) summarizes the final list of performance measures used by the CC to compare and evaluate operating alternatives.

Table 2: Summary of CBWUP Objectives[31]

OBJECTIVES
Archaeological, Cultural & Historical ♦ Maximize access for First Nations traditional uses ♦ Maximize access for Recovery of artefacts/inventory of sites ♦ Maximize protection of sites from erosion, pot hunting, flooding
Domestic Water ♦ Maximize reliability of access to water supply ♦ Minimize cost ♦ Maximize water quality
Fish (Coquitlam River) ♦ Mimic natural hydrograph ♦ Maximize the availability of suitable (fish) habitat ♦ Optimize secondary productivity ♦ Maximize water quality ♦ Minimize direct mortality
Fish (Coquitlam Reservoir) ♦ Maximize availability of suitable habitat ♦ Optimize secondary productivity ♦ Minimize direct mortality
Fish (Indian Arm) ♦ Minimize direct mortality of fish ♦ Maximize water quality
Flood Control ♦ Minimize adverse effects of flooding flood damage & public safety
Hydroelectric ♦ Maximize the financial value of power generation ♦ Minimize the loss of generating capability in the Lower Mainland ♦ Minimize cost of providing emergency black start capability ♦ Avoid other environmental impacts
Industry ♦ Improve gravel industry storm management through sediment dilution[32]
Recreation ♦ Maximize opportunities for recreation on Coquitlam River ♦ Maximize opportunities for recreation at Buntzen Reservoir ♦ Maximize quality of recreation ♦ Maximize public safety
Wildlife & Environment ♦ Maximize the area & suitability of aquatic & riparian habitat for indigenous wildlife, including species at risk and organisms not captured by fish objectives.

[31] Over-arching values and concerns raised in relation to the CBWUP objectives are provided in Appendix E of this report.
[32] An initial industry objective was dropped after further technical review indicated it was not a feasible objective: "Improve gravel industry storm water management in retention/detention and disposition areas for sand, silt and sediment within areas affected by river flows."

The following section provides an overview of the objectives and performance measures considered during the Coquitlam-Buntzen WUP.

Archaeology, Culture, and History

Representatives of the Katzie, Kwikwetlem, Sto:lo, and Tsleil-Waututh First Nations formulated and discussed their **objectives** at meetings of the First Nations Table and at the Consultative Committee Table. They wished to *maximize First Nations access for traditional uses, inventory of sites and recovery of artefacts* and it was of importance to them and other CC members that *areas & sites of cultural, spiritual, historical & archaeological significance are protected.* A WUP study to identify areas & sites that are or may be impacted by water allocation in the Coquitlam-Buntzen system determined the following:

- The study confirmed known sites and documented the discovery of new archaeological sites in the Coquitlam Reservoir study area.
- The study documented no sites in the Coquitlam River and Buntzen Reservoir study areas.
- The study documented no heritage (non-archaeological) sites that reservoir or river levels in the Coquitlam-Buntzen system are expected to impact.

Aside from this, Kwikwetlem First Nation noted in early 2001 that they had made important archaeological discoveries at IR2. These are located outside the old dike and are not protected. These were not documented in the archaeological study.

A meeting was held in the spring of 2001 with First Nations to discuss archaeological study results and whether there are trade-offs to be made regarding archaeological objectives. All participating First Nations were invited. Only Kwikwetlem First Nation attended the meeting. Comments on the study were received in writing from Tsleil-Waututh First Nation.

After reviewing conclusions of the Coquitlam-Buntzen WUP archaeological study, the following suggestions were accepted by the CC:

- Downstream archaeological and cultural sites should be addressed through the **flooding performance measure**. The key point is that flows having any impact on sacred sites at IR2 are unacceptable to the Kwikwetlem First Nation. Flooding of the Kwikwetlem First Nation's cemetery would occur at 140 cms[33] (~120-160 cms) and is of the highest priority for protection. It was also noted by Kwikwetlem First Nation that 60 acres at IR2 are exposed and at risk of flooding at ~70-100 cms.
- First Nations access to the Coquitlam Reservoir is best addressed through direct consultation between First Nations and GVRD.
- The development of an Archeological Management Plan between BC Hydro, First Nations, and GVRD was acknowledged to be First Nations' preferred approach to address archaeological issues in the reservoir area.

This approach had the added benefit of keeping sites and study results confidential as requested by the Kwikwetlem First Nation.

[33] Field observations on January 7, 2002 confirmed that Coquitlam River flows of up to 136.6CMS (as measured at Port Coquitlam WSC Gauge Site) can be accommodated within the river banks at IR2. No flooding of the First Nations cemetery occurred at these flows and additional freeboard within the riverbanks of approximately 2 feet was recorded. No other flooding was observed at IR2 during this event.

Domestic Water [34]

Domestic water **objectives** in Table 2 are based on the broad objective of maximizing GVRD's ability to meet the safe, cost effective and reliable drinking water demands for a growing population in the Greater Vancouver Regional District with water from Coquitlam Reservoir, as determined across all source and system alternatives.

To satisfy its domestic water objectives for this WUP, GVRD proposed an increase in water allocation from Coquitlam that is expected to meet municipal demands through to the middle of the next century and to ensure adequate supply of good quality (low turbidity) water during a prolonged period of turbid water in the Capilano and/or Seymour sources during the winter season. Under the proposed GVRD/BC Hydro agreement, the future allocation to the GVRD increases from the current average annual allocation of 7.88 cms to 14.36 cms (or 62 percent of the average annual reservoir inflow). The proposed agreement was developed assuming that the GVRD continues with its existing water conservation programs in particular the restriction on outdoor sprinkling to two times a week during the summer period.

The GVRD supplied the Consultative Committee with information stating that it will have to bring forward the development of another new water supply source (with undesirable environmental and financial implications) if the proposed agreement GVRD allocations are not met in an average year.

Six **performance measures** were used to *broadly* indicate how well operating alternatives satisfy the Domestic Water objectives:

- ***Measure 1****:* The annual amount of water allocated to the GVRD. (See table below).
- ***Measure 2****:* The number of days GVRD *maximum* nomination is not satisfied. The Summary Evaluation reflects the annual median over the 39-year modeling period. This measure is important because if the proposed agreement GVRD allocations are not met in an average year the GVRD will have to develop a new water supply source with (undesirable environmental and financial implications) sooner then expected (see Measure 4). (See table below).[35]
- ***Measure 3:*** The number of days GVRD *minimum* nomination is not satisfied. This minimum is a reduced Stage 4 Water Shortage Response Plan that reflects about 10% less of the May-Sep volume than what is requested under the proposed agreement. The Summary Evaluation reflects the annual median over the 39-year modeling period. (See table below).
- ***Measure 4:*** Annualized capital cost to GVRD to develop alternate water sources sooner than if allocated the proposed agreement flows from the Coquitlam Reservoir.
- ***Measure 5:*** Starting year for construction of alternate water sources. This depends on the allocation of flows to GVRD from the Coquitlam Reservoir.
- ***Measure 6:*** Change in reliable regional water supply capacity relative to proposed agreement flows. The proposed agreement allocation would increase the GVRD water system reliable supply capacity by about 5.2 cms (450 ML/d). This is enough water for about 1.2 million people living in 375

[34] GVRD provided extensive background material to the CC in response to member's concerns and suggestions. This is provided in Appendix G.

[35] Definitions: **Median**: The median is the number in the middle of a set of numbers; that is, half the numbers have values that are greater than the median, and half have values that are less. The median of the following numbers 1,2,3,10 equals 2.5. **Annual median**: middle number (measure) over the number of years. **Average**: the arithmetic mean. The average of the following numbers 1,2,3,10 equals 4.

thousand single-family homes (or enough to supply the needs of the GVRD region for 30 years of growth).

GVRD Nominations Under Current and Proposed Agreement (cmsd*)

Constraints	*Jan*	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***	Annual Average
CURRENT AGREEMENT Maximum nominations under current agreement	6.4	6.4	6.4	6.4	7.2	7.8	9.7	12.6	12.4	6.4	6.4	6.4	7.88
PROPOSED AGREEMENT Maximum nominations under proposed agreement	11.9	11.9	11.9	12	12	12	18	23	23	12	12	11.9	14.36
PROPOSED AGREEMENT Minimum nominations	10.7	10.7	10.7	10.8	11	10.9	15.8	20.2	20.9	10.8	10.8	10.7	11.93

*A measure of volume per day expressed as the average instantaneous rate of flow (cubic metres per second) for a duration of one day.

Domestic water objectives included the quality of water in the Coquitlam Reservoir because the Coquitlam watershed is a domestic water source for Greater Vancouver and the Lower Mainland. However, upon further review (given the very high quality of water in the Coquitlam reservoir) this objective was dropped from consideration.

Fish[36]

The fish objectives for this WUP (listed in Table 2) apply to the Coquitlam River and Reservoir, and to the Buntzen outflow in Indian Arm[37]. The majority of the performance measures related to fish objectives were focused on the Coquitlam River, downstream of the dam.

Coquitlam River (downstream of Coquitlam Dam)

The productivity and success of fish on the river, as in many other coastal streams, is dependent on the rearing stages for those salmonids that rear in the river after emergence. At present, in the case of steelhead, parr habitats are considered limiting in the context of all other life history habitats. Also, the embeddedness of substrate in the Coquitlam River, downstream of Or Creek, is considered limiting for the productivity and success of both fish and invertebrates.

- The Consultative Committee developed five fish objectives for the Coquitlam River (Table 2). The performance measures used by the CC (Table 3) measure the degree to which different operating alternatives achieve two of the five objectives, namely maximizing availability of suitable (fish) habitat and optimizing secondary productivity – see Fish Information Appendix E for a detailed description of fish performance measures. The original intention of the CC was to include an index of substrate embeddedness and composition as a measure of the availability of suitable habitat. Instead, substrate quality was included in the weights assigned to the measures of useable spawning and rearing habitat in the river.

The other three objectives listed in Table 2 were considered as follows:

[36] Appendix H provides additional information about fish objectives and performance measures.
[37] There were no fish objectives nor performance measures identified for the Buntzen Reservoir, as the recommended summer target elevations for Buntzen reservoir were thought to mitigate any negative effects to fish values associated with different flow alternatives at Coquitlam dam.

- Mimic natural hydrograph objective: This objective was initially proposed based on the assumption that natural systems evolved under conditions of a natural hydrograph. The underlying concept was to mimic the natural system in the Coquitlam River using the shape, not magnitude, of the hydrograph. This approach recognizes that there is much that we do not know about natural systems and we should strive to reproduce natural conditions as much as possible. Therefore, it was considered a means to approximate the degree to which fish benefits may be achieved in a natural system. After more careful consideration, however, the performance measure developed for this objective was insensitive and did not aid in decision-making. It was also recognized that the Coquitlam river is no longer a natural system and that the benefits from a natural hydrograph may not be achieved (because of dyking, urbanization, and restricted flows at the bottom and top ranges as compared to a natural hydrograph). In the end, this objective was considered a check to add perspective on the final flow alternatives. The Frequency of Events PMs (Table 3) were developed for the final flow alternatives to compare minimum threshold river flows against natural flows, relating flow options to the expected natural hydrograph results.
- Water quality objective: The particular concern about water quality was whether temperature of the river would remain within a range that supports healthy fish populations. Based on findings of a temperature study for the Coquitlam Reservoir, it was determined that no performance measure is required for this WUP because data to date suggests that the river temperatures are dominated by Or Creek (which enters the Coquitlam river downstream of the dam) and by climatic influences.
- Direct mortality objective: This objective dealt with fish stranding in the mainstem or tributaries because of the rate of water level drawdown during critical periods for fish and at critical elevations in the river. This variable is to be addressed through monitoring.

In the review and development of fish performance measures, other variables were considered but found to not have an affect on the objectives.

- Dissolved oxygen: This performance measure was dropped from the analysis
- pH: It was recognized that pH is not related to changes in flows from the reservoir but to geology of the catchment area and rainfall. Therefore, no performance measure was considered because it would not aid decision making.
- Total Gas Pressure: TGP is the metric used to describe the degree to which gases (mostly oxygen and nitrogen) are concentrated in the water column. If the water becomes super-saturated with gases it can lead to gas-bubble trauma in fish, which can be lethal or detrimental. Due to the low level outlet release facilities and the fact that there are no generators at Coquitlam Dam, excessive TGP is unlikely to occur. This was confirmed by measurements taken during a spill where TGP levels did not exceed provincial guidelines. Since it was clear that operations at the Coquitlam Dam do not result in changes to TGP above the BC guidelines, this issue was not considered in the Coquitlam-Buntzen WUP or monitoring program.
- Suspended sediment/turbidity: This variable was initially considered a very important issue, however after further evaluation it was determined that the range of flow alternatives being considered by the CC would not have a significant affect on the concentration of suspended particles and turbidity (for a more detailed overview refer to Section 3.3 at the end of this chapter).

Fish (Coquitlam Reservoir)

The Consultative Committee identified three fish objectives for the Coquitlam reservoir (Table 2).

- Optimize productivity: *Effective littoral zone,* one of many possible indicators of reservoir health, was used as a measure of productivity. Effective littoral zone measures the area of littoral habitat provided

by an operating alternative, and the number of days each area is provided. The hypothesis is that increased littoral area benefits fish and fish food organisms through carbon accrual. Although the method for establishing this PM is not fully developed, this measure ended up being insensitive for all except the most extreme alternatives and was not considered further because it did not aid in decision making.

- Suitable habitat objective (Access to Tributaries): Availability of suitable habitat in the reservoir was to be measured by accessibility to key tributaries during critical seasons for each species. Study results indicated:
  - Only three fish bearing creeks are known to have barriers to migration in the drawdown zone.
  - All three barriers are high in the drawdown zone. Ensuring fish passage during kokanee and trout spawning seasons would require minimum reservoir elevation of 150m during the months of February to April and September, October.

  There were data gaps which could not be identified within the timeframe of this WUP and therefore no performance measure was developed. This item was to be addressed through monitoring.

- Direct mortality objective: This objective dealt with the degree to which stranding would occur with fish eggs and juvenile spawners in tributaries (with decreasing reservoir elevations) and entrainment of fish and fish food. Based on the professional opinion of FTC members, this objective was not considered further since it would have been difficult to develop any meaningful performance measures that would have aided decision making.

Fish (Indian Arm)

The CC developed two objectives related to the Buntzen outflow into Indian Arm (Table 2): minimizing direct mortality of fish, and maximizing water quality. Three variables were directly evaluated regarding these objectives, as follows:

- Impact of flow releases from the Buntzen power stations on the near shore marine environment;
- Impact of angling in freshwater Buntzen tailrace on wild stocks of Pacific salmon
- Impact of Buntzen flow contribution on water quality (flushing rate) of Indian Arm.

The Consultative Committee concluded that these variables would not be significantly affected by the range of flow alternatives being considered for the Coquitlam River and therefore no performance measures were developed for Indian Arm (See Appendix E).

Flood[38]

To measure the degree to which flood control objectives (Table 2) would be achieved, the Consultative Committee used the number of days on which releases of greater than 85cms from the dam would occur. The value of 85cms was considered "bank full"; this value was back calculated from a value of 110cms at the POCO station (located near Lougheed Bridge) and is considered a safe level of discharge at the dam (90% of the time). Flows above this level at POCO are a trigger point for minor local flooding events (e.g. some trails). Any flows above 140cms by IR2 are expected to flood Kwikwetlem First Nation's cemetery. It should be stressed that all operating alternatives adopted the same flood control strategies to equally mitigate the possibility of spills from the dam.

[38] Additional information on flood control performance measure in Appendix I.

Hydroelectricity

The CC identified four objectives related to hydroelectricity (Table 2).

The following two performance measures were used to evaluate how well operating alternatives satisfy the hydroelectricity objectives of maximizing the financial value of power generation and minimizing the loss of generating capability in the Lower Mainland:

Measure 1: Annual total power production using the 39-year median (in gigawatt hours, GWh); and,
Measure 2: The total amount of revenue generated, including electricity and GVRD payments.

An additional measure, which does not relate directly to a hydroelectricity objective, but was accounted for (by the CC) under the heading of "hydroelectricity":

Measure 3: Capital costs refer to modifications to existing BC Hydro infrastructure (additional fish valves or modification to one low level outlet (LLO)) to provide the necessary flows in the Coquitlam river.

The other two hydroelectricity objectives were addressed as follows:

- Emergency black start capability objective: There was agreement among CC members that when it came to BC Hydro system emergency situations, these events would take precedence in the Water Use Plan and therefore be applied as a condition of any operating alternative.
- Environmental impacts objective: The CC discussed this objective (related to greenhouse gas emissions) but there remained unresolved issues regarding replacement energy. The CC agreed to accept their differences in opinion and to evaluate operating alternatives for this WUP without a performance measure for greenhouse gas emissions.[39]

Industry

The CC identified one objective related to storm management for industry (Table 2). The performance measure developed assessed the degree to which there was more water available in the river during storm events when industry was most challenged in meeting their storm management requirements (basically the more water there is in the river, the easier it is for industry to meet drainage challenges). After the initial round of alternatives, no flow alternatives were considered which reduced the amount of water in the river and therefore this performance measure did not aid decision making.

Recreation[40]

Four objectives were identified for recreation in this WUP (Table 2).

Coquitlam River

To measure the degree to which the maximizing recreational opportunities objective was achieved, the number of recreational days *not* at preferred river levels was used. From May 24-Sept 30 the preferred level is between 1cms and 6cms—as measured from the dam—to primarily accommodate swimming,

[39] Feb. 5, 2001 CC meeting: The CC agreed to start with the value of energy expressed in MWh and dollars as a measure for valuing hydroelectricity and to revisit the issue of greenhouse gas emissions later in the process if necessary. There were no requests to revisit this issue.
[40] Additional information on recreation performance measures for the Coquitlam River in Appendix I.

wading, tubing and floating. Any days outside this range are counted. From October 1 - May 23 the preferred level is above 1cms as measured from the dam, to primarily accommodate fishing and canoeing. Any days less than 1 are counted.

There was concern expressed about public safety issues with any increased base flows from the dam. This issue was not addressed in this WUP, as flow changes from the dam are relatively small, with the exception of the opportunistic flushing flow experiment.

Buntzen Reservoir

The CC recommended that recreation objectives for the Buntzen Reservoir be met as follows:

- Proposed summer target reservoir levels: the CC recommended minimum water levels needed for maximizing recreation opportunities and addressing public safety concerns (refer to the Buntzen Reservoir Management Plan in the Appendices for additional information). These proposed reservoir levels were applied to all flow alternatives considered, by the CC, for the Coquitlam River.
- WUP monitoring of water quality: In the event of reduced inflows from Coquitlam to Buntzen Reservoir, there remains some uncertainty about the impact on the quality of water (basically colliform count) for recreation during the summer months. It was suggested that this be addressed through WUP monitoring, however it was later determined that colliform monitoring is already being performed by the Simon Fraser Health Unit and therefore this item was not included in the WUP monitoring program.

Wildlife & Environment

One objective was identified for wildlife and environment in this WUP (Table 2).

Coquitlam River

In terms of maximizing the area and suitability of aquatic and riparian habitat objective, the performance measure developed assessed the degree to which the low bench ecosystem area would be affected by flows in the river. It was determined that for the range of flow alternatives considered, that medium and high bench ecosystems would not be affected. To lose significant amounts of the low bench ecosystem persistent flooding (5cms increase over current flows, 90% of the time) of the root zone during the growing season of mid June to mid September over two consecutive years would need to take place and no flow alternatives considered had this effect.

Coquitlam Reservoir

The literature review undertaken for this WUP found that, because of the steep slope of land surrounding the reservoir, only a small wet area along the eastern shore opposite Coquitlam Island would be vulnerable to reservoir elevation changes. Therefore, no wildlife performance measure was considered for the Coquitlam Reservoir.

Buntzen Reservoir

The proposed target reservoir elevations identified to meet recreation objectives were also considered acceptable to satisfy fish and wildlife/environment objectives at the Buntzen Reservoir and therefore no performance measures were developed.

Species and Habitats at Risk:

The Coquitlam-Buntzen Water Use Plan specifically addressed the issue of species at risk. Two plant communities in the Coquitlam Reservoir portion of the watershed are on the revised BC Blue List (McIntosh and Robertson 2001). Four of the seven Coastal Western Hemlock (CWHdm) habitats mapped along the Coquitlam River in 2001 are on the provincial Red and Blue Lists (McLennan and Veenstra 2001).

In a review of existing information, McIntosh and Robertson (2001) identified a number of Red or Blue listed species that have been documented within the watershed, or may be present (e.g., grizzly bear, wolverine): plants (12 species); frogs (2 species); reptiles (2 species); birds (6 species); mammals (5 species).

Given the range of alternatives considered by the CC, it was felt that no adverse impacts would occur on the identified species at risk. In addition, it was assessed that flushing flows would not have an impact on species at risk as long as they occurred during the late fall or winter. Monitoring of riparian habitat was also considered by the CC.

Table 3: Summary of CBWUP Performance Measures

OBJECTIVE	PERFORMANCE MEASURES	UNITS (over 39 year model period)
Archaeological, Cultural & Historical	Not applicable to WUP. All objectives to be addressed through the Flood Control PM and through an archaeological management plan.	
Domestic Water	Annual average water allocation	cmsd (median)
	GVRD maximum nomination not satisfied per year	# of days (39 yr median)
	GVRD minimum nomination not satisfied per year	# of days (39 yr median)
	GVRD annualized capital costs for new water source	$ in millions
	Timing of new water source construction	starting year
	Change in regional water supply capacity relative to proposed agreement flows	cms/equivalent #people/ equivalent # of single family homes
Fish (Coquitlam River)	Fish habitat for: ♦ Steelhead Parr (rearing) ♦ Steelhead spawning ♦ Chinook spawning	weighted usable area, sqm
	Invertebrate habitat	weighted usable area, sqm
	Frequency of events: ♦ Short-term survival flows not met ♦ Rearing flows not met ♦ Spawning flows met or exceeded	% of days for each life history that flows are not met (exceeded, in the case of spawning flows)
Fish (Coquitlam Reservoir)	Effective littoral zone. Not used since the FTC felt that the algorithm was insensitive across the operating alts.	Littoral Area-days (million sqm-d)
Fish (Indian Arm)	Not applicable. No issues related to BC Hydro operations.[41]	
Flood Control	Bank full exceeded – 85 cms release from dam	# of days (total over 39 years)
Hydroelectric	Annual total power production	GWh - annual total (39 year average)
	Annual total power production and GVRD payments[42]	$ in millions - annual total 39 year average
	Capital Costs	$ in millions – total
Industry	Annual average number of days industry is “worse off” during storm event (less than current flow)	# of days (total over 39 years)
Recreation (river)	Recreational days *not* at preferred river level	# of days (39 yr median)
Environment & Wildlife	High sustained flows in late growing season (mid-June-mid Sept) capable of destroying low bench ecosystem	% low bench ecosystem lost
Environment, Industry, Recreation	Minimum threshold crossed (below current minimum flow of 0.65 cms)	# of days (median year)

[41] For further detail, see Indian Arm Study briefs distributed to CC for December 11, 2000 and July 9, 2001 meetings.
[42] Capital costs for infrastructure are not included in these figures. Modifications/additions to achieve flows beyond 2 fish valves are expected to cost in the range of $200,000-$310,000. (source: BC Hydro)

3.3 Suspended sediment (turbidity) . . .

Suspended sediment (turbidity) in the Coquitlam River was raised as an issue of concern at many points throughout the Coquitlam-Buntzen WUP planning process at both the working group level (Recreation, Flood, Fish, Industry) and the Consultative Committee level. Members of the CC wanted to determine whether alterations to dam flow releases would change the concentration, transportation and deposition of sediment, thereby having an impact on:

- Recreation – high concentration of suspended sediment is detrimental to fishing and other recreational pursuits on the river.
- Flood control - sediment deposition has over the years raised the level of the river bed in lower reaches of the Coquitlam River.
- Kwikwetlem First Nation boat access – boat access has become a problem over the years because of sediment deposition between IR#1 and IR#2 in the lower reaches of the Coquitlam River.
- Industry – change in the concentration of suspended sediment in the river as a result of increased flows has the potential to benefit the gravel industry's storm water management.
- The effectiveness of habitat created for fish – concern of some members about the impact of suspended sediment and pollutants on the health of fish and fish habitat.

Issues related to suspended sediment in the Coquitlam River were difficult for the CC to resolve within the parameters and mandate of the WUP. In June 2000, the Consultative Committee delegated the issues to a working group for discussion and recommendations to the CC. The working group met once in June. The issues were discussed briefly by the CC in July 2000 and then deferred until an information session on suspended sediment was held in February 2001. Ken Rood, a guest speaker at the information session, presented the CC with the following conclusions about the potential to change the concentration, transportation and deposition of sediment in the Coquitlam River by altering dam flow releases: [43]

- None of the flow scenarios under consideration by the CC have any significant impact on the concentration of suspended particles and turbidity (questioned by gravel industry representative – see below). Flushing flows increase turbidity only during their release.[44] The highest flow scenarios under consideration (aside from flushing flows) are expected to create only slightly higher turbidity during the summer and all other flow scenarios are expected to have no effect on turbidity.[45]
- Of all the flow scenarios under consideration by the CC, only flushing flows are expected to have an affect on transportation and deposition of sediment.
- The gravel industry representative expressed the opinion that additional dam flow releases, particularly during storm events do have an impact on turbidity and are beneficial to the gravel operators' storm water management. The industry performance measure for storm water management indirectly captures these changes in suspended sediment and turbidity. Some members of the Consultative Committee did not feel it was appropriate to compensate for industry discharges through manipulating flow regimes, including flushing flows. Instead, it was felt that the appropriate regulators/enforcement agencies should address discharge and run-off issues.

[43] Information provided by Ken Rood, Northwest Hydraulics Consultants (invited speaker at February 1, 2001 Information Session and the consultant retained to carry out "Coquitlam River Channel Morphology and Substrate Condition Study" for the CBWUP). Background reference sheet provided in Appendix F.
[44] Noted that this occurs in nature anyhow, due to flooding and natural catastrophic events.
[45] Ken Rood suggested that sediment source management would probably be more effective than dam flow releases as means of reducing the concentration and deposition of suspended sediment and turbidity in the river.

Ian Birtwell (Department of Fisheries and Oceans) made a presentation on suspended sediment and fish health/habitat. He noted that although turbidity provides some fish cover from predation, eventually, as concentrations increase, the benefit of predation cover is outweighed by increased stress and feeding impairment.

City of Coquitlam Councilor, May Reid, spoke to the CC about the mandate and workings of the Coquitlam River Aggregate Task Force, which she chaired. The Task Force was created to find consensus between regulators and operators on the problems of the river, and how to solve them.[46]

On the basis of what the CC learned about suspended sediment and turbidity, the following points were made:

- Flushing flows were considered by the CC as a means of cleaning substrate of the Coquitlam River. Benefits, costs, and risks associated with flushing flows were evaluated and are documented in this report.
- While acknowledging that operational changes made as a result of the WUP have little control over turbidity/suspended sediment, the impacts of sedimentation on substrate quality will be assessed as a part of the opportunistic flushing flow experiment.

Much of the suspended sediment was considered an issue linked to land use, namely extensive logging of the timber licence area in the Or Creek watershed and open pit gravel mining in the Coquitlam River watershed. Also contributing to suspended sediment are natural slope failures. However, it was acknowledged that the reduced base-flows and lack of flushing flows in the Coquitlam River have also adversely impacted substrate quality, and therefore substrate quality will be assessed if opportunistic flushing flow experiments occur during the review period.

[46] The Task Force membership included representation from the gravel industry, municipalities (Coquitlam and PoCo), provincial & federal (DFO) government, and BC Hydro. Al Geissler (BC Hydro) and Jim Allard (Allard Industries) participated in both the CBWUP consultation process and the Aggregate Task Force.

4 INFORMATION GAPS AND STUDIES…

4.1 Study selection process

During the process of identifying issues and structuring objectives, many questions were raised regarding the relevance and uncertainty of particular issues to the water allocation decisions being made. Consequently, a list of proposed studies was developed to address information gaps related to these questions. This list of proposed studies was then prioritized in order to maximize effective decision-making, make best use of available resources, and work within the time constraint of this WUP. The Consultative Committee approved a list of studies for each area of concern in June and July 2000. The following 5-step methodology (also expressed graphically in Figure 7) developed at other WUP tables was used by the Consultative Committee to evaluate, and then prioritize and approve proposed studies.

Step 1. *Will the study provide information related to the calculation of a performance measure?*
If not, the study is not eligible.

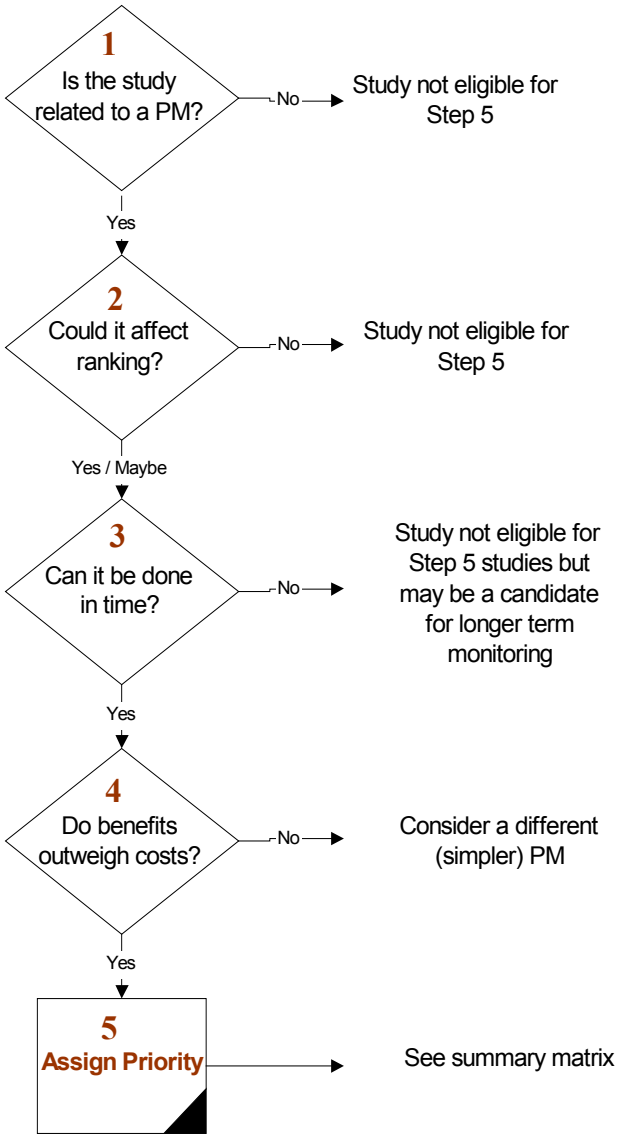
Step 2. *Is the data gap or uncertainty that this study addresses significant enough to affect the ranking of alternatives?*
A "no" answer should normally disqualify a study from further consideration. For some studies, the answer will be clearly "yes". For others, it may be unclear. Judgment will have to be used.

Step 3. *Can the study provide meaningful, reliable data within the time frame available in the WUP project schedule?*
If not, the study is not eligible. However, some proposed studies might be candidates for longer term monitoring programs that are conducted as part of WUP implementation.

Step 4. *Do the benefits outweigh the costs?*
If answers 1 through 3 are "yes", the range of study designs and associated data quality should be evaluated. If costs are very high, it may be important to consider alternative or simpler performance measures.

Step 5. *Assign Priority*
If answers to test #1 through 4 are "yes", the study is assigned one of the following five priorities (Figure 8):

Figure 7: 5-Step Guide for WUP



Study Selection[47]

Figure 8: Study Prioritization[48]

Priority 1	The information provided by this study is essential for WUP. Responsible decisions cannot be made without it.
Priority 2	This study will provide information that is likely to affect the ranking of alternatives. The benefits clearly outweigh the costs.
Priority 3	This study has benefits, but is of lower priority. Some reasons for lower priority include: - costs may outweigh benefits; - the benefits may not be significant enough to affect ranking of alternatives; - the PM this study addresses has less likelihood of being the "limiting factor" (relative to other PMs).
Priority 4	This study is not necessary or desirable for WUP.
Priority X	This study may be important, but cannot be completed within the WUP timeline.

[47] Source: Compass Resource Management

[48] Compass Resource Management

4.2 Fish Studies

Table 4 provides an overview of the fish studies conducted for the Coquitlam-Buntzen WUP.

Table 4: Summary of Fish Information Collected

Interest	Information Collected	Description/Rationale
Fish (Coquitlam River)	Coquitlam River **Instream Flow Needs** (IFN) Assessment: transect data collection, channel surveys, linear habitat mapping, snorkel survey[49]	Detailed analysis of the river including habitat, hydrology, and biological assessments at various flow regimes. Results intended as principal input to the weighted useable area (habitat suitability) performance measures.
	Data on natural inflows for analysis of deviation of proposed operating strategies from **natural hydrograph**	Data on natural inflows used for comparison to frequency of events PM. Comparison made to ensure that biological criteria determined in other fish studies reflect natural hydrologic characteristics.
	Site evaluations & review of historic **access** issues to key tributaries & mainstem regions	To determine through questionnaire & fish group expertise whether mainstem & tributary access is an issue on the Coquitlam River.
	Substrate and Channel Morphology Assessment	To assess current state of the river channel and determine flows for channel maintenance. Used to determine flushing flow requirements for fish benefits. Substrate quality was recognized as a potential limiting factor for Coquitlam River productivity.
	Review of existing **invertebrate habitat** data & HSI Curve development	To evaluate the amount of habitat available to insect productivity at each study flow. Used as background information for invertebrate habitat performance measure.
	Determination of flow-**temperature** relationships	To determine whether temperature is an issue on the Coquitlam River.
	Transect analysis & expert consultation to determine **ramping protocols**	To develop ramping rates designed to minimize stranding of fish when dam flow releases are decreased (this item was not completed during the WUP, and was included as a part of the WUP monitoring plan).
Fish (Coquitlam Reservoir)	Assessment of **tributary access** with respect to reservoir elevations	To determine whether tributary access is an issue on the Coquitlam Reservoir.
	Literature review, site samples, & model of **littoral & pelagic productivity**	Used to develop effective littoral productivity performance measure.
Fish (Indian Arm)	Expert consultation on **nearshore** marine environment	To determine whether nearshore marine environment is impacted by flow releases from the Buntzen power stations.
	Expert consultation on the Buntzen tailrace fishery	To determine whether angling of the fish attracted to freshwater Buntzen tailrace has an impact on wild stocks of Pacific salmon.
	Assessment of **water quality** (Indian Arm flushing rate)	To determine whether Buntzen flow contributions have an impact on water quality (flushing rate) in Indian Arm.

[49] Partially completed during this WUP.

Instream Flow Needs (IFN) Data Collection

The IFN assessment was intended to be the primary input to calculate fish habitat areas, using the PM weighted useable area (habitat suitability) for this WUP. However, given the abnormally low water levels experienced during the fall and winter (2000/01), very little data was actually collected by the time all other CBWUP studies were complete and, aside from fish performance measures, the CC was ready to proceed with trade-off analyses. By February 2000, much of the IFN data collection was incomplete. The CC was faced with a trade-off decision between three choices:

- Collect the data, but given the low water levels, cause a process delay in order to do so (from months to years);
- Request the release of dam water, at major costs to BC Hydro and potentially significant impacts to fish and domestic water later in the year; or
- Move forward in the process without the data for the time being using modeled analyses.

In order to permit the WUP consultation process to proceed, the CC endorsed a FTC recommendation to base fish performance measures, for the time being, on modelled analysis in combination with available empirical data. Collection of field data was to continue as inflows allowed (data for the most important river reaches was subsequently collected by mid-January 2002).

As a result of continuing dry weather, the habitat suitability performance measures available to the CC throughout the remainder of the consultation period were based primarily on transect modeling in combination with some empirical data and the professional opinion of FTC members. Even during the final period of trade-off analysis, the FTC and CC members expressed a need to complete the IFN study and confirm the upper target fish flows for Flow Trial #2 (STP#5).

4.3 Non-fish Studies

Table 5 provides an overview of the non-fish studies conducted for this WUP.

Table 5: Summary of Non-fish Information Collected

Interest	Information Collected	Description/Rationale
Archaeology, Culture, History (Coquitlam River & Reservoir; Buntzen Reservoir)	Review of documentation, archival & archaeological records. Field review. Interviews with community elders & members.[50]	To identify areas & sites of cultural, spiritual, historical & archaeological significance that are or may be impacted by water allocation in the Coquitlam-Buntzen system.
Flood Control, including Kwikwetlem navigation issues & public safety (Coquitlam River)	Update of existing maps & extension of maps of potential flooding to north end of Hockaday Road.	To determine tidal, backwater & sedimentation influences, dike and dam influence/capacity & historical floods. Results used to establish thresholds for flood control performance measure and to assess costs and risks associated with flushing flow alternatives.
	Review of navigation (boat access) issues & flood protection at Kwikwetlem IR1 and IR2	
Recreation (Coquitlam River)	Working Paper on Visitor Use of Coquitlam River Corridor based on local knowledge[51]	Information for decision making with respect to Coquitlam River issues.
Wildlife/Environment (Coquitlam River)	Terrain ecosystem mapping of riparian zone below the GVRD gate.	To determine location & extent of riparian & wetland areas of the Coquitlam River. Used to develop riparian habitat performance measure.
Wildlife/Environment (Coquitlam River & Reservoir)	Wildlife literature review & expert opinion	To determine linkage between flows/reservoir levels and riparian/wetland wildlife habitat. Used to develop riparian habitat performance measure.
Suspended Sediment (Coquitlam River)	Literature review & general education session	To determine whether alterations to dam flow releases change concentration, transportation and deposition of sediment, thereby having an impact on flood control, Kwikwetlem boat access, recreation, industry, and effectiveness of habitat created for fish.

Notes regarding information collection

- The Archaeology Study was kept confidential at the request of First Nations representatives. The information is part of First Nations' heritage and some sites are considered sacred. In addition, general knowledge about site locations exposes them to potential degradation and pot-hunters.
- With regard to wildlife/environment, many members of the Consultative Committee expressed a need to develop a better understanding of:
  - What indigenous species and habitat areas exist now (baseline information/inventory);
  - How riparian areas along the river and reservoir are affected by BC Hydro operations; and

[50] Focus on First Nations but consider non-First Nations.
[51] Report compiled by Clive Wilson (BC Hydro CBWUP Project Team) with input from Consultative Committee members.

- How specific habitats will be affected by operating alternatives (e.g. habitat for endangered species, migration routes, wetlands, islands in the river that may be submerged/exposed, bird and amphibious nesting areas, etc.).

Historical Context and Map Atlas Proposals

In addition, the Coquitlam-Buntzen Consultative Committee considered proposals for two projects: one a Historical Context Study and the other a Map Atlas. There was disagreement among committee members as to the importance and relevance of these projects in the water use planning context. Ultimately it was decided not to fund the studies because they did not directly address any of the performance measures, and did not meet the criteria set out in the WUP guidelines to fill critical information gaps. BC Hydro offered to support efforts to seek funds from other sources to have these projects carried out and Derek Bonin (GVRD) provided the CC with a list of maps available from GVRD and from other sources.[52]

[52] List included as an information sheet in Appendix I.

5 OPERATING ALTERNATIVES…

5.1 Overview

As required under Step 6 of the WUP process, the committee created a meaningful set of alternative operating regimes with which to evaluate and compare the impacts on different water user's interests and objectives. Operating alternatives are the allocation of water through water control structures to satisfy stated objectives within given operating constraints, subject to natural variability. In the Coquitlam-Buntzen system water control facilities affect the allocation of water from the Coquitlam Reservoir to the Coquitlam River, GVRD pipeline, and the Buntzen tunnel. Water from the Buntzen tunnel flows into Buntzen Reservoir, then to the Buntzen power generating stations on Indian Arm. Where and when water is released from the two reservoirs directly impacts the stated objectives. For example, an alternative may provide increased water flows into the Coquitlam River during the summer months to improve rearing habitat, or to the GVRD pipeline to improve capacity for meeting peak summer domestic water demand. Alternatives are forward looking recognizing that facilities are in place and that the focus of WUPs is on improvements to operations to reflect different uses.

Two sets of operating alternatives dominated the Coquitlam-Buntzen WUP Consultative Committee process: those primarily related to *flows* down the Coquitlam River and GVRD pipeline and those related to *flushing flows* down the Coquitlam River. Flow alternatives refer to the regular operating procedures throughout the course of a year. Flushing flow alternatives are singular events; large releases of water at one time intended to "flush" the system and clean the substrate on the river bottom. Although these two types of alternatives clearly effect each other, and the degree to which some objectives can be improved, they remained separate throughout the consultative committee process largely because of uncertainties associated with quantifying the benefits of flushing flows.

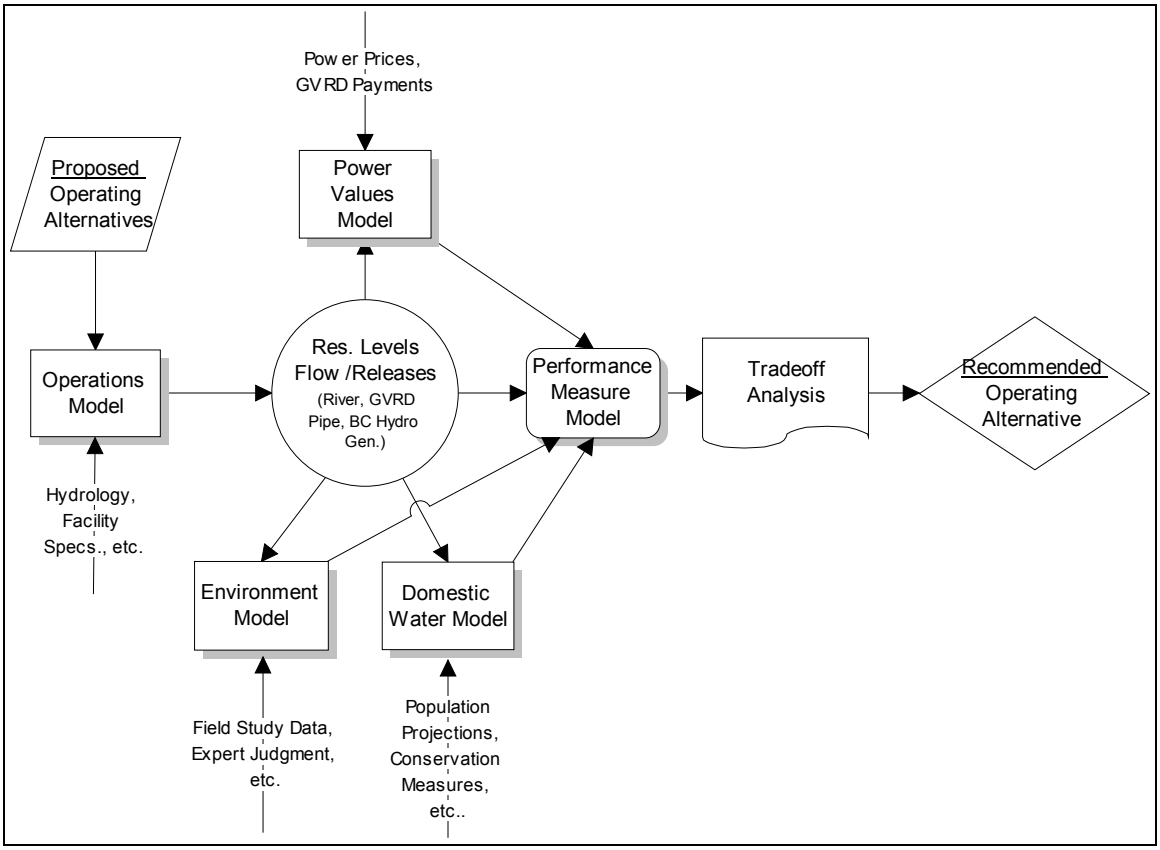
Flow alternatives selected by the CC were run through BC Hydro's operations model, AMPL, to determine how the system responds to a given set of constraints (see inset). Output from the AMPL model (e.g., reservoir levels, river flows) were used to calculate previously determined performance measures. Performance measures were then used to determine the degree to which objectives were met (see Table 6).

THE AMPL (OPERATIONS) MODEL

The AMPL model is BC Hydro's operations model used to determine how the system responds to a given set of constraints. Physical and equipment constraints and historic inflow data (39 years) are invariable inputs to the model. Variable inputs to the model include constraints the Committee has agreed to test, such as providing flows for fish during certain times of the year, or maintaining a minimum reservoir elevation. The AMPL model maximizes for power subject to these constraints. Output from the model for any particular alternative provides daily averages for power production (Megawatts), turbine discharges, reservoir levels, dam releases and spills.

From these 'reservoir level' and 'flow' outputs, performance measures were calculated for each alternative. Alternatives were then assessed based on these performance measure results. This assessment is described in the next chapter.

Table 6: Overview of Alternative Development to Evaluation



Infrastructure Changes

Most of the flow and flushing flow alternatives identified during the consultation process required infrastructure modifications at the Coquitlam Dam. This was due to the fact that any controlled increase in flows down the Coquitlam River required infrastructure changes. Currently water is released to the river via two fish valves which are always open, and via the Low Level Outlets which are either fully opened or fully closed (the LLOs are used for pre-spill). Alternatives that included infrastructure changes were supported by the CC interpretation of the Water Use Planning Guidelines (p. 26) and a Draft Decision Tree[53] developed by the WUP Management Committee to assist consultative committees in determining if an alternative was within the scope of WUPs or not.

Chapter Structure

In Section 5.1 is a discussion of the process used to generate and narrow flow alternatives. Then, an overview of general constraints applied to all flow alternatives is provided. By the final meeting, the CC had to consider six different flow alternatives, and these are summarized and discussed at the end of Section 5.1. In Section 5.2, the process of developing and narrowing flushing flow alternatives is described, which the CC spent considerable effort on.

[53] *DRAFT:* Creating WUP Alternatives. Identifying Appropriate Issues and Developing Preferred Strategies. March 1, 2001

5.2 Flow Alternatives

Process for Generating and Narrowing Flow Alternatives

The process for generating flow alternatives was open and iterative. First, a brainstorming exercise by the CC was held in October 2000 to generate a full spectrum of alternatives for Coquitlam-Buntzen systems. Dozens of alternatives, ranging from maximizing power to removing the dam, were generated. These were then organized into non-operating and operating alternatives.[54] Flow alternatives evolved as the CC worked with technical input from the FTC, GVRD, BC Hydro and Working Groups to develop, evaluate and refine over two dozen flow alternatives in detail. As new information was collected, alternatives were refined and modified over the course of the process.

As the process of refining flow alternatives progressed, it became clear that the most significant trade-offs, both technical and value-based, were between fish, domestic water and hydroelectric objectives. The CC confronted a value-based disagreement between the existing operating alternatives. Therefore, they recommended that a smaller Working Group of CC members be formed that included representatives from BC Hydro, GVRD, and fish interests. The Working Group was tasked with developing modifications to the "front runner" alternatives -- those flow alternatives that performed well for most CC members in a swing weighting trade-off exercise. Specifically, the Working Group was asked to explore opportunities to craft new flow alternatives that addressed fluctuations between wet and dry years, seasonality, and had built-in flexibility. In addition, during dry years Domestic Water interests should share the burden equally with Fish interests was a principle that guided the Working Group's efforts designing new alternatives.

The Working Group succeeded in refining existing alternatives and developing new alternatives that better met the conflicting objectives of the CC, however no single alternative could be agreed upon. As a result, after the working group's efforts were combined with the previous work of the CC, a total of six alternatives were considered at the final decision-making CC meeting held on October 22, 2001. The next section describes key points and general constraints applied to all flow alternatives, followed by an overview of the final flow alternatives considered at the last CC decision meeting.

General Modeling Constraints, Assumptions, Specifications and Key Points Applied to all Flow Alternatives

General Constraints and Assumptions

- The AMPL model is run with 5-day forward knowledge only and an optimized monthly reservoir soft target level.
- All flow alternatives were run with a one-meter flood buffer in place to protect property and public safety downstream of the Coquitlam Dam.

[54] "Operating alternatives" include changes to reservoir levels at Coquitlam and Buntzen Reservoirs, and changes in outflow to GVRD, the Coquitlam River, Buntzen Reservoir and Indian Arm (all including daily, monthly, seasonally, or yearly timing). "Non-operating alternatives" include changes that are either indirectly related to WUP or outside the WUP scope (e.g. changes to dikes, regulations, or land uses) and are summarized in Appendix H.

- All flow alternatives were run with Buntzen Reservoir maintained at an average daily elevation of 122.5m. To improve public safety, the Buntzen/Coquitlam S.O.O. was modified on 22 June 2001 to restrict minimal operating level 15 May to 1 October to 122.2m during daylight hours. At other times the operating range is 120.09-122.9 m. therefore no specific consideration was given to the balance of water flows into and out of the Buntzen Reservoir.[55]
- All flow alternatives (aside from some preliminary operating alternatives that were run for reference purposes) were run respecting the current interim fish flow agreement and the current GVRD agreement.[56]

Infrastructure Constraints and Assumptions

- All alternatives were run with a minimum volume of water equivalent to 2 fish valves always open. In all alternatives 2 fish valves always open did not meet the minimum identified requirements for fish objectives in the Coquitlam River. An upgrade of one low level outlet (LLO) was required to improve the degree to which fish values could be met. In some cases it was assumed that 1 LLO could be partially opened and the other 2 LLOs opened fully or closed in order to aid the delivery of the desired flows.
- All LLOs were used for pre-spill.
- For all operating alternatives evaluated (except current operations and the Electric Operating Review Alternative (ESOR)), 1 unit at Buntzen Plant 1 (LB 1) and 3 units at Buntzen Plant 2 (LB 2) were modeled.

Specifications

- Flow alternatives only specified monthly flow requirements from the Coquitlam Reservoir to the river and the GVRD outflow; power generation was optimized within these requirements.
- Each operating alternative includes a procedure for prioritizing where water goes first, second, and third (i.e. river, GVRD, power). This was done because, as a result of reservoir constraints, there was insufficient water in dry years (especially between July 1st to September 30th) to meet flow requirements associated with domestic water and fish values.
- Flow alternatives specified either the "current" or "proposed" requested nominations from GVRD to meet domestic water objectives. All flow alternatives except the 2FVC use the proposed GVRD nominations. The difference between these is explained in Chapter 3 (domestic water objectives and performance measures).
- The GVRD is modeled to be curtailed when minimum fish requirements could not be met.

[55] Although the operating range is not being changed, the way in which BC Hydro operates the reservoir during part of the year is being changed. Reservoir elevation below 120.09 m can cause vortexing at the intake; above 122.9 m creates an unacceptable risk of spilling. A fluctuation of at least 0.65m in water level is required for the effective operation of the Buntzen plants.
[56] *Interim fish flow agreement*: minimum 0.65 cms flow to Coquitlam River from 2 fish valves in Coquitlam Dam (0.57 cms) and Grants Tomb/Swoboda (0.08 cms). *Current GVRD agreement*: maximum average annual flow nomination of 7.88 cms.

Key Points

- When a Coquitlam River target/minimum flow is specified, the target flow already includes the Swoboda Channel fish flow. In the model, Swoboda flow is discharged through the fish valves and LLOs for accounting purpose only. The minimum fish flow of 0.65 cms includes the Swoboda flow (0.08cms).
- The GVRD is modeled to withdraw the same amount of water every day as specified by their nomination. If, in reality, the GVRD withdraws less than nominated (which Hydro has no control over) when the reservoir is near full pool, there may be a risk of pre-spilling.

Overview of Flow Alternatives

The matrix below provides a brief overview of the flow alternatives. The alternative names evolved naturally in the process and are descriptive of the alternative in terms of infrastructure (e.g., 2 Fish Vales Current), CBWUP objective primarily being satisfied (e.g., Fish Friendly Flow) or CC mandate (e.g., Share the Pain). All except current operations require an infrastructure modification to one of the Low Level Outlets (LLOs). The priority is where the water goes first, once that objective is satisfied, the next priority then receives water. Power was always the first water user to be curtailed (i.e. the third priority) in the final set of alternatives considered by the CC. The final set of alternatives shown below are organized from top to bottom in terms of how much water is allocated for the Coquitlam River, with less flow at the top, or first alternative described (2FVC) and more at the bottom (FFF). More detail is provided following the matrix.

Table 7: Description of the Final 6 Flow Alternatives[57]

Alternative Name	Infra Reqmnt	GVRD Agmnt	Priority #	Comments
2FVC- 2 Fish Valves Current Operations ***Reference – Base Case***	2FV	current agreement	#1 River #2 Dom Water #3 Power	Reflects the current situation under existing agreements (GVRD currently does not use all their water allocations allowed under their current agreement with BC Hydro)
DWF(2FVP): Domestic Water Friendly -2 Fish Valves Proposed Operations	2FV	proposed agreement	#1 River #2 Dom Water #3 Power	Designed to satisfy the domestic water objectives.
(**4FVN)**: The 4 Fish Valves New (Optimized)	Modified LLO	proposed agreement	#1 River #2 Dom Water #3 Power	Is the equivalent of 4 fish valves in volume (or 10-12% mean annual discharge or MAD), but the shape of the hydrograph is modified by the use of an adjustable LLO to optimize monthly flow releases for fish.

[57] The ESOR alternative is not included here. ESOR is a flow alternative specified in BC Hydro's 1994 Electric System Operating Review; included in CBWUP for reference only.

Alternative Name	Infra Reqmnt	GVRD Agmnt	Priority #	Comments
(STP4): "Sharing the Pain #4"	Modified LLO	proposed agreement	Oct-June #1 River and Dom Water #3 Power July-Sept #1 Dom Water #2 River #3 Power	Designed to provide a target flow nomination to both the river and GVRD on a monthly basis to satisfy optimal conditions where reservoir operations allow. Where reservoir operations deviate from the prescribed operation (i.e. reservoir elevation drops below target reservoir elevation), BC Hydro diversion from Coquitlam Reservoir is the first to be restricted. When the reservoir elevation drops further than approximately 2 m below the target elevation, depending on the priority of the water user, nominations are gradually reduced to the minimum targets for both/either GVRD and river flows as needed.
(STP5): "Sharing the Pain #5	Modified LLO	proposed agreement	Same as STP#4	Same river & GVRD target flows as STP4. Minimum river flow allocation for STP5 higher than STP4 to provide more opportunities for fish in low flow years.
(CF): Conservation Flow	Modified LLO	proposed agreement	#1 Dom Water #2 River #3 Power	Conservation flow is the "optimal" fish flow based on a knowledge of BC rivers in general (provincial standard)
FFF: The "Fish Friendly Flow	Modified LLO	proposed agreement	#1 River #2 Dom Water #3 Power	This included preliminary estimates of "optimal" fish flow demonstrating the best possible outcome for the fish on the Coquitlam River on the basis of available fish performance measures. In contrast to the "conservation flow", this operating alternative takes into account regulation and diking that make the Coquitlam River different from typical BC streams.

Discussion of Final Flow Alternatives

2FVC: *2 Fish Valves - GVRD existing agreement* (Reference Base Case)

Two fish valves are always open with reservoir elevation always maintained above 142.1m to ensure minimum river flow requirements. GVRD maximum nominations under current agreement is always satisfied. There is no spill over the spillway. However, there are a couple of pre-spill events through the LLOs

DWF (2FVP): *2 Fish Valves - GVRD Proposed agreement: Domestic Water Friendly*

Two fish valves are always open with reservoir elevation always maintained above 142.1m to ensure minimum river flow requirements. GVRD allocations are the maximum nominations under proposed agreement. With existing infrastructure (i.e. fish releases through fish valves), the GVRD proposed unsigned agreement flow pattern is usually satisfied, except sometimes from mid Aug to mid Oct. If fish flow releases occur through the fish valves as modelled by BC Hydro, then there is no spill.

The primary reason that requested flows from GVRD's proposed agreement with BC Hydro cannot be met all the time is that reservoir elevations need to be maintained at 142.1 m to achieve the current interim fish flow agreement (0.57 cms discharge from the dam into the Coquitlam River) through the use

of the existing fish valves. However, internal modeling at GVRD shows that the 14.36 cms monthly nomination can be met with an average 2 Fish Valve volumes using the Low Level Outlets rather that the fish valves for release, thus overcoming the reservoir elevation constraint. Based on GVRD's internal analysis, which was done without hydraulic constraints (i.e. without constraints on reservoir elevation), this alternative *has the potential* to be "domestic water friendly", that is, to satisfy the GVRD proposed agreement nominations. Therefore, this operating alternative is "domestic water friendly" on the assumption that fish flow is not released through the existing fish valves – see comments below.

4FVN: *Four Fish Valves Optimized (Volume of 10-12%MAD)*

This is equivalent to the average volume release if four fish valves were always open, approx. 10-12% of the mean annual discharge or MAD. It is a misnomer as it uses a modified LLO to achieve flows that are better for fish rather than four fish valves. In other words, it is doing more for fish by when water is released into the river rather than how much. Monthly flows (see table below) released within prescribed volume to optimize key reaches in the river.

4Fish Valve River Flow Targets													
4FVN	River Flows	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Target (cms)	1.1	2.3	4.32	3.52	3.01	4.88	1.74	3.26	1.03	1.1	1.1	1.1

In this alternative, a minimum release of 1.1cms is a required minimum constraint maintained throughout the year (except Sep) to satisfy minimum flow criteria (in Reaches 2, 3, and 4 in the river). The GVRD proposed agreement flow pattern is usually satisfied, except sometimes from mid Aug to mid Oct. There is no spill but one pre-spill event.

STP4 & 5: *Share the Pain Alternatives*

Priorities are shown in the table below. The "Share the Pain" alternatives were designed by the CC Working Group to provide a target flow nomination to both the river and GVRD on a monthly basis to satisfy optimal conditions where reservoir operations allow such provision. Where reservoir operations deviate from the prescribed operation (i.e. reservoir elevation drops below target reservoir elevation), BC Hydro diversion from Coquitlam Reservoir is the first to be restricted. When the reservoir elevation drops further than approximately 2 m below the target elevation, depending on the priority of the water user, nominations are gradually reduced to the minimum targets for both/either GVRD and river flows as needed. The Working Group defined five sharing the pain (STP) alternatives, although only two alternatives emerged from the working group for submission to the CC as the others did a poor job of satisfying the Working Group's task of finding a satisfactory balance. The two chosen by the Working Group to bring forward are STP 4 and STP 5, as outlined in the table below.

- Two sets of target flows for the GVRD and river nominations respectively: the first set defines the target flows which would maximize respective benefits, and the second set defines the lower limits acceptable for each objective on a monthly basis (see flow provisions outlined below)
- Monthly river flows (see table below) released within prescribed volume to optimize each river PM at reaches 2 and 3

- If the reservoir is at a higher than target elevation, the model allows power tunnel flow which is used for generation. Otherwise, no tunnel flow and generation is allowed and the water will be saved in the reservoir for later use.

Where both parties share first priority, both nominations are restricted at the same time when reservoir elevation drops approximately 2 m below the target elevation.

Table 8: "STP" River Flow Targets

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Share the Pain #4	River Flow Targets (cms)	3.3	2.9	7.6	6.9	6.3	5.0	4.6	6.1	5.6	3.0	3.0	3.0
	River Flow Minimum (cms)	2	2	2	2	2	3	3	3	3	3	2	2
	River Priority	1	1	1	1	1	1	2	2	2	1	1	1
	GVRD Flow Target (cms)	11.9	11.9	11.9	12	12	12	18	23	23	12	12	11.9
	GVRD Minimum (cms)	10.7	10.7	10.7	10.8	11	10.9	15.8	20.2	20.9	10.8	10.8	10.7
	GRVD Priority	1	1	1	1	1	1	1	1	1	1	1	1
Share the Pain #5	River Flow Targets (cms)	3.3	2.9	7.6	6.9	6.3	5.0	4.6	6.1	5.6	3.0	3.0	3.0
	River Flow Minimum (cms)	3	2.9	3	3	3	4	4	4	4	3	3	3
	River Priority	1	1	1	1	1	1	2	2	2	1	1	1
	GVRD Flow Target (cms)	11.9	11.9	11.9	12	12	12	18	23	23	12	12	11.9
	GVRD Minimum (cms)	10.7	10.7	10.7	10.8	11	10.9	15.8	20.2	20.9	10.8	10.8	10.7
	GRVD Priority	1	1	1	1	1	1	1	1	1	1	1	1

Additional Comments: The river targets represent reduced fish friendly flows, which are intended to maximize the performance of fish flows in reaches 2 and 3 based on inflows. The minimum flow allocations are to meet the following objectives:

- Share the Pain 4: Increase base flows and rely on natural inflow variability to meet specific requirements for rearing in the spring and summer months. For spawning, the increased base flows will lengthen and increase storm events to allow more spawning opportunities
- Share the Pain 5: In the ways STP 4 increase rearing and spawning opportunities, STP 5 will provide more opportunities in low flow years.

For both Share The Pain alternatives, curtailment of fish flows and the GVRD flow takes place throughout the year. However, the magnitude of the curtailment is usually limited by the defined amount. The curtailment in the Aug to Oct for the GVRD is not as severe as observed in other operating alternatives. The minimum fish flow requirement (0.65cms) is always met. The fish flow reduction in Aug to Oct is also not as severe as observed in other operating alternatives.

CF: Conservation Flow (GVRD as Priority 1)

In this alternative, neither the GVRD flow target nor the conservation flow target is met all the time. Both of targets are not met usually in Aug to Oct. There is neither spill nor pre-spill

Table 9: Monthly Minimum "Conservation" River Flow Targets

Constraint	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg daily (cmsd)
Minimum River Discharge cms/d*	2.75	4.15	7.63	6.86	6.31	2.63	1.99	3.56	5.77	5.65	5.09	6.12	4.88

*cubic metres per second per day

FFF: Fish Friendly Flow

In this model run, neither fish flow nor GVRD flow is entirely satisfied. The GVRD flow is reduced when needed in order to keep the reservoir elevation to provide the hydraulic head required for fish friendly flow discharge. The fish friendly flow requirement is not always satisfied due the 5 day foresight built into the model. In other words, there are times when the reservoir elevation is too low for discharging the required fish flow because it is unknown when the next storm will come to fill the reservoir to the required level. There is a pre-spill with magnitude of about 15 cms in May. The pre-spill in May results because by keeping the forebay elevation high to save water for later use increases the risk of pre-spilling.

Table 10: Monthly Minimum "Fish Friendly" River Flow Targets

Constraint	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg daily (cmsd)
Minimum River Discharge cms/d*	3.3	2.9	10.2	9.4	8.9	5.6	7.6	9.1	8.6	3.5	1.4	2.4	6.1

Trade-offs and discussion of these flow alternatives are presented in Section 6.

5.3 Flushing Flows

Process for Generating and Narrowing Flushing Flow Alternatives

Substrate quality is thought to be one of the most significant limiting factors for fish productivity in the Coquitlam River. Due to this, the CC spent a great deal of effort reviewing options for improving substrate quality with "flushing flows," large short-term water releases from the dam. Also known as substrate maintenance flows, they were recommended by the FTC to clean substrate downstream of the Coquitlam dam for the benefit of fish and benthic invertebrates. Other methods for improving substrate quality, such as mechanical cleaning, were discussed but not pursued by the CC as some members felt they were expensive, ineffective and had many adverse environmental impacts. The process for generating flushing flow alternatives originated with the FTC in their efforts to maximise fish benefits. Once designed and evaluated by the FTC, they were brought forward to the CC for evaluation and recommendation. Two evaluations of flushing flows occurred.

The first evaluation provided only one option (besides the status quo) a 200 cms release from the dam for 8 hours every 2-5 years. This flushing flow was designed to meet the objective of maximising fish benefits and was based on work done by North West Hydraulics (shown as Alternative 3 in the table below). This was based on their assessment that this was a threshold flow and the minimum required to achieve significant benefits for fish. Although there was a great deal of discussion of the costs and benefits involved, flood issues related to public safety, personal property damage and cultural issues at IR1 and IR2 would need to be addressed before a 200 cms flow would be possible. These outstanding

issues related to flooding resulted in the CC acknowledging that a 200 cms flushing flow is not feasible in the time frame available for this Water Use Plan.

The second evaluation took place as a result that a 200cms flushing flow could not be implemented within the timing of the WUP and as a result the FTC requested additional technical clarification from North West Hydraulics[58] regarding flushing flows. This new information suggested benefits of a flushing flow less than 200cms may have measurable benefits. The FTC generated a full set of flushing flow alternatives. The new alternatives evaluated flows from 30 to 110cms, lasting 3 to 10 days and occurring every 1 to 2 years – as well as the original 200cms recommendation (see Table 11 below).

From this set of flushing flows (FFs) the FTC made an interim recommendation (until a 200cms flushing flow may safely be released downstream) of a flushing flows alternative for a controlled release from the dam of between 30-50cms lasting between 3 to 5 days in October to December and be co-ordinated with high forecasted flows from Or Creek above 30cms. This alternative did not negatively affect reservoir operations nor require infrastructure modifications nor cause significant impacts downstream. This alternative became known as the FTC's interim flushing flow recommendation (also referred to as the opportunistic flushing flow alternative and sometimes the maintenance flow).

Two other flushing flows, Alternatives 1 and 2a, would use existing infrastructure but would require sufficient water storage in the dam to provide head pressure to meet the duration requirements. Alternative 2b would require spillway modifications to achieve the 110 cms level. Alternative 3 also required modifications to the spillway to control flows (flushing flows of 200cms could be achieved by filling the reservoir and allowing it to spill, but this would cause unacceptable downstream flood, safety and cultural impact issues). Flushing flow alternatives are discussed more in Section 6.

Table 11: Overview of Flushing Flow Alternatives[1]

Flushing Flow Alternative	Magnitude (m^3/s)	Duration [2] (days)	Frequency (years)	Infrastructure Changes	Affect Regular Reservoir Operations?
FTC Interim Recommendation	30 - 50	3 to 5 or more depending on Or Creek	opportunistically every year depending on Or Creek	LLO Modifications (as required for most flow alternatives)	No
1	50	5 to 10	every year or second year	LLO Modifications (as required for most flow alternatives)	Yes
2a	50	5 to 10	every year or second year	LLO Modifications (as required for most flow alternatives)	Yes
2b	110	at least 1	every second year	Spillway Modifications	Yes
3	200	0.33 to 1	every two to five years	Spillway Modifications	Yes

1. Flow magnitudes, durations and frequencies are calculated but we recommend monitoring to better establish these values. Timing of the releases has not been determined but the substrate maintenance flows will be most effective if released during periods of low sediment inflows.
2. Duration refers only to peak flows and does not include ramping to the peak and from the peak to base flows.

[58] In February 2001, Ken Rood of Northwest Hydraulics (author of the CBWUP substrate maintenance study) explained to the CC that, aside from flushing flows, none of the CC's other operating alternatives would improve substrate conditions in any meaningful way – Ref: Section 3.3 of this report ("Suspended Sediment (turbidity)" and "Comparison of Proposed Flow Scenarios for Managing Coquitlam River Sediment" in Appendix F.

6 TRADE-OFF ANALYSIS AND RECOMMENDED OPERATING STRATEGY

6.1 Overview

The operating alternatives described in Section 5.0 were evaluated and compared through technical analysis and discussions among the members of the consultative committee, as required under Step 7 of the WUP process. Three CC meetings were held (plus 3 Working Group meetings) involving trade-off evaluation and discussions. During this period, over two-dozen alternatives were considered and multiple trade-off techniques were employed. Numerous trade-off tools were used to assess the technical trade-offs and value trade-offs including: direct choice, ranking, swing weighting, and pair-wise comparison exercises.

Technical trade-off analysis consists of analysis of technical and scientific information presented as performance measures. Throughout the WUP process this information was evaluated in the form of graphs, descriptions and matrices. Alternatives were compared and those that were clearly "dominated", or performed worse across performance measures either by direct comparison or agreement by the CC, were dropped from further analysis. Those that required value trade-off analysis were then further analyzed and discussed by the CC. Value-based trade-offs and committee member preference analysis helped answer the question of how important the impacts were as indicated by the technical performance measures.

Key Issues and Results Summary

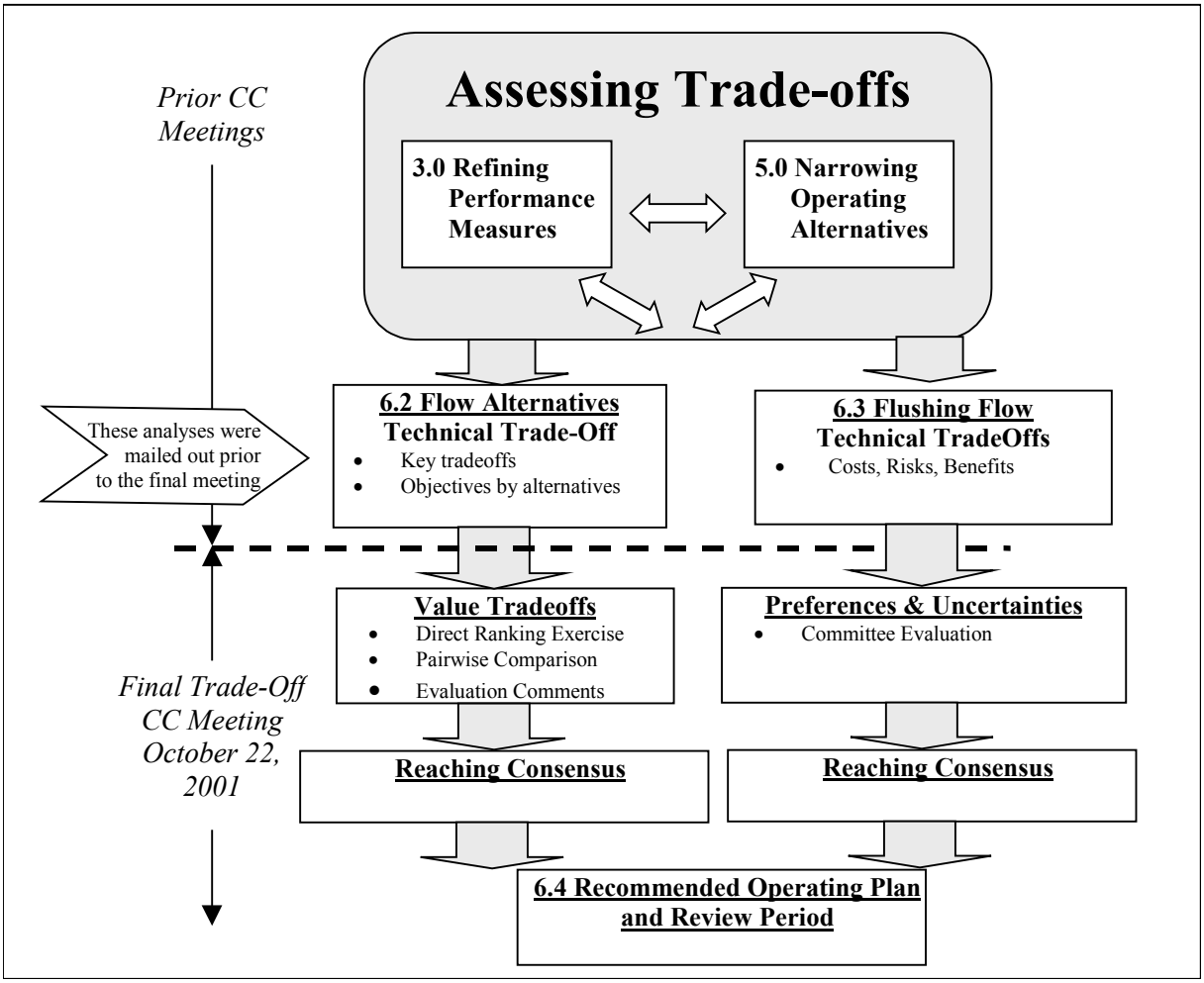
Three key issues that dominated the trade-off discussions. First, both domestic water and fish interests would be better off than they currently are under all final flows alternatives considered by the CC. Second, there is simply not enough water in the system to satisfy both the fish objectives and the domestic water objectives, even when hydropower is relegated to taking whatever was 'left over' after trying to satisfy these first two objectives. Third, the uncertainty associated with the performance measures, in particular the fish performance measures, played a significant role in the trade-off discussions. Insight into technical issues and value-based thresholds were explored providing the basis for the consensus agreement. The consensus agreement centred on an adaptive management program that will test two flow trials on Coquitlam River and review the results within a 15 year period. The ultimate goal of addressing these uncertainties is to conduct more informed trade-off analysis at the conclusion of the review period.

Chapter Structure

This chapter first discusses the trade-off analysis of the flow alternatives in Section 6.2. This includes technical trade-offs, value or preference trade-offs, and a description of how consensus was reached. Section 6.3 reviews the trade-offs associated with flushing flows, including the technical and value trade-offs and the final recommendation. Because the adaptive management plan affects the timing of the flushing flow recommendation, a special section is included. In Section 6.4 the recommended operating plan is described.

An illustrative framework for the final stages in the trade-off analysis and how this section is organized is provided in Table 12.

Table 12: Framework Illustrating the Assessment of Trade-offs by the CC



6.2 Flow Alternatives Trade-offs Analysis

Technical Trade-off Analysis

The technical trade-off analysis helped to focus the Consultative Committee on the objectives that most affected their recommendations. Several of the objectives experienced relatively little change across the range of final flow alternatives, including Flood, Fish (reservoir), Industry, Recreation, and Wildlife & Environment. These were not dismissed, but they played a small role in the trade-off discussions. The CC spent most of their effort understanding the impacts to Domestic Water and Fish (river) objectives. Hydropower also experienced significant impacts across the range of alternatives. However, Hydropower played a more minor role in the final trade-off discussions than Domestic Water and Fish. This general preference is also reflected in the fact that Hydropower was given third priority in each of the final flow alternatives.

This section first provides a brief description of the narrowing of objectives by describing the objectives that experience the least change across the range of final flow alternatives. This is presented in Table 13 below. Then an overview of the key trade-offs between domestic water, fish (river) and hydropower are presented, followed by objectives by alternatives matrices. Value trade-offs determined by CC member preference analysis and uncertainties are then discussed.

Table 13: Objectives Experiencing Least Change

Objective	Summary
Flooding	A one-meter flood buffer and current procedures which lowers the reservoir level before the fall storm cycles provided the same level of flood protection as is currently employed, was adopted early on by the CC (and recommended by the Flood Working Group) and applied to all the final alternatives considered. As a consequence, this objective performed equally for all the alternatives, but did not aid in selecting between alternatives. Archaeological sites at IR1 and IR2 downstream of the reservoir were evaluated under the flood objective.
Fish Habitat: Coquitlam Reservoir	With exception of current operations, littoral habitat varied relatively little between the operating alternatives under consideration by the CC. The estimated effective littoral zone is 31.6 million square metre days under current operating rules whereas under the other operating alternatives that provide more water to the river along with the proposed agreement allocation to GVRD, it is about 1.0 million square metre days.
Industry	The gravel industry identified their ability to control storm water runoff as one of their main management challenges and as the most significant industry benefit from changes to dam operations at Coquitlam Reservoir. By having more water in the river during and after storms, the gravel industry could better meet regulations through sediment dilution. All operating alternatives under the range of alternatives considered for the CBWUP have annual average river flows at or above current levels. Consequently, the worst-case scenario for industry would be current operations and no change to instream flow patterns. All other alternatives offer an improvement in storm water management on an average annual basis.

Recreation	Only about 5% of all recreational activities on the Coquitlam River would be affected by a change in flows. With the current minimum flow of 0.65 cms release from the dam, recreation would not be a primary 'driver' in the analysis and all alternatives would marginally benefit net recreation values. Recreation safety at Buntzen Reservoir was an issue and it was dealt with by the proposed target summer reservoir elevations (BC Hydro's SOO) and applied to all alternatives.
Wildlife and Environment	The overall ecosystem health under different flows provides a good measure of the area and suitability of riparian/wetland areas for indigenous wildlife. It was concluded by the Wildlife and Environment Working Group that existing flows are adequate to maintain floodplain ecosystem health and this was reflected in the PM that was insensitive across the final alternatives.

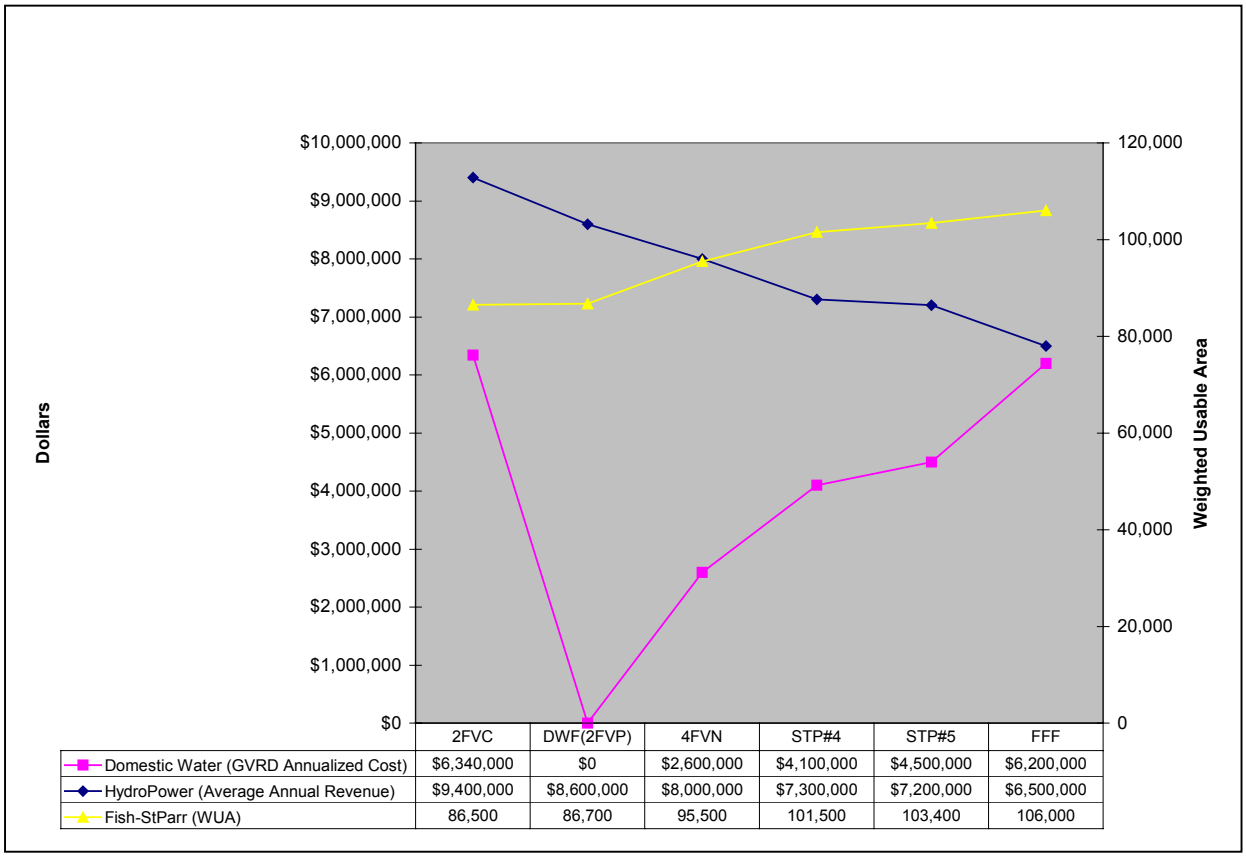
Overview of Key Trade-offs between Flow Alternatives

The trade-offs between domestic water, fish (river) and hydropower dominated the evaluation and discussion by the CC. Figure 9 and Table 14 provide an overview of the key trade-offs using select performance measures. The Conservation Flow alternative was not considered in this analysis as it was dominated by the new Sharing the Pain #5 (STP5) alternative developed by the Working Group. In other words, STP5 is better (or nearly the same) for Fish, GVRD and Hydroelectric power than the Conservation Flow alternative (see Alternatives x Objectives Matrix, Table 15, and Table 17).

As indicated in Figure 9 and Table 14, there is a significant cost savings to the GVRD of $6.34 million from moving from the current situation (2FVC) to the proposed agreement (DWF (2FVP)) with little impact to fish and a loss in BC Hydro annual revenue of $800,000 ($9.4 million - $8.6 million = $800,000). The GVRD cost saving is based on the annualized capital costs associated with having to raise Seymour Dam *earlier.* For the rest of the alternatives, moving from left to right in the graph and tables below, there is a direct trade-off between the volume of water released down the Coquitlam River for fish benefits and the environmental impacts and revenue-loss/costs to domestic water and hydroelectric power objectives.

In other words, as the analysis moves from a 2FVC release (volume) to a 4FVN (volume) release to a STP alternative, and so on, there is improved fish habitat at an increased dollar and environmental cost trade-off to domestic water (cost savings) and hydroelectric power (revenue loss). Although flow targets for domestic water are based on the "proposed" GVRD agreement for all scenarios other than 2FVC, the actual volume of water available for domestic water GVRD decrease from left to right (i.e. starting from DWF/2FVP to FFF) because there is not enough water to satisfy all the objectives. The critical period is during dry years when none of the alternatives could provide the minimum water needs to satisfy both domestic water and fish requirements during the summer months, excluding hydroelectric power production altogether. What is also clear from this analysis is that all alternatives beyond 2FVC indicate an improvement for domestic water and fish objectives.

Figure 9: Overview of Change to Selected PMs: Domestic Water, Fish, Hydroelectric Power



	2FVC	DWF(2FVP)	4FVN	STP#4	STP#5	FFF
Domestic Water (GVRD Annualized Cost)	$6,340,000	$0	$2,600,000	$4,100,000	$4,500,000	$6,200,000
HydroPower (Average Annual Revenue)	$9,400,000	$8,600,000	$8,000,000	$7,300,000	$7,200,000	$6,500,000
Fish-StParr (WUA)	86,500	86,700	95,500	101,500	103,400	106,000

Table 14: Impacts to Objectives using Key Performance Measures

Objective (performance measure)	2FVP	4FVN*	STP#4	STP#5*	FFF
Domestic Water (GVRD annualized capital costs savings for development of a new water source compared with current agreement and operations) (millions)	$6.34	$3.74	$2.24	$1.84	.14
Hydroelectric Power (BC Hydro annual average revenue losses from current operations) (millions)	.80	$1.40	$2.10	$2.20	2.90
Fish Steelhead Parr rearing (increase in habitat – weighted usable area in sq. metres – over current operations)	.2%	10.4%	17.3%	19.5%	22.5%
Fish: Steelhead Parr (Flows less than 5.4cms at PoCo gauge in August)	97%	87%	77%	58%	0%

* Gray highlights in the table above indicate the final two flow alternatives of the CC.

For domestic water, the performance measure shown in Table 14 reflects the annualized cost savings associated with developing an alternative water source later than would be required, based on the GVRD satisfying their proposed nominations of water from the Coquitlam reservoir in their proposed agreement. As indicated, all alternatives satisfy the domestic water objective better than the current situation. The annualized cost saving to the GVRD and ratepayers ranges from $6.34 million in 2FVP to only $.14 million in FFF. The "final frontrunner alternatives," 4FVN and STP#5, discussed in greater detail in the following section are highlighted here in gray. The technical trade-off between these alternatives is $3.7 million for 4FVN and $1.8 million for STP#5 (a difference of $1.9 million annually).

For hydroelectric power, the performance measure shown below is the average annual revenue loss from current BC Hydro operations (including VOE and GVRD payments). The range of revenue loss is $.8 million in 2FVP to $2.6 million in FFF. The "final frontrunner alternatives," 4FVN and STP#5, show a technical trade-off of $1.4 million for 4FVN and $2.2 million for STP#5 (a difference of $800,000 annually).

For fish in the Coquitlam River, rearing habitat is one of the key limiting factors. Table 14 highlights the difference in expected rearing habitat using the weighted useable area (referred to as WUA and is calculated by weighting habitat quality considerations for different sections of the river) for steelhead parr, which is considered the most sensitive species and therefore a good indicator of all rearing habitat. Projected habitat gains range from a .2% increase over current operations to 22.5% gain in the FFF alternative. For the final "frontrunner alternatives" the difference is 10.4% for 4FVN and 19.5% for STP#5 (a difference of 9.1%).

However, this habitat measure was criticized as not sufficiently sensitive, particularly considering the importance of flows during the summer months. Therefore, CC members often cited a flow threshold performance measure which indicated the frequency that river flows did not meet minimum rearing requirements (based on 20% of the mean annual discharge) for steelhead during August. This is also shown in the table below and indicates that 97% of the time this flow threshold is crossed in 2FVP and 0% in the FFF alternative. Under the 4FVN alternative, these minimum flows are not met 87% of the time while under STP#5 they are not met 58% of the time (a difference of 29%).

Significance of Domestic Water and Fish Performance Measures for the Final Two Alternatives 4FVN and STP#5

Domestic Water

GVRD would like to increase its water system reliable supply capacity by about 5.2 cms (450 ML/d) which is enough water for about 30 years of population growth (or water for about 375 thousand single family homes). This is possible by accessing water from Coquitlam or by developing another source. GVRD used raising the existing Seymour dam as an example of a project that would provide a similar increase in GVRD water supply capacity to that of the proposed agreement allocation. Raising the Seymour dam would cost about $100 million or an annualized equivalent of $6.34 million per year (using BC Hydro's amortization rate of 6% over 50 years). The water supply capacity of the GVRD system with the current agreement for Coquitlam water is sufficient to meet expected demand until 2030. If the GVRD allocation were increased to the proposed agreement then the raising of Seymour dam (or other additions to supply capacity) would not need to proceed until about 2060. GVRD showed that this was possible under the 2FVP option.

Under the 4FVN alternative, there is a reduction in the potential regional water supply capacity by 1.2 cms (water for 280 thousand people living in 88 thousand single-family homes) relative to the proposed agreement flows; it also raises Seymour dam about 7 years sooner (2053) than if allocated the proposed agreement flows and it would cost $40.6 million or $2.6 million per year (starting in 2053). Moving to the STP#5 alternative would reduce the potential regional water supply capacity by 2.6 cms (water for 600 thousand people living in 188 thousand single-family homes) relative to the proposed agreement flows and require raising Seymour dam about 15 years sooner (2045) than if allocated the proposed agreement flows at a cost $71 million or $4.5 million per year (starting in 2045). FFF alternative would be similar to the current situation, costing $97 million or $6.2 million per year (starting in 2032). In addition, with the Seymour example, 3.7 km of the Seymour River would be flooded upstream of the reservoir amounting to approximately 93,000 square metres of total area (plus approximately another 50,000 square metres from other tributaries). Additional background information from the GVRD on domestic water options is provided in Appendix F of this report.

Fish

To fulfill its mandate to the CC, the FTC provided the most comprehensive assessment of fish habitat that it could with available data. A key point made by the FTC is that the productivity and success of fish in the Coquitlam River, as in many other coastal streams, is dependent on the rearing stages for those salmonids that rear in the river after emergence. In the case of steelhead, parr habitats are considered limiting in the context of all other life history habitats. In alternatives where only 2 Fish Valves are used, there is insufficient baseflows, which will result in low frequency of spawning periods for both steelhead and chinook spawners; spawning flows of diminished magnitudes; and high frequency of low flow periods. Low flow periods cause fish stress due to reduced insect production and fish food supply/drift, increased competition for habitat, reduced growth and numeric abundance, decreased condition, increased predation, and increased susceptibility to temperature stress.

In 4FVN there is significant improvements for steelhead spawning and rearing habitats over current operations, but no improvements for chinook spawning. There is more habitat for steelhead life histories through optimized release (10%-48% over 2FV CA); slightly less habitat for chinook spawning and the bottleneck period indicates that parr habitat will be 5% less in August than for the rest of the year, and flows less than 2.7cms will be less frequent, due to high base flow releases during the critical period. With flows of STP#5 significant improvements for all life history periods in terms of habitat gains and availability of

spawning, rearing and short term survival flows. Rearing flows frequency much improved due to increased base flows in summer and shared benefits during high flow years beneficial to PM outcomes, due to the high probability that target flows are met. There is more habitat for all life histories (19%-69% over 2FV CA) and change from natural in frequency of events less than 2.7cms range from 0%-6% reductions from natural, due to continued releases from the dam. Bottleneck periods are well served under this scenario. With FFF, there is more habitat for all life histories (15%-70% over 2FV CA). Bar charts and data used by the FTC to prepare the assessment are included in Appendix E of this report.

Objectives by Alternatives Summary Matrix

The matrices in Table 15, Table 16, and Table 17 compare operating alternatives across these objectives for the CBWUP. These performance measures are split into two tables. Table 15 and Table 16 display the "original" performance measures that were used by the CC to conduct the broad evaluation of alternatives. Table 17 displays the "new" performance measures introduced by the FTC, GVRD and BC Hydro prior to the final CC decision meeting on October 22, 2001. These "new" performance measures were considered more sensitive and better able to distinguish between the final set of alternatives. Both sets of performance measures were referenced by the CC at the final decision meeting. An information session was provided to CC members to inform and answer any questions about these new PMs on Oct 10, 2001; as well, a complete overview and detailed description of all the PMs were sent out before the Oct 22, 2001 CC meeting.

Table 15: Objectives by Alternatives Matrix for Objectives Experiencing the *GREATEST* Change - Original PMs

Objective	Performance Measure	Units (Over 39 year model period)	(2FVC) 2 Fish Valves Current GVRD Agreement	(2FVP) Dom. Water Friendly* GVRD Proposed	(4FVN) 4 Fish Valves New 10-12%MAD Optimized	(STP#4) Sharing The Pain #4	(STP#5) Sharing The Pain #5	(CV) Conservation Flow	(FFF) Fish Friendly Flow	ESOR
Domestic Water	Annual average water allocation	cmsd (median)	7.88	*14.36**	14.31	13.85	13.84	14.02	12.43	3.21
	GVRD maximum nomination not satisfied per year	# of days (39 year median)	0	*0**	0	85	91	11	37	0
	GVRD minimum nomination not satisfied per year**	# of days (39 year median)	0	*0**	0	0	0	11	34	0
	GVRD Annualized Capital Costs for New Water Source	$ in million	$6.34	*0**	$2.60	$4.10	$4.50	$4.60	$6.20	na
Fish (River)^^	Steelhead Parr (rearing habitat)	weighted usable area in square metres	87,000	86,700	95,500	101,500	103,100	99,700	106,000	79,100
	Steelhead Spawning habitat	weighted usable area in square metres	15,900	17,000	23,700	26,500	26,900	27,100	28,000	14,500
	Salmon Spawning habitat	weighted usable area in square metres	17,000	16,800	16,800	21,100	21,100	22,500	20,500	16,000
	Invertebrate habitat	weighted usable area in square metres	93,600	93,900	105,000	114,200	116,200	112,600	124,300	85200
Hydroelectric	Annual total power production	GWh - annual total (39 year average)	125	71	60	48	48	44	42	173
	Annual total power production and GVRD payments^^^	$ in millions - annual total 39 year average	$9.40	$8.60	$8.03	$7.31	$7.22	$7.06	$6.54	$10.19

Table 16: Objectives by Alternatives Matrix for Objectives Experiencing the *GREATEST* Change - Original PMs, Driest Year Results

Objective	Performance Measure	Units (Over 39 year model period)	(2FVC) 2 Fish Valves Current GVRD Agreement	(2FVP) Dom. Water Friendly* GVRD Proposed	(4FVN) 4 Fish Valves New 10-12%MAD Optimized	(STP#4) Sharing The Pain #4	(STP#5) Sharing The Pain #5	(CV) Conservation Flow	(FFF) Fish Friendly Flow	ESOR
Driest Year Results										
Domestic Water	average water allocation	cmsd (median)	7.88	***14.36****	11.6	11.6	11.2	11.0	8.3	3.2
	GVRD *maximum* nomination not satisfied per year	# of days (driest year of 39)	0	***0****	57	317	317	71	122	0
	GVRD *minimum* nomination not satisfied per year**	# of days (driest year of 39)	0	***0****	55	74	80	68.0	122	0
Fish	Steelhead Parr (rearing habitat)	weighted usable area in square metres	64,800	63,600	84,000	86,700	88,700	81,100	102,500	42,200
Hydroelectric	Annual total power production	GWh - annual total (driest year of 39)	50.30	9.32	1.87	1.90	0.00	9.37	0.00	9.67

* Italicized domestic water values calculated by GVRD assuming 2 FV volume released to Coquitlam River using LLOs. Other PMs calculated as before assuming use of existing fish valves for releases to the river. GVRD constraints on reservoir elevations: below 142.1 m (constraint of the existing infrastructure) and below 140.5 m in very dry year.

Table 17: Objectives by Alternatives Matrix for Objectives Experiencing the *GREATEST* Change – New PMs

Objective	Performance Measure	Units (median over 39 year model period)	(2FVC) 2 Fish Valves Current GVRD Agreement	(2FVP) Dom. Water Friendly* GVRD Proposed	(4FVN) 4 Fish Valves New 10-12%MAD Optimized	(STP#4) Sharing The Pain #4	(STP#5) Sharing The Pain #5	(CV) Conservation Flow	(FFF) Fish Friendly Flow	ESOR
Domestic Water	Timing of new water source construction	# years before 2060	30	*0*	7	13	15	16	28	na
		starting year	2030	*2060*	2053	2047	2045	2044	2032	na
	Change in regional water supply capacity relative to proposed agreement	cms	-5.2	*0*	-1.2	-2.3	-2.6	-2.8	-4.9	na
		equivalent # of people	-1.2 million	*0**	-280,000	-520,000	-600,000	-640,000	-1.1 million	na
		equivalent # of single family homes	-375,000	*0**	-88,000	-163,000	-188,000	-200,000	-350,000	na
Fish (River)^^	Flow less than short term survival flow for steelhead parr (Mar-Oct)	% of days Mar-Oct that PoCo flow<2.7cms	33%	33%	15%	0%	0%	6%	0%	41%
	Flow less than short term survival flow for steelhead parr (Aug only)	% of days in Aug that PoCo flow<2.7cms	61%	68%	0%	0%	0%	0%	0%	81%
	Flow less than short term survival flow for steelhead spawners	% of days Mar-Jun that PoCo flow<2.7cms	16%	13%	0%	0%	0%	0%	0%	19%
	Flow less than short term survival flow for salmon spawners	% of days Oct1-Jan15 that PoCo flow<2.7cms	27%	25%	25%	0%	0%	3%	5%	36%
	Flow less than rearing requirement for steelhead parr (Mar-Oct)	% of days Mar-Oct that PoCo flow<5.4cms	68%	66%	48%	35%	25%	33%	4%	73%
	Flow less than rearing requirement for steelhead parr (Aug only)	% of days in Aug that PoCo flow<5.4cms	97%	97%	87%	77%	58%	81%	0%	97%

Objective	Performance Measure	Units (median over 39 year model period)	(2FVC) 2 Fish Valves Current GVRD Agreement	(2FVP) Dom. Water Friendly* GVRD Proposed	(4FVN) 4 Fish Valves New 10-12%MAD Optimized	(STP#4) Sharing The Pain #4	(STP#5) Sharing The Pain #5	(CV) Conservation Flow	(FFF) Fish Friendly Flow	ESOR
	Flow less than rearing requirement for steelhead spawners	% of days Mar-Jun that PoCo flow<5.4cms	50%	48%	14%	6%	5%	2%	0%	55%
	Flow less than rearing requirement for salmon spawners	% of days Oct1-Jan15 that PoCo flow<5.4cms	57%	56%	57%	38%	38%	12%	43%	62%
	Flow above spawning requirement for steelhead	% of days Mar-Jun that PoCo flow>12cms	11%	12%	19%	38%	38%	38%	71%	10%
	Flow above spawning requirement for salmon	% of days Oct1-Jan15 that PoCo flow>12cms	21%	21%	21%	24%	24%	30%	23%	19%
Hydroelectric	Capital Costs	$ millions - total	0.00	0.31	0.31	0.31	0.31	0.31	0.31	0

Value Trade-offs: Preferences and Uncertainties

Given the information provided in the previous section regarding technical trade-offs between operating alternatives, Consultative Committee members provided their assessment of preferred alternatives and whether or not they could support each of the six final operating alternatives. This was discussed at a final trade-off meeting (October 22, 2001) with 22 CC members in attendance.[59]

Direct Ranking Exercise

CC members first expressed their level of support (see Table 19 & 20) for each alternative using the scoring scale described in Table 18 and then were given the opportunity to elaborate on the rationale for their scores. Comments were elicited about how individuals valued impacts to objectives and what it would take to remove 'Blocks' on operating alternatives. This exercise of eliciting individual's initial evaluation of operating alternatives provided a better understanding of committee members' points of agreement and disagreement; as well as, providing a starting point for coming up with an acceptable operating plan at Coquitlam. The scoring was treated as a discussion tool and participants were free to change their views through the course of the meeting. The evaluation exercise was **not** to set up a voting process on preferred outcomes for the WUP. The results are presented below.

Table 18: Scale for Measuring Level of Support for Operating Alternatives

	Score	Level of Support	Definition
BLOCK	0	Block	You cannot support this alternative. Minimum needs are not met.
ACCEPT	1	Accept with major reservations	Far from ideal but you can live with it if necessary in view of tradeoffs between objectives.
	2	Neutral	This is acceptable although pros and cons roughly offset each other
ENDORSE	3	Endorse with minor reservations	Good balance between objectives, but you have some concerns that you would like to record.
	4	Fully endorse	You fully support this alternative. It provides a significant improvement in the balance between objectives given information available at this time.

[59] CC members and observers in attendance on October 22nd are identified in Appendix C.

Table 19: Results of Direct Evaluation Exercise

	CC Members at Final Trade-off Meeting**																						
	BC Hydro		GVRD				Prov. Water	LR	BRWR PA	BCFDF	DFO	LR	CRWS	WWSS		LR	BMN	HCSP	NFSAP	Prov. Fish	BMN	LR	LR***
2FVC	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	n/a	0	0	0	0	0	0	3
2FVP	0	0	1	3	3	1	2	1	0	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0
4FVN	3	3	3	4	4	4	3	3	3	2	1	1	1	1	0	0	0	0	0	0	0	0	0
STP4	0	0	0	0	0	1	3	3	4	4	3	2	2	2	1	1	1	1	1	1	0	0	0
STP5	0	0	0	0	0	1	3	3	4	4	4	3	3	4	4	3	3	3	3	3	3	2	0
FFF	0	0	0	0	0	0	0	1	3	4	3	4	2	2	4	3	3	3	3	3	2	3	0
Summary Comments	BC Hydro and GVRD representatives "endorsed" the 4FVN alternative and "blocked" or "accepted with major reservations" any alternative allocating more water to promote Fish PMs. They indicated that the trade-offs between fish benefits and/or domestic water and power were not justified, especially considering the significant uncertainty regarding Fish PMs.						4 CC members "endorsed" or "accepted/neutral" all alternatives between 4FVN and STP#5, with two of those members "blocking" or "accepting with major reservations the FFF flow.				4 CC members "endorsed" or were "neutral on" all alternatives greater than STP#4 and would accept 4FVN with major reservations. Reasons given were similar to those blocking 4FVN (see next box).				8 CC members "endorsed" alternatives STP#5 or FFF, while 6 members would accept with major reservations STP#4. Reasons commonly given were that there was a lack of flow for fish, especially during the critical rearing month of August. Uncertainty regarding Fish PMs was also cited, suggesting that a precautionary approach favouring fish was preferable under this uncertainty.							

* The Conservation Flow is not included in the above analysis as it was dominated bySTP#5, although the CC did evaluate it to come to this conclusion.

** All scores are rounded: BCFDF (BC Federation of Drift Fishers), BRWRPA (Buntzen Ridge Wilderness Recreation and Parks Association), BMN (Burke Mountain Naturalists), CRWS (Coquitlam River Watershed Society), DFO (Department of Fisheries and Oceans), GVRD (Greater Vancouver Regional District), HCSP (Habitat Conservation and Stewardship Program, Maple Ridge-Coquitlam), LR (Local Individual Residents), NFSAP (North Fraser Salmon Assistance Project - Coquitlam River Watershed Society), WWSS (Watershed Watch Salmon Society)

*** CC member would not support more water for GVRD.

Analysis: Pairwise Comparison of Operating Alternatives

After the direct ranking exercise, a pairwise comparison analysis, directly comparing one alternative with another, was performed (with the CC at the October 22, 2001 meeting) to help focus attention on a preferred operating alternative. Several sets of alternatives lent themselves to a pairwise comparison and the results are explained below.

- 2FVC vs. 2FVP – 2FVP was preferred or tied by all CC members except one. This effectively removed 2FVC from the group analysis.

- 2FVP vs. 4FVN – after final evaluations, 4FVN was preferred or tied by all CC members eliminating 2FVP from the analysis.
- STP5 vs. FFF – STP5 was preferred or tied by all CC members except two. On the assumption that GVRD would raise Seymour Dam with both alternatives, both members placed higher value on expected fish gains than on the time value of postponing the need to raise Seymour Dam. They noted that their rankings were not significantly different between these two alternatives, allowing the CC to focus on the more preferred STP5. (Note: Later during the meeting, both of these CC members supported the recommended operating plan which allowed for dam release up to, but no greater than STP5).

The CC was then asked to comment on their evaluation scores, focusing on 4FVN, STP#4 and STP#5 and discuss ideas for modifying alternatives and removing "blocks". Comments shown below in alphabetical order.

Table 20: Committee Member Evaluation Comments

Organization*	Comments
BC Federation of Drift Fishers	Prefers the Fish Friendly Flow, as this is the flow that is best for fish. However, recognizes competing interests and trade-offs and therefore hopes that there is some chance of consensus, possibly with one of the STP alternatives.
BC Hydro (2 members)	BC Hydro representatives only supported the 4FVN alternative, citing the uncertainty regarding fish benefits and the desire to achieve incremental improvement for fish. Uncertainty includes both fish response to increased flow levels and external factors such as substrate quality or ocean survival. In their opinion, fish benefits beyond 4FVN do not justify the trade-off with power and domestic water. Therefore, BC Hydro would need more certainty regarding fish to warrant providing more water down the river than 4FVN. Finally, BC Hydro cited value in consensus and in this light they expressed a willingness to explore options that modify existing alternatives with monitoring and flushing flows.
Buntzen Ridge Wilderness Recreation and Parks Association	Prefers one of the alternatives that has a chance at consensus: 4FVN, STP4 or STP5. The evaluation needs to be conducted within the context of a 100 year old dam and altered ecosystem, and in this sense realism is required. BRWRPA recognizes the value of domestic water and of hydropower, and is opposed to the increased flooding of areas that would result with the raising of dams in other watersheds (Capilano, Seymour).
Burke Mountain Naturalists (2 CC members)	Prefers STP5. Pleased by the flexibility that has developed over the past 2 years in the CC. One member believes the question comes down to whether to spend money sooner or later on domestic water development, preference is to spend the money sooner than push it off on future generations. Cited concerns with all the alternatives given the lack of water during the summer, increasing in probability during dry years, which is unacceptable. The other member was concerned that 4FVN does not allocate enough water during the winter and concerned with allocating water to the GVRD now although they do not currently require it. Also cited concerns related to GVRD assumptions of population growth. Supplementary studies are needed during the next 10 years and ocean survival must be accounted for.
Coquitlam River Watershed Society	The STPs and FFF are expensive but believes that STP5 is probably the best alternative. Believes that 4FVN does not offer enough benefits to the environment. Would like to believe the alternatives can be mixed.
Department of Fisheries and Oceans	Believes that STP5 is best alternative. DFO representative's evaluations were conducted in the interest of reaching a consensus. Willing to consider STP4 if it contributes to consensus. Suggests experimenting may address some of the possible deficiencies with identified alternatives.

Organization*	Comments
Greater Vancouver Regional District (4 CC members)	Prefers 4FVN. One member stressed that the best alternative is the one that balances the costs to society not simply the alternative that is best option for fish, domestic water or hydropower. Also cited fact that this is no longer a natural system, which needs to be recognized in evaluation. All representatives believe that 4FV offers a significant improvement for fish, which should be monitored and modified as required and then re-evaluated. GVRD is looking for gains for fish and domestic water, noting that there is still a little too much uncertainty related to the fish information. Observing positive results associated with increased flows would remove some of the uncertainty. They did recognize that there is some merit to STP4 and 5 with monitoring. GVRD representatives indicated that they did not have a mandate from their board to go beyond the 4FVN flow regime until their board is presented with a sufficiently strong case for supplying additional fish flows.
Habitat Conservation and Stewardship Program, Maple Ridge-Coquitlam	Prefers one of the STP alternatives. Did not assign a rating of 4 to any alternative because of uncertainty related to fish outcomes. Suggested that we cannot know the effects of greater flows unless it is tested. Disappointed that no one appears willing to share. Noted that there is little difference between STP4 and STP5 except during the summer. Suggests monitoring to better adjust the option in the future. Feels if the group approves 4FVN, shifting to greater flows will never happen.
Local Individual Residents (5 CC members with comments listed separately)	Favours 4FVN or one or the STP alternatives after considering damage, societal costs, and benefits across all objectives. Discouraged the extreme alternatives of FFF and 2FV as damaging to important objectives.
	Prefers FFF. Concerned with all alternatives. Not prepared to 'write off' the river. Concerned there is a backroom deal being made between BC Hydro and GVRD, therefore favours the alternative that offers the most water down the river.
	Prefers current operations--2FVC. This member indicated that there are no fixed 'blocks'. Very concerned over the assumption with all the alternatives (except 2FVC) that allocates more water for the GVRD without questioning the growth management strategy for the region. Preference is for not allocating more to the GVRD as the population targets are unreasonable. Although favouring 2FVC, would prefer flows that show gains to the river (fish) and to power.
	Favours FFF but doubts it is practical. Does not see a significant difference between STP5 and FFF. Does not believe the GVRD needs as much water as they say they do and in all the STP alternatives the GVRD still wins in the summer months.
	Prefers STP5 or FFF. Technological advances will affect the future and this should be kept in mind. Eco-tourism, sport fishing, etc., will have incremental impacts. Cautioned the CC on making permanent decisions based on information that will be dated in a few years.
Ministry of Water, Land, and Air Protection (formerly MELP) (Fish, Wildlife and Habitat Protection)	Prefers STP5 and FFF. Based on available information, could give up FFF. Seeing little movement in people's opinions. Suggests that the CC consider selecting 2 options and trying adaptive management over the next decade. Until this is complete, unlicensed water should remain on the table. Some certainty should be given to the GVRD but should not exceed a specified amount.
North Fraser Salmon Assistance Project - Coquitlam River Watershed Society	Prefers STP5 and FFF. Difference between STP5 and FFF requires more clarification. STP5 with flushing flows is preferred.

Organization*	Comments
Watershed Watch Salmon Society (2 CC members)	Prefers STP5 and FFF. Rated STP4 low because of significant bottlenecks for fish rearing in summer months. These may not be too severe but require monitoring. Agrees with the arguments related to uncertainty, but suggests that biological issues always have uncertainty. The uncertainty must be worked through monitoring. Increasing flows is likely to improve conditions for fish. Indicated that the CC and working groups have spent at least 100 hours in STP meetings, yet a large portion of the group is now distancing themselves from the STP options. STP *was* the result of tweaking efforts. Flows could be reduced in the future depending on monitoring results.

Table 21: Observers Comments

Organization*	Comments
City of Coquitlam	Commented that all issues and recommendations would be taken back to City Council for discussion.
Katzie First Nation	Did not comment on alternatives but did mention the issue of continued funding after the decision and the problems faced by those involved in the Alouette and Stave).
Provincial Ministry (MSRM - Water Management Branch)	Prefers either 4FVN, STP4, STP5 as these are a good balance. FFF is the wish list alternative and too extreme.

*There is one CC member per organization unless otherwise indicated.

Reaching Consensus

Many members stressed their desire to find common ground and a consensus alternative. The primary reason given for the gap in not reaching consensus was the uncertainty surrounding fish performance measures.

GVRD and BC Hydro representatives indicated that the trade-offs between fish and domestic water and/or power were, in their opinions, not justified past 4FVN-- especially considering the high level of uncertainty. Both GVRD and BC Hydro place significant value on certainty for planning and operation purposes. The GVRD and BC Hydro representatives indicated that they would require significant demonstrable benefits in actual fish numbers (not necessarily adult returns, and taking into consideration external factors like ocean survival and siltation) to justify financial costs associated with water releases down the Coquitlam River beyond the 4FVN alternative. Neither party specifically defined what is meant by “significant” or “demonstrable” fish benefits.

Many CC members supporting STP5 also cited uncertainty, suggesting that in such an environment flows favouring fish as a precaution were preferred. They recognized that, at present, the FTC cannot supply a better case for fish benefits because of uncertainty. Uncertainty regarding fish benefits and preferred fish flows would be significantly reduced through completion of the IFN study (2 years) and through long-term field-testing (12 years). CC members agreed that reducing the uncertainty would allow for a more informed decision.

Therefore, the CC agreed to a consensus alternative based on field testing and monitoring (referred to as an adaptive management program) that confines the range of future alternatives to within the 4FVN and STP5 alternatives and that all the water between these two alternatives would be "on the table" at the end of the review period, to be completed within 15 years[60] (starting from October 2001).

Although consensus was reached regarding future BC Hydro operations, there are clear value-based differences within the CC regarding trade-offs between objectives within the range of alternatives being considered.

Support for Recommendations

The CC reached consensus on the operating plan with one member accepting the group's decision, but with strong reservations with it[61]. It was also agreed that CC members not present at the meeting would have the option of signing off on the final CC Report.

[60] This included an assumed 2 to 3 year time period for Provincial Comptroller of Water Rights approval, and to make the necessary infrastructure changes to one of the low level outlets; leaving 12 years to carry out flow trials and monitoring. This is also coincided with the GVRD's long term planning requirements to have a WUP review within 15 years.

[61] One area resident expressed strong reservations with providing the GVRD with more water, given their growth management strategy and their forecasted population targets which were considered unreasonably high. However, this resident did agree to the consensus decision which had more water in the river for the benefit of fish.

6.3 Flushing Flow Alternatives Trade-offs Analysis

Technical Trade-off Analysis

Trade-off analysis regarding flushing flow alternatives took place at two distinct periods during the CC process as alternatives were developed and brought forward to the CC. As described in Section 5.3, the FTC initially recommended 200 cms flushing flows to maximize fish productivity on the Coquitlam River. Based on their initial assessment, fish benefits on the Coquitlam River were expected to be "significant" with a 200 cms flushing flow and "minimal" by comparison without one. Significant was then defined as an increase between 40%-50% for rearing and more than 100% for spawning.

Numerous costs and downstream impacts were identified for a 200cms flushing flow including a need to modify the dam spillway, dyke improvements downstream, cleanup, erosion protection among other issues. In total, it was calculated that approximately $18.0 million was needed in capital cost modifications and an additional $850,000 in per event costs were needed. Annualized, this alternative was estimated to cost $1.4 million. As indicated in Section 5.2, a full suite of flushing flow, or maintenance flow, alternatives was developed by the FTC and evaluated by the CC. As part of the package of flushing flow alternatives, the FTC recommended an "interim flushing flow" be used until a 200 cms flushing flow can be safely achieved.

The technical trade-off information for the range of alternatives is provided in Table 22 and the ultimate FTC interim recommendation for an opportunistic flushing flow *(also referred to as substrate cleaning flows or maintenance flows*) is provided in Table 23. A detailed flushing flow cost benefit analysis is available from BC Hydro for the 200cms Flushing Flow.[62]

[62] Study Brief: Coquitlam River Flushing Flow Overview - Benefits, Costs, Risks and Losses from a 200cms Flushing Flow every 3-5 years. *Prepared by:* EcoPlan International, Inc./Maria Harris based on input from the Coquitlam-Buntzen Water Use Plan, BC Hydro, FTC, GVRD, knowledgeable outside experts and consultants. *Prepared for:* The Coquitlam-Buntzen Water Use Plan Consultative Committee. May 2001. Also: Study Brief Addendum: Clarification of Costs & Assumptions 200 cms Flushing flows (May 23, 2001), compiled by Michael Harstone, BC Hydro for CBWUP CC.

Table 22: Preliminary Benefits/Cost and Risks of Various Flushing Flows

Flow	Description of Release from Dam [1]			Substrate Information Associated with each Flow			Benefits		Costs			
	Magnitude	Duration [2]	Frequency	Physical Objective of the Release	Effectiveness for Substrate Maintenance	Implications for Downstream Reaches	Habit Improvement	Relative Ranking of Flow Alternatives by the FTC	Capital Costs Associated with WUP	WUP Annualized Costs (based on an amortized 6% rate over 50 years)		Other Non-WUP Costs (d/s costs)
	(m^3/s)	(days)	(years)				(m^3)		($)	**Low [5] ($)**	**High [5] ($)**	($)
1	50	5 to 10	every year or second year	entrain material finer than 8 mm (granules) from the bed surface and upper surface layer and transport them to Reach 1. Coarse bed material would remain immobile	Expected to clean surface and upper 5 to 10 cm of substrate. May be uneven cleaning along Reaches 3 and 2, with deposition along the lower part of Reach 2	It is anticipated that up to 5,000 m^3 of sand and granules would be transported to Reaches 1 and 0 and deposited there.	Too much uncertainty to meaningfully quantify, but better than no cleaning flow	**4** Productive capacity of substrate enhanced only marginally	**$0**	**$170,000**	**$610,000**	$80,000
2a	50	5 to 10	every year or second year	release 50 m^3/s from Coquitlam Dam during maximum flows on Or Creek to provide peak flow greater than 100 m^3/s. This would just mobilize the upper substrate layer, entrain sand and granules and transport them to Reaches 1and 0. Releases from dam would continue after peak flow from Or Creek for transport of sediment	Expected to clean surface layer of fine sediment and remove sand and granules up to depth of 20 to 30 cm. Cleaning expected to be patchy or uneven because of deposition of sediment from Or Creek.	It is anticipated that up to 5,000 m^3 of sand and granules would be transported to Reaches 1 and 0 and deposited there.	Too much uncertainty to meaningfully quantify; however, this flow is expected to be better than Flow 1	**3** Productive capacity expected to increase; Or Creek sediment contributions may limit effectiveness of overall flushing	**$0**	**$170,000**	**$610,000**	$80,000+
2b	110	at least 1	every second year	Just mobilize the upper substrate layer, entrain sand and granules and transport them to Reaches 1 and 0	Expected to clean surface layer of fine sediment and remove sand and granules to a depth of about 20 to 30 cm.	It is anticipated that from 5,000 to 10,000 m^3 of sand and granules would be transported to Reaches 1 and 0. Minor bank erosion along Reaches 2 and 1.	Too much uncertainty to meaningfully quantify; however, this flow is expected to be better than Flow 2a since flows from Or Creek will be sediment laden	**2** Productive capacity expected to increase	**$7,400,000 to $10,000,000**	**$600,000**	**$760,000**	$450,000+
3	200	0.33 to 1	every two to five years	mobilize the upper layer of the substrate, cause general bed transport and entrain fine sediment stored in the lower substrate layers and transport it to Reaches 1 and 0.	Expected to clean surface layer of fine sediment and remove sand and granules to depth of about 30 to 50 cm. Gravel and cobbles will also be mobile and re-arrangement of bars and bed expected.	It is anticipated that 10,000 m^3 or more of sand and granules would be transported to Reaches 1 and 0 with some grave. Cobbles would be deposited on the large bar above the Lougheed Highway. Bank erosion expected along Reaches 3, 2 and 1. Erosion of alders along the lower banks of Reaches 3, 2 and 1.	Significant Habitat Gains as follows: **Approx. 50% Increase to Rearing Habitat** **Approx. 100% Increase to Spawning Habitat** (for other fish benefits refer to the May 14 Briefing Paper)	**1** Productive capacity of substrate expected to be maximized (see flushing flow brief)	**$10,000,000**	**$710,000**	**$860,000**	$8,200,000+

Table 23: Benefit/Cost and Risks of FTC's Recommended Opportunistic (substrate cleaning) Flushing Flow

FTC's Recommended Interim Substrate Cleaning Flow (as a part of a monitoring plan)												
	Magnitude	Duration 2	Frequency	Physical Objective of the Release	Effectiveness for Substrate Maintenance	Implications for Downstream Reaches	Habit Improvement	Relative Ranking of Flow Alternatives by the FTC	Capital Costs Associated with WUP	WUP Annualized Costs Low	WUP Annualized Costs High	Other Non-WUP Costs (d/s costs)
	30 - 50 from LLOs	3 to 5 or more depending on Or Creek	opportunistically every year	release 30-50 m^3/s from Coquitlam Dam during maximum flows on Or Creek to provide peak flows targetted at approximately 70-100 m^3/s. This would just mobilize the upper substrate layer, entrain sand and granules and transport them to Reaches 1and 0. Monitoring is essential to determine the effectiveness on the substrate and improvement to fish habitat.	Expected to clean surface layer of fine sediment and remove sand and granules up to depth of 20 to 30 cm. Cleaning expected to be patchy or uneven because of deposition of sediment from Or Creek.	It is anticipated that up to 5,000 m^3 of sand and granules would be transported to Reaches 1 and 0 and deposited there.	Too much uncertainty to meaningfully quantify; however, this flow is expected to be better than Flow 1	Relative ranking close to Flow 2a	**$0**	**$183,000**	**$330,000**	$80,000+

General Notes and Assumptions:

1. Flow magnitudes, durations and frequencies are calculated but we recommend monitoring to better establish these values. Timing of the releases has not been determined but the substrate maintenance flows will be most effective if released during periodstions and frequenci
2. Duration refers only to peak flows and does not include ramping to the peak and from the peak to base flows.
3. Unless otherwise noted, assumptions and methods for cost estimates are the same as those used for the May 14th Study Brief and the May 23rd Study Brief Addendum
4. Assumed no negative impacts and/or costs (other than potential dredging costs) by IR2 for Flows 1, 2A & 2B
5. High/Low WUP Annualized Costs provide a range of values depending on the duration and frequency of flow events
6. Did not include costs associated with damages to Swoboda channel, the fish hatchery, or impacts/erosion to pvt residences near Hockaday and industrial lands by Scott Creek or other impacted downstream areas in WUP costs
7. Did not include any costs for additional technical or engineering studies, however some costs would likely have to be included for any flows above 50 cms

Value Trade-offs, Uncertainty and Reaching Consensus

After a review of the technical trade-offs provided above, the Working Group suggested that, because of the high degree of uncertainty associated with trying to quantify the benefits of an opportunistic flushing flow, it should be considered separate and be conducted on an opportunistic basis as recommended by the FTC. Then incorporation of flushing flows would be considered after an alternative was selected. The recommended opportunistic flushing flow also did not require any additional infrastructure upgrades.

The FTC and Working Group recommendations along with the technical trade-off information were brought forward for discussion at the final decision meeting on October 22, 2001. **The opportunistic interim flushing flow was considered separately from flow alternatives on the recommendation of the FTC and this was accepted by the CC.** There was no agreement regarding the implementation of a 200cms flushing flow in the future, there was only agreement a 200cms flushing flow would be re-evaluated once the down stream issues were resolved. The opportunistic flushing flow recommendation is summarized below:

- Flushing flow (maintenance flow) released from existing low level outlets (LLO's) in the dam during high inflows from Or Creek.
- This flushing flow release is interpreted as an event when possible between October and December.
- It is a targeted release from the LLOs between 30-50 cms basically keeping the LLOs fully open when there is a flow from Or Creek in the forecasted range of 30 cms or more for 3 days or more.
- Dam releases would be of 3-5 days duration or more, depending on Or Creek. [63]

Flushing Flows and Monitoring

The CC agreed to evaluate the FTC's interim flushing flow as a one time experiment in conjunction with a monitoring plan and continued investigation of other possible options for substrate maintenance as an operating alternative for this WUP. After reviewing the proposed adaptive management program, the FTC recommended that opportunistic flushing flows be postponed until after the flow trials had been conducted so as to not confound the results. There may be an opportunity to carryout FFs if the flow trials are completed earlier than expected (i.e. if preliminary flow trials show conclusive results and/or their duration reduced), or if there is a weak correlation between increased flows and habitat improvements.

[63] Note that for the preferred flow (2a) there is a high probability (according to historical records) that Or Creek flows could not be coordinated – in terms of duration and magnitude- to give the desired flows in Reach 2. (Reference: The probability of timing releases to achieve sustained high flows from LLO openings with high tributary inflow from Or Creek was briefly addressed by BC Hydro project team members in a discussion paper provided to the CBWUP CC on the July 9, 2001).

6.4 Recommended Operating Plan

The recommended operating package plan agreed to by the CC members is summarized in Table 24:

Table 24: Summary of CBWUP Operating Recommendations[64]

Recommendations	Comments
Instream Flow Needs (IFN) Assessment	♦ Complete the IFN study (that began with this WUP) as soon as possible (anticipated to be within the next 2 years) and this information is to be used to finalize the second test flow (STP5) parameters
Change one low level (LLO) outlets at Coquitlam Dam to permit 4FVN & STP5 flows	♦ Both flow regimes (4FVN & STP5) will require the same infrastructure change, allowing regulated and variable flows through one of the LLOs (expected to be complete within 2-3 years)
Adaptive Management Program Implement and monitor 2 flow trials: ♦ Test flow #1: 4FVN and ♦ Test flow #2: STP5 or less	♦ Part of adaptive management program to test fish benefits from increased flows to Coquitlam River ♦ 10-12 years to better understand benefits to fish from higher dam flow releases to the Coq. River to inform review ♦ Test flow #1 will be tested first ♦ Test flow #2 to be selected after due consideration of IFN results ♦ Both test flows will be complete within 15 years of Oct 2001 ♦ Develop a monitoring plan with clear design measures (by the FTC)
Recommend that a Monitoring Committee be formed	♦ For duration of review period to oversee implementation of the adaptive management program & to ensure that there is sufficient information in place by the end of the review period to determine the fish benefits of both test flows & to enable a better understanding of trade-offs between fish, domestic water & power generation. ♦ Agreed that results from the committee be made available to the community through an information session to be held annually.
After monitoring, recommend and implement "final" flow alternative between 4FVN & STP5	♦ To follow 10-12 year flow testing program ♦ Agreed that future flow regimes to the river will not be less than 4FVN, will not exceed STP5, and that all water allocations within the 4FVN & STP#5 will be on the table for review at that time. ♦ To be done within 15 years or less from October 22, 2001
Implement and monitor opportunistic flushing flow impacts as recommended by FTC and subject to monitoring program design[65]	♦ To be incorporated into adaptive management program design ♦ In coordination with FTC, BC Hydro will look into interim testing of flushing flows before Comptroller approval. ♦ Fish and other impacts to be monitored ♦ Incorporate continued investigation of other possible options for substrate maintenance.
Operationalizing target flow rates for the flow trials	♦ Target flow releases from Coquitlam dam would be modified once per week and only if the release is outside of +/- 10% range of the target except for July and September when –10% becomes a hard constraint.

[64] "4FVN" represents approximately a doubling of the present fish flows to the river, an increase in flows to GVRD, and a reduction in flows to the power generating station. "STP5" represents higher flows to the river and lower flows to GVRD and power than "4FVN". A more detailed explanation of these operating alternatives is found in Chapter 5 ("Operating Alternatives").

[65] The FTC has subsequently recommended that opportunistic flushing flows (OFFs) be postponed until after the review period and flow trials have been conducted so as to not confound the results. There may be an opportunity to carryout OFFs if the flow trials are completed earlier than expected (i.e. if preliminary flow trials show conclusive results and/or their duration reduced), or if there is a weak correlation between increased flows and habitat improvements.

Finally, there were a number of recommendations and/or acknowledgements, which were made during the course of this WUP which were accepted by the CC and are summarized below:

Operations:

- BC Hydro system emergency situations would take precedence over the Water Use Plan alternatives. Historically these events are very rare and of a short-term nature (normally hours). Emergencies include those required to address dam safety, actual or potential loss of power supply to customers, dam breach or potential dam breach, extreme flood flows, fire or explosion, environmental incidents, major equipment failure, or threat to employee or public safety.
- Ramping rates at Buntzen #1 and #2—no restrictions apply
- Diversion tunnel between Coquitlam and Buntzen reservoirs—no restrictions apply
- Ramping rates at Coquitlam dam—these are considered a *work-in-progress* and no ramping rates were agreed to. This item is to be finalized as a part of the monitoring program. However, the CC agreed to target ramping rates based on DFO's suggested maximum water level changes in the river of 5 centimeters per hour. In the interim (until an accurate stage/flow relationship is established) the following three-step ramping rate protocol is proposed as a starting point:
    - Above 7.1cms, ramp down at 9.5cms/hour
    - Below 7.1cms, ramp down at 0.71cms per every half hour
    - Below 2.8cms, ramp down at 0.42cms per every half hour
    - Ramping up rates are currently at 9.5cms/hour
- The CC recommended the following reservoir target elevations for the Buntzen Reservoir[66]:
    - Restrict minimal operating level to 122.2m between 15 May to 1 October during daylight hours
    - At other times the operating range is 120.09-122.9 m[67]
    - When emergency drawdowns below this point are required, the Buntzen Reservoir Warden will be contacted. A procedure is being developed for employing additional staff and placing additional signage to advise the public of the increased hazard when such drawdowns do occur.
- The operational and maintenance requirements at Grant's Tomb (a tripartite agreement between DFO, BC Hydro, and GVRD) were not addressed within this WUP. However, the allocation of water (up to 9 cubic feet per second) was included in the operating alternatives.

[66] Operating levels specified in the plan were implemented by BC Hydro in June 2001 prior to final CC approval of the plan in January 2002.
[67] Although the operating range is not being changed, the way in which BC Hydro operates the reservoir during part of the year is being changed. Reservoir elevation below 120.09 m can cause vortexing at the intake; above 122.9 m creates an unacceptable risk of spilling.

Other issues and recommendations (outside the scope of this Water Use Plan):

- First Nations access to the Coquitlam Reservoir is best addressed through direct consultation between First Nations and GVRD.
- The development of an Archeological Management Plan between BC Hydro, First Nations, and GVRD was acknowledged to be First Nations' preferred approach to address archaeological issues.
- The CC supported the idea for the Kwikwetlem First Nations' desire to restore sockeye to the Coquitlam Reservoir[68]. However, this issue was considered beyond the scope of this water use plan, but was to be addressed through the Bridge Coastal Restoration program[69]. It was recommended by the CC that if efforts are undertaken to return sockeye to the Coquitlam reservoir, that this should trigger the re-opening of the WUP. The GVRD indicated that they would support the return of sockeye assuming it would not significantly impair drinking water quality.
- Tower Creek (located just upstream of the Coquitlam Dam) is now being wholly diverted into the Coquitlam River. Committee members expressed a concern that the creek is being diverted directly into the river only when it is turbid. GVRD representatives indicated that this occurs only during the winter months and agreed to look into the issue, but pointed out that this is a larger issue that other agencies need to be involved in and that needs to be resolved outside this WUP.

[68] This WUP dealt with access issues for all salmonids from the mouth of the Coquitlam River to the dam.
[69] A feasibility study was conducted on the Coquitlam River system and concluded that it is not a strong candidate for salmon passage initiatives because of technical uncertainties around smolt screening during out migration.

7 MONITORING PLANS

7.1 Rationale and Objectives for the Coquitlam WUP Monitoring Program

The monitoring program for the Coquitlam WUP was recommended to ensure that there is sufficient information in place by the end of the review period to determine the fisheries benefits of two test flows and to enable a better understanding of trade-offs between fisheries, domestic water and power generation. Understanding the benefits to fish between the two test flows will assist a future review committee to make more informed trade-offs when determining a river flow regime. The two test flow regimes would be conducted within bookends established by the "Four Fish Valve New" (4FVN) and "Share the Pain 5" (STP5) alternatives: the first test flow will be 4FVN, while the second flow will be set at STP5 or less, depending on the results of the Instream Flow Needs (IFN) study.

On October 22, 2001, GVRD and BC Hydro representatives indicated that they would require significant demonstrable benefits in actual fish numbers to justify the financial costs associated with river releases for fish. Therefore the monitoring program needs to address the following questions during and after the review period:

(a) Have the operating decisions developed in the Coquitlam-Buntzen WUP helped to achieve the objectives defined in the Coquitlam-Buntzen WUP process? and

(b) What are the expected benefits associated with changes to operations in the future?

Figure 10 describes the application of the Coquitlam-Buntzen WUP Monitoring Program results to address the questions raised above.

7.2 Background and Supporting Documents

On October 22, 2001, the Coquitlam-Buntzen Water Use Plan Consultative Committee (Coquitlam-Buntzen WUP CC) recommended an adaptive management program for the system that would see two flow regimes evaluated over a 12 year period. The CC directed the fish technical committee (FTC) to develop a monitoring program for the system that would describe the proposed costs, schedule, and key monitoring questions, and expected outcomes, described herein.

This document describes only those components of the program monitoring fish populations, fish habitat and fish food resources responses to operational changes. A detailed summary of the monitoring program is included in Appendix L and this section only highlights the main components of the plan, and the discussions and feedback from the CC. Additional comments and information about the monitoring program is included in the minutes from the last CC meeting held on March 11, 2002 (see Appendix K).

This document refers to several supporting documents developed for the Coquitlam-Buntzen WUP CC. Refer to the following documents for more information about the Water Use Plan and the Monitoring Program:

COQ WUP FTC, 2001. *Draft* Coquitlam-Buntzen Water Use Plan monitoring committee terms of reference. Prepared for COQ WUP Project (BC Hydro), Burnaby, BC.

WUP Interagency Committee, 2001. *Draft* WUP monitoring guidelines and summary of principles. Prepared for BC Hydro WUP Program, Burnaby, BC.

COQ WUP WTC, 2001. Environment monitoring program (wildlife and recreation). Prepared for COQ WUP Project (BC Hydro), Burnaby, BC.

7.3 Scope of the Coquitlam-Buntzen WUP Monitoring Program

Monitoring Program Focus

The monitoring program recommended by the FTC primarily focused on the Coquitlam River, rather than assessing the degree to which operations affected Buntzen and Coquitlam reservoirs, and Indian Arm. This reflected both CC priorities as well as recognizing the value of information that would be gained and the affects that dam operations may have on these other areas.

Study Area

The Lower Coquitlam River (from the Coquitlam Dam release facility, to the confluence with the Fraser River) will be the main focus of the monitoring program. Specific regions within the study area will be identified for each monitoring component. The results from many of the components monitored for the study area will be compared with the results from a control stream, which is also part of the monitoring program.

Terms of Flow Agreement

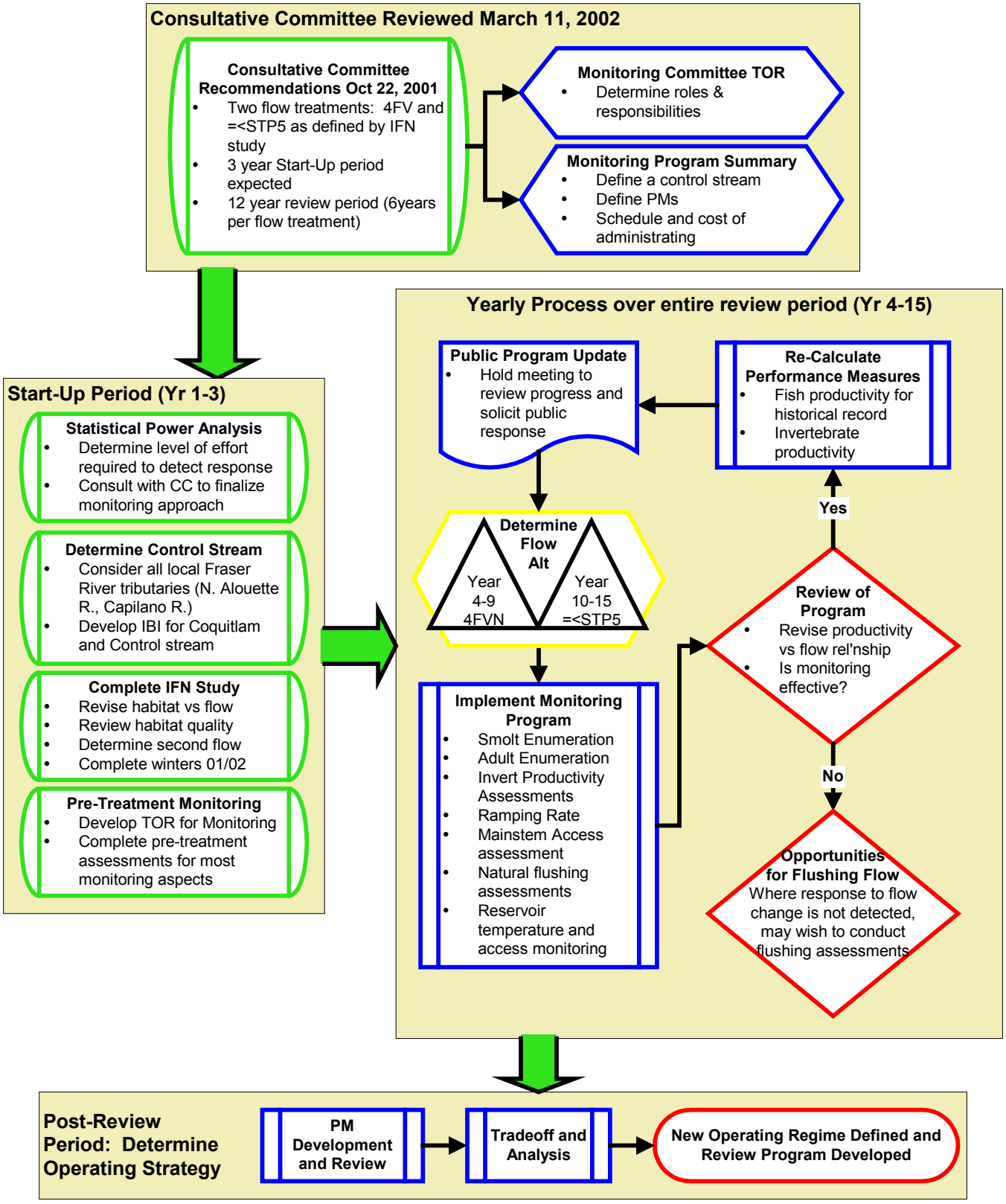
The Coquitlam-Buntzen WUP CC agreed to an adaptive management program consisting of two flow treatments, each of which will require 6 years to complete.

Treatment A: Four Fish Valves "New": Treatment A will provide twice the annual average volume of flow available presently, but redistributed each month to optimize for salmon and trout spawning and rearing requirements.

Treatment B: Share the Pain: As illustrated in Figure 10, the second test flow will be defined by the results of the Instream Flow Needs Assessment (IFN) study, but will not exceed the "Share the Pain 5" flow regime.

Flushing Flows Assessments: Flushing flows are defined for the Coquitlam-Buntzen WUP as those opportunistic releases that provide peak flows to Reaches 2 and 3 of between 70 and 100cms, for three to five consecutive days. Such flows, if provided naturally over the review period, will be assessed as per NHC (2001), where substrate size distribution analysis will describe the level of sediment removal achieved with each flushing flow.

Figure 10: Role of the monitoring program in water use decision making.



Treatment Schedule and Decision Criteria

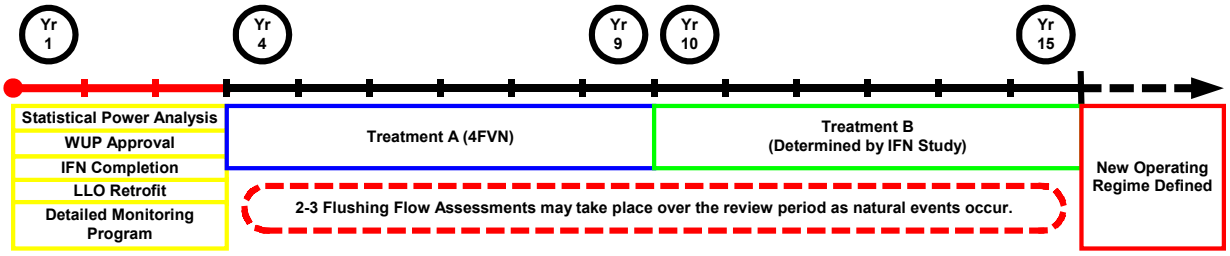
Figure 11 below illustrates the expected treatment schedule.

Statistical Power Analysis: Power analysis is a statistical method widely used to assess the ability of monitoring methods to detect a treatment response. It is currently being applied to the relevant components of this plan (as agreed to at the last CC meeting held on March 11, 2002) discussed in Section 7.5, the consultative committee may be reconvened if the power analysis suggests that changes to the monitoring program and/or the treatment schedule outside of the scope set by the consultative committee are required to detect productivity changes between respective flow treatments. Given the level of knowledge currently available to the COQ WUP FTC, the following monitoring program is summarized under the assumption that the methods proposed will be effective in detecting changes in productivity for the treatment schedule proposed.

Treatment Period Duration: The two flow treatments will be tested for a period of 6years, based on the expected return period of steelhead (4-6 years) and salmon species (3-5 years).

Flushing Flow Experiment: The FTC concluded that since we cannot control the provision of natural events, the monitoring plan should provide for assessment of natural events which meet the criteria of a flushing flow as summarized in section 5.2.

Figure 11: Schedule for flow trial implementation.



Use of a Control Stream

Biological responses to the two flow treatments will be difficult to interpret unless efforts are taken to reduce the uncertainty associated with factors outside of BC Hydro's control. These factors include ocean survival (temperature factors and fish management), hatchery enhancement programs, habitat enhancements and urban drainage contributions.

To address these concerns, the FTC strongly supports the inclusion of a control stream in the program design. The control stream will be monitored for those components of the program where additional information needs are anticipated, as described in this document. See Appendix L for further rationale and costs associated with the inclusion of a control stream for invertebrate and fish productivity indices on the Coquitlam River.

Screening of WUP Monitoring Requests

The FTC underwent a process to screen components of the monitoring program to ensure that the information collected (and their results) would meet the objectives outlined by the CC and aid future decision making. The initial components considered for the monitoring program consisted of 17 study items which are summarized in Table 26. These 17 monitoring studies were reduced[70] down to 8 components (see the summary in Table 27), which comprised the monitoring program that the FTC recommended to the CC. The CC reviewed the program at their last meeting held on March 11, 2002 (their comments are summarized in Section 7.5). For further information on the screening process refer to Appendix L.

[70] The FTC screening process reviewed: (a) the data gap being addressed (competing hypotheses), (b) the value of information (or amount of learning) that the study would produce, (c) duration of the study to produce meaningful results (as compared to the flow trial durations), (d) timeframe that the information would be used, and (e) the study costs.

Table 26: Initial List of Monitoring Studies Considered by the FTC

Note that study costs do not include lost power revenues, and that some costs were not reviewed due to the low issue priority.

Study Area	Title	Description	Competing Hypotheses (Likelihood Hypothesis is true, L/M/H)	Amt of learning expected through monitor-ing (L/M/H)	Est. Dur-ation of Study	State the time frame in which this information will be used: Before/ During/ After the next WUP	Est. Cost ($000's)	Impor-tance of issue ad-dressed (L/M/H)	Rat-ing of Study (L/M/H)
Indian Arm (Buntzen Outfall)	*Nearshore Community Impacts Proximal to the Buntzen*	Determine the impact (if any) of changing freshwater releases from LB1/LB2 on the nearshore marine community in Indian Arm.	H0: Fluctuations in freshwater releases do not change the productivity of the nearshore community (High) H1: Fluctuations in freshwater releases change the productivity of the nearshore community (Low)	Low	10-12 yrs	Before	N/A	Low	
	Chinook Fisheries Impacts due to Outfall Attraction Flows	Determine the extent to which LB1/LB2 releases contribute to the attraction of returning wild Indian River chinook salmon and to overfishing in the tailrace area.	H0: Freshwater releases do not attract wildstock chinook salmon returning to the Indian River, limiting subsequent Indian River spawning success (High). H1: Attraction flows from LB1/LB2 contribute to the decline of wild chinook returns to the Indian River (Low).	Low	10-12 yrs	Before	N/A	Low	
	Stock Partitioning due to Outfall Attraction Flows	Determine the extent to which LB1/LB2 attraction flows contribute to the partitioning of salmonids returning to Coquitlam River.	H0: Freshwater releases do not attract salmonids returning to the Coquitlam River, limiting subsequent Coquitlam River spawning success (High). H1: Attraction flows from LB1/LB2 contribute to the decline of salmonid returns to the Coquitlam River (Low).	Low	10-12 yrs	Before	N/A	Low	
	Water Quality Impacts due to Changing Outfall Flows	Determine the impact of changing freshwater releases from LB1/LB2 on water quality in the Indian Arm estuary for rearing salmonids.	H0: LB1/LB2 operations do not contribute to water quality impacts in the Indian Arm (High). H1: LB1/LB2 operations contribute to water quality impacts in the Indian Arm (Low).	Low	12 + yrs	During	$ 5	Medium	
Coquitlam Reservoir	*Access to Tributaries*	Within the range of operations, determine the extent of habitat loss reservoir fluctuations create by limiting access to tributaries (if any exist).	H0: Salmonid access to tributaries is unfettered by operations in the drawdown zone (Low-Medium). H1: Operations in the drawdown zone limit access to tributaries and disrupt natural habitat use in tributaries for adfluvial salmonids (Medium-High).	High	2 yrs[1]	Before	$ 25	High	
	Effective Littoral Zone (ELZ)	Complete development of ELZ model through integration of findings/conclusions from other monitoring programs and site	H0: The productivity of the littoral zone is unaffected by reservoir management (Low). H1: The productivity of the littoral zone is increased through stable reservoir management (High).	Low	2 yrs[1]	Before	$ 26	Low	
	Fish Production Index	Determine the cumulative impacts of reservoir operations on the productivity of fish in the Coquitlam Reservoir.	H0: Reservoir operations do not affect fish productivity (Low). H1: Fish productivity is adversely affected by reservoir operations according to the extent and frequency of reservoir fluctuations (High).	Low	12+ yrs	During	>400	High	
Coqu	*Ramping Rates*	Through assessment of impacts of changing dam operations, determine rates of flow change for the Coquitlam River that reduce fish mortality.	H0: Changes in release flows from the dam do not lead to fish mortality and stranding (Low). H1: Fish mortality and stranding are a function of the rate of change of operations, channel morphology, and species life histories (High).	High	2 yrs[1]	Before	$ 15	High	
	Habitat Suitability Criteria	Refine available HSI data by collecting in-situ fish habitat use data at varying flow, mesohabitat and seasonal conditions.	H0: Changes in habitat availability (through changes in flow) do not affect fish habitat use criteria for the Coquitlam River (Medium). H1: Habitat use changes with availability of habitats provided at different flows, and at different times of the year (Medium).	High	2 yrs[1]	Before	$ 45	Medium	
	Instream Flow Needs Assessment	Complete the data requirements outlined in the IFN Assessment TOR, to refine the flow regime for Treatment B (STP 5).	H0: Available fish habitat is not affected by changes in flows (Low). H1: The quality and quantity of fish habitat is related to the flows in the Coquitlam River (High).	High	1-2 yrs	Before	$ 20	High	
	Pink Salmon Access	Determine if pink salmon passage in the Coquitlam River mainstem is hindered, and if so, the flow at which passage is successful.	H0: Pink salmon mainstem access is not affected by the proposed flow changes in the LB1 WUP (High). H1: Pink salmon mainstem access is affected by the proposed flow changes in the LB1 WUP (Low).	High	10 yrs[2]	Before	$ 29	Medium	
	Invertebrate Productivity Index	Through direct measurement, refine modeled habitat-flow relationships for invertebrates for the Coquitlam River, in the context of control stream results.	H0: Flow releases in the Coquitlam River do not affect invertebrate productivity (Low). H1: Invertebrate productivity is optimized for a particular flow regime, and is related to habitat availability as per habitat suitability criteria for each invertebrate species (High).	High (w/ cntrl strm) High (cntrl in U. Coq. R.) Med (w/o cntrl stream)	10-12 yrs 10-12 yrs 10-12 yrs	Before Before Before	$ 576 $ 451 $ 296	High	
	Primary Productivity Index	Through direct measurement, refine modeled habitat-flow relationships for periphyton and algal growth in the river, in the context of control stream results.	H0: Primary productivity in the Coquitlam River is not affected by changes in flow regimes (Medium). H1: The flow releases proposed for the LB1 WUP will alter the productive capacity for algae and periphyton in the Coquitlam River (Medium).	Low	10-12 yrs	Before	$ 200	Medium	
	Reservoir Release Temperature Regime	Determine the relationship of reservoir elevations with dam release temperatures and the extent of impacts on river ecosystems.	H0: Reservoir operations do not affect the dam release temperatures, and/or release temperatures do not affect the quality of downstream habitats (Low-Medium). H1: Release temperatures are related to the operating elevation of the reservoir. Downstream habitat quality is subject to the magnitude and temperature of the releases (Medium-High).	High	3-4 yrs	Before	$ 20	Medium	
	Fish Productivity Index	Through direct counts of adults and outmigrant smolts, determine the productivity-flow relationship for key fish species in the Coquitlam River, in the context of control stream results.	H0: Fish productivity is not affected by changes in flows in the Coquitlam River (Low). H1: Fish productivity response to Coquitlam River flow treatments will be habitat related, as described by the habitat-flow curves predicted in the IFN assessment results (High).	High (with control stream) Med (w/ cntrl every 2yrs) Low (w/o cntrl strm)	10-12 yrs 10-12 yrs 10-12 yrs	Before Before Before	$ 2,905 $ 2,275 $ 1,645	High High	
	Riparian Monitoring (Wildlife)	Replicate the ecosystem mapping of the Lower Coquitlam River undertaken by OIKOS in 2000. A control stream should be included	H0: Proposed flows in the Lower Coquitlam River do not significantly change the area of low bench ecosystem H1: Proposed flows in the Lower Coquitlam River change the area of low bench ecosystems.	Med/Low (with control) Low (without control)	10-12 yrs	Before	$ 78 $ 54	Medium	
	Flushing Flow Effectiveness	Measure the benefits of flushing flows on habitat quality and fish production by comparing various indicators before and after opportunistic flushing flow releases.	H0: Opportunistic flushing flows as recommended by the FTC will not increase habitat quality and influence productivity (Low). H1: Opportunistic flushing flows as recommended by the FTC will increase habitat quality and increase fish productivity in the Coquitlam River (High).	High	6 yrs[3]	During	$ 100	High	

[1] Year "0" and first year data collection will be incorporated into a Performance Measure which will evaluate each year of the monitoring program
[2] Will only occur in odd years when pink returns are prominent; study will end when flow requirements for passage are known
[3] Will be opportunistically applied toward the end of each Treatment period for 2-3 years (years 4-6 and 10-12)

7.4 Monitoring Program Summary

Table 27 FTC Recommended Monitoring Program Reviewed by CC March 11, 2002

Study Area	Title	Impact Hypotheses *(Uncertainty being Addressed)*	Amt of learning expected through monitoring (L/M/H)	Duration of Study	Estimate Costs ($000's) Based on 12 years
Coquitlam Reservoir	***Access to Tributaries***	Tributary access by discrete populations of salmonids is affected by operations in the drawdown zone	High	2 yrs[1]	$25
Coquitlam River	***Ramping Rates***	Fish mortality and stranding are affected by flow rate changes at the dam	High	2 yrs[1]	$15
	Habitat Suitability Criteria	Habitat use changes with availability of habitats provided at different flow releases from the dam, and at different times of the year	High	2 yrs[1]	$45
	Pink Salmon Access	Pink salmon mainstem access is not affected by the proposed flow changes from the dam	High	10 yrs[2]	$29
Coquitlam River	***Invertebrate Productivity Index***	Flow releases from the dam affect invertebrate productivity and is related to habitat availability	High (with control stream)	10-12 yrs	$576
			High (with control in Upper Coq R.)	10-12 yrs	$451
			Medium (no control stream)	10-12 yrs	$296
	Reservoir Release Temperature Regime	Reservoir operations do not affect dam release temperatures nor affect downstream fish habitat quality	High	3-4 yrs	$20
	Fish Productivity Index	Coquitlam River flow treatments (dam releases) affect Fish productivity (as described by the habitat-flow curves predicted in the IFN assessment results)	High (with control stream)	10-12 yrs	$2,905
			Med (w/ control stream every 2yrs)	10-12 yrs	$2,276
			Low (no control stream)	10-12 yrs	$1,647
	Flushing Flow Effectiveness	Flushing flows from the dam significantly improves habitat quality and fish productivity in the Coquitlam River	High	6 yrs[3]	$100

[1] Year "0" and first year data collection will be incorporated into a Performance Measure which will evaluate each year
[2] Will only occur in odd years when pink returns are prominent; study will end when flow requirements for passage are
[3] Will be assessed as natural high flow events occur during Flow Trials 1 & 2 (one in each, plus an initial assessment in

7.5 Consultative Committee Evaluation of the Monitoring Plan

At the Final CC Meeting on March 11, 2002, the Consultative Committee was asked to comment and rank different components of the monitoring program developed by the FTC (for more detail see minutes of final meeting in Appendix K). Prior to the meeting, CC members were given the opportunity to review a preliminary version of the proposed monitoring program and the FTC subsequently revised some aspects of the program and short listed number of studies. The FTC arrived at the shortlist of studies using the following criteria:

1) amount of learning,
2) duration of study,
3) cost effectiveness,
4) the probability that competing hypotheses may be correct, and
5) expected impact on future water use plans.

These revision were presented to the CC and they were asked to evaluate the monitoring plan. An important issue that was presented to the CC for the first time was the use of a control stream. A summary of the discussion is provided below.

Key Issue: Use of Control Stream

An important outstanding issue before finalization of the CBWUP monitoring plan is whether to include a control stream as part of monitoring invertebrate and fish productivity. The CC reviewed biological rationale, selection criteria, and possible options for including a control stream and it became clear that there are cost-benefit trade-offs to be made. The following costs and benefits associated with a control stream for assessing invertebrate and fish productivity were provided by the FTC as part of the evaluation worksheet given to the CC by BC Hydro Resource staff:

Benefit/Cost Information About Use of A Control Stream for CBWUP Monitoring

(Excerpt from the Monitoring Evaluation Worksheet)

Monitoring Item	Impact Hypotheses *(Uncertainty being Addressed)*	Amt of learning expected through monitoring (L/M/H)	Estimate Costs ($000's) Based on 12 years
Invertebrate Productivity Index	Flow releases from the dam affect invertebrate productivity and is related to habitat availability	High (with control stream)	$576
		High (with control in Upper Coq R.)	$451
		Medium (no control stream)	$296
Fish Productivity Index	Coquitlam River flow treatments (dam releases) affect Fish productivity (as described by the habitat-flow curves predicted in the IFN assessment results)	High (with control stream)	$2,905
		Med (w/ control stream every 2yrs)	$2,276
		Low (no control stream)	$1,647

FTC members explained to the CC that a control stream is required to improve the ability to isolate natural variation from changes arising as a result of dam releases and that without a control stream, the

effects of the proposed dam releases would not be quantifiable within the proposed review period. It was noted that natural variation is expected to come from several sources, including:

- Ocean survival shifts due to changes in food availability/temperature
- Localized impacts due to water quality issues, climate (urban drainage, sediment loading, CMS example)
- Fisheries management changes – over-fishing/ conservation efforts affect numbers of returns.
- Availability of habitat - increased habitats mean that cohort survivals will gradually increase, and response time may increase due to limits on spawning recruitment.
- Hatchery programs, habitat enhancements, etc.

BC Hydro representatives on the Committee commented of the importance of cost and their desire to finalize the consultation process. They indicated they would not stand in the way if technical experts and the WUP Management Committee (or the Fisheries Advisory Team) conclude that a control stream is a good investment for this WUP.

Wildlife Riparian Monitoring

It was reported to the CC that, because of overlap between FTC and wildlife working group members, the FTC evaluated a monitoring request for riparian ecosystem mapping. The purpose of the request was to determine effects of flow treatments on the extent of Coquitlam River low bench riparian habitat. The CC supported the FTC's recommendation to drop this item from further consideration because:

- Results would not change CC's flow choices
- Probability of quantifying changes in low bench is low
- Impacts of possible changes in low bench ecosystem on wildlife are unknown

Evaluation Worksheet

CC members were asked at the final meeting held on March 11, 2002 to rank each component of the proposed monitoring program on a scale of high, medium, or low based on the impact they expect its outcome to have on their own water allocation choices. Of the 23 CC members at the meeting, 20 filled out evaluation forms although some completed them only partially. Ranking and comments for each monitoring plan component are summarized in Figures 12 & 13 below:

Figure 12 CC Ranking of Monitoring Program Components

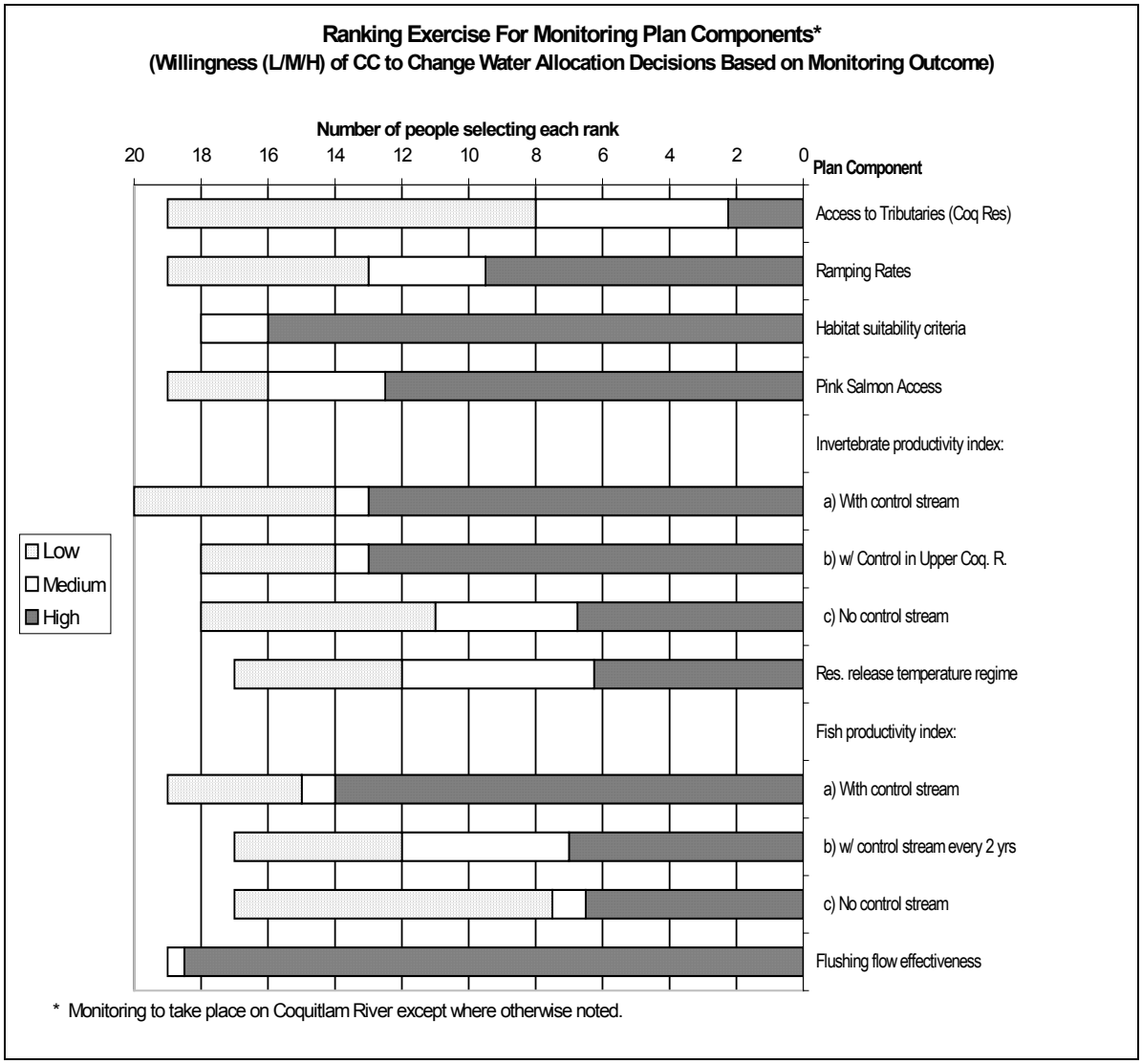


Figure 13 CC Member Comments From Monitoring Plan Ranking Worksheet

C Coquitlam Reservoir	***Access to Tributaries***	
	Habitat Conservation and Stewardship Program	I don't believe impacts to the reservoir will affect too many decisions. However, it's important to watershed productivity and therefore affects downstream habitat as well.
	Watershed Watch Salmon Society	Not as likely to provide decision making evidence as other studies.
	Port Coquitlam Fishing and Hunting Club	Not until Sockeye introduction above dam.
	Burke Mountain Naturalists	Not a river issue
	GVRD	Generally the lower reaches of these streams are on lower gradient alluvial fans. Bathymetric data available.
	Resident	Possible remedial measures in some streams; will not change flow regime selected, but very good idea
	BC Hydro	Highly unlikely to impact decisions on most appropriate operating regime in 12 to 15 years time.
	Ramping Rates	
	Habitat Conservation and Stewardship Program	Important, but take a conservative approach rather than spending big bucks to tweak the rate to get it exactly right for the Coquitlam
	Watershed Watch Salmon Society	Important and must be done/determined
	Port Coquitlam Fishing and Hunting Club	Ramping must be done with as little impact to fish as possible.
	Port Moody Ecological Society	Fish are too valuable to loose by implementing large/fast ramping rates.
	BC Hydro	Highly unlikely to impact decisions on most appropriate operating regime in 12 to 15 years time.
	Ministry of WLAP	Essential to set proper ramping rates; therefore very important to study. But ramping rate will not affect flow decisions.
	Resident	Will not change flow regime but very important for **all** flow regimes.
	Habitat suitability criteria	
	Watershed Watch Salmon Society	Part of original WUP design and needs to be finished.
	GVRD	Supports the recommendation for which ultimate flow.
	BC Hydro	Habitat is a primary performance measure.
	Ministry of WLAP	The development of HSI criteria are important to fish productivity index but, of themselves, will not affect flow decisions; should be completed as part of IFN, not monitoring.
	Resident	May be very important and assist with evaluation of fish productivity.
	Pink Salmon Access	
	Habitat Conservation and Stewardship Program	May only have to monitor for a few years until we get a dry year. If Pink migration OK in a dry year-could assume it's OK at higher levels.
	Port Coquitlam Fishing and Hunting Club	Do with as little impact to fishery as possible.
	Ministry of WLAP	Probably not an issue on the river, BUT if it was an issue its effect on flow decisions would be high.
	Resident	May affect flow regime, important science. Likely to result in simple, easy to define flow requirements.
	Invertebrate productivity index (with control stream, w/ control in Upper Coquitlam River and with no control stream)	
	GVRD	I assume invertebrate productivity is a good indicator of ecosystem health. Hence this seems to be a cost/effective study.
	Habitat Conservation and Stewardship Program	Should look to share control stream with other WUPs if possible to save money. Ron Ptolemy mentioned another sampling method (electro-shocking) which could significantly save money with same or better results.
	Watershed Watch Salmon Society	With or without control there is great value and benefit to this study. In combination with other study results can give very good idea of flow benefits
	Port Coquitlam Fishing and Hunting Club	Yes. Go ahead with long term study
	PoCo Hunting and Fish Club/Port Moody Ecological Society	Extensive work all over North America (Index of Benthic Invertebrates - IBI)
	Burke Mountain Naturalists	These monitoring programs have a faster "response time" and would yield better data than looking at tertiary production. Good controls are important but what about gravel mines.
	Port Moody Ecological Society	It would be good to explore "sharing" a control stream with other water use plans. Invertebrate production index- absolute necessity.
	GVRD	With control stream: cost/benefit low. Without control stream: use other WUP monitoring as the control.

BC Hydro	Control stream benefits not enough to offset additional costs. There is still too much uncertainty on control stream benefits and selection of suitable control stream.
Resident	This performance measure is important but not direct enough. It is more important to focus on fish productivity; defer to fish productivity index.
Reservoir release temperature regime	
Habitat Conservation and Stewardship Program	If needed to save money-monitor in-stream only
Watershed Watch Salmon Society	Notes for both Invertebrate and flow may be able to do for less money. Utilizing funding from other sources etc. And in-kind work.
Port Coquitlam Fishing and Hunting Club	Try to adjust discharge temperatures to maximize fish production.
GVRD	A few measurements should be able to determine this.
BC Hydro	Not likely to impact operating regime.
Ministry of WLAP	Probably not an issue on the river, but if it is an issue it would play large role in flow decisions.
Resident	Will not change selected flow rates.
Fish productivity index (with control stream, with control stream every 2 years and with no control stream)	
GVRD	Am concerned by high costs. However, this type of information is critical.
Habitat Conservation and Stewardship Program	Share control streams if possible to save money.
Watershed Watch Salmon Society	With or without control there is great value and benefit to this study. In combination with other study results can give very good idea of flow benefits
Port Coquitlam Fishing and Hunting Club	Habitat and hatchery improvements to the river are not to be stopped for the purpose of studies. A method of adding these changes must be created.
Burke Mountain Naturalists	These are very expensive programs and data obtained from them could be confounded by other events - El Nino, variations in ocean survival. Therefore, I would be worried about decisions being made based on these studies.
GVRD	With control stream: cost/benefit low. Without control stream: use other WUPs monitoring as the control, cost/benefit high.
BC Hydro	Control stream benefits not enough to offset additional costs. There is still too much uncertainty on control stream benefits and selection of suitable control stream.
Resident	Necessary science in order to determine success of flow changes. Will impact future WUP.
Flushing flow effectiveness	
Habitat Conservation and Stewardship Program	Important to monitor carefully to determine effectiveness of various flows in terms of depth of cleaning etc. Consultant very uncertain as to magnitude and duration required to affect a positive change. Smaller flows or shorter *could* be of some benefit.
Port Coquitlam Fishing and Hunting Club	After flushing actions have been evaluated, alternative methods of substrate cleaning should be looked into.
Resident	High priority after both flows have been run (12-15 years)
Burke Mountain Naturalists	It is important to examine impacts of flushing flows.
GVRD	The information during this WUP has indicated that the best benefit for the Coquitlam River fish habitat is from the flushing flows.
BC Hydro	Expect direct impact on suitability of habitat, our main PM.
Ministry of WLAP	Very important – flushing flows likely to have large effect on fish productivity.
Resident	If flushing flow achieved, then very important study.
General comments	
Coquitlam River Watershed Society	I believe that either the FTC or the monitoring group should be deciding on what should be monitored, or how to monitor. Perhaps a budget should be set for that particular monitoring plan (a suggested 1.8 million was mentioned) Then that group should work out what can be afforded, what is important. A CONTROL STREAM IS IMPORTANT.
Watershed Watch Salmon Society	"high' means to me this will have a significant impact on any future decision and is highly necessary in future decision making.

7.6 Monitoring Committee Terms of Reference

Also discussed at the final CC meeting held on March 11, 2002 was the terms of reference for a proposed monitoring committee. The terms and conditions are as proposed below.

Monitoring Committee Representation

The CC recommends that a Monitoring Committee (MC) should be formed, whose membership should include:

- BC Hydro
- Fisheries and Oceans Canada
- GVRD
- Kwikwetlem First Nations
- Ministry of Water, Land and Air Protection
- Municipal Governments – Coquitlam & Port Coquitlam
- Signatories of this CBWUP consultative committee – need to determine appropriate representation?

The Monitoring Committee's Purpose is to ensure that there is:

- continuity of expertise and knowledge derived from this CC WUP consultative process and the proposed study program to ensure the transference of knowledge to facilitate a decision by those responsible for the 15 year WUP review.
- make study program adjustments as noted below within preset budget and time limits approved by, or constraints ordered by, the Comptroller of Water Rights.

The Comptroller of Water Rights is responsible for approving the proposed study program (within the set time period and budget) and will also be responsible for approving any program changes which result in budget increases or adjustments or have any operational impacts beyond what is originally directed by the Comptroller.

The Monitoring Committee's Mandate should include:

Determination of Treatment B (2nd Flow Trial):

- The CC has requested the Monitoring Committee recommend Treatment B target flows according to flow-habitat information provided by the Instream Flow Needs (IFN) study. Monthly species life history requirements will be dictated by peak-habitat relationships defined by the IFN study. Target flows must be between 4 FVN and STP5 monthly flow targets. The MC will recommend the regime within the terms expressed by the CC for submission to, and approval by, the Comptroller of Water Rights.

Timing of Flushing Flow Assessments:

- After a significant inflow event (1:3 year storm event or greater) the Monitoring Committee will convene to determine if a flushing flow assessment is warranted based on the CC recommended criteria of an Opportunistic Flushing Flow (eg. 30 – 50 cms from the dam), within each Treatment Period.
- The Monitoring Committee will consider the timing, magnitude, available hydrologic information, and budget, before approving or delaying the assessment in anticipation of other opportunities. This is likely to occur once within each treatment period and assessment costs must be within the set budget approved by the Comptroller of Water Rights.

Monitoring Committee's Meeting Schedule

The Monitoring Committee may be convened to discuss restoration projects pending for the Coquitlam River, to ensure appropriate consideration of consequences to Water Use Plan parameters being monitored, and to make recommendations to project proponents for monitoring. In general, Monitoring Committee representatives will continually support the monitoring program by bringing such proposals to light, for consideration by the committee.

One annual public meeting to provide study program results and plans and meeting(s) as proposed to address key milestone events identified above.

Additionally, depending on the results of the power analysis, the Monitoring Committee may be required to meet once to refine the above Study Program and to provide a recommendation to the CC. Subsequently, the CC may be required to meet once to provide a recommendation for changes to the Water Use Plan, as per the decision framework recommended by the CC. Recommendation for submission to, and approval by, the Comptroller of Water Rights.

7.7 References for Monitoring Program

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Decker, A.S. 1998. Influence of off-channel habitat restoration and other enhancement on the abundance and distribution of salmonids in the Coquitlam River. Unpublished report prepared for B.C. Hydro Power Facilities, Burnaby, B.C. 35 p. (January 1998).

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Korman, J. and R. Ahrens, 2001. Escapement estimation of winter-run steelhead on the Cheakamus River: Stock assessment and monitoring implications. Prepared for CMS WUP Project (BC Hydro), Burnaby, BC.

Sneep, D (FOC), 2001. COQ WUP Information Sheet – Buntzen outfall impacts. Prepared for COQ WUP Project (BC Hydro), Burnaby, BC.

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8 REVIEW PERIOD

As part of the consensus adaptive monitoring program, the Consultative Committee recommended a 15 year review period for the Coquitlam-Buntzen Water Use Plan, starting from October 2001. This review period included 2 - 3 years assumed necessary for approval of the WUP and to make the necessary infrastructure changes to one of the low level outlets[71]. It was recommended by the CC that if efforts are undertaken to return sockeye to the Coquitlam reservoir, that this should trigger the re-opening of the WUP[72].

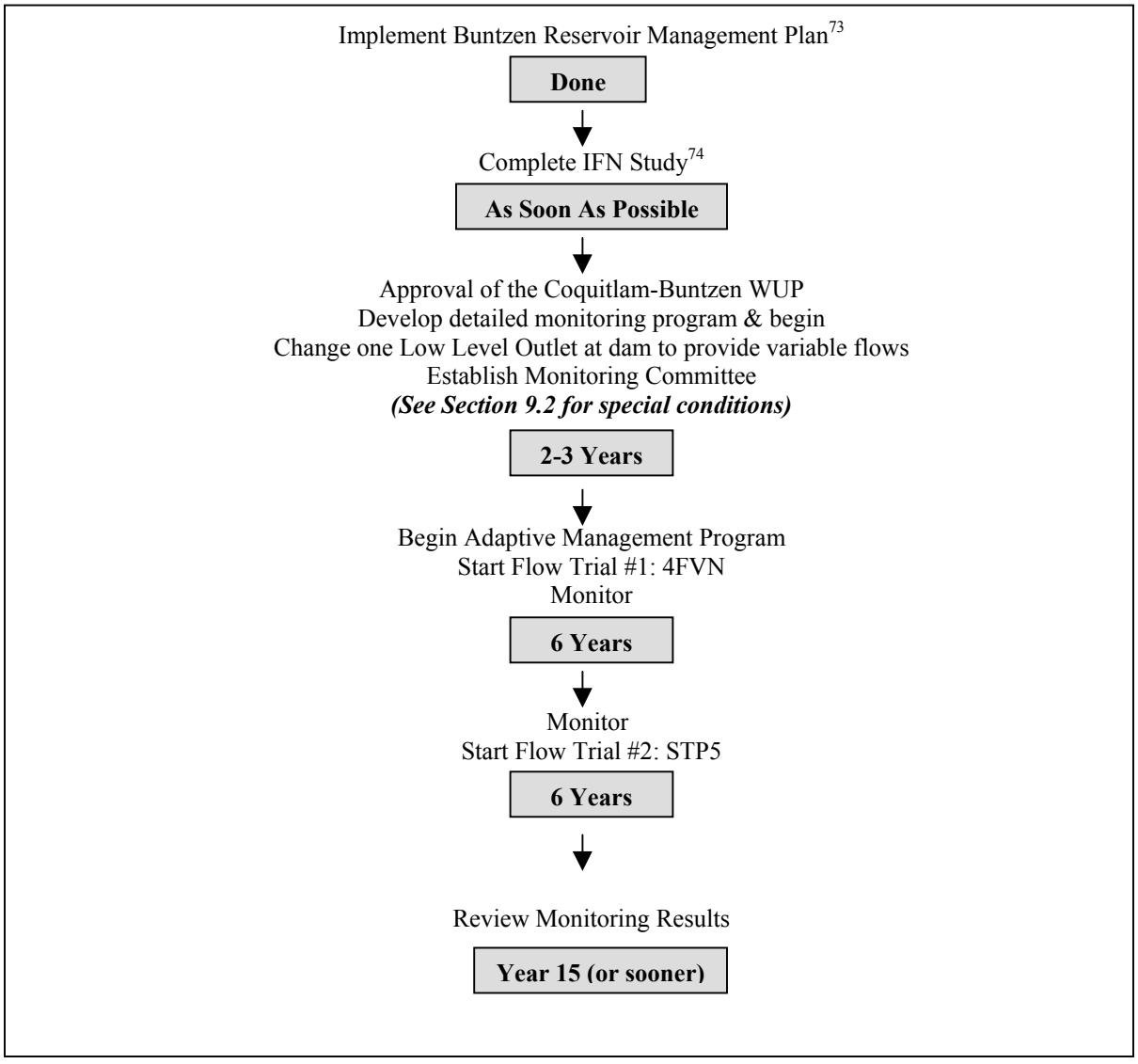
[71] This review period also coincided with the GVRD's long term planning requirements.
[72] Taken from the June 11th 2001 CC Meeting Minutes as stated, "*The CC supports the idea of restoring sockeye to the Coquitlam River if it is found to be technically feasible. This WUP will incorporate operational issues regarding sockeye from the mouth of the Coquitlam River to the dam. If restoration of sockeye to the system is found to be technically feasible, then this should trigger re-opening of the WUP and consideration of operating issues related to sockeye upstream of the dam.*"

9 IMPLEMENTATION OF WATER USE PLAN PACKAGE

9.1 Sequence of Events

In summary, the sequence of events for implementation of the operational changes, adaptive management monitoring program, and other recommendations are described in the flow diagram shown in Figure 14.

Figure 14: Flow Diagram Showing Implementation Timing



[73] Implemented by BC Hydro as interim measure in June 2001, pending approval by CC.
[74] Study partially complete. Funding for completion in place.

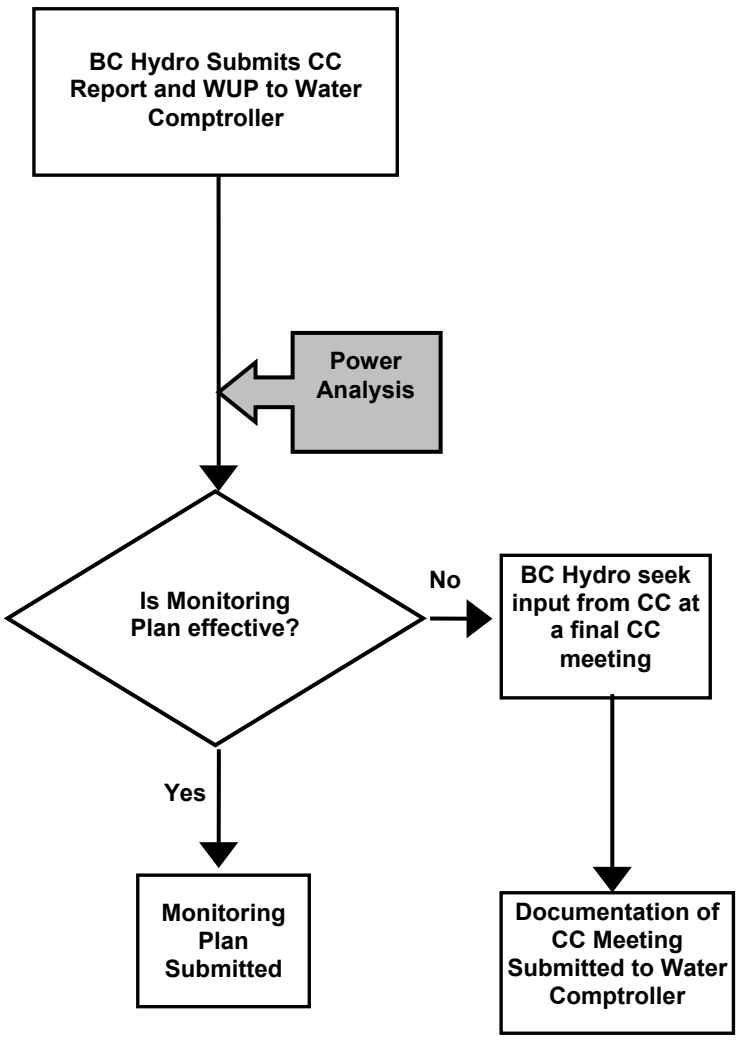
9.2 Important Final Note: Report Submission and Implementation

At the final meeting held on March 11, 2002, it was brought to the attention of the Consultative Committee that there is a possibility that the two recommended flow trials might not yield meaningful results: In other words, the information gathered through monitoring may not clearly distinguish between the two flow trials and, therefore, not adequately inform a future Consultative Committee (for more detail see Appendix K). To determine this possibility, BC Hydro is undertaking a statistical power analysis to gain insight into the effectiveness of the monitoring plan. In light of this information, the Consultative Committee agreed to submit this report to the Comptroller of Water Rights along with BC Hydro's Water Use Plan under the process shown in Figure 14 with the understanding that the report is subject to the following two conditions:

1. An effective monitoring plan can and will be implemented. "Effective" is defined as being cost effective and having sufficient statistical power to distinguish between the two flow trials as documented in this Consultative Committee Report. Modification to the proposed monitoring plan can be made (i.e. based on the review by the Fisheries Advisory Team) but the Coquitlam-Buntzen Fish Technical Committee will determine effectiveness. Any changes to the monitoring plan that is included in this report will be submitted to the Comptroller of Water Rights and the Consultative Committee will be informed of the result.

2. If an effective monitoring plan cannot be implemented (again, subject to review and agreement by the Coquitlam-Buntzen Fish Technical Committee), the Consultative Committee will be reconvened for one final meeting to discuss alternatives and perhaps change recommendations. The results of this meeting will be submitted to the Comptroller of Water Rights.

Figure 14: Process for CC Submissions to Water Comptroller



Appendix A ISSUES PAPER

INTRODUCTION . . .

Why an "Issues Paper"?

As the title indicates, the purpose of this paper is to report on issues and concerns that have been addressed to date in the development of a Water Use Plan (WUP) for the Coquitlam-Buntzen system. It provides some background information on how the WUP process is structured, how concerns and issues have been dealt with, and outlines the objectives, associated performance measures, and critical needs studies that will inform recommendations for water allocation.

The Coquitlam-Buntzen System

The Coquitlam-Buntzen hydroelectric facility has been in operation since 1903, making it the oldest in the Lower Mainland. It is able to produce about 200 gigawatt hours of electricity each year-- enough to provide electricity for 18,000 homes.

Water Use Plans (WUPs) address power and non-power objectives affected by the rules and procedures adopted by BC Hydro in the operation of its hydroelectric facilities.

The Coquitlam River originates in the Lower Mainland's coast mountains and flows south to the Fraser River via release facilities at Coquitlam Dam. The dam provides significant downstream flood control benefits and facilitates regulation of inflows such that the river's water can be allocated for power generation, domestic water supply, fish and wildlife habitat, and recreation.

What is a WUP?

Water Use Plans (WUPs) address power and non-power objectives affected by the rules and procedures adopted by BC Hydro in the operation of its hydroelectric facilities. These operating rules and procedures include changes to water levels in reservoirs and to water flows out of reservoirs.

Water use planning is not intended to address issues pertaining to original construction and/or inundation that cannot be mitigated through changes in water flow and reservoir levels. For example, treaty entitlements and historic grievances are considered outside the scope of WUP. WUPs are not equivalent to the comprehensive watershed management plans that are being produced through other processes in the province. Issues that were raised but could not be resolved or addressed through water allocation decisions are integrated and listed in this document.

Who is involved in this WUP?

Public involvement in the development of the Coquitlam-Buntzen WUP began with a mailout to 70+ organizations and two open-houses (September, October 1999. Subsequently, individuals and organizations interested in or affected by water use planning decisions were invited to become part of a formal Consultative Committee. The purpose of the Consultative Committee is to provide recommendations for long term reservoir and water management strategies, both for consideration by BC Hydro when preparing its WUP for the Coquitlam-Buntzen Area and by the Comptroller of Water Rights when reviewing BC Hydro's Water Use Plan.

Membership on the Consultative Committee includes representatives of community organizations (such as environmental and recreation groups), First Nations, industry, and government agencies (local, regional, provincial, federal) as well as local residents. The Consultative Committee met for the first time in November 1999. Since that time, there have been approximately 35 Consultative Committee, subgroup and related technical meetings.

First Nations Representation and Involvement

The Katzie, Kwikwetlem, and Tsleil Waututh First Nations and Sto:lo Nation are participating in this water use planning process. In addition, the Musqueam First Nation is receiving meeting minutes. Squamish First Nation, was also invited and decided not to participate in this WUP.

Aboriginal rights and title

First Nations' participation in the WUP process is based on the understanding that Aboriginal rights and title to all lands and resources within the Coquitlam-Buntzen watershed are unextinguished and, therefore, that the WUP process is without prejudice to Aboriginal rights and title. Similarly, the First Nations have stated an interest in maximizing consideration of Aboriginal rights and title in all aspects of BC Hydro facility operations. For this reason, Aboriginal rights and title should be considered as an overarching issue when developing operating alternatives as it may influence the choice of water allocation for the WUP.

Understanding First Nations concerns

In order that Consultative Committee members more fully understand the context and concerns of First Nations people involved in this WUP process, cross-cultural training was given by BC Hydro and the First Nations involved. In addition to the direct participation of First Nations in the process, more activities to promote an understanding will take place in the course of the WUP (e.g. Archaeological/Cultural/Historical Study findings).

The Coquitlam Reservoir, view to the North

PROCESS AND PROGRESS. . .

Issue Identification

For approximately one year, the Consultative Committee has been working with BC Hydro through the WUP process outlined in Figure 1.

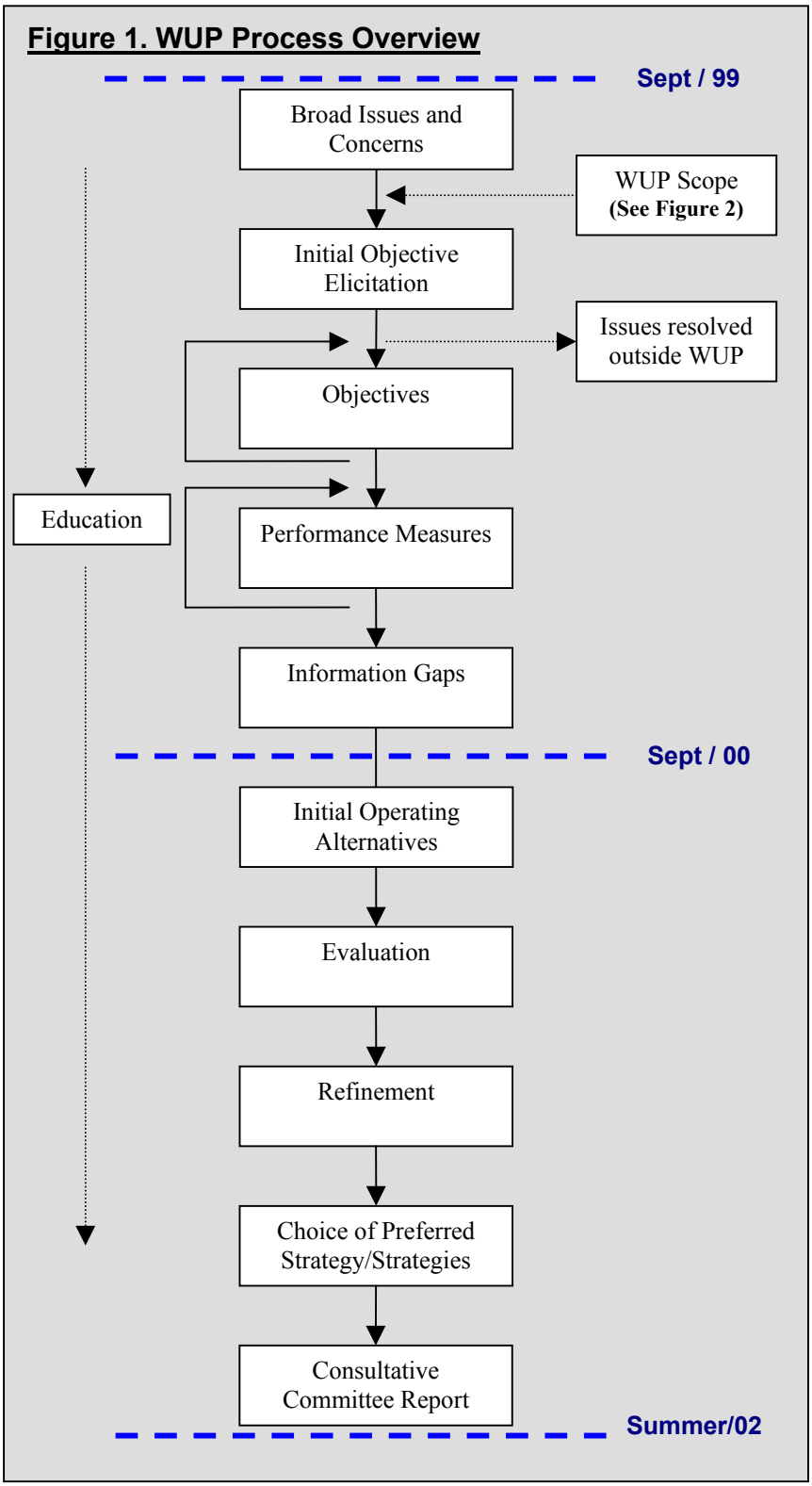
This process began in the fall of 1999 with the identification of issues and concerns to be addressed by the WUP. Issues raised were assessed through an analytical framework (see Figure 2) to determine their relevance to the water use planning process.

Issues that can be controlled through water allocation formed the basis of water use planning objectives.

Other issues that were raised and are documented in this report include:

- Issues that may be considered during later stages of the planning process (for instance, during trade-off analysis of operating alternatives or post-WUP monitoring).
- Issues that fall outside the WUP scope because they do not influence the choice of water allocation for this or future water use plans.

Figure 1. WUP Process Overview



Through this solicitation process it became clear that most issues fell into the following broad categories or themes:

- Archaeology/Culture/History
- Domestic Water
- Fish
- Flood Control
- Hydroelectricity
- Industry/Economic Development
- Recreation
- Wildlife & Environment

In addition, suspended sediment (turbidity) has been raised as an issue of concern throughout the Coquitlam-Buntzen WUP planning process, both at the working group level (Recreation, Flood, Fish, Industry) and the Consultative Committee level. An overview of suspended sediment (turbidity) concerns is provided in this document. At this point in time, the Consultative Committee is deliberating the issue of suspended sediment (turbidity) and its inclusion within the WUP.

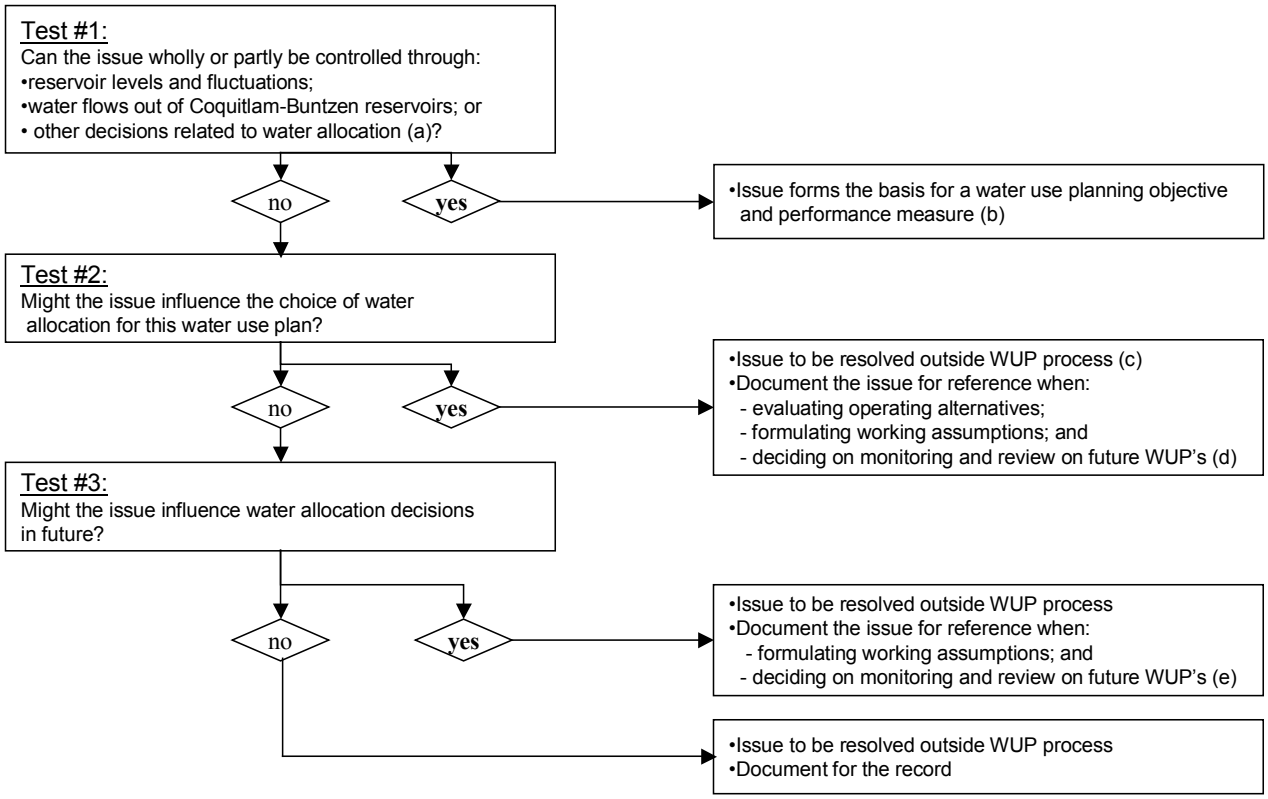
For each of these subject areas, smaller working groups made up of Consultative Committee members were formed to consider how these issues and concerns could be reflected in a set of measurable objectives for the WUP. From these meetings, subsequent Consultative Committee meetings and conversations with individual members of the working groups, a set of proposed objectives and performance measures were developed and approved by the Consultative Committee in July 2000.

Developing Objectives

The following framework was developed to help decide whether issues raised by Consultative Committee members could be resolved within the water use planning process and whether, as a consequence, they should be reflected in the proposed objectives. All issues that pass Test #1 in Figure 2 below were subsequently developed and reflected in the objectives for the WUP.

For example, the issue of fish habitat is directly controlled through water allocation decisions (Test #1), and thereby forms the basis for a WUP objective and performance measure. However, water quality flowing into the Coquitlam River downstream from the dam is not controllable through water allocation (Test #1) but might influence the choice of water allocation (e.g. for fish in the river) for this WUP (Test #2). Finally, while some issues can neither be controlled by water allocation decisions nor influence the choice of water allocation for this WUP, they may influence water allocation decisions in the future (Test #3). For example, in the case of quality of water flows into the Coquitlam Reservoir for domestic water, working assumptions must be formulated if preferred water allocation would be different should the quality of inflows change at some point in the future. All other issues are to be documented for the record but resolved entirely outside the WUP process.

Figure 2. Proposed Analytical Framework For Reviewing Issues, Coquitlam/Buntzen WUP



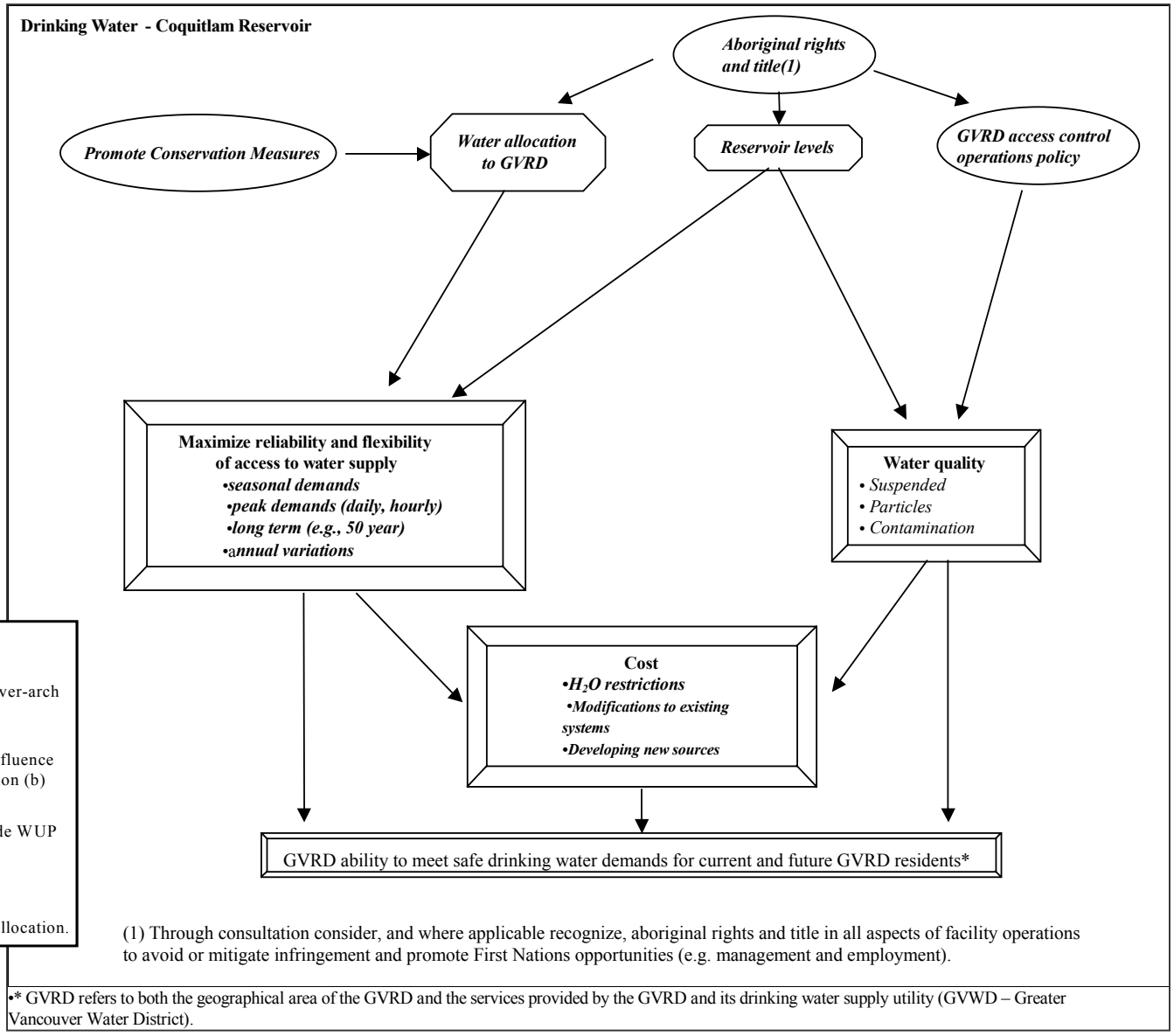
(a) If there are any, they need to be defined.
(b) Performance measures are indicator of how successfully actions meet objectives.
(c) There may be a few exceptions to this - to be discussed.
(d) eg. quality of water flowing into Coquitlam River downstream of the dam is not controllable through water allocation but it is relevant to the decision of how much water to allocate to, for example, fisheries interests in the river.
(e) eg. Water flows into the Coquitlam Reservoir are of sufficient quality to meet requirements for raw domestic water. Working assumptions are needed if preferred action would be different under different assumptions.

Reviewing Objectives

As a tool for reviewing proposed objectives, an influence diagram, or framework, was developed for each area of concern and set of objectives.

In the example in Figure 3, the link between the drinking (domestic) water objectives for the Coquitlam Reservoir, the issues (values) influencing operating strategies, and the available operating strategies themselves are made explicit. This and the other influence diagrams for each area of concern attempt to visually explore how actions will influence outcomes based on identified objectives.

Figure 3. Influence Diagram for Domestic Water



Developing Performance Measures

To be meaningful, objectives must be measurable. A performance measure is used to measure the degree to which an objective is achieved. Therefore, the ability to measure an objective is critical to evaluating water allocation decisions. Performance measures must:

- be clearly linked to the objective they are measuring
- provide a way to refine discussions of objectives
- provide a way to identify progress in meeting objectives
- provide a way to develop alternatives and understand trade-offs being made between alternatives
- provide a way to select the preferred alternative(s)

For each objective, performance measures were identified, refined and approved by the Consultative Committee.

Developing specific objectives and performance measures of this nature required a great deal of discussion about how water allocation decisions may or may not affect an issue and what component of an issue could be effectively measured within the constraints of time, budget and available technology. For each objective, performance measures were identified, refined and approved by the Consultative Committee.

Information Gaps & Associated Studies

During the process of identifying issues and structuring objectives, many questions were raised regarding the relevance and uncertainty of particular issues to the water allocation decisions being made. Consequently, a list of proposed studies was developed to address information gaps related to these questions. This list of proposed studies was then prioritized in order to maximize effective decision-making, make best use of available resources, and work within time restraints. The Consultative Committee approved a list of studies for each area of concern in June and July 2000. The following 5-step methodology (also expressed graphically in Figure 4) developed by BC Hydro at other WUPs was used by the Consultative Committee to evaluate, and then prioritize and approve proposed studies.

Step 1. *Will the study provide information related to the calculation of a performance measure?*
If not, the study is not eligible.

Step 2. *Is the data gap or uncertainty that this study addresses significant enough to affect the ranking of alternatives?*
A "no" answer should normally disqualify a study from further consideration. For some studies, the answer will be clearly "yes". For others, it may be unclear. Judgment will have to be used.

Step 3. *Can the study provide meaningful, reliable data within the time frame available in the WUP project schedule?*
If not, the study is not eligible. However, some proposed studies may be candidates for longer term monitoring programs that are conducted as part of WUP implementation.

Step 4. *Do the benefits outweigh the costs?*
If answers 1 through 3 are "yes", the range of study designs and associated data quality should be evaluated. If costs are very high, it may be important to consider alternative or simpler performance measures.

Step 5. *Assign Priority*
If answers to test #1 through 4 are "yes", the study is assigned one of the following five priorities (Figure 5):

Figure 4*.

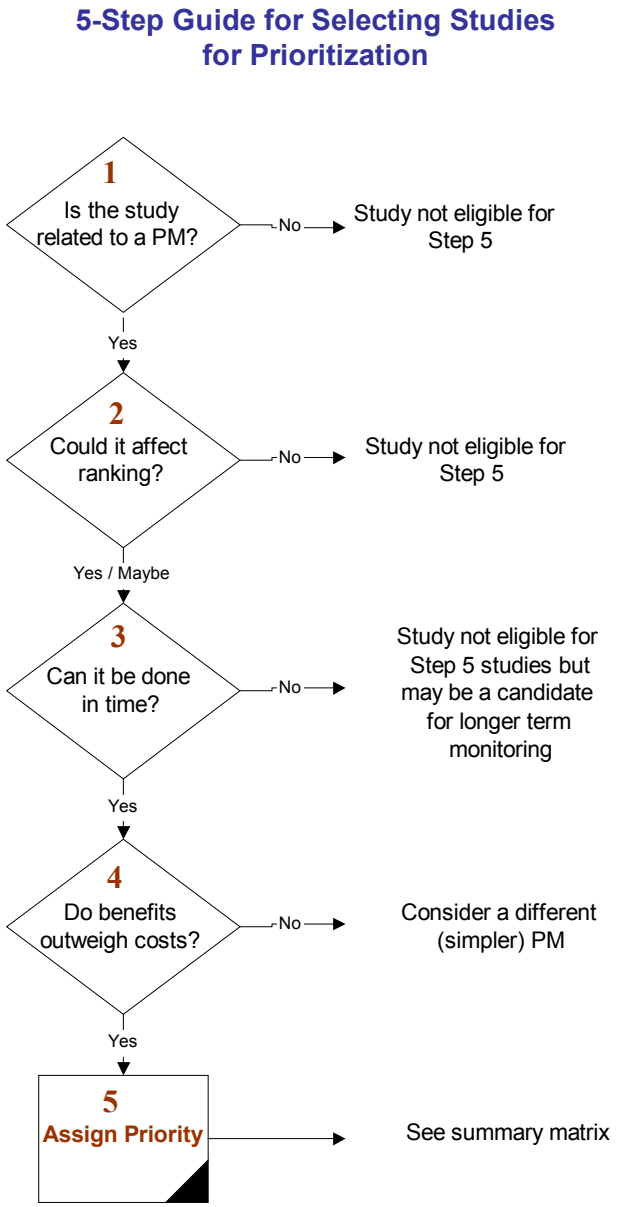


Figure 5. Study Prioritization*	
Priority 1	The information provided by this study is essential for WUP. Responsible decisions cannot be made without it.
Priority 2	This study will provide information that is likely to affect the ranking of alternatives. The benefits clearly outweigh the costs.
Priority 3	This study has benefits, but is of lower priority. Some reasons for lower priority include: - costs may outweigh benefits; - the benefits may not be significant enough to affect ranking of alternatives; - the PM this study addresses has less likelihood of being the "limiting factor" (relative to other PMs).
Priority 4	This study is not necessary or desirable for WUP.
Priority X	This study may be important, but cannot be completed within the WUP timeline.

* Source: Compass Resource Management.

ARCHAEOLOGY, CULTURE & HISTORY. . .

Objectives and Performance Measures

	SPECIFIC OBJECTIVES	PERFORMANCE MEASURES	UNITS
Archaeological, Cultural & Historical	**1. Maximize <u>access</u> for:** • *First Nations' traditional uses*	♦ **Number of appropriately regulated traditional practice access[75] opportunities for First Nations** • *Subject to water levels at Coquitlam and Buntzen Reservoirs*	♦ **Number of sites and level of importance**
	2. Maximize access for:[76] • *Recovery of artifacts* • *Inventory of archaeological, cultural, and historical sites*	♦ **Number of appropriately regulated access opportunities for First Nations (Coquitlam and Buntzen Reservoir)** ♦ **Number of appropriately regulated access opportunities for non-First Nations (Coquitlam and Buntzen Reservoir)**	♦ **Number of sites and level of importance**
	3. Maximize protection of archaeological, cultural and historical sites from: • *Shoreline erosion* • *Pot hunters* • *Flooding*	♦ **Number of sites (and their importance) exposed to wave action within (1 metre?) of designated reservoir level and reservoir fluctuations** ♦ **The risk to the number of sites (and their importance) exposed to flooding, and from flooding** ♦ **Number of sites exposed to pot hunters (both reservoirs and the river)**	♦ **Number of sites and level of importance**

[75] Kwikwetlem First Nation agree there may be justifiable infringement of aboriginal right and title for public health and safety, and that regulated access to the Coquitlam watershed may be practical and reasonable under the following conditions:
- Agreement on access must be determined with Kwikwetlem First Nation through negotiations that represent appropriate and meaningful consultation; and,
- Infringement must be as minimal as possible.

[76] Indications are that non-First Nations archaeological, cultural and heritage will be outside the WUP. Proposed studies are to verify this.

Over-arching values of WUP objectives[77]

- Maximize consideration of aboriginal rights and title in all aspects of facility operations
- Integrity of both First Nations heritage and cultural values
- Preservation of both First Nations and non First Nations archaeological, cultural and historical sites.

[77] These were expressed by consultative committee members as values which are to be addressed in the WUP process through use of objectives listed in the previous table.

Related Concerns[78]

- Need for improved knowledge about traditional uses and existence of heritage sites
- Confidentiality of exact location of First Nations archaeological, historical & cultural sites as well as other heritage sites to protect them[79]
- Documentation of existing First Nations and non-First Nations archaeological, cultural, and historical sites
- Aboriginal rights and title
- Indications are that non-First Nations archaeological, cultural and heritage will be outside the WUP scope as they are not anticipated to be affected by changes in water flows. There are proposed studies to verify this. If any non-First Nation sites will be affected by the WUP, specific performance measures will be developed and they will be included in the WUP process. If non-First Nation sites are identified and they are outside the WUP they will be included in the final report as an issue to be addressed outside the WUP process.

Issues for resolution outside WUP[80]

- Direct management of all areas with First Nations archaeological and cultural values by First Nations
- First Nations to provide management for recreation areas such as Buntzen lake and provision of eco-tourism opportunities for First Nations within the watershed (noted as an issue for the record under heading of recreation
- Compensation to the First Nations for destruction of the Coquitlam River salmonid populations
  - Compensation in the form of additional flows – noted as a value underlying fish objectives
  - Financial compensation – noted as an issue for the record under the heading of fish.

Information Gaps & Studies

There is a lack of information regarding archaeological, cultural & historical sites and traditional use affected by BC Hydro's reservoir levels and flows.

Specific parts of the Archaeological, Cultural & Historical study related to First Nations may need to be kept confidential. This information is part of First Nations' heritage and some sites are considered sacred. In addition, general knowledge about site locations exposes them to potential degradation and pot-hunters. How study information will be integrated in the trade-off analysis as part of WUP will be examined closely with First Nations.

Access to the Coquitlam Reservoir for the purpose of any proposed studies related to WUP will be addressed through the appropriate channels at GVRD. Other issues related specifically to First Nations access will be addressed through meaningful consultation with First Nations and GVRD.

As a contribution to the historical study, a large timeline poster with key dates will be posted at meetings to illustrate the historical context of the Coquitlam-Buntzen watershed. Consultative Committee members are invited to add key dates and events to this interactive poster.

[78] Concerns that were raised during the process in relation to objectives.
[79] Including First Nations and non First Nations sites.
[80] Classification of issues explained in Figure 2.

						OBJECTIVES ADDRESSED			
Archeological/Cultural/Historical	**Study Area**	**Study**	**Priority**	**Study Costs**	**Time Sensitive**	**Access for Traditional Use**	**Access for artifacts and sites**	**Protection of sites**	**Context for all objectives**
	Archeo-logical, Historical, Cultural	Identify sites, use and significance, focus on FN but consider non-FN	1	$20K	Maybe	Π	Π	Π	
	WUP Context*	Watershed Historical Study, Coquitlam/Buntzen (Literature review & analysis)		$25K	No.				Π
		Watershed Inventory Atlas, Coquitlam/Buntzen		$15K	No.				Π

* These studies have not been addressed by the Consultative Committee.

Kwikwetlem First Nation Representative on a Study Tour of the Coquitlam Dam and Reservoir

DOMESTIC WATER. . .

Objectives & Performance Measures

BROAD OBJECTIVE: Maximize GVRD ability to meet the safe, cost effective and reliable drinking water demands in the Greater Vancouver Regional District with water from Coquitlam Reservoir – as determined across all source and system alternatives.

	SPECIFIC OBJECTIVES	PERFORMANCE MEASURES	UNITS
Domestic Water	**1. *Maximize reliability and flexibility of access to water supply*** ♦ seasonal demands ♦ peak demands (daily, hourly) ♦ long term (e.g., 50 year) ♦ annual variations	♦ **GVRD dissatisfaction[81] - operating requirements not met** • *maximum one day demand* • *average annual demand* • *minimum reservoir operating level*	♦ **Yes/No[82]**
	2. *Minimize cost* ♦ water restrictions ♦ modifications to existing systems ♦ developing new sources	♦ **Amount of saving realized by utilizing Coquitlam Reservoir, based on maximum allocation levels and year these levels are reached.** These include both monetary (money saved) and environmental (habitat not destroyed)	Dollars –present value Hectare-years of habitat not destroyed
	3. *Maximize water quality[83]* • Suspended particles • Contamination	• Dependent on Consultative Committee recommendations to have salmon in the reservoir	

[81] The GVRD is not expected to be dissatisfied for approximately 30-50 years. The trade-offs then would take place in the cost measure.
[82] May need to be revisited/revised as it may present problems in the trade-off analysis.
[83] A performance measures for this objective will be considered subject to reintroduction of salmon in the Coquitlam Reservoir.

Over-arching values of WUP objectives[84]

- Meeting GVRD proposed objectives to 2050 regarding reliable supply including seasonal, peak and other demands as well as timely distribution of water
- Water quality (safe, clean)

Related Concerns[85]

- Long-term GVRD water needs based on expected demand in 2050 may restrict interim planning for other uses in the Coquitlam system
- Prevent/delay the necessity of raising Seymour Dam or future development of new/existing sources of drinking water
- GVRD access to water (threshold reservoir levels, water pressure)
- Kwikwetlem First Nation specified interest in having knowledge about future plans to raise the level of the reservoir and to build a 2nd intake valve.
- Access to watershed to conduct studies for this WUP, especially Archaeological Cultural/ Historical studies.
- Aboriginal rights and title

Issues for resolution outside WUP[86]

- Water conservation
  - Concern that existing conservation measures be continued and new conservation measures be investigated in order to reduce the amount of water the GVRD needs from Coquitlam. This issue should be taken into consideration when evaluating water allocation for domestic water.
- Change of water license from BC Hydro to GVRD or other users
- Drinking water quality standards of "finished" water (as opposed to quality standards of water in the reservoir)
- Logging operations and potential impacts on water quality (e.g. increased run-off and sediment, potential for flooding)
  - This may be an issue for future WUPs – for now, working assumption is that current water quality in the Coquitlam Reservoir is sufficient for domestic water.
- Restrictions on human use of the Coquitlam Reservoir
  - This issue should be taken into consideration when evaluating water allocation for domestic water.

Study Tour of Coquitlam Dam

Information Gaps & Studies

No critical information gaps were anticipated other than further GVRD analysis regarding information needs for trade-off analyses and the potential analysis of water quality pending the issue of salmon reintroduction to the reservoir.

[84] These were expressed by consultative committee members as values which are to be addressed in the WUP process through use of objectives listed in the previous table.
[85] Concerns that were raised during the process in relation to objectives.
[86] Classification of issues explained in Figure 2.

FISH…

Objectives and performance measures

The following summary outlines the proposed objectives and performance measures approved by the Consultative Committee.

BROAD OBJECTIVE: Provide the best conditions for fish life history requirements (spawning, incubation, rearing, feeding, migration).			
	SPECIFIC OBJECTIVES	**PERFORMANCE MEASURES**	**UNITS**
Fish	***1. Mimic natural hydrograph (Coquitlam River)***	♦ ***Deviation from Coquitlam River natural hydrograph*** *(Natural Flow Index)*	♦ **Deviation in flow, timing** *(determined by the IFN study)*
	2. Maximize the availability of suitable (fish) habitat (Coquitlam River)	♦ ***The degree of accessibility to key tributaries*** • *During critical seasons for fish access (for each species)*	♦ **Number of days** • *Number of days the tributary can be accessed versus the number of days access is required*
		♦ ***The quality and quantity of spawning and incubation habitats***	♦ **Area of available habitat and assessed value of habitat versus flow**
		♦ ***The quality and quantity of over-wintering habitats***	♦ **Area of available habitat and assessed value of habitat versus flow**
		♦ ***The quality and quantity of summer rearing habitats***	♦ **Area of available habitat and assessed value of habitat versus flow**
		♦ ***Provision of passage for adult fish in the mainstem***	♦ **Number of days** • *Number of days the mainstem can be accessed versus the number of days access is required*
		♦ ***Substrate Quality***	♦ ***Index of substrate quality*** • *Based on factors such as embededness and composition and a measure of substrate quantity*
	3. Optimize Secondary Productivity (Coquitlam River)	♦ ***Area of suitable habitat for aquatic invertebrates***[87]	♦ ***Area***

[87] Further research and consultation is required in order to determine if this can be measured. If it can't be measured, it is recommended that secondary productivity be included as a post-WUP monitoring item.

	SPECIFIC OBJECTIVES	PERFORMANCE MEASURES	UNITS
Fish	***4. Optimize Secondary Productivity (Coquitlam River)***	♦ ***Area of suitable habitat for aquatic invertebrates[88]***	♦ ***Area***
	5. Maximize Water Quality (Coquitlam River)	♦ ***Water temperature*** • *Water temperature within range that supports healthy fish populations*	♦ ***Maximum temperatures over a time period*** • *Constructed scale that will show when water temperatures are unhealthy for fish*
	6. Minimize Direct Mortality (Coquitlam River)	♦ ***Extent and rate of water level drawdown*** • *During critical periods for fish and at critical elevations in the river*	♦ ***Ramping rates for various river levels***
	7. Maximize Availability of Suitable Habitat (Coquitlam Reservoir)	♦ ***The degree of accessibility to key tributaries*** • *During critical seasons for fish access (for each species)*	♦ ***Number of days*** • *No. of days tributary can be accessed vs. the no. of days access is req'd*
	8. Optimize Secondary Productivity (Coquitlam Reservoir)	♦ ***Effective littoral productivity*** ♦ ***Effective pelagic productivity[89]***	♦ ***Area (hectares)***
	9. Minimize Direct Mortality[90] (Coquitlam Reservoir)		
	10. Minimize Direct Mortality of Fish (Indian Arm)	♦ ***Is salmon stock being impacted by the angling occurring when B1 and B2 are discharging?***	♦ ***Yes/No***
		♦ ***Is the nearshore marine community damaged by the discharge from B1 and B2?***	♦ ***Yes/No***
	11. Maximize water quality (Indian Arm)	♦ ***Does the discharge from Buntzen have a significant impact on the water quality of Indian Arm?***	♦ ***Yes/No***

[88] Further research and consultation is required in order to determine if this can be measured. If it can't be measured, it is recommended that secondary productivity be included as a post-WUP monitoring item.
[89] Pelagic productivity has been included in a study on littoral productivity as recommended by the Fisheries Advisory Team.
[90] The Fish Working Group was delegated the task of determining whether the following issues are of concern at Coquitlam: a) entrainment; b) egg and juvenile spawning in the tributaries of the Coquitlam Reservoir; c) physical abrasion of nearshore marine communities at Buntzen outflow area of Indian Arm; and d) attraction of adult spawners to freshwater discharge at Buntzen outflow area of Indian Arm.

In addition to the performance measures listed in the table above, the Fish working group and the Consultative Committee considered a number of other performance measures that will not be used in the WUP. The rationale for not using these measures is provided in brief below.

- Performance measures for Buntzen Reservoir: It was agreed that Fish objectives for Buntzen Reservoir, namely maximizing the availability of suitable habitat and optimizing primary and secondary productivity, will be met as long as the reservoir is managed within elevations required for recreation/public safety. This type of management plan is currently in place, resulting in a fairly narrow normal operating range (120.1-122.9 metre elevation). As long as this or a similar management protocol remains in place, performance measures for Buntzen Reservoir are not required for the trade-off process.
- Dissolved oxygen: This was not found to be an issue for fish in the Alouette WUP. Furthermore, there is a direct link between the amount of dissolved oxygen and water temperature. Monitoring temperature, therefore, provides a good proxy for this information.
- pH: It was recognized that pH is not related to changes in flows from the reservoir but to geology of the area and rainfall. Therefore, as a performance measure it will not influence decisions for WUP. It was suggested as a voluntary monitoring option.
- Total Gas Pressure: TGP occurs when water spills from a high elevation and becomes supersaturated with oxygen. TGP can have a detrimental affect on fish. As it is unlikely that these conditions would occur on the Coquitlam River during regular operations, it was agreed that during a spill event a spot check will be done to confirm that no TGP performance measure is required.
- Quality and Quantity of Riparian Habitat: The study time frame is to short to make decisions with regard to how flow changes affect riparian habitat. This is likely a post WUP monitoring item.
- Suspended sediment (turbidity): Issues related to suspended sediment (turbidity) are addressed under a separate heading of this report. Rationale for not including suspended sediment (turbidity) **as a fish performance measure was as follows:**
  - Downstream sources of suspended sediment (turbidity) are not within BC Hydro/WUP control.
  - Impacts of suspended sediment (turbidity) on habitat are included under Substrate performance measure for fish.
  - Suspended sediment (turbidity) will not influence decision for best flows: rather, they will be based on habitat.
  - Responsibility for suspended sediment (turbidity) sources to control their discharges should not be compromised.
  - Inclusion of a fish performance measure for suspended sediment (turbidity) would not aid regulatory or enforcement actions.

Over-arching values of WUP objectives[91]

- Fish population
- Wild fish population
- First Nations food, ceremonial, and cultural fishery
- Compensation to the First Nations for destruction of the Coquitlam River salmonid population through allocation of flows.

[91] These were expressed by Consultative Committee members as values which are to be addressed in the WUP process through use of objectives listed in the previous table.

Related Concerns[92]

- Health of river processes
- Health of aquatic and riparian ecosystem (benthic population)
- Commitment from stakeholders to support water quality gains made through increased releases from the dam, should these occur.[93]
- Aboriginal rights and title

Issues for resolution outside WUP[94]

- Quality of water flows into the Coquitlam River downstream of the dam (consideration should be given to this issue when evaluating additional flows for fish, wildlife, and recreation)
- Sub-surface water table may be available as an alternative source of water to achieve objectives (consideration should be given to this issue when evaluating additional flows for fish, wildlife, recreation, and gravel industry)
- Quality of water flowing into Coquitlam Reservoir (this may be an issue for future WUPs – for now, working assumption is that current water quality in the Coquitlam Reservoir is sufficient for fish.)
- First Nations have expressed an interest in capacity building and employment in fish research as well as other areas (monitoring, operations management, archaeological research)
- Financial compensation to the First Nations for destruction of the Coquitlam River salmonid population.

Coquitlam River

[92] Concerns that were raised during the process in relation to objectives.
[93] Concern expressed about both pollutant and silt concentration in the Coquitlam River downstream of the dam.
[94] Classification of issues explained in Figure 2.

Information Gaps & Studies

						OBJECTIVES ADDRESSED				
	Study Area	**Study**	**Priority**	**Study Costs**	**Time Sensitive/ Completion Date**	**Mimic Natural Hydrograph**	**Minimize Direct Mortality**	**Maximize Availability of Suitable Habitat**	**Maximize Water Quality**	**Optimize Productivity**
Fisheries	**Coquitlam River**	Coquitlam River Instream Flow Needs (IFN) Assessment	1	$130K	Completion Date: Nov 00		Π	Π	Π	Π
		Natural Hydrograph (a) Analysis; and (b) Background Paper on Value of Emulating the Natural Hydrograph	1	None	No	Π		Π		Π
		Degree of tributary/mainstem access	2	None	Yes (low flow target?)			Π		
		Substrate quality study: (a) River functions review, and (b) Tractive force Analysis *Note that FAT members recommended this approach*	1	$35K	No			Π		
		Invertebrate Study: Literature Review and Habitat Suitability Indices (HSI) Curve Development *Note that FAT members recommend this approach*	1	Up to $15K	No					Π
		Temperature Study	2	$7K	No Proposed reservoir monitoring to continue to Jan/2001. Interim report by mid-Nov/2000.				Π	
		Ramping Rate Study: (a) Transect analysis; and (b) fisheries expert recommendations	1	$5K	No		Π			
	Coquitlam Reservoir	Tributary access assessment: (a) Literature and Data Review; and (b) Site Evaluation *Note that FAT members recommended additional studies into anadromous access would be outside the scope of WUP*	1	$15K	Yes (need results before drawdown)			Π		
		Littoral and Pelagic Productivity: (a) Literature Review (Stave River WUP) and Site Sampling; and (b) Littoral Productivity Model *Note that FAT recommends review of both pelagic and littoral productivity*	2	$15K	No; Proposed reservoir monitoring to continue until Jan 2001; interim report by mid November					Π
	Indian Arm	Nearshore assessment - Expert consultation	3	None	No		Π			
		Tailrace Fisheries Assessment - Expert Consultation	3	None	No		Π			
		Water quality (Indian Arm flushing) assessment	2	Up to $2K	No				Π	

FLOOD CONTROL. . .

Objectives and Performance Measures

	SPECIFIC OBJECTIVES	PERFORMANCE MEASURES	UNITS
Flood Control	**1. Minimize adverse effects of flooding** • *Flood damage and* • *Public safety*	♦ ***Frequency that bank-full is exceeded*** ***Alternative Performance Measure if bank-full is not possible:*** ♦ ***Frequency of floods of a size equal to or greater than the floods of 1995 (fall) and 1991 (summer)***	♦ ***Number of times***

It was agreed that the most appropriate performance measure for flood control should be the number of anticipated times per year that the bank-full is exceeded. However, it was also acknowledged that this might be an overly complicated matter requiring extensive research and modelling.

If this is the case, an alternate performance measure could be used that looks at the frequency of floods of a size equal to or greater than the floods of 1995 (fall) and 1991 (summer), in order to understand the operations during different seasons.

Related Concerns[95]

- Public safety especially below the dam during storm events
  - Currently, this is a priority concern and operations are managed to meet Provincial requirements
- Dam safety
- Minimize damage to property, cultural heritage sites, dikes, in-stream and riparian habitat
  - Kwikwetlem First Nation and Colony Farm lands are likely at the greatest risk should flooding occur
  - Kwikwetlem concerns re: property, land, safety, archaeology, and heritage
- Manage reservoir to best of ability to shave off the peak of the flood
- Storm water run off from urban development and inflows of creeks downstream of the dam
- Aboriginal rights and title

Issues for resolution outside WUP[96]

- Emergency preparedness (e.g. stability of the dam during a seismic event)
  - Consideration should be given to this issue when evaluating water allocation for power
- Standards for construction of provincial dams and dikes along Coquitlam River system

[95] Concerns that were raised during the process in relation to objectives.

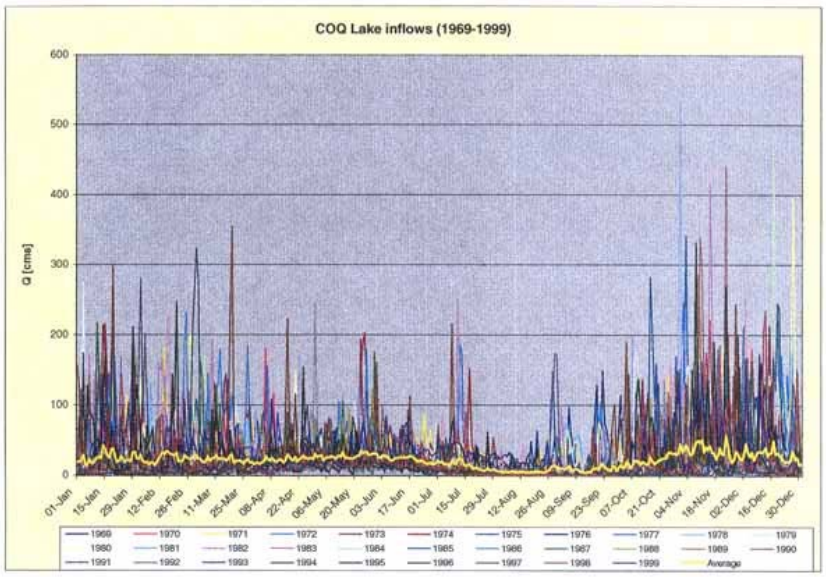
[96] Classification of issues explained in Figure 2.

Information Gaps & Studies

A number of information gaps concerning the proposed performance measure need to be addressed:

- Tidal, backwater and seasonal effects[97]
- Sedimentation information
- Historical information
- Dikes (e.g. responsibility, effectiveness)
- Seasonality

						OBJECTIVES ADDRESSED	
Flood Control	**Study Area**	**Study**	**Priority**	**Study Costs**	**Time Sensitive**	**Minimize flood damage**	**Maximize public safety**
	Coquitlam River	Study of tidal, backwater and sedimentation influences, dyke and dam influence/capacity, and historical floods	1	Up to $59K	No	Π	Π



Coquitlam Lake/Reservoir Inflow Data from 1969-

[97] A BC Hydro representative explained that BC Hydro operates at bank-full capacity (100cms at Port Coquitlam Bridge). Backwater and tidal effects complicate this and, therefore, there are large data gaps in areas affected by the tides. In addition, the 100 cms number is derived from an older report and thus new data is needed for more accurate figures.

HYDROELECTRICITY. . .

Objectives and Performance Measures

BROAD OBJECTIVE: To maximize the value of power generation to BC Hydro, the Lower Mainland, BC customers, and government [98]			
	OBJECTIVES	**PERFORMANCE MEASURES**	**UNITS**
Hydroelectricity	**1. Maximize the financial value of power generation.** **2. Minimize the loss of generating capability in the Lower Mainland Region.**	♦ **Financial Value of Power Generation** ♦ **Financial Value of Lost Generating Capability in the Lower Mainland** This measure to be based on dollars per mega Watt hour ($/mWhr). This will: • *Require a working assumption and agreement on what a mWhr is worth* • *Incorporate a Lower Mainland premium* • *Incorporate a seasonal specification of value* Dollar value of change in power generation (change in power generation * unit value of power)	♦ Total $ / year
	3. Maintain the availability of the Buntzen facilities for the purpose of emergency black start. **or: Minimize cost of providing emergency black start capability?**	♦ **Emergency Black Start Availability** Can be measured with a simple YES / NO. *If NO, will include a measure in dollars ($) of the replacement cost of black start capability.*	♦ YES / NO ♦ If NO, replacement cost in dollars ($)
	4. Avoid other environmental impacts (e.g. greenhouse gas emissions).	♦ **Green House Gas Emissions** Environmental impacts of replacing hydro with thermal power generation can be measured in terms of emissions or tonnes of equivalent carbon dioxide (eCO_2). *To be meaningful, it is suggested that several different interpretations of this measure be presented.*	♦ Tonnes of equivalent carbon dioxide (eCO_2)

[98] The value of power reflects financial value as well as other values such as quality and reliability of service as well as avoided air emissions. Financial value is the difference between cost and revenue of power from Buntzen Generating Station. Regulatory and corporate management decisions determine how this is allocated between BC Hydro, domestic customers, and government.

Over-arching values of WUP objectives[99]

- BC Hydro profit
- Domestic power rates to BC customers
- Government revenues
- Generating capability
- Black start capability
- Quality and reliability of power supply

Related Concerns[100]

- Financial value of power
- How greenhouse gases are measured
- How power models used are developed
- Air emissions related to thermal plant power generation and reduced generation at Coquitlam
- Aboriginal rights and title

Issues for resolution outside WUP[101]

- Energy conservation
    - Consideration should be given to this issue when evaluating water allocation for power
- First Nation interest in capacity building and employment in the areas of monitoring and management of operations.[102]
- Option of raising electricity rates as a means of reducing power consumption and increasing financial value of power generation from existing facilities.

Information Gaps & Studies

- Working group members requested further information on how the financial value of power is measured and how revenue is allocated. Regarding the second point, it was suggested that an education session or backgrounder that breaks revenue into components (e.g. provincial taxes, dividends to province) would be useful. BC Hydro confirmed that this information is available and could be gathered and presented back to the group.

View of Coquitlam Dam and "Grant's Tomb"

[99] These were expressed by consultative committee members as values which are to be addressed in the WUP process through use of objectives listed in the previous table.
[100] Concerns that were raised during the process in relation to objectives.
[101] Classification of issues explained in Figure 2.
[102] Similar interest expressed by First Nations in areas of fisheries and of archaeological research.

INDUSTRY & ECONOMIC DEVELOPMENT. . .

Objectives and Performance Measures

	OBJECTIVES	PERFORMANCE MEASURES	UNITS
Industry & Economic Development	1. Improve gravel industry storm management through sediment dilution	♦ Number of days on which criteria for sufficient water are met	♦ Number of days
	2. Improve gravel industry storm water management in retention/detention and disposition areas for sand, silt, and sediment within areas affected by river flows.	♦ Suitable area available for retention/detention and disposition of sand, silt and sediment	♦ Hectares

Related Concerns[103]

Aboriginal rights and title

Issues for resolution outside WUP[104]

Maximize the socio-economic value of resources and land downstream of the Coquitlam Reservoir for: gravel extraction; land development; eco-tourism opportunities (for First Nations); and other potential development.

- While this objective was originally put forward, there is limited scope within the WUP process to influence potential for commercial development downstream of the Coquitlam Reservoir because this is largely determined through land use and/or public planning processes. However, it is recommended that the potential for ecotourism be considered along with recreation objectives.

There may be potential for gravel extraction to create additional spawning channels, thereby achieving the same impact on fish habitat with less flow.

- Take into consideration when evaluating additional flows for fish habitat.

There may be potential for disposition of sand, silt, and sediment from gravel pits to be used for the benefit of wildlife/environment, thereby achieving the same impact on wildlife objectives with less flow.

- This issue needs clarification. If there are specific examples, they should be taken into consideration when evaluating additional flows for fish habitat.

View of Gravel Operations

[103] Concerns that were raised during the process in relation to objectives.
[104] Classification of issues explained in Figure 2.

Education needed on the potential for containment of gravel pit discharge

- Consider when evaluating additional flows for sediment dilution.

Gravel operators can achieve same dilution with less flow if they are able to get access to water from the river and dilute sediment before discharging it.

- Take into consideration when evaluating additional flows for sediment dilution.

Sub-surface water table may be available as an alternative source of water to achieve objectives.[105]

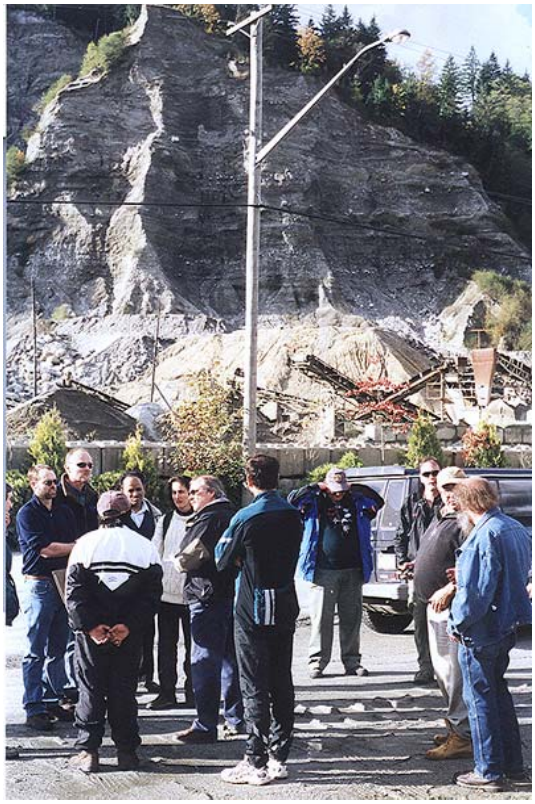
- Take into consideration when evaluating additional flows from Coquitlam Reservoir for sediment dilution and for the benefit of water quality for fish, wildlife, and recreation.

Continuing existence of gravel pits and operators is dependent on economic advantages of extraction Take expected life of gravel pits into consideration when evaluating:

- Additional flows for sediment dilution; and
- Potential to use financial value of water from the Coquitlam-Buntzen system over the short term to rebuild the river for the benefit of other interests in future.

Logging and associated road building affect the rate of flow into the Coquitlam Reservoir

- This may affect future WUP's – changes in inflow to the Coquitlam Reservoir may in future alter the range of possible operating alternatives.



Study Tour of Gravel Operations

Information Gaps & Studies

Issue to be resolved: to date, no study has been proposed for the Industry objective regarding storm water management in areas affected by river flows (e.g. study of elevation of settling ponds).

For other information gaps, see suspended sediment (turbidity) issue.

[105] For instance, discharge dilution from gravel pits and other sources.

RECREATION. . .

Objectives and Performance Measures

	SPECIFIC OBJECTIVES	PERFORMANCE MEASURES	UNITS
Recreation	**1. Maximize opportunities for recreation on Coquitlam River**	♦ ***Number of visitor days by activity*** • *Depending of results of study, a simple constructed scale -high, moderate, low- may be used*	♦ **Number of days** • *Constructed scale: H-M-L*
	2. Maximize opportunities for recreation at Buntzen Reservoir	♦ ***Number of days recreation is adversely affected by reservoir levels*** • *Adversely is defined by the minimum water level by season*	♦ **Number of days**

Over-arching values of WUP objectives[106]

- Diversity of recreation
- Quality of recreation.
- Ensure public safety.
- Opportunities for First Nations involvement in ecotourism in the watersheds and/or management services for recreation areas such as Buntzen Lake

Related Concerns[107]

- Seasonal demand for different forms of recreation
- Flow requirements for different forms of recreation
- Physical conditions for recreation
- Suspended sediment (turbidity)
- Option of altering the slope of the reservoir to remove the drop-off near the public beach[108].
- Consultative Committee has agreed to recommend maintaining minimum water levels to ensure public safety
- Aboriginal rights and title

Issues for resolution outside WUP[109]

- As part of a larger watershed plan, impacts to the areas to the north and west of Burke Mountain need to be considered. This is a GVRD issue.
- Long-term monitoring of suspended sediment (turbidity)
- Expansion of watershed tours by the GVRD (GVRD to lead this initiative)
- Management Plan for Buntzen Reservoir[110]

[106] These were expressed by consultative committee members as values which are to be addressed in the WUP process through use of objectives listed in the previous table.
[107] Concerns that were raised during the process in relation to objectives.
[108] This has been estimated to cost $0.25 million by BC Hydro.
[109] Classification of issues explained in Figure 2.
[110] Due to safety considerations, the committee agreed to recommend Buntzen maintain a "safe operating range" regarding reservoir levels. Because of this, recreation concerns will not be affected by the WUP.

Information Gaps & Studies

						OBJECTIVES ADDRESSED		
	Study Area	**Study**	**Priority**	**Study Costs**	**Time Sensitive**	**Recreation Opportunities**	**Quality of Recreation**	**Recreation Safety**
Recreation	**Buntzen**	**Alternative to proposed study:** Monitor water quality after any changes to operating regime and make appropriate changes to water flows if necessary.		up to $2,000/yr			Π	Π
		Alternative to proposed study: Minimum Water Level Commitment for Buntzen Reservoir				Π	Π	Π
	Coquitlam River	**Alternative to proposed study:** Interim Report based on local knowledge				Π	Π	

WILDLIFE & ENVIRONMENT. . .

Objectives & Performance Measures

	SPECIFIC OBJECTIVES	PERFORMANCE MEASURES	UNITS
Wildlife & Environment	**1. To maximize the area and suitability of aquatic and riparian habitat for indigenous wildlife, including species at risk and organisms not captured by fish objectives.**	♦ **Area of riparian/wetland habitat** The primary performance measure will be based on area (hectares) of suitable habitat for indigenous wildlife (river and reservoirs) • *By type of habitat (e.g. islands, types of wetland, types of riparian habitat, etc.)* • *Measure to be further studied, refined and developed* ♦ **Fish objectives and performance measures as a proxy for aquatic habitat** Fish performance measures to be further reviewed and assessed as to adequacy in this regard	◆ **Hectares**

Over-arching values of WUP objectives[111]

Quality and health of the aquatic, riparian and inter-tidal ecosystem of the Coquitlam River downstream of the dam and in the Coquitlam-Buntzen Reservoirs and Inlet, including:

- ◆ Abundance, distribution and diversity of wild native species
- ◆ Benthic populations
- ◆ Protection of species at risk
- ◆ Natural diversity
- ◆ Natural bio-diversity
- ◆ Sustainable physical and biological environment

Related Concerns[112]

Riverbed health: aquatic and benthic habitat, entrenchment, natural gravel shifting

- ◆ Fish performance measures may not adequately consider the aquatic environment and associated habitat and species issues

Wildlife Habitat near Coquitlam. River

[111] These were expressed by consultative committee members as values which are to be addressed in the WUP process through use of objectives listed in the previous table.

[112] Concerns that were raised during the process in relation to objectives

Fluctuating flows to maximize riparian habitat conditions may cause flooding or changes in the riparian zone on property legally held by other groups such as Kwikwetlem First Nation or the CPR. The legality of these issues must be considered in making recommendations for flows.

Aboriginal rights and title

Issues for resolution outside WUP[113]

Damage caused by transmission line right-of-ways feeding into the Meridian Substation (e.g. herbicide usage).

- This issue could potentially be resolved by way of discussion with herbicide and pest personnel at BC Hydro.

Quality of water flows into the Coquitlam River downstream of the dam.

- Consideration should be given to this issue when evaluating additional flows for fish, wildlife, and recreation

Quality of water flowing into Coquitlam Reservoir.

- This issue was resolved with the working assumption that current water quality in Coquitlam Reservoir is sufficient for wildlife/environment. However, monitoring may be appropriate as this may be an issue in later WUPs.

Information Gaps & Studies

During discussions, the idea of adding "learning" as a Wildlife and Environment objective was seriously considered. However, it was agreed by the Consultative Committee that measurement of this objective was not practical and work would instead focus on identifying information gaps. Specifically, working group members expressed a need to develop a better understanding of:

What indigenous species and habitat areas exist now (baseline information/inventory)?
How riparian areas along the river and reservoir are affected by BC Hydro operations?
How specific habitats will be affected by operating alternatives (e.g. habitat for endangered species, migration routes, wetlands, islands in the river that may be submerged/exposed, bird and amphibious nesting areas, etc.)?

The following one or two-part study is designed to address these questions. Part one of this study was started in August 2000. Part two of the study will only be undertaken if required.

						OBJECTIVES ADDRESSED
Wildlife & Environment	**Study Area**	**Study**	**Priority**	**Study Costs**	**Time Sensitive**	**Area & productivity of riparian habitat**
	Coquitlam River	Development of a Riparian Habitat Performance measure for wildlife *(1) Mapping, literature review and expert opinion*	1	$10K	Yes (To be completed by September 30, 2000)	Π
		Development of a Riparian Habitat Performance measure for wildlife *(2) Use of modeling to define performance measure*	1	$10K	Yes (If required, to be completed by December 31, 2000)	Π

[113] Classification of issues explained in Figure 2.

Suspended sediment (turbidity). . .

Concerns

- Impact of suspended sediment and pollutants on fish and fish habitat.
- Impact of suspended sediment on recreation opportunities
- Cumulative impacts of suspended sediment (turbidity) and sediment disposition/sedimentation on Kwikwetlem First Nation lands and river access between IR1 and IR2
- Implications of sedimentation for flooding
- How the gravel industry would respond to increased flow
- Value of monitoring to determine whether or not sedimentation/suspended sediment (turbidity) improves with increased flows
- While the quality of existing flows into the Coquitlam River could be taken into consideration when evaluating additional flows for fish, wildlife and recreation, some members of the Consultative Committee did not feel it was appropriate to compensate for discharges through manipulating flow regimes. Instead, it was felt that the appropriate regulators/enforcement agencies should address discharge and run-off issues.

Suspended sediment (turbidity) has been raised as an issue of concern at many points throughout the Coquitlam-Buntzen WUP planning process at both the working group level (Recreation, Flood, Fish, Industry) and the Consultative Committee level. It has been a difficult issue to resolve within the parameters and mandate of the WUP. In June 2000, the Consultative Committee delegated the issue to a working group for discussion and recommendations to the Consultative Committee. On June 22nd, the Industry/Suspended sediment (turbidity) working group met and recognized that:

> ***Changes in concentration, transportation and disposition of sediment due to flow changes, influence recreation, flood control, Kwikwetlem boat access, industry, and, potentially, the effectiveness of habitat created for fish.***

Deliberation to date within the Fish Working Group has resulted in the recommendation that the issue of suspended sediment (turbidity) not be considered an appropriate performance measure for fish objectives for this WUP for the following reasons:

- Downstream sources of suspended sediment (turbidity) are not within BC Hydro/WUP control.
- Impacts of suspended sediment (turbidity) on habitat are included under substrate performance measure for fish.
- Suspended sediment (turbidity) will not influence decision for best flows: rather, they will be based on habitat.
- Responsibility for suspended sediment (turbidity) sources to control their discharges should not be compromised.
- Inclusion of a fish performance measure for suspended sediment (turbidity) would not aid regulatory or enforcement actions.

Issues for resolution outside WUP

- Gravel operators wish to raise public awareness that:
    - Discharge from all industry & development (not just from gravel industry) affects water quality for fish/environment in the Coquitlam River.[114]
    - Run-off from developments through gravel pits to Coquitlam River increases sediment discharge.
    - Better, independent, up to date science about appropriateness of the 75 ppm guideline for sediment dilution, particularly with respect to particle size and shape
        - Consider status of decisions outside WUP process when evaluating flow for sediment dilution.[115]
        - Take quality of inflows into Coquitlam River into consideration when evaluating additional flows for fish, environment, and recreation.

Monitoring & Evaluation

- Consideration may be given to monitoring for suspended sediment (turbidity) in the future
- E.g. baseline study of suspended sediment (turbidity) to determine whether suspended sediment (turbidity) improves or deteriorates in the future under the WUP.

Information Gaps & Studies

To better understand how and if the issue of suspended sediment (turbidity) should be incorporated as an objective in the Coquitlam-Buntzen WUP and if there is a need for long-term monitoring the working group recommended the following studies be undertaken by a third party:

- A study on the effect of sedimentation on flooding and boat access for Kwikwetlem Nation
- A collection of literature on suspended sediment (turbidity) influences on recreation, flood control, industry, and fish

Given these information gaps and questions regarding the value of monitoring for suspended sediment (turbidity), the Consultative Committee agreed in July 2000 that:

- A meeting would be scheduled in the fall for a compiled literature review (by consultants) and general education session to be delivered to the Consultative Committee. Possible dates will be suggested at the first Consultative Committee Meeting in September.
- Post-WUP suspended sediment (turbidity) monitoring would be considered once operating alternatives are developed.
- The relationship between flow and (a) flood management; (b) Kwikwetlem boat access; and (c) substrate quality for fish and other aquatic organisms will be incorporated in the decision framework.
- Suspended sediment (turbidity) would not be lost as an issue in the decision making process and may be revisited in the fall after the Consultative Committee education session.

[114] Concerns noted at Consultative Committee meetings include: (i) water from Tower & Orr Creeks (related points: slide activity on both creeks; ongoing management activities on Tower Creek); and (ii) discharge/run-off from gravel industry, Westwood Plateau, storm sewers, Lougheed Highway at Red Bridge, Essondale swimming pool, Colony Farm fertilizers, Chicken processing plant on Scott Creek.

[115] For instance, is there change expected in regulation, redirection of stormwater run-off from Westwood Plateau through gravel pits, or other initiatives?

Consultative Committee

The Consultative Committee for the Coquitlam-Buntzen Water Use Plan includes representatives from the following organizations and groups:

Allard Contractors Ltd.
BC Federation of Drift Fishers
BC Hydro
BC Watershed Stewardship
Buntzen Ridge Wilderness Recreation & Parks Association
Burke Mountain Naturalists
City of Coquitlam
Coquitlam River Watershed Society
Fish & Oceans Canada
Fraser Basin Council
Greater Vancouver Regional District
Habitat Conservation and Stewardship Program
Katzie First Nation
Kwikwetlem First Nation
Local individual residents
Ministry of Environment, Lands & Parks
North Fraser Salmon Assistance Project
Port Coquitlam Hunting and Fishing Club/RACE
Port Moody Ecological Society
River Springs Strata Corporation
River Springs Streamkeepers
Sto:lo First Nation
Tsleil-Waututh First Nation
Watershed Watch Salmon Society

Appendix B CBWUP MEETINGS[116]

CONSULTATIVE COMMITTEE MAIN TABLE

Nov 8, 1999
Nov 22, 1999
Dec 13, 1999
Jan 15, 2000
Jan 24, 2000
Feb 7, 2000
Mar 6, 2000
Apr 17, 2000
Jun 5, 2000
Jun 15, 2000
Jul 6, 2000
Sep 25, 2000
Oct 16, 2000
Oct 30, 2000
Dec 11, 2000
Feb 5, 2001
Mar 5, 2001
May 14, 2001
Jun 11, 2001
Jul 9, 2001
Oct 22, 2001
March 11, 2002

CONSULTATIVE COMMITTEE WORKING GROUPS

Archaeology, Culture, & History

Oct 13, 2000
Jan 25, 2001
Feb 13, 2001
Apr 26, 2001

Fish/Environment

Feb 28, 2000
Apr 1, 2000

Fish Working Group

May 9, 2000
May 15, 2000*
May 25, 2000*
May 29, 2000

Wildlife and Environment

May 17, 2000
Oct 11, 2000
Nov 28, 2000

Flood Control

Mar 1, 2000
May 10, 2000

Domestic Water

Feb 22, 2000
May 15, 2000

Hydroelectric

Apr 3, 2000
May 17, 2000

Industry

Mar 29, 2000
May 15, 2000
Jun 22, 2000

Recreation

Mar 30, 2000
May 10, 2000
Sep 28, 2000

[116] These meetings are in addition to numerous phone calls, conference calls and e-mail dialogue, particularly by the FTC.

Operating Alternatives Refinement

Jul 19, 2001
Aug 14, 2001
Sep 5, 2001
Feb 23, 2001

FISH TECHNICAL COMMITTEE

Aug. 1, 2000
Aug 29, 2000
Oct 30, 2000
Nov 23, 2001
Nov 29, 2001
Jan 11, 2001
Jan 26, 2001
Feb 1, 2001*
Mar 1, 2001
Mar 8, 2001*
Mar 19, 2001*
Mar 26, 2001
Apr 2, 2001
Apr 11, 2001
May 3, 2001
May 30, 2001
Jun 18, 2001
Jun 28, 2001
Aug 27, 2001
Sep 17, 2001
Sep 28, 2001
Oct 15, 2001**
Nov 8, 2001
Feb. 14, 2002

* Sub-committee meetings; no minutes

** Included session with GVRD staff to clarify significance of fish impacts across operating alternatives.

FIRST NATIONS TABLE

Dec 6, 1999
Jan 10, 2000
Mar 13, 2000
Apr 10, 2000
Apr 26, 2000
May 2, 2000
May 9, 2000
May 30, 2000

KWIKWETLEM FIRST NATION TABLE

Jul 5, 2000
Feb 13, 2001 (Flooding)
Mar 5, 2001 (Flooding)

CROSS CULTURAL TRAINING SESSION

Feb 22, 2000

FIELD TRIPS & INFORMATION SESSIONS

Nov 1999	Site Tour
Jul 9, 2000	Tour of Coquitlam River to discuss riparian issues (consultant, BC Hydro, & 2 CC members)
Sep 14, 2000	BC Hydro & Comptroller of Water Rights Presentation
Oct 21, 2000	Coquitlam River Field Trip
Feb 1, 2001	Suspended Sediment/Turbidity Information Session
Oct 10, 2001	Progress update on July-September 2001 Working Group and FTC meetings

PUBLIC OPEN HOUSE

September 20, 1999
October 18, 1999

Appendix C PROCESS PARTICIPANTS

NOTE:

Item #1. First Nations involvement changed throughout the CBWUP process and is therefore listed in a separate table with comments.

Item #2. Provincial agency name changes occurred at the end of the process (in the summer of 2001):

- Ministry of Energy and Mines was Ministry of Employment and Investment;
- Ministry of Water, Land and Air Protection was Ministry of Environment, Lands and Parks (Fish and Wildlife);
- Ministry of Sustainable Resource Management was BC Fish; and
- Ministry of Sustainable Resource Management was Ministry of Environment, Lands and Parks (Water Management).

Consultative Committee Members[117]

* Present when recommended operating plan was developed and agreed to at October 22, 2001 CC meeting

Affiliation	Name
Allard Contractors Ltd.	Allard, Jim
BC Federation of Drift Fishers	Aronetz, Cal*
BC Hydro	Misewich, Bruce* Udell, Walter*
Buntzen Ridge Wilderness Recreation and Parks Association	Bojczuk, Lawrence*
Burke Mountain Naturalists	Gillespie, Don* Golds, Elaine*
City of Coquitlam	Lees, Fraser (member to May 14/01; observer on Jun 11/01) Henry Wong (attended CC meeting Jul 9/01, status unresolved) Brian Shields (observer Oct 22/01)*
Coquitlam River Watershed Society	Hodge, Eunice*
Department of Fisheries and Oceans	Calla, Karen (maternity leave from Nov 01) Sneep, Dan*
Greater Vancouver Regional District	Archibald, Paul* Bonin, Derek* Dunkley, David* Wood, Stan*
Habitat Conservation and Stewardship Program, Maple Ridge-Coquitlam	Jarvis, Janice*
Local Individual Residents	Carroll, Sherry* Gillespie, Dr. Don* Hilpert, Brent* McArthur, Ian* Pauker, Joseph*
Ministry of Water, Air, & Land Protection	Neuman, Ross*
Ministry of Sustainable Resource Management	Kartha, Bijou (attended meetings as full CC member until July 2001; observer at last 2 CC meetings - Oct 2001 and Jan 2002)*
North Fraser Salmon Assistance Project - Coquitlam River Watershed Society	Matahlija, Tony*
Port Moody Ecological Society	Simpson, Rick (last attended CC meeting on Feb 5/01 and final meeting on March 11, 2002) (also representing PoCo Hunting & Fishing Club) Aichberger, Nancy (last attended CC meeting on Dec 11,2000 and final meeting on March 11, 2002)
Port Coquitlam Hunting & Fishing Club	Goeson, Wayne (alternate Al Grist/Rick Simpson)
Watershed Watch Salmon Society	Doucette (Aichberger), Kirsten* Orr, Craig*

[117] First Nation involvement noted separately below.

First Nation Involvement

First Nation	Representative	Comments
Katzie First Nation	Tom Blackbird Debbie Miller*	Attended meetings 1999 to March 2001 Received minutes of CC meetings Attended meetings periodically 1999-2001
Kwikwetlem First Nation	Ed Hall Tom Blackbird Glen Joe George Chaffee	Attended meetings 1999 to February 2000 Attended meetings 1999 to May 2000 Attended meetings March 2000 through to October 22, 2001. Received minutes of CC meetings.
Musqeam First Nation	Willard Sparrow	Attended meetings 1999 to January 2000 Chief and Council received minutes of CC meetings.
Sto:lo Nation	Colin Duffield Riley Lewis	Attended meetings 1999 to May 2000 Attended meetings May 2000 to May 2001
Tsleil-Waututh First Nation	Doug Aberley Leah George-Wilson	Attended meetings 1999 to October 2000 Received minutes of CC meetings Attended meetings October 2000 and February 2001. Received minutes of CC meetings.

BC Hydro Project Team

Role	Name
Consultation/Communications	Bemister, Charlotte
CBWUP Project Manager	Geissler, Al
Resource Valuation	Harstone, Michael (previously Kristy McLeod)
Environment	Hill, Ed
Aboriginal Relations	Hutchings, Janie (previously Lorrie MacGregor)
Fish	Leake, Alf
Power studies	Lee, Kathy
Member of Fish Technical Committee	Longworth, Goff
Power studies	Plesa, Vlad
Recreation	Wilson, Clive

External Resources

Position/Role	Name
Resource Valuation & Trade-off Consultants	Harris, Maria Trousdale, William
Non-CC Members of Fish Technical Committee (FTC)	McAdam, Steve, Ministry of Water, Air and Land Protection Ptolemy, Ron, Ministry of Water, Air and Land Protection

Recipients of Minutes Only from CC Meetings[118]

Affiliation	Name
Burrard Inlet Marine Enhancement Society / Fish Ecology Program, Centennial Senior Secondary	Foster, Ruth
Canada Coast Guard - Pacific Region	Mackie, John
Canada Wildlife Service	Brock, Ken
City of Port Coquitlam	Jensen, Al
City of Port Moody	Pavey, Julie
Colony Farm Park Association	Beckenbach, Karen
Coquitlam River Watershed Society	Poirier, Norman Zosiak, Lisa
Department of Fisheries and Oceans	Macfarlane, Steve
Fraser Basin Council	Bob Purdy
Friends of the Watershed	Koop, Will
Hoy/Scott Creek Streamkeepers	Girvan, Lori
Jack Cewe Ltd.	Home, George Turi, George
Local Resident	Williams, Niall
Ministry of Energy & Mines	Mullen-Dahlmer, Denise
Ministry of Water, Land, & Air Protection (Fish, Wildlife and Habitat Protection)	Clark, Brian
Ministry of Forests	Knutson, Russ
Northeast Coquitlam Ratepayer's Association	Ward, Eleanor
River Springs Strata Corporation	Kelly Wainwright
River Springs Streamkeepers – CRWS	Jakse, John
Steelhead Aggregates	Esau, Bob
Steelhead Society of BC	Brown, Haley
Tilbury Cement Limited	Savelieff, Ron
Town Centre Community Association	Friesen, Claudette
Village of Anmore	Weinberg, Mayor Hal
Village of Belcarra	McGregor, Moira
Westwood Plateau Community Association	Beaudoin, Gary

[118] First Nations involvement noted separately.

Appendix D PUBLIC CONSULTATION AND COMMUNICATION ACTIVITIES

Process Initiation Advertisement

Advertisement in local regional papers:

Tri City News	15 & 19 September, October 13, 1999
Now	15 & 18 September, October 13, 1999

Invitation Letter

To MLA, MP, Cities of Coquitlam, Port Coquitlam, Port Moody, Belcarra and Anmore.
All known community and environmental interest groups active in the watershed
Provincial non-governmental organizations advised of WUP initiation

Information Sessions

20 September and 18 October, 1999

BC Hydro Water Use Plan Website www.bchydo.com/wup

Provides WUP overview and project specific information

Community Events

Water Use Planning Display, Handouts and knowledgeable staff available at the following community events:

Coquitlam Salmon Come Home Days	October 1999, 2000, 2001
Coquitlam Trail Fest and Environment Fair	April 2000
Coquitlam Tree Fest at Riverview	September 2000
Hyde Creek Salmon Festival	November 2000, 2001
Coquitlam Environmental Days – Earth Day	April 2001
Port Moody Fingerling Festival	May 2000, 2001

Update Information Advertisements

Titled “Coquitlam Buntzen Water Use Plan: Finding a better balance” in local regional papers

Now	30 September 2000
Tri City News	1 October 2000

Titled “Coquitlam Buntzen Water Use Plan Update”

Tri City News	25 May 2002

Documentation

A copy of the CC Report will be made available at the Coquitlam Public Library (Poirier Street Branch)
Access to documentation is also available on BC Hydro’s Website: http//www.bchydro.com/wup

Appendix E FISH INFORMATION SHEETS

This Appendix summarizes the fish information that CC members used to refine performance measures & operating alternatives and to carry out trade-off analyses.[119]

Information sheets in this appendix:

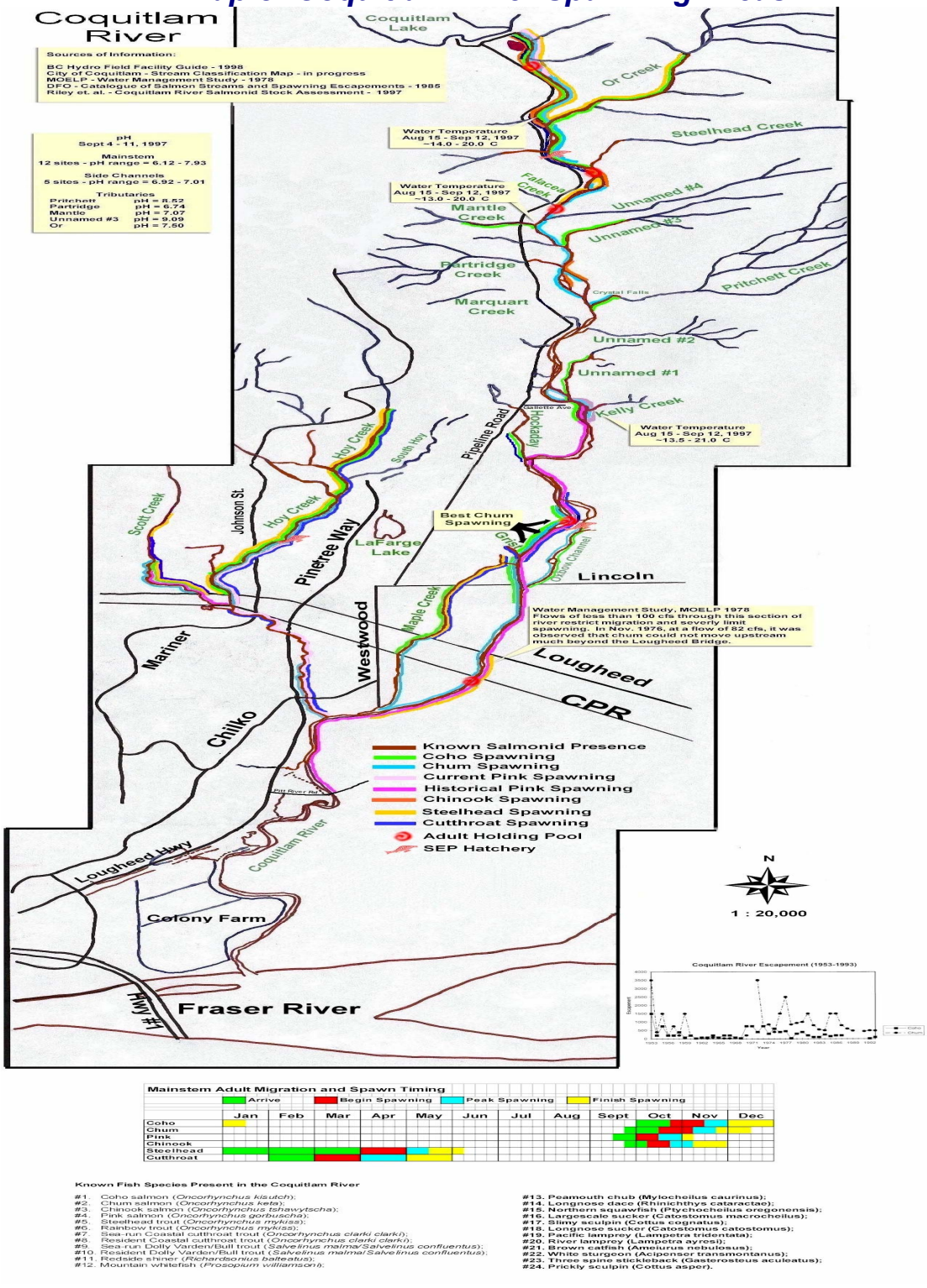
Item #1	**Coquitlam River**
Item #1a	Map Of Coquitlam River Spawning Areas
Item #1b	Detail On Fish Performance Measures (PMs) and Impact Analyses
Item #1c	Instream Flow Needs (IFN) Assessment & Transect Analysis Summary
Item# 1d	Invertebrate Habitat Analysis
Item #2	**Coquitlam Reservoir**
Item #2a	Effective Littoral Zone
Item #2b	Tributary Access Issues
Item #3	**Indian Arm**
Item #3a	Nearshore Marine Community & Tailrace Fishery
Item #3b	Water Quality Impacts from Changing Buntzen (LB1/2) Operations
Item #4	**Fish Friendly Flow Alternative**
Item #5	**FTC Flushing Flow Recommendation**

[119] This appendix only includes information about the fisheries performance measures that were ultimately used by the Consultative Committee for trade-off analyses. In addition, the CC considered other information on the basis of which they decided NOT to create performance measures for this WUP. The study briefs that are not reproduced here but are available along with CC minutes and meeting materials include the following:

- Coq. River: Degree of Spawner Accessibility to the Coquitlam River & Key Tributaries
- Coq. Reservoir:
  - Water Quality Study, including temperature findings for the river

Item #1 Coquitlam River

Item #1A Map of Coquitlam River Spawning Areas[120]



[120] Produced by Janice Jarvis (CC member) for the CBWUP Consultative Committee.

Item #1B Detail on Fish PMs and Impact Analyses

This information sheet was compiled using material supplied by the FTC to the Consultative Committee. It provides additional detail about Coquitlam River fish performance measures and impact analyses.

Fish Definitions

Weighted Usable Area (WUA): WUA, documented in square metres of habitat, is an established means of evaluating flows for fish benefits, integrating depth and velocity conditions as well as reach habitat values for each species with preference criteria specific to fish life history requirements.[121]

Life History Period (Fish Periodicity): The life histories describe the time periods of assessment (see references below). The conservation flow regime is directly influenced by the life histories of the Coquitlam River.

Bottleneck Period (Parr Habitat): The phenomena of habitat bottlenecks are important but often poorly understood (Weins 1977). The basic premise of the bottleneck is that populations of aquatic organisms are related to the availability of habitat *through tim*e. These flow-related habitat bottlenecks typically occur 1 to 3 or more years prior to maturation, when their effects are detectable in the adult population (Nehring and Anderson 1993; Bovee et. 1994). The FTC has highlighted the month of August as a critical bottleneck period in the analysis of parr habitats and frequency of events periods.

Change from Current (used in data tables below): a relative difference meant to illustrate the difference each alternative provides for habitats in terms of current operations. The formula is:

$$\% \text{ Change} = 100\% * (WUA_{\text{Alt X}} - WUA_{\text{Current Ops}}) / WUA_{\text{Current Ops}}$$

Frequency of Events (% of life history): see PM descriptions below

Natural Flow Outputs: For the Frequency of Events performance measures, comparisons were made to "natural flows" which are the flows expected at the Port Coquitlam gauge for the modeling period (1960-1998). Reservoir inflows are assumed to be dampened over 10-days due to the storage in the original lake, and are then added to the local (lower basin) inflows (as read at the Port Coquitlam gauge) each day.

Change from Natural Flows (used in data tables below): Percent differences from natural flows, not to be confused with relative difference, percent difference is simply the difference of the alternative evaluated from natural, in terms of percent of time flows meet a certain threshold. For example, in the first section, "ESOR", the steelhead parr period has flows less than 2.7cms for 41% of the period. This is 35% more than would occur naturally (by default, natural flows provide flows less than 2.7 cms for only 6% of the parr rearing period).

[121] Detail on calculation methods provided in *IFN PM Information Sheet,* July 9, 2001 – included as a separate information item in this appendix.

Coquitlam River Reach Boundaries & Lengths:

Reach	Boundaries	Length (1:20,000 map)
R0	Fraser to Lougheed Hwy	5.8
R1	Lougheed Hwy to Patricia FootBridge	2.2
R2a	Patricia Footbridge to Lincoln Road	3.1
R2b	Lincoln Road to Monte Creek	3.2
R3	Monte Crk to Or Crk	1.7
R4	Or Crk to Dam	1.7
	Total	**17.7**

Coquitlam River Fish Performance Measures

Three types of measures are used for comparing and evaluating the CBWUP operating alternatives. Measures 2 and 3 are guides to help inform the FTC and CC members on the value of each alternative. Measure 1 remains the main tool for evaluating flow alternatives. ***Limiting Factors in the Coquitlam River:*** The productivity and success of fish in the Coquitlam River, as in many other coastal streams, is dependent on the rearing stages for those salmonids that rear in the river after emergence. In the case of steelhead, parr habitats are considered limiting in the context of all other life history habitats.

(1) ***Measure 1***: **Fish habitat suitability PM**, expressed as weighted usable area available for each of three salmonid life histories.
Life History Period (Fish Periodicity): The following four salmonid life histories are evaluated in the river:

salmon spawning (late September to early January, covering chinook, pink and coho spawning periods);
steelhead spawning (beginning of March to early June); and
steelhead parr (late March to mid October);
steelhead parr – bottleneck period (August only)

(2) ***Measure 2:*** **Invertebrate habitat suitability PM**, expressed as weighted usable area in square metres. Invertebrate preference curves, defined for an indicator subgroup of species in the Coquitlam River, are integrated with transect flow modeling to develop habitat versus flow data for the river. The PM is then integrated against daily flows in the river to define median habitat area values for invertebrate life history (beginning of March to end of October). The results are meant to act as a check on the fish WUA PM outputs primarily because they mirror the results of the steelhead parr results, and secondly to reduce the amount of information the CC must consider.[122]

(3) ***Measure 3:*** **Frequency of Events (FOE) PMs** represent the frequency with which alternatives satisfy flow requirements for various life histories. FOE PMs are compared to natural events, as this links the operating alternatives to the expected natural hydrograph results for the evaluation period[123]. Flow requirements are described below:
   (a) **Short Term Survival Flows (STSF):** STSF, defined as 10% of mean annual discharge (MAD, 2.7cms at the Port Coquitlam gauge) , has been documented on natural BC rivers as the minimum flow for sustaining a natural river ecosystem. The minimum flow must be increased after a short

[122] Background on invertebrate habitat analysis done for the CBWUP provided in *Invertebrate Habitat Analysis Information Sheet,* July 9, 2001 – included as a separate information item in this appendix.
[123] "Natural flows" are defined as the flows expected at the Port Coquitlam gauge for the modeling period (1960-1998).

period of time (less than two weeks), in order to maintain year class success. This PM is presented as the percentage of time flows are below 2.7cms during the life history period. The lower the percentage, the better the habitat conditions.

(b) **Rearing Flows***:* Defined as 20% of MAD (5.4cms at the Port Coquitlam gauge) for steelhead parr requirements, rearing flow criteria are based on natural river studies in BC. Such flows have been judged in this evaluation as optimal for rearing salmonids, and aquatic insects. WUA PMs developed specifically for the Coquitlam River, using riffle/cascade transects, have indicated that parr habitat is maximized at a much higher flow (10.1cms at the Port Coquitlam gauge). This PM is presented as the percentage of time flows are below 5.4cms during the life history period. The lower the percentage, the better the habitat conditions.

(c) **Spawning Flows***:* Defined as 46% MAD (12cms at the Port Coquitlam gauge) for steelhead and chinook based on studies of natural rivers. WUA PMs for the Coquitlam River indicate that habitat is maximized for chinook spawners at 7.5cms, and steelhead spawners at 14.15cms. This PM is presented as the percentage of time flows are above 12cms during the salmon life history period. The higher the percentage, the better the habitat conditions.

Detailed Charts and Data for Fish Impact Analyses (Coquitlam River)

ESOR		ST Sp		ST Parr		CH Sp		Invertebrates	
Weighted Usable Area PMs:		*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*
		14547	-8.8%	79077	-9.1%	15968	-5.8%	85239	-8.9%
Freq. of Events PMs (% of Life History):	***Threshold Criteria:***	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*		
	< 2.7 cms	19%	19%	41%	35%	36%	36%		
	< 5.4 cms	55%	55%	73%	57%	62%	57%		
	>12 cms	10%	-81%	7%	-60%	19%	-60%		

2FV - CA		ST Sp		ST Parr		CH Sp		Invertebrates	
Weighted Usable Area PMs:		*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*
		15943	0.0%	86955	0.0%	16956	0.0%	93553	0.0%
Freq. of Events PMs (% of Life History):	***Threshold Criteria:***	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*		
	< 2.7 cms	16%	16%	33%	26%	27%	27%		
	< 5.4 cms	50%	50%	68%	52%	57%	52%		
	>12 cms	11%	-80%	8%	-59%	21%	-58%		

DWF (2FV - PA)

		ST Sp		ST Parr		CH Sp		Invertebrates	
Weighted Usable Area PMs:		*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*
		16995	6.6%	86740	-0.2%	16753	-1.2%	93900	0.4%
Freq. of Events PMs (% of Life History):	***Threshold Criteria:***	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*		
	< 2.7 cms	13%	13%	33%	27%	25%	25%		
	< 5.4 cms	48%	48%	66%	50%	56%	51%		
	>12 cms	12%	-79%	8%	-59%	21%	-58%		

4FV Optimized

		ST Sp		ST Parr		CH Sp		Invertebrates	
Weighted Usable Area PMs:		*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*
		23651	48.4%	95547	9.9%	16784	-1.0%	104987	12.2%
Freq. of Events PMs (% of Life History):	***Threshold Criteria:***	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*		
	< 2.7 cms	0%	0%	15%	9%	25%	25%		
	< 5.4 cms	14%	14%	48%	32%	57%	52%		
	>12 cms	19%	-72%	12%	-55%	21%	-58%		

STP4

		ST Sp		ST Parr		CH Sp		Invertebrates	
Weighted Usable Area PMs:		*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*
		26522	66.4%	101480	16.7%	21089	24.4%	114241	22.1%
Freq. of Events PMs (% of Life History):	***Threshold Criteria:***	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*		
	< 2.7 cms	0%	0%	0%	-6%	0%	0%		
	< 5.4 cms	6%	6%	35%	19%	38%	34%		
	>12 cms	38%	-53%	18%	-49%	24%	-54%		

STP5

		ST Sp		ST Parr		CH Sp		Invertebrates	
Weighted Usable Area PMs:		*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*
		26918	68.8%	103087	18.6%	21089	24.4%	116232	24.2%
Freq. of Events PMs (% of Life History):	***Threshold Criteria:***	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*		
	< 2.7 cms	0%	0%	0%	-6%	0%	0%		
	< 5.4 cms	5%	5%	25%	9%	38%	34%		
	>12 cms	38%	-53%	19%	-48%	24%	-54%		

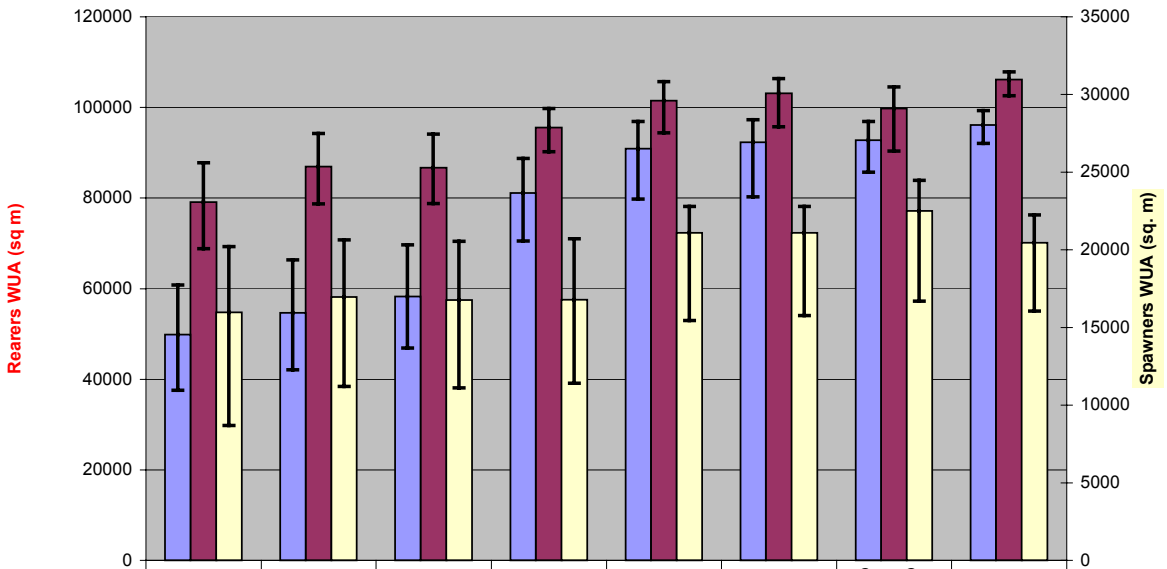
Cons Q - GVRD

		ST Sp		ST Parr		CH Sp		Invertebrates	
Weighted Usable Area PMs:		*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*
		27067	69.8%	99748	14.7%	22496	32.7%	112608	20.4%
Freq. of Events PMs (% of Life History):	***Threshold Criteria:***	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*		
	< 2.7 cms	0%	0%	6%	0%	3%	3%		
	< 5.4 cms	2%	2%	33%	17%	12%	7%		
	>12 cms	38%	-53%	19%	-48%	30%	-49%		

FFQ

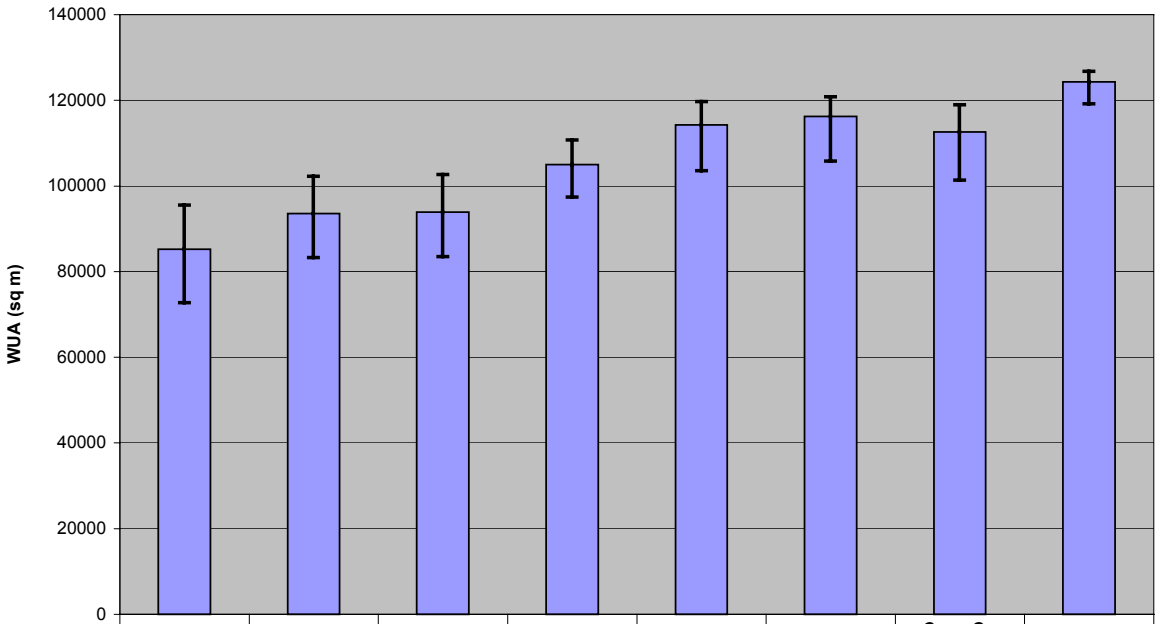
		ST Sp		ST Parr		CH Sp		Invertebrates	
Weighted Usable Area PMs:		*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*	*WUA (sq m)*	*Change from Current Ops (% of current)*
		28032	75.8%	106127	22.0%	20458	20.7%	124322	32.9%
Freq. of Events PMs (% of Life History):	***Threshold Criteria:***	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*	*% of Time*	*Change from Natural Inflows (% Diff)*		
	< 2.7 cms	0%	0%	0%	-6%	5%	5%		
	< 5.4 cms	0%	0%	4%	-12%	43%	38%		
	>12 cms	71%	-20%	37%	-30%	23%	-55%		

Evaluation of Current Alternatives:
Weighted Usable Area in River (sq m) for all Indicator Species Life Histories
Error Bars indicate 90th and 10th percentile outputs



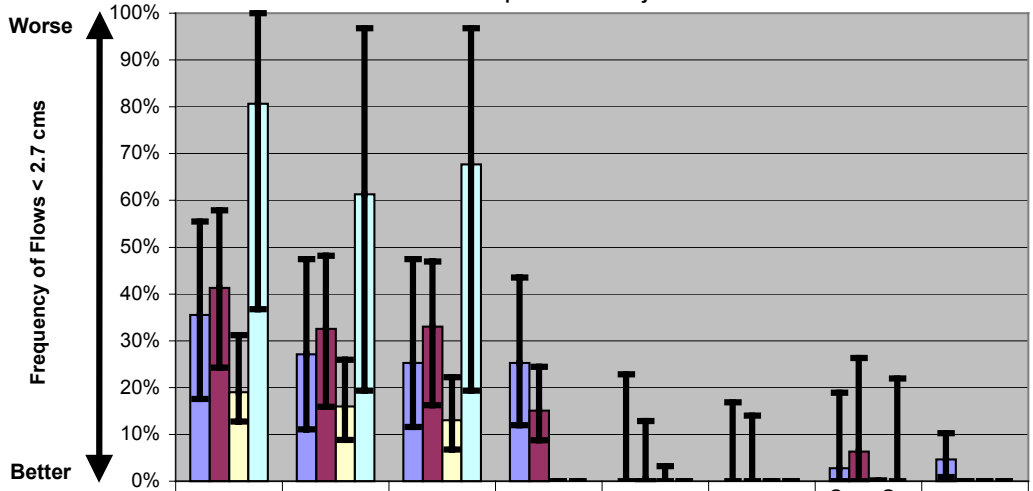
	ESOR	2FV and CA	2FV and PA	4FV New	STP4	STP5	Cons Q - GVRD	FFQ
ST Parr	79077	86955	86740	95547	101480	103087	99748	106127
ST Sp	14547	15943	16995	23651	26522	26918	27067	28032
Salmon Sp	15968	16956	16753	16784	21089	21089	22496	20458

Evaluation of Current Alternatives:
Invertebrate WUA in River (sq m)
Bars indicate 90th and 10th percentile outputs



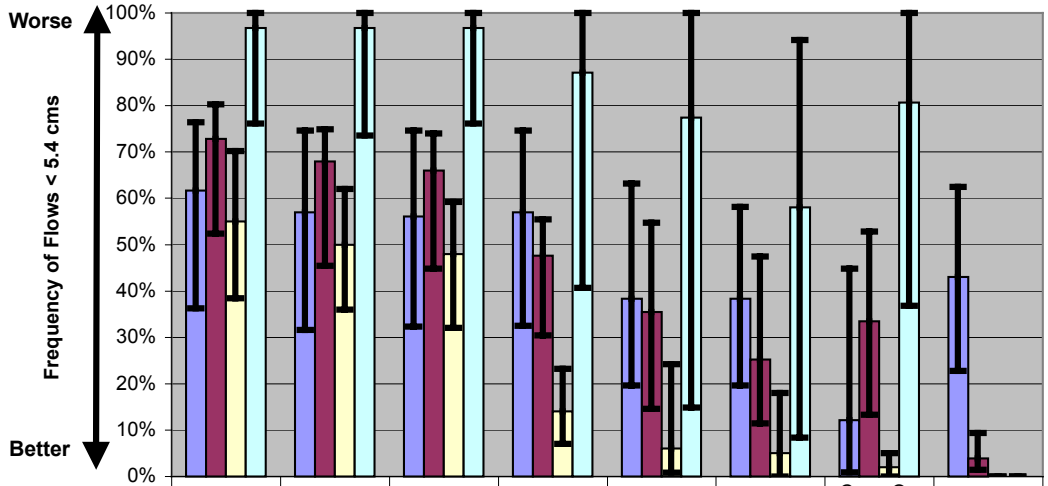
	ESOR	*2FV and CA*	*2FV and PA*	*4FV New*	*STP4*	*STP5*	*Cons Q - GVRD*	*FFQ*
Inverts	*85239*	*93553*	*93900*	*104987*	*114241*	*116232*	*112608*	*124322*

Current Alternatives Evaluation:
Frequency of Flows Below Short Term Survival Requirements
(Less than 2.7 cms - 10% MAD - at PoCo Gauge)
Bars indicate 10th and 90th Percentile Outputs over the 40yr Period

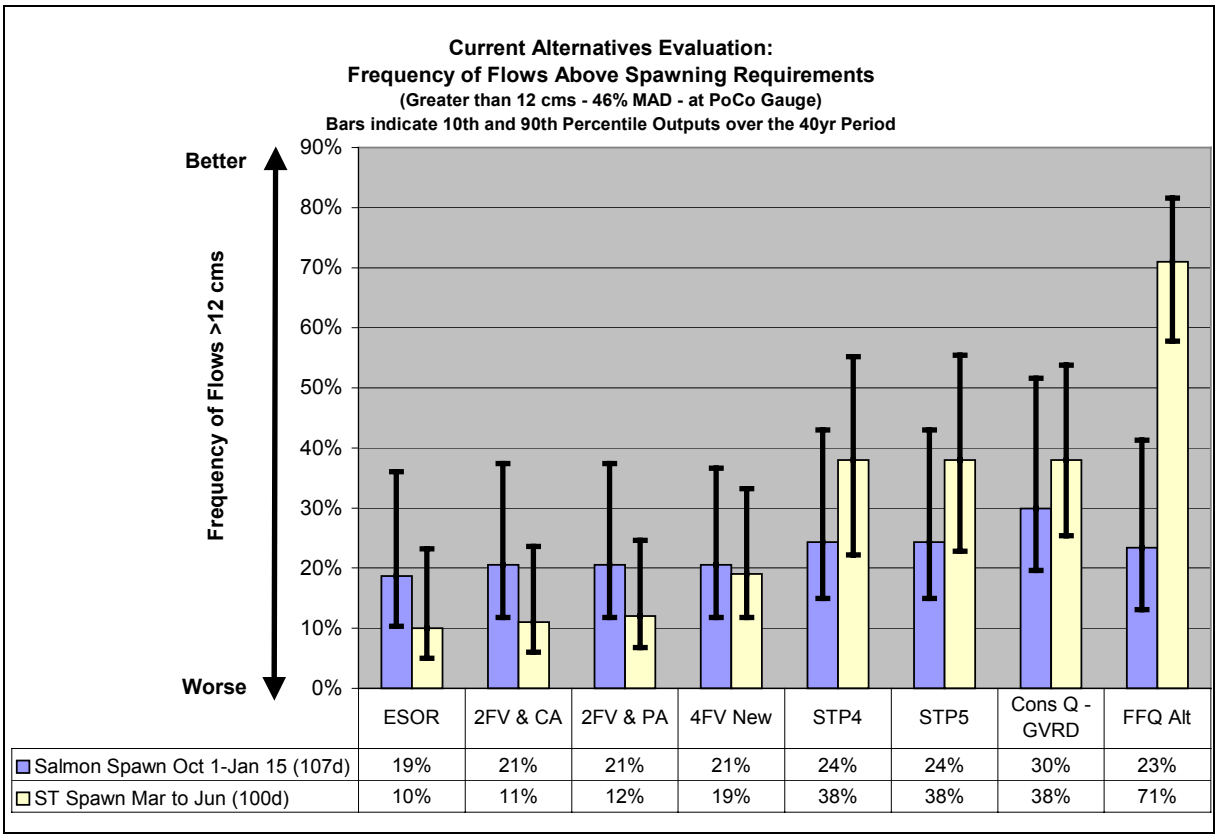


	ESOR	2FV & CA	2FV & PA	4FV New	STP4	STP5	Cons Q - GVRD	FFQ Alt
Salmon Spawn Oct 1-Jan 15 (107d)	36%	27%	25%	25%	0%	0%	3%	5%
ST Parr Mar to Oct (206d)	41%	33%	33%	15%	0%	0%	6%	0%
ST Spawn Mar to Jun (100d)	19%	16%	13%	0%	0%	0%	0%	0%
ST Parr Aug Only (31d)	81%	61%	68%	0%	0%	0%	0%	0%

Current Alternatives Evaluation:
Frequency of Flows Below Rearing Requirements
(Less than 5.4 cms - 20% MAD - at PoCo Gauge)
Bars indicate 10th and 90th Percentile Outputs over the 40yr Period



	ESOR	2FV & CA	2FV & PA	4FV New	STP4	STP5	Cons Q - GVRD	FFQ Alt
Salmon Spawn Oct 1-Jan 15 (107d)	62%	57%	56%	57%	38%	38%	12%	43%
ST Parr Mar to Oct (206d)	73%	68%	66%	48%	35%	25%	33%	4%
ST Spawn Mar to Jun (100d)	55%	50%	48%	14%	6%	5%	2%	0%
ST Parr Aug Only (31d)	97%	97%	97%	87%	77%	58%	81%	0%



	ESOR	2FV & CA	2FV & PA	4FV New	STP4	STP5	Cons Q - GVRD	FFQ Alt
Salmon Spawn Oct 1-Jan 15 (107d)	19%	21%	21%	21%	24%	24%	30%	23%
ST Spawn Mar to Jun (100d)	10%	11%	12%	19%	38%	38%	38%	71%

Item #1C Instream Flow Needs (IFN) Assessment & Transect Analysis Summary

This is a study brief submitted to the CBWUP Consultative Committee on July 9, 2001 by the Fish Technical Committee (FTC). It provides background information about how habitat suitability performance measures for the Coquitlam River were derived for this WUP.

COQUITLAM/BUNTZEN WUP FTC INFORMATION SHEET
Coquitlam River Instream Flow Needs Assessment (IFN) and Transect Analysis Summary

Hypothesis Addressed:
Fluctuations and abundance in salmonid habitat downstream of the Coquitlam Dam determines the productive capacity of the Coquitlam River.

Description:
Salmonid behavior differs between species and life stages, and is usually characterized by the important bottle necks which drive species success. For the Coquitlam River, these life stages are characterized by:
1. Rearing for fry and juveniles;
2. Spawning for adults;
3. Incubation for spawning sites (redds); and
4. Passage for migrating adults.

Since passage for adults has been assessed as adequate given the current flow agreements, the Coquitlam FTC has focussed on assessing habitat for the first three life stages, for the following species:
1. Coho fry, adult spawners, and incubation;
2. Chinook fry, adult spawners, and incubation;
3. Pink spawners, and incubation;
4. Chum spawners, and incubation; and
5. Steelhead fry, parr, adult spawners, and incubation.

Sockeye were not considered in habitat assessments due to the lack access to appropriate lake habitats for rearing and above which historical populations would have spawned.

Objectives:
Maximize the productive capacity of the Coquitlam River.

Timing and Target Species:
Figure 1 describes the life history table which dictates the species and timing for life stages which govern the assessment tools used to evaluate flow alternatives.

Calculations:

Methods:
Data collected in the habitat suitability assessment portion of the the instream flow needs assessment (IFN) study, and suitability curves from agency databases provided probability of use statistics for various rearing and spawning species in the river. These data were to be integrated with transect and linear habitat mapping data to derive habitat versus flow curves for each life history and species. However, data collection for the IFN study was dependant on inflows that were lacking in the 00/01 hydrology year, and

transect analysis was initiated using modeling of river flows. Because of the need to reduce the scope of calculations, chinook and coho spawning timing were extended to meet chum and pink spawning timing, which then allowed the FTC to ignore pink and chum use in the river.

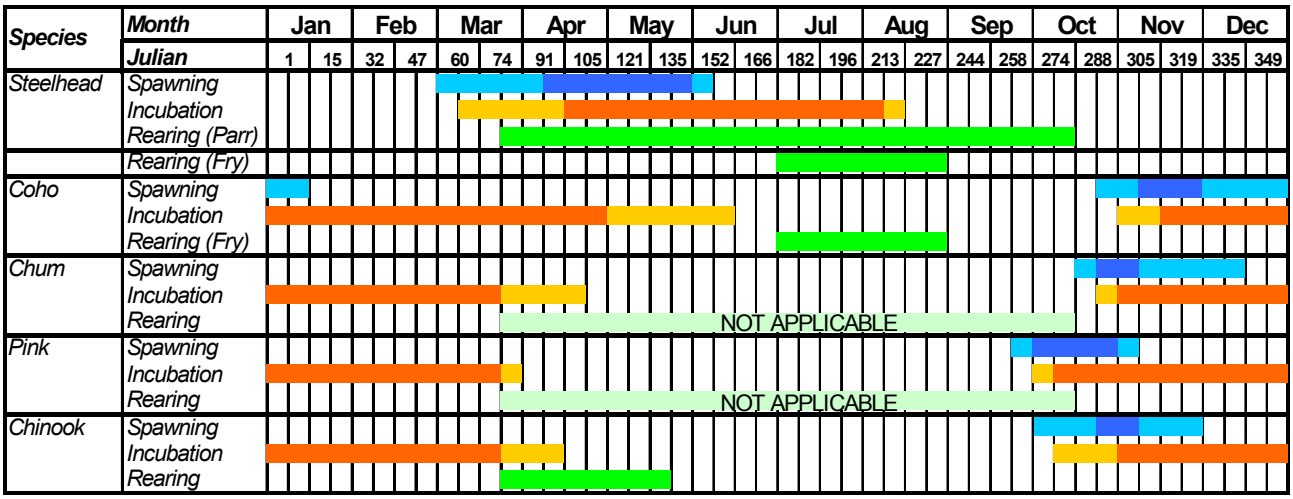


Figure 1 – Fish periodicity chart for the Coquitlam River WUP assessments.

The calculation went as follows:

- Percent usable width (PUW) is calculated and converted to weighted usable width for each flow regime and averaged over the entire operating history (roughly 30 years). The output is weighted usable width (WUW) in metres.

- WUA: However, we can still obtain WUA by averaging the reach WUW's for the reach and multiplying by the length. Averaging transects chosen to be representative assumes that the average transect is representative of the reach. This assumption has been approved by the FTC in the past, and is the basis of the terms of reference for the Coquitlam Instream Flow Needs assessment.

  $$WUA_{Reach} = WUW_{Reach\ Average} * Length_{Reach}$$

- Inclusion of reach values: in the spreadsheet, the reach values and species values are represented in the lookup tables provided by professional opinion (table 1). These values are multiplied by reach lengths and the respective WUW values and are either done by a weighted average (in which case the final answer is in WUW – m) or by actual weights (final answer in WUA – sq.m).

  $$WUA_{Reach} = WUW_{Reach\ Average\ by\ Species} * Length_{Reach} * Reach\ Value_{\ Reach\ and\ Species}$$

  Note: by including the reach value, one must be careful that they accept the limitations and/or duplication that may be inherent in these values. For example, using LHM fisheries assessment weights includes a hydraulic component implicit in the original WUW evaluations – in this example, fisheries habitat would be weighted twice for hydraulic suitability.

Table 1 – Professional opinion of reach habitat values for each species, based on substrate quality and species use.

Preliminary reach weightings for use with Transect Model Results

(April 6, 2001) Derived from %habitat type/substrate/cover and fish association with stream size

	R0	R1	R2a	R2b	R3	R4
Steelhead Parr						
Old regime	0.1	0.2	0.5	0.5	0.3	0.2
2 FV; no FF	0.1	0.2	0.5	0.5	0.35	0.25
2 FV w/ FF	0.15	0.25	0.7	0.7	0.6	0.4
CF (w/ FF)	0.2	0.4	1.5	1.5	1	0.6
Chinook rearing						
Old regime	0.5	0.3	0.2	0.2	0.3	0.1
2 FV; no FF	0.5	0.3	0.21	0.22	0.32	0.12
2 FV w/ FF	0.6	0.4	0.24	0.25	0.35	0.15
CF (w/ FF)	0.8	0.5	0.3	0.3	0.4	0.2
Steelhead Fry						
Old regime	0.05	0.1	0.4	0.4	0.5	0.75
2 FV; no FF	0.05	0.1	0.43	0.44	0.54	0.77
2 FV w/ FF	0.07	0.15	0.63	0.65	0.65	0.78
CF (w/ FF)	0.1	0.2	0.7	0.7	0.7	0.8
Coho Fry						
Old regime	0.02	0.1	0.1	0.1	0.2	0.3
2 FV; no FF	0.02	0.1	0.1	0.11	0.21	0.32
2 FV w/ FF	0.06	0.15	0.15	0.15	0.25	0.37
CF (w/ FF)	0.1	0.2	0.2	0.2	0.3	0.4
Steelhead Spawning						
2 FV; no FF	0.05	0.2	0.1	0.1	0.05	0.2
2 FV w/ FF	0.2	0.4	0.2	0.2	0.12	0.3
Chinook Spawning						
2 FV; no FF	0.1	0.2	0.1	0.1	0.05	0.1
2 FV w/ FF	0.3	0.4	0.2	0.2	0.12	0.15
Coho Spawning						
2 FV; no FF	0.05	0.2	0.1	0.1	0.05	0.2
2 FV w/ FF	0.1	0.4	0.2	0.2	0.12	0.3

Inherent in the above calculations are the following suitability criteria (figures 2-6) which were then evaluated against the modeled flows to provide flow versus habitat curves (example of Reach 2A, figures 7 and 8):

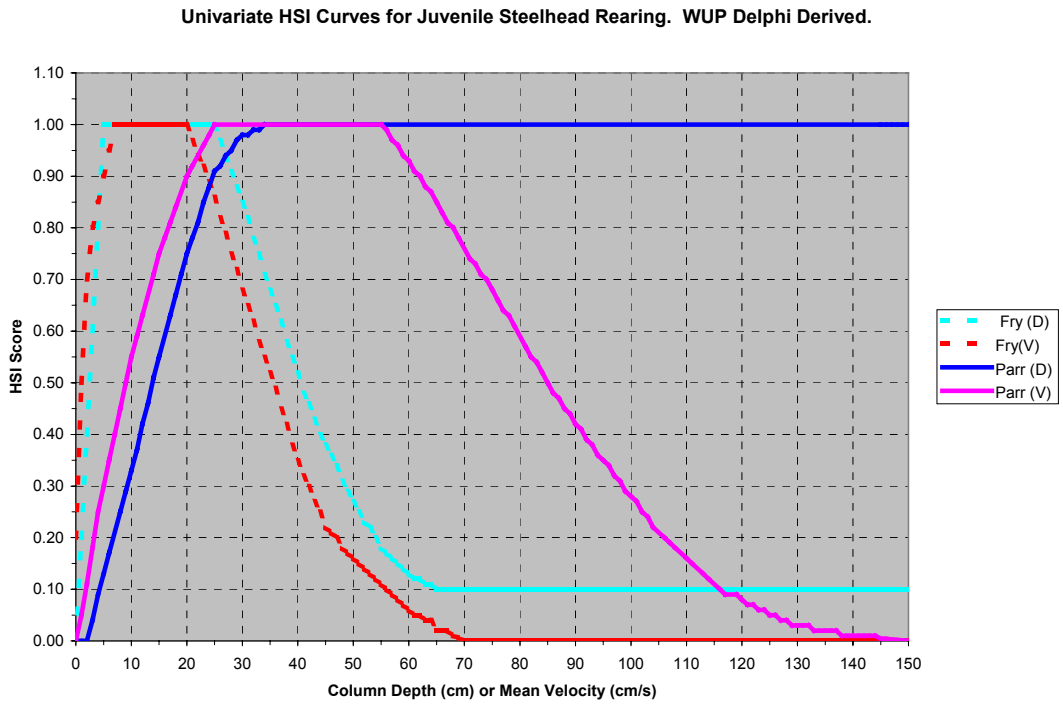


Figure 2 – Juvenile and Parr Steelhead rearing suitability criteria.

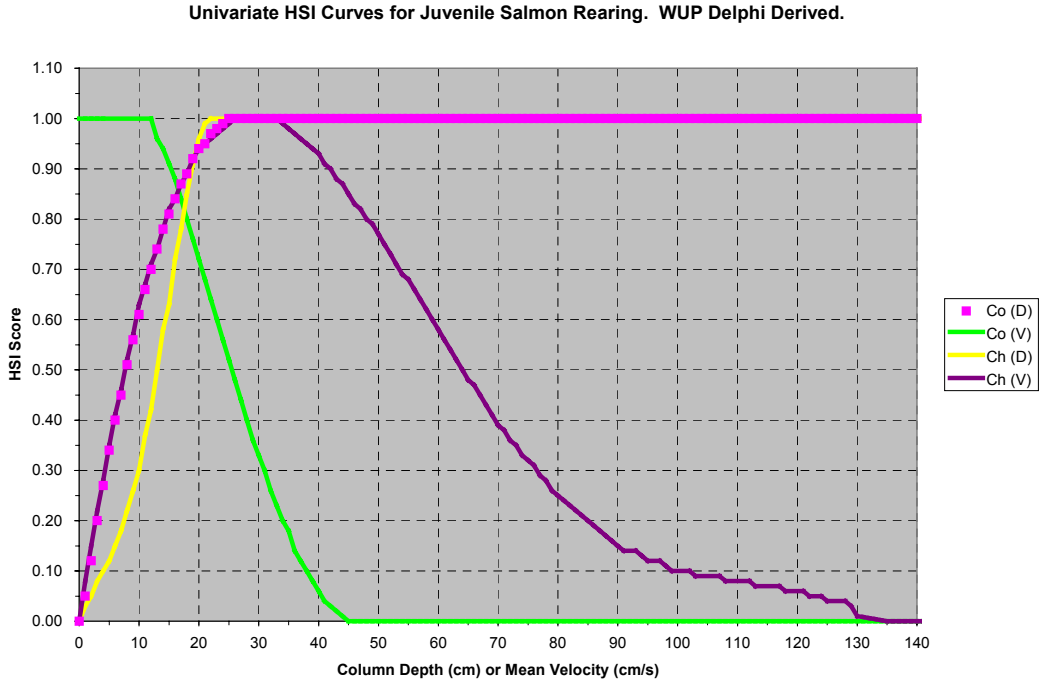


Figure 3 – Coho and Chinook fry rearing suitability criteria.

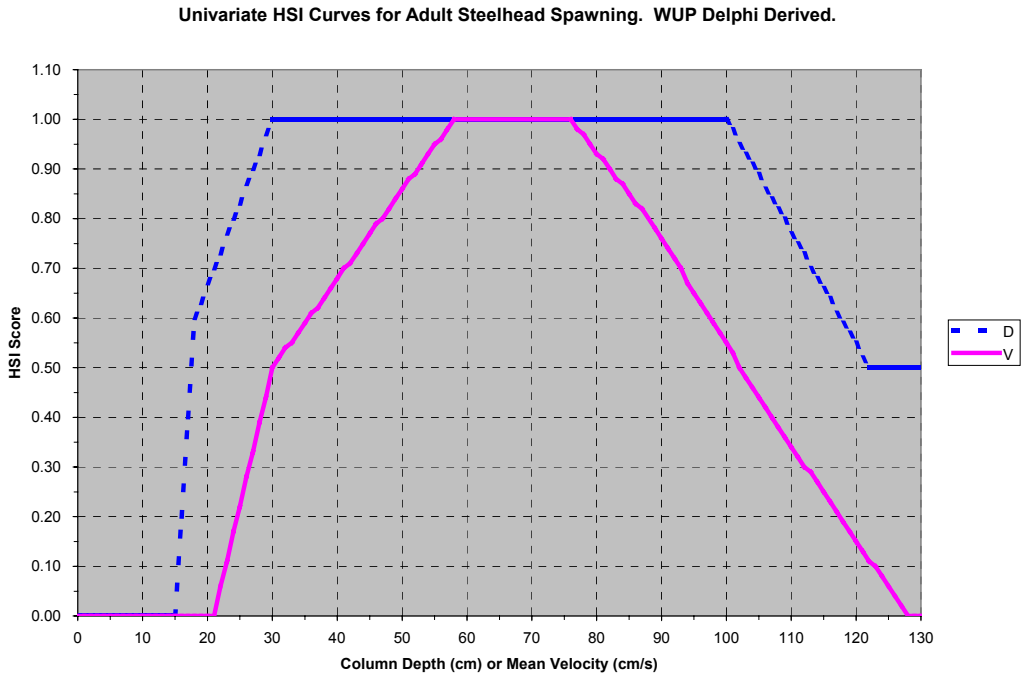


Figure 4 – Adult Steelhead spawning suitability criteria.

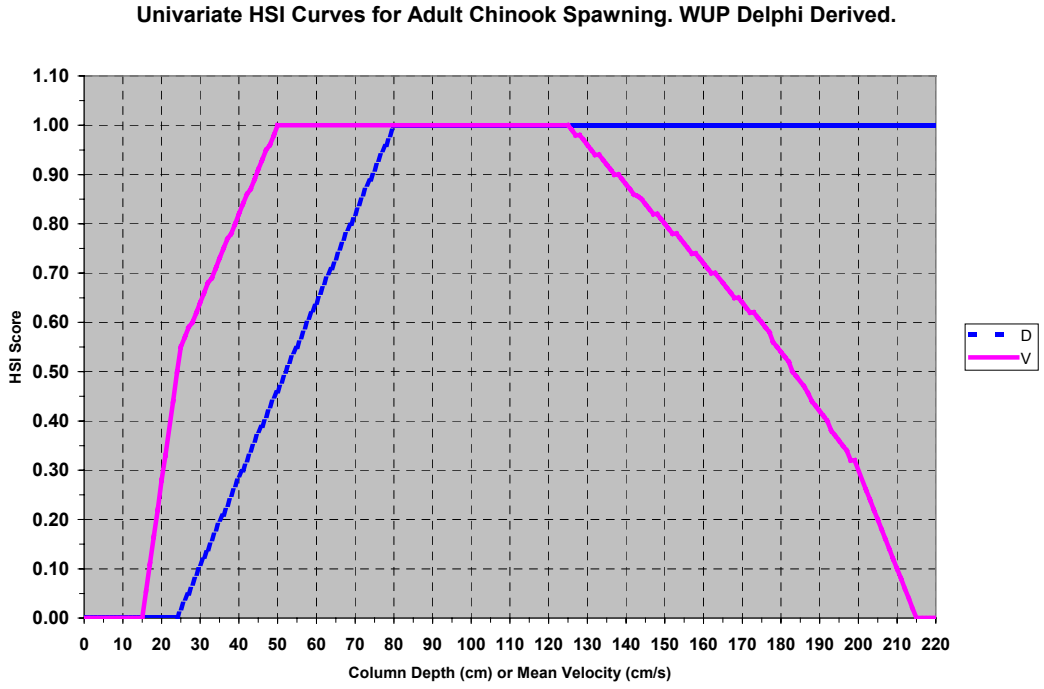


Figure 5 – Chinook Spawning suitability Criteria

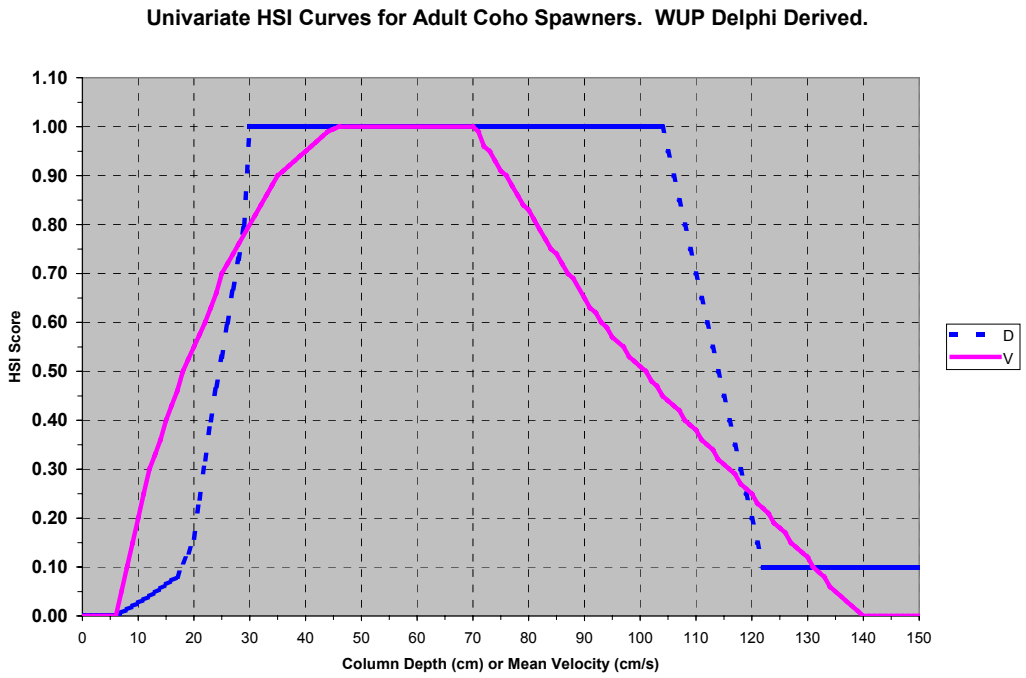


Figure 6 - Coho spawning suitability indices.

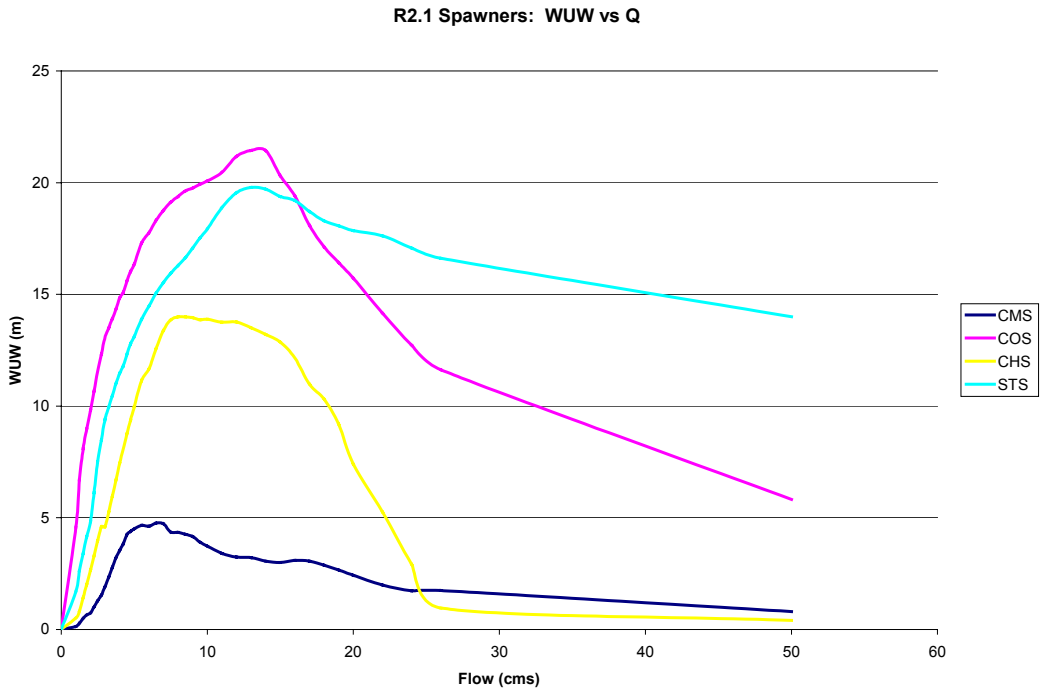


Figure 7 – Example from reach 2A of spawner (Coho = COS, Chum = CMS, Chinook = CHS, Steelhead = STS) weighted usable width (WUW) curves derived from integrating life history suitability criteria with modeled transect depths and velocity information.

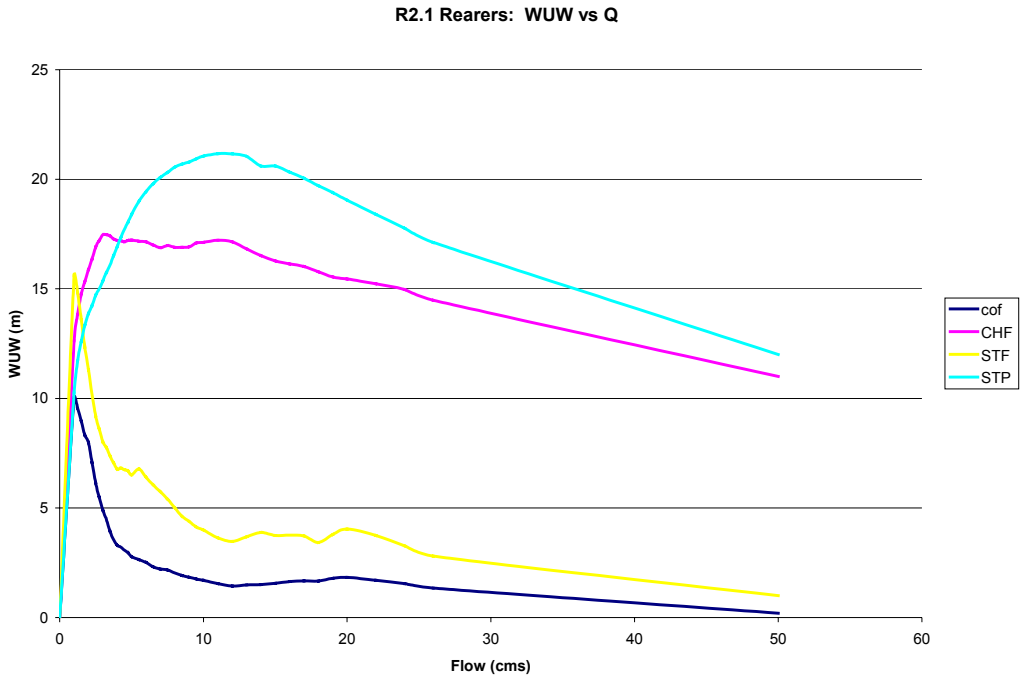


Figure 8 - Example from reach 2A of rearing (Coho = COF, Chinook = CHF, Steelhead Parr and Fry = STP and STF) weighted usable width (WUW) curves derived from integrating life history suitability criteria with modeled transect depths and velocity information.

Assumptions and Caveats:
The approach defined above is based on modeled results, and while the FTC has attempted to describe the habitat benefits in the best possible manner, empirical data collection is preferred for the analysis of habitat for the COQ WUP. Below is a summary of the approaches taken to date, and the limitations of each.

The following table (Table 1 attached) describes the benefits of each approach we have agreed to review:

- Meta-analysis: a regression analysis of over 1500 different IFIM studies on West Coast and inland streams, which develops habitat relationships with flows for various life histories, based on the mean annual discharge (MAD) and location. The outputs are in terms of "portion of maximum habitat", where maximum habitat is the maximum value determined in each study within the analysis. This is not the maximum wetted width, but is the maximum habitat expected for that life history. Therefore, maximum habitat for ST fry will be different than that for ST Parr, as determined by the regression analysis of the 1500 studies.

- Transect Analysis: described above, is the method of using real survey data to model water levels and velocities across transects, comparing to habitat suitability of various life histories, and tabulating weighted usable widths for each flow. The average weighted usable width for a reach is then multiplied by the reach length to give weighted usable area for the reach.

- IFN Empirical Model: combining data collection of linear habitat mapping, which includes professional judgement of fisheries habitat, with transect measurements of hydraulic attributes to describe the relationship of flow to fish habitat for various life histories. Require actual flows to measure the parameters before complete (incomplete at this time).

Coquitlam River Study Updates cont.
Item# 1D Invertebrate Habitat Analysis

This is a study brief submitted to the CBWUP Consultative Committee on July 9, 2001 by the Fish Technical Committee (FTC). It provides background information about the invertebrate habitat performance measures for the Coquitlam River.

COQ WUP PERFORMANCE MEASURE INFO SHEET

Invertebrate Habitat Analysis

Hypotheses addressed:
Changes in dam operations affect invertebrate habitats in the Coquitlam River.

Description:
Invertebrate productivity indicators have been best described in fisheries circles in terms of EPT productivity as a fraction of overall invertebrate productivity: genera Ephemoptera (mayflies), Plecoptera (stoneflies), and Tricoptera (caddisflies) are the most sensitive to habitat condition.

Examining invertebrate productivity sensitivities to flow changes can be quite prohibitive for the following reasons:

(a) Impacts of flow changes are multidimensional, encompassing water quality, habitat access, substrate quality and hydraulic variation;
(b) Life stages and habitat uses between genera vary greatly, with seasonal, life stage, and diurnal variations; and
(c) Literature reviews and field sampling programs for the Coquitlam River were limited in scope and applicability.

The Coquitlam River Water Use Plan fisheries technical committee reviewed recommendations provided by Lynda Ritchie in her literature review and field data analysis (2000 and 2001), and discussed various methods of evaluating habitat. Faced with limited data availability, the group focussed on two types of analysis:

(a) Riffle analysis based on wetted width; and
(b) Habitat suitability analysis based on Ritchie (2000) criteria.

Riffle analysis is based on the premise that the EPT functional group habitat productivity is maximized in riffle sites. Thompson (1972) and Stalnaker and Arnette (1976) indicate that riffles are the most productive riverine habitats for invertebrates, and the fact that these sites are most sensitive to flow would necessitate their analysis. Figure 1 describes the relationship of flow with riffle wetted width for the Coquitlam River.

Habitat suitability makes no conclusions on the habitat type in its analysis of habitat value for invertebrates. Suitability will be limited to hydraulic suitability, which may or may not be a primary factor in the productive equation for invertebrates. Figure 2 describes the relationships of flow with the specific hydraulic suitability laid out in Ritchie (2000 and 2001).

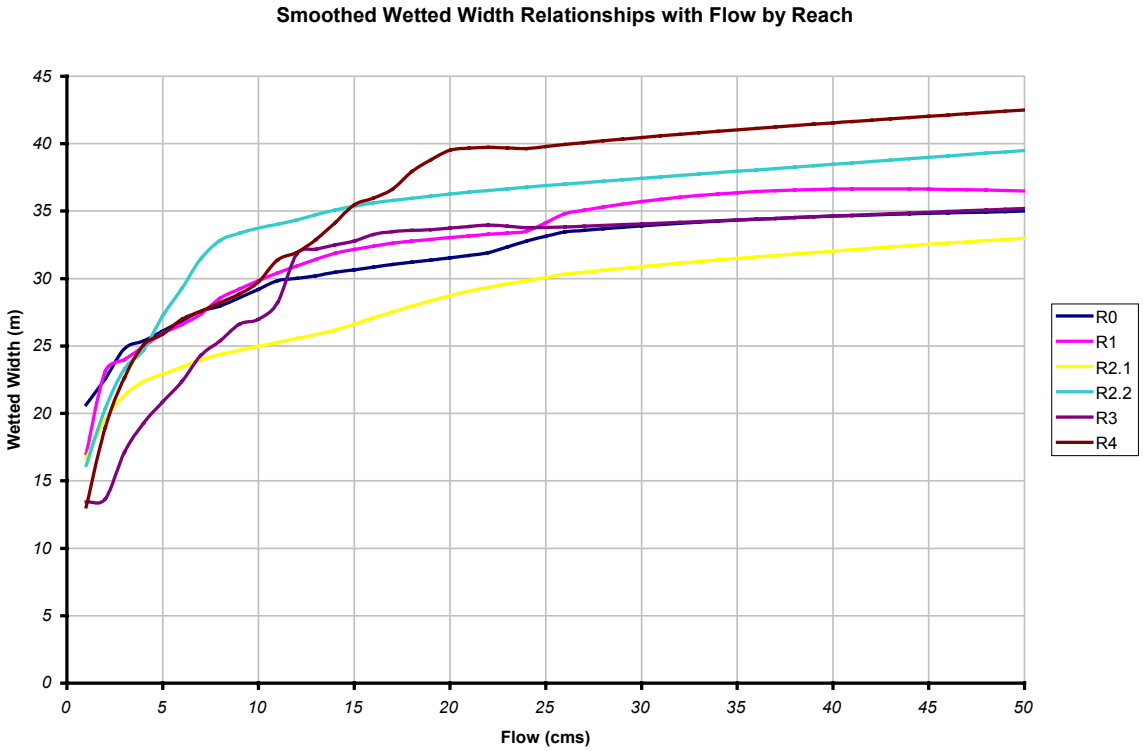


Figure 1 - Riffle width versus flow for each reach.

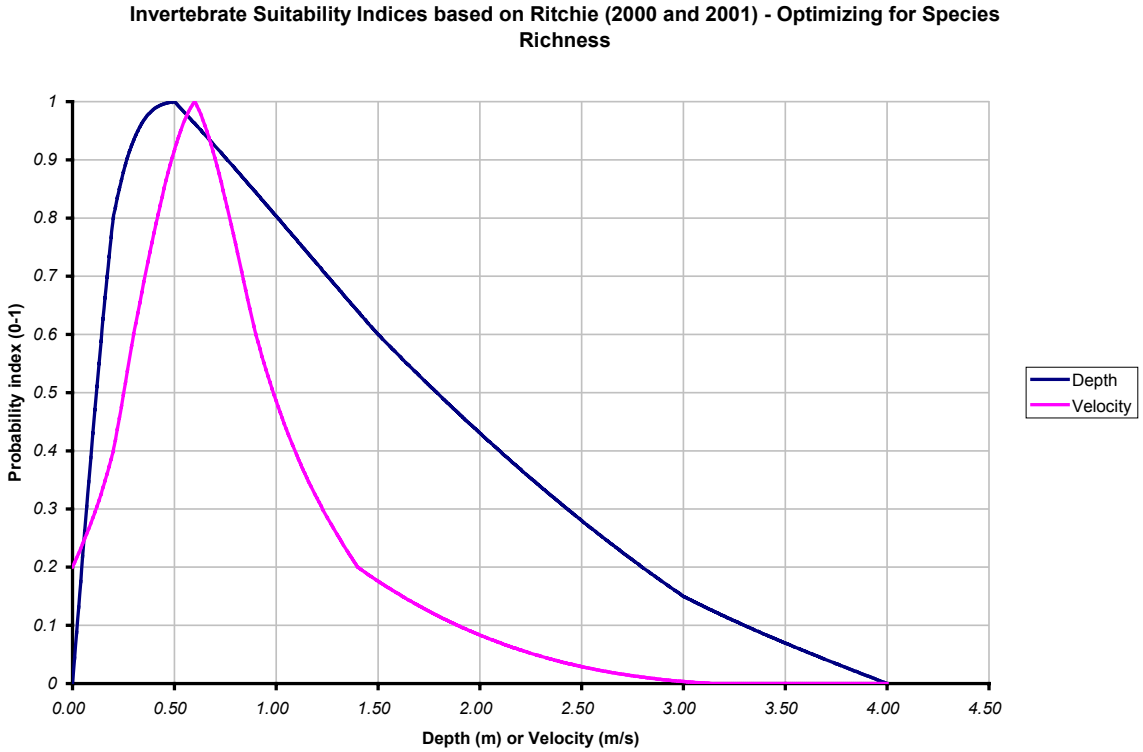


Figure 2 - Hydraulic suitability criteria for invertebrates, from Ritchie (2000, 2001).

The Coquitlam WUP FTC reviewed both options, and determined that while riffle analysis is an applicable measure for invertebrate productivity, the reality of hydraulics in the Coqutilam River are not governed by riffle width alone. **The hydraulic suitability criteria were adopted as the basis for the invertebrate productivity measure.**

Objectives
Maximize the littoral productivity of the Coquitlam Reservoir

Target Species
Benthic inertebrates, and organisms that depend on benthic production.

Timing
March to October

Calculations

Methods
For any given day, d_n, a daily weighted usable width is calculated by:
1. Looking up values from a table which describes the relationship between flow and weighted usable width (WUW) – processed before analysis began – and corresponding the daily flow with the appropriate width value
2. Averaging the usable width for each year of growth; and
3. Presenting the median value over the average year set as the indicator of WUW
4. Multiplying reach length by WUW for each reach and summarizing the values in terms of weighted usable area for the entire river.

assumptions and uncertainties
Assumption: Invertebrate productivity is positively correlated with weighted usable area as described by depth and velocity conditions for varying flows.

Uncertainty: Habitat quality factors affected by flow other than depth and velocity, such as temperature, habitat access, and substrate suitability are unknown and immeasurable aspects of invertebrate productivity.

Assumption: majority of habitat benefits derived March through October.

data required
1. Daily average Coquitlam River flows for the period of simulation.
2. The relationship between flow and invertebrate weighted usable area – included are suitability indices for invertebrates, and weighted usable width calculations with respect to flows.

data available
1. Several alternatives have been provided over the WUP Period
2. Based on suitability indices of invertebrates (Ritchie 2000, 2001), weighted usable widths were developed for each reach for the growing season March to October.

data quality/status
1. The QA/QC data outputs provided by BCH using the AMPL routing model include average daily reservoir elevations from 1960-1998.

2. BCH WUW lookup tables are in draft form, although final results should not differ greatly from the draft.

data sources

1. BCH is the data source for historic reservoir elevations.
2. Latitude Geographics is the data source for all bathymetric data.
3. Secchi disk data are compiled in White Pine (2000).

References

The document template is provided by Todd Hatfield, May, 2001, in information provided to the Campbell River WUP FTC.

Stalnaker, C.B. and J.L. Arnette (eds.). 1976. Methodologies for determination of stream resource flow requirements, an assessment. USDI USFWS. Office of Biological Services.

Thompson, K. 1972. Determining stream flows for fish life. in Proceedings, Instream Flow Requirement Workshop. Pac. N.W. River Basin Comm., Vancouver, Wash. pp. 31-50.

Ritchie, L. 2000. A literature review and data analysis of benthic macroinvertebrate habitat suitability for the Coquitlam River (draft). Prepared for BC Hydro Water Use Plans, Burnaby.

Ritchie, L. 2001. Habitat suitability of macroinvertebrates in the Coquitlam River (draft). Prepared for BC Hydro Water Use Plans, Burnaby.

Item #2 Coquitlam Reservoir

Item #2a Coquitlam Reservoir Effective Littoral Zone

This information sheet was submitted to the CBWUP Consultative Committee by the Fish Technical Committee (FTC). Its purpose was to provide the CC with background information about the effective littoral zone (ELZ) performance measure for the Coquitlam Reservoir.

COQ WUP PERFORMANCE MEASURE INFO SHEET

Effective Littoral Zone

Hypotheses addressed:
Changes in reservoir elevations cause littoral habitats to be disrupted in function, extent and, ultimately, productivity.

Description:
Productivity of littoral areas is determined by physical and biological factors, including depth of the euphotic zone, soil types, area available for colonization, nutrient levels, and interactions among species. Depending on timing and magnitude, water level fluctuations may reduce productive littoral area. During times of low water levels, high shoreline areas are exposed and the lower limit of the euphotic zone is at its lowest elevation (Figure 2). At times of high water levels, high shoreline areas are inundated and the euphotic zone limit is shifted to higher elevation.

Productivity of high shoreline areas will be proportional to the duration and timing of inundation—organisms must be given sufficient time to colonize, grow, and reproduce in this zone. Productivity of low elevation littoral areas will likewise be proportional to timing and duration of drawdown—during drawdown organisms must colonize and grow in this area. Exaggerated water level fluctuations may thus result in mid-elevation littoral areas being the most productive littoral area. The term "effective littoral area" is meant to distinguish between littoral area that is wetted and littoral area that has positive biological production.

If effective littoral area declines with increased water level fluctuations then pelagic production would be expected to become a greater proportion of total primary and secondary production. Therefore, in lacustrine environments with large water level fluctuations fish would be expected to obtain relatively more of their total energy from limnetic sources. That is, pelagic production would become a stronger "signal" in fish tissues if one were to track food energy sources utilized by fish (e.g., using stable isotopes). Several studies have shown strong coupling between benthic and pelagic production when littoral areas are relatively undisturbed.

The Coquitlam Reservoir typically operates between els. 154m and 140m, drawing down in late summer and spring to accept fall rains and freshet inflows respectively. The reservoir is oligotrophic, likely exacerbated by routine drawdowns and unnatural diversion rates.

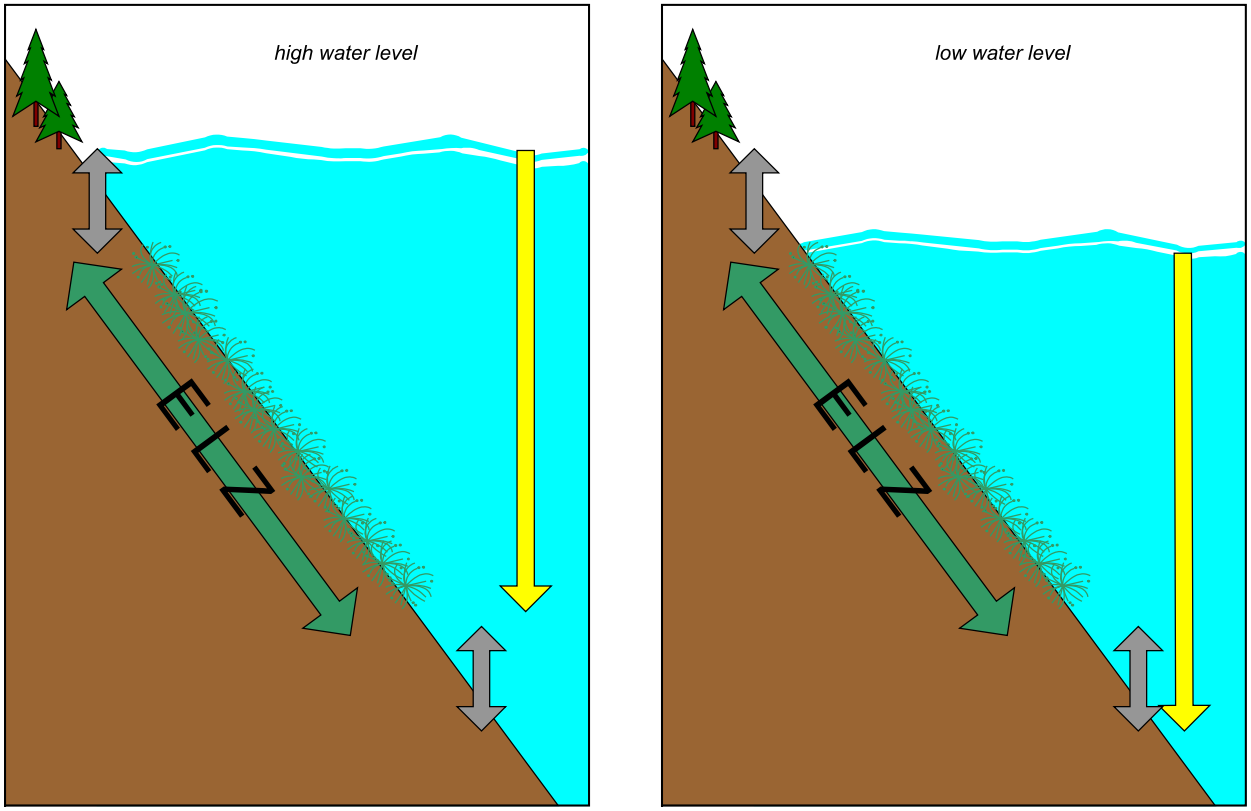


Figure 15 Conceptual diagram of effective littoral zone (ELZ) in reservoirs.

Productivity in high shoreline areas is influenced by exposure during drawdown periods, whereas low shoreline areas may receive adequate light for insufficient time to be biologically productive.

Objectives
Maximize the littoral productivity of the Coquitlam Reservoir

Target Species
Benthic plants and animals, and organisms that depend on benthic production.

Timing
Currently, the timing is year round, but other than

Calculations

Methods
For any given day, d_n, a daily ELZ is calculated by:

a. noting the reservoir elevation of that day (this is the upper boundary of the ELZ)
b. calculating the lower boundary of the ELZ by subtracting the depth of effective light penetration
c. determining the incremental area submerged within the effective zone; and
d. tabulating the consecutive days each increment of area (elevation band) is submerged.

Productive periods for each elevation band are summed for the year and averaged. ELZ values will range from littoral area bands that remain wetted and receive adequate light for 365 days/year to area bands that remain wetted and receive adequate light for only 1 day per year.

Assumptions and Uncertainties

Assumption: Positive correlation between duration of inundation and littoral productivity.
Uncertainty: Strength of correlation and shape of functional relationship is poorly understood. This is a key uncertainty. Greater understanding may change the weight given to the ELZ criterion and consequently influence the ranking of alternatives. Sensitivity analysis may help to reveal the effect of this uncertainty on final ranking of options.

Assumption: Positive correlation between ELZ and ecosystem productivity.
Uncertainty: Strength of correlation and shape of functional relationship is poorly understood. Studies elsewhere indicate that coupling between littoral and pelagic production may be strong (Hecky and Hesslein 1995), but this remains unquantified for BC lakes and reservoirs.

Assumption: Other factors that may be critical to a productive littoral zone (e.g., temperature, pressure etc.) can be safely ignored.
Uncertainty: There is a risk that the ELZ PM may not capture the true dynamics of littoral zone productivity. Other environmental factors may be limiting production and expected benefits arising from the ELZ measure may not be realized. This is particularly important if the PM will be used in an adaptive management experiment.

Assumption: Growth season is year round; production rates are constant; every day of growth has the same growth potential: unlimited potential and no introductory lag periods.
Uncertainty: Every aspect of littoral primary productivity is unknown save two requirements: water and light.

Assumption: Definition of euphotic zone is straightforward.
Uncertainty: Alternative definitions of the euphotic zone may change the depth of the littoral zone and consequently the absolute value of the ELZ. The effect on selection of operating alternatives may be small since it will not change the relative impact of different alternatives.

Assumption: The appropriate time step for ELZ calculations is yearly.
Uncertainty: The present calculations allow the ELZ to wander from year to year, such that the ELZ may be 171 to 185m one year and 178 to 192 m another year. This assumes that there is no benefit to having the ELZ in the same location each year. The cost/benefit difference between a stable ELZ and a wandering ELZ is not known.

Data Required

1. Daily average reservoir elevations for the period of simulation.
2. The relationship between reservoir surface water elevation and slope area (ha) of submerged substrate.
3. A measure light penetration through the water column.

Data Available

Several alternatives have been provided over the WUP Period:

Table 28: Alternatives Considered

Alt X	Alt O	Alt 1a	Alt 1b	Alt 2	Alt 3a	Alt 3b	Alt 4	Alt Y	Alt Z
Power Maximized	Current Operations	2 Fish Valves	2 Fish Valves	4 Fish Valves	Conservation Flow	Conservation Flow **	30% Previous Day Inflow **	ESOR	Dam Removal
Priority #1 Power		Priority #1 GVRD Current	Priority #1 GVRD Proposed Agmt	Priority #1 GVRD Proposed Agmt	Priority #1 GVRD Proposed Agmt	Priority #1 River	Priority #1 River		

1. GVRD has provided a bathymetric model of the reservoir based on previous data collection. Latitude Geographics is providing the storage vs elevation computations, which includes the elimination of areas of shore slopes > 15%, which are too steep for effective littoral colonization.
2. Light penetration data collected by White Pine consultants found secchi depths of 8.55m on average in the reservoir. Secchi depths translate into available light depths using the following equations:
   a. light attenuation coefficient (η) = 1.7 / Secchi depth
   b. $I_z = I_0 e^{-\eta z}$, where I_z is irradiance at depth z.
   c. depth of X% light level = $-\log_e(X) / \eta$ (note that 1% is often taken as depth of euphotic zone)

Data Quality/Status
1. The QA/QC data outputs provided by BC Hydro using the AMPL routing model include average daily reservoir elevations from 1960-1998.
2. BC Hydro/GVRD reservoir elevation lookup tables are in draft form, although final results should not differ greatly from the draft.
3. Secchi disk data should be considered approximate. Accuracy varies among users and local conditions.

Data Sources
1. BC Hydro is the data source for historic reservoir elevations.
2. Latitude Geographics is the data source for all bathymetric data.
3. Secchi disk data are compiled in White Pine (2000).

References

The document template and majority of technical discussion is provided by Todd Hatfield, May, 2001, in information provided to the Campbell River WUP FTC.

White Pine Environmental Consultants, 2001. Coquitlam reservoir and system water quality study. Prepared for BC Hydro, Burnaby, BC.

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

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

Item #2b Coquitlam Reservoir Tributary Access Issues Identification

This information item is a study brief submitted to the CBWUP Consultative Committee by the Fisheries Technical Committee (FTC). Its purpose was to provide the CC with background information to determine whether to incorporate a tributary access performance measure for the Coquitlam Reservoir in the trade-off analysis for this WUP.

COQ WUP DATA COLLECTION SUMMARY

Coquitlam Reservoir Tributary Access Issues Identification

Background:

As per the TOR, White Pine Environmental Resources observed known fish-bearing tributaries to the Coquitlam River October 24 and 27, 2000 to determine the extent of operational issues affecting access to these streams. The tributaries were sampled by Acres International in July/August 1997 for the GVRD and found to have fish present. Only those streams with known fish presence were sampled for this investigation.

Methods:

Methods are outlined in the data collection TOR.

Calculations for critical reservoir elevation:

$$El_{Critical} = El_{Day} + (s \bullet l)$$

Where:

$El_{Critical}$ is the elevation below which access is limited to the tributary
El_{Day} is the elevation of the reservoir at the time of investigation (back calculated from operations database)
S is the slope (%/100)
L is the length (m) of tributary between confluence with reservoir and obstruction.

Results:

Table 1 outlines the data collected for this investigation. Reservoir elevations were 147.66m on October 24, and 147.38m on October 27, 2000. This is about 10m above the operating minimum, although operations rarely bring the reservoir below 143.0m. Because of the objectives and the limitations of the investigation, White Pine was asked to look at the inundated portions of the stream to determine if any access issues are evident at lower elevations.

Meech Creek and two of its tributaries were identified as having limited access at reservoir elevations below 149.96m. However, biologists claimed that habitat above the barrier was limited and flows at the time were estimated at less than 0.5cfs. Freshet flows are expected to be around 5cfs, although this is a rough approximation.

Meech Creek was shown to have cutthroat trout (Acres, 1999) and is therefore believed to have rainbow and spawning kokanee using the system.

Table 1. Assessment of fish access to tributaries in Coquitlam Lake during low reservoir levels, October 24 & 27, 2000.

Tributary	Critical El.[1]	Wetted Width (m)	% Gradient	% Spawning	Approx. flow	Comments
Upper Coq. River	none	20 - 25	5%	none	~ 300 cfs	no spawning in first 100 m Barrier at ~ 300 m u/s of reservoir
Flow Far Creek	none	8	7 - 9 %	5%	~12 cfs	located at upper Coq R,/ Res. confluence
Cedar Creek	none	23	1%	~35 %	~ 60 cfs	Significant spawning gravels in lower 150 m of Creek which is more suitable for large salmonids Good cuthroat habitat upstream of Bridge.
Di Creek	none	10	5%	2%	~8 cfs	WW decrease to ~ 3m past 50 m u/s of confluence Good Cutthroat habitat u/s of 50 m
Beaver Creek	none	5.5	10%	1 - 2 %	~ 15 cfs	Fish obstruction noted at 20 m u/s confluence (@ 10 %) which may be a barrier at lower flows Good cutthroat habitat past ~ 50 m u/s
Root Creek	none	5	5%	10%	6 - 8 cfs	some spawning potential in lower 100 m
Doozer Creek (trib. to Cedar Cr.)	none	5	4%	15%	~ 12 cfs	Doozer creek confluence with Cedar Creek about 400 m u/s of reservoir
Meech Creek (Site CO-37)	149.96m	4	16 - 26 %	< 1%	~ 3 cfs	Critical El. - 11.5 m at 20 % gradient from reservoir elevation to top of obstruction (11:45 hrs, 27 Oct. 2000)
Unamed Creek (Site CO-43)	149.96m	2	20%	none	~ 0.5 cfs	Tributary to Meech Creek, same critical elevation. Obsruction noted just u/s of confluenec with Meech Cr. No fish habitat in this creek.
Unamed Creek (Site CO-35)	149.96m	2	> 20 %	none	< 1 cfs	Trib. To Meech Creek quite far u/s No fish habitat
Maple Creek	none	2	5 - 20 %	< 1%	~ 2 cfs	Channel width 10 - 15 m, evidence of periodic high-flow events. Little/No fish habitat.

1. Where no critical elevation was noted, there were no barriers to fish migration within the drawdown zone of the reservoir and none observed below the reservoir elevation at the time of the assessment.

Conclusions:
Reservoir operation can affect fish production in creeks tributary to the reservoir in a number of ways. Two key effects are:

- Fish migration into the creeks might be blocked by physical barriers during drawdown. At full pool these barriers would be flooded and not a problem. If such barriers exist, drawdown timing is important so as not to block migration at a critical life stage (eg. spawning migration).

- Low pool during spawning season might result in fish spawning in the drawdown zone and subsequent flooding of redds as reservoir levels rise. Depending on the depth to which redds are flooded and water flow over and through the redds, flooding might, or might not, result in egg mortality.

The Acres study sampled 40 reaches in over 30 streams as part of a study to update stream classification according to Forest Practices Code requirements. Twelve reaches were found to contain salmonids and a further 4 were assumed to be fish bearing because they were low gradient tributaries to confirmed fish streams.

The White Pine survey addressed fish access in the drawdown zone. Eleven streams flowing into the reservoir were examined in a brief field survey to assess the potential for fish migration blockages during reservoir drawdown. Study streams were chosen based on fish presence from the Acres study or known fish presence (David Dunkley, pers.comm. to Alf Leake).

Fish barriers were noted on three creeks (Meech, Unnamed Site CO-43 and Unnamed Site CO-35) between the test elevations (147.66m and 147.38m) and full pool (154.86m). The elevation of the barriers in all three creeks was calculated to be 150m which is approximately 5m below full pool.

Both studies have deficiencies that limit their usefulness.

- Fish sampling (Acres study) was conducted by minnow trapping only. Minnow trapping is useful to determine fish presence, only if fish are caught. To confirm fish presence/absence, sampling should have been by closed site electrofishing, ideally paired with snorkel floating. In conclusion, we know fish are present in 10 of the 40 test reaches but have little more than a suggestion of absence in the other 30 reaches. The utility of the White Pine study is limited by the fact that test streams were chosen based on fish presence information from the Acres study.

- The timing of field sampling in the Acres study (July and August) almost guarantees that kokanee salmon would not be found. Kokanee at these latitudes generally spawn in September or October (sometimes as early as August) and fry have migrated out of the stream into the reservoir no later than the end of May next. Based on this study, we cannot determine which Coquitlam Reservoir streams might be used by spawning kokanee.

- Some streams were dry at the time of the Acres study. These streams might be used by salmonids at other times of the year. Trout could spawn in these creeks in spring and/or kokanee in the fall and the progeny enter the reservoir before the creeks dry up in summer.

- The White Pine study did not adequately examine fish access at reservoir elevations below 147.38m. It is not possible to assess potential barriers to fish migration in a creek bed that is inundated by up to 10m of water.

Recommendations:

1. Tributary access should not be considered in the trade-off analysis to evaluate operating alternatives.
   Rationale:
   - Only three fish bearing creeks are known to have barriers to migration in the drawdown zone.
   - All three barriers are high in the drawdown zone. Ensuring fish passage during kokanee and trout spawning seasons would require minimum reservoir elevations of 150m during the months of February to April and September, October. This would seriously limit flexibility in the trade-off analysis to protect a resource of unknown value.

2. Conduct bio-physical lake and stream surveys as part of the post WUP monitoring program to:
   - Assess fish populations and fish habitat to determine the impact of the WUP.
   - Provide background information for the next iteration of the WUP.

3. Examine the three barriers in question to determine if they can be easily removed.

Photo-Summary:
The following list of photos are attached for further evaluation:

Upper Coq. River
Photo 1 - View u/s from reservoir confluence
Photo 2 - view u/s from 150 m u/s confluence
Photo 3 - view u/s of falls ~300 m u/s confluence
Photo 4 - view d/s from 100m u/s confluence
Photo 5 - view d/s from 50 m u/s confluence

Flow Far Creek
Photo 6 - view u/s from ~100 m u/s confluence
Photo 7 - view d/s from ~75 m u/s confluence

Cedar Creek
Photo 8 - view u/s from ~ 10 m u/s confluence
Photo 9 - view u/s from ~ 10 m u/s confluence
Photo 10 - view u/s from ~ 100 m u/s confluence
Photo 11 - view d/s from ~ 100 m u/s confluence

Di Creek
Photo 12 - d/s view from ~ 50 m u/s confluence
Photo 13 - u/s view from ~ 50 m u/s confluence

Beaver Creek
Photo 14 - d/s view from ~ 40 m u/s confluence
Photo 15 - u/s view from ~ 40 m u/s confluence
Root Creek
Photo 16 - d/s view from ~ 65 m u/s confluence
Photo 17 - u/s view from ~ 65 m u/s confluence
Photo 18 - u/s view from ~ 100 m u/s confluence

Doozer Creek
Photo 19 - u/s view from ~ 20 m u/s confluence
Photo 20 - d/s view from ~ 20 m u/s confluence

Meech Creek
Photo 21 - u/s view from ~ 40 m u/s confluence
Photo 22 - d/s view from ~ 40 m u/s confluence
Photo 23 - u/s view of barrier from reservoir

Unamed Creek (CO - 43)
Photo 24 - u/s view from obstruction
Photo 25 - u/s view from obstruction

Unamed Creek (CO - 35)
No Photos

Item #3 Indian Arm
Item #3a Nearshore Marine Community & Tailrace Fishery

COQ WUP FTC STUDY BRIEF

Nearshore Marine Community and Tailrace Fishery

Prepared by:
The Fisheries Technical Committee (FTC)

Prepared for:
The Coquitlam-Buntzen Water Use Plan (CBWUP) Consultative Committee

Background: The CBWUP CC has identified a variety of fisheries issues and objectives as part of its development of a WUP for the Coquitlam-Buntzen facilities. The CC has formed an FTC to collect information on these issues. This information will contribute to the development of performance measures and the evaluation of operating alternatives. This document summarizes the outcome of an FTC investigation related to one of these fisheries objectives.

Objective: Minimize direct mortality of fish in Indian Arm

Issues: Potential impacts of LB1/LB2 discharges on the Indian Arm nearshore marine community
Potential impacts of LB1/LB2 discharges on susceptibility of fish in Indian Arm to angling

Study: Information review

Results:
Potential Impacts of LB1 and LB2 on the nearshore marine community in Indian Arm: Information related to this issue is somewhat limited. Some inferences can be made from the results of a biophysical inventory of Burrard Inlet conducted in 1996 for the Burrard Inlet Environmental Action Program. This study produced detailed maps of substrate and benthic marine life in the subtidal zone of the entire inlet, including Indian Arm. Electronic copies of two of these maps are provided in Appendix 1 for your review.

Based on these maps, the distribution and abundance of benthic marine organisms in the Buntzen outflow area do not appear to be substantially different than in the rest of the Arm. The entire Arm does not appear to contain much benthic life other than red and green algae. This is likely related to its limited littoral area. These results suggest that if Buntzen outflows have an impact, it would more likely be on pelagic species such as jellyfish. Based on anecdotal evidence jellyfish are relatively abundant in the Arm. Unfortunately these maps don't document pelagic species, and other sources of information on their distribution, abundance, or potential interactions with Buntzen outflows appear to be lacking.

Potential impacts of LB1/LB2 discharges on the susceptibility of fish in Indian Arm to angling: Information on this issue was obtained through an internet and literature search as well as discussions with Department of Fisheries and Oceans (DFO) staff. A detailed search of various databases on fisheries enhancement projects and fish distribution (i.e., Fisheries Information Summary System, Fish Wizard, Fisheries Project Registry) provided information on net pen operations in Indian Arm as well as data on

fish distribution in certain tributaries. These databases did not contain information on fish use of the Arm itself. DFO data on fish supplementation activities in the vicinity of LB1 and LB2 since 1982 have been summarized in Appendix 1, Table 1. These outplantings of salmonids have been conducted with the intention of enhancing angling opportunities in the Arm.

Available reports on salmonid distribution and sports fisheries in Indian Arm are dated, and do not mention fish use or angling activities in the Buntzen area. The reports reviewed are listed in Appendix 1. Discussions with DFO enhancement and fisheries management staff indicated that angling pressure in the vicinity of the Buntzen facilities is most likely on fish (primarily chinook) originating from net pen operations in the area. These populations were established with the intention of supplementing sport fishing in the area. The potential for impacts on threatened stocks of wild fish (i.e., Indian River coho) is negligible. These fish spawn some distance from LB1 and LB2 (i.e., the Indian River) and as such would be unlikely to spend much time if any in the outflow area. In addition, the coho fishery in the Arm is open during September, and the Indian River run begins in November. Finally, coho harvest is limited to fin-clipped (i.e., hatchery) fish, so impacts on wild stocks would be minimal.

Recommendations: Based on the outcome of these investigations, the FTC recommends that this fisheries objective for Indian Arm be removed from consideration in the WUP decision making process. Available information suggests that impacts of LB1 and LB2 releases on the nearshore marine community are quite localized and limited to pelagic species. The relative impacts to populations of these species in the Arm as a whole are probably quite low. The susceptibility of fish to angling in the Buntzen outflow area may be increased as a result of freshwater releases, but the populations affected most likely originate from enhancement operations intended to improve angling opportunities in the area.

Detailed Information:

Burrard Inlet biophysical inventory maps: The Burrard Inlet biophysical inventory maps are in Autocad, but have been saved in a format that you should be able to view if you download the Autodesk Whip viewer from the Autocad website (the web link is also provided below). This viewer allows you to open the map files in your web browser, where you can click your right mouse button to zoom in or out and pan around the maps by selecting the various commands. If you want to print the maps, do it from that menu rather than the print command on your web browser. Hard copies of these maps can be made available to the CC as well.


autodesk - WHIP!.url


map 1.dwf


map 2.dwf

Literature Reviewed:

Fedorenko, A.Y. and B.G. Shepherd. 1984. Review of salmonid resource studies in Indian River and Indian Arm, and enhancement proposals for the area. Can. MS Rep. Fish. Aquat. Sci. 1769: 30 p.

Hancock, M. J. and D. E. Marshall. 1986. Catalogue of salmon streams and spawning escapements of statistical area 28, Howe Sound - Burrard Inlet. Can. Data. Rep. Fish. Aquat. Sci. 557: 190 p.

Renyard, T. S. 1985. Initial development strategies for the Burrard Inlet shore-based fisheries. Rep. prep. for Department of Fisheries and Oceans, Vancouver, BC.

DFO data on fish supplementation activities in the vicinity of LB1 and LB2 since 1982:

Table 1. Summary of coho and chinook salmon releases into Indian Arm, 1982-2000.

Location	Species	Operation	Stage	Date	Number
Bedwell Bay	Coho	Seapen	Smolts	15-May-93	9900
				15-May-94	10000
				23-May-95	9500
				21-May-96	9000
				19-May-97	6500
				13-May-98	5000
				6-Jun-99	11252
				29-May-00	8829
	Chinook	Seapen	Smolts	7-Jun-88	50983
				2-Jun-89	50000
				25-May-90	49900
				30-May-91	49900
				30-May-92	50000
				31-May-93	50000
				2-Jun-94	49000
				1-Jun-95	46500
				1-Jun-96	48000
				23-May-97	38000
				21-May-98	49500
				20-May-99	49971
				23-May-00	30240
Richards Creek	Coho	Hatchery Transplant	Fry	30-Apr-82	18500
				15-Jun-82	6000
				30-Apr-83	25000
				28-Feb-84	20000
				15-Jun-85	27000
			Smolts	15-May-86	200
			Fry	1-May-86	9000
			Smolts	31-Oct-86	450
			Fry	Feb-91	2400
				May-92	1800
				15-May-93	1800
			Smolts	7-Jun-95	900
				Jun-96	800
				29-May-98	2000
				Jun-99	200
			Fry	26-Nov-99	1200
	Chinook	Hatchery Transplant	Smolts	1-Jul-87	13000
			Fry	1-Jun-88	27700
			Smolts	23-Jun-89	10000
		Seapen		26-May-90	33500
				30-May-91	18784
				12-May-92	36000
		Hatchery Transplant	Fry	25-Feb-93	3000
				15-Mar-94	3000
		Seapen	Smolts	16-May-95	43000
				9-Jun-96	28000
				2-Jun-97	42000
		Hatchery Transplant		13-May-98	7800
		Seapen		9-Jun-99	34300
Windermere Creek	Coho	Hatchery Transplant	Fry	11-Oct-94	1916
				19-Oct-99	750

Item #3b Water Quality Impacts from Changing Buntzen (LB1/2) Operations

This item is an information sheet submitted to the CBWUP Consultative Committee on July 9, 2001 by the FTC. The purpose of the information sheet was to report on the relationship between discharge from the Buntzen outflow at LB1/2 and the general physical and chemical characteristics of water quality as they relate to the fauna in Indian Arm.

COQ WUP FISHERIES PM SUMMARY SHEET

Indian Arm Water Quality[*] Impacts from Changing LB1/2 Operations: Update

Background:
Operations of hydroelectric facilities on the Coquitlam-Buntzen project results in significant discharge into the Indian Arm via LB1 and LB2 generating facilities. Under changes to our current operating regime proposed within the water use plan (WUP), this discharge may be altered in consideration of fisheries, First Nations, recreation, and other regional concerns. Several members of the consultative committee (CC) agreed that the issue be investigated to better understand the relationship between discharge and the general physical and chemical characteristics of water quality as they relate to the fauna in the Indian Arm.

Description of Indian Arm Issues with Respect to Water Quality[*]:
The saltwater environment in Indian Arm differs from the Burrard Inlet and the Georgia Strait in several ways. The morphometry of the arm is defined by steep terrain on it's eastern and western shores, the Indian River confluence in the north, and an abrupt shelf at the south end that restricts large boat access and likely restricts tidal flushing in the arm. The arm is one of the deepest waters in the Lower Mainland, is home to several marine species, and a passage for migrating salmon into the Indian River. The following factors results in beach closures and high fecal coliform counts in the summer months:

- recreation use in the summer, dominated by pleasure boaters;
- year-round storm and sewage runoff into the arm;
- localized geese grazing coupled; and
- lack of adequate flushing due to the constraints listed above.

There are several questions that need to be answered for this assessment to be beneficial:

- What are the changes in freshwater inputs proposed under the COQ WUP?
- What impacts will these changes have on the in the arm?
- What impacts will these changes have on salt-water fauna in the arm?

[*] Water Quality was chosen as the indicator which this performance measure (PM) was to assess under changing operations. However, it is clear that water quality is a subjective assessment which itself is determined by changes in physical and chemical characteristics. In addition, the impact of changes to water quality differs among different users. Since this PM was intended for fisheries assessment, water quality in this case describes the saltwater characteristics as they affect survival of saltwater fauna.

Freshwater interactions with saltwater result in a localized freshwater lens over saltwater which will have an effect on the local seabed. Mixing of the two layers, as a result of tidal action and equilibric tendencies, generally occurs away from the freshwater outfall.

It is hypothesized that contaminants to water quality in the arm are most concentrated in the summer months. However, the causes of increased concentrations appear to be localized to Deep Cove and Panorama Beach, which experience little flushing within the cove, while receiving contaminants from flocks of geese prone to summer feeding in those areas. It is therefore difficult to determine (a) whether there are water quality concerns outside of these localized regions of the arm, and (b) whether freshwater contributions into the arm have any impact on the quality of water for sea-fauna.

Methods:
The investigation has been broken into two sections, to describe the operations in the context of freshwater inputs, and to describe the relationship of these inputs with the physical and chemical characteristics of Indian Arm water in general.

Operations Summary
A simple watershed analyses was conducted on the Indian Arm watershed, which included inputs from the Indian River, adjacent streams, and localized runoff from the western and eastern hillsides. For this exercise, the arm extends south from the Indian River confluence, to the "shelf" bridging Belcarra and North Vancouver. Under the Coquitlam-Buntzen WUP (COQ WUP) operations analyses, inflows are modeled based on constraints set in place by stakeholders of the CC, and the resultant operations meet the constraints. The sum of the monthly inflows determined by watershed analysis, and those determined by the operations modeling from Coquitlam River inflows are calculated for each operating alternative, and compared to current operations to determine the significance of any changes to freshwater inputs into the arm. Two comparisons are made for this summary: between current and proposed, and between "power friendly" and proposed. The former comparison does not meet GVWD requirements for expected water usage to 2050, while the latter does.

Indian Arm Water Quality as a function of Freshwater Inputs
Shellfish biologists within the Department of Fisheries and Oceans (DFO) were consulted to relay their experiences on shellfish fisheries closures in the arm, and the relationships with year-round freshwater inputs. GVRD water quality technicians were also consulted to derive trends in water quality in monitoring stations in the arm. Biological interactions in estuarine communities were discussed with David Wilson of BC Hydro and David Frissel of ASL Technologies in Sydney. Flushing impacts were relayed to Steve Pond of UBC Oceanography.

Results:
The following are results to date on discussions and analyses conducted for the Indian Arm investigations. As all data has not been gathered, the summary below is preliminary and subject to change.

Operations Summary:
The portion of the Indian Arm watershed being investigated is 317.7 km^2 (BC Watershed Atlas), which sheds an average combined volume of 7430.15 cms-d/year runoff into the arm (derived from Summit, 2000; Coast River, 199?). Current BC Hydro operations divert an average of 6633.31 cms-d/year from the Coquitlam River watershed, or about 47% of the inflow into the area of concern. The following table summarizes the range of operations explored under the COQ WUP to date and the expected changes to the inflow volume, inclusive of natural runoff from Indian and adjacent watersheds.

Table 1: Summary of average (over 30+ years of data) total Indian Arm inflow volumes (cms-d) expected under various operating options. Minimum and maximum values are summations of various year's monthly extremes (5^{th} and 95^{th} percentiles, respectively), and do not represent typical years.

Option	Average	Minimum	Maximum
Current	14048.01	5371.65	24685.35
Current with GVWD Requirements	12441.03	4096.62	23413.44
4 Fish Valves (Currently 2)	10374.80	3459.39	21195.95
4 Fish Valves - Successive	10351.72	3215.20	21277.63
Coq R. Conservation Flow Regime	9369.32	2979.46	19361.08
30% of Inflows Past Dam	9557.17	3361.90	19269.00

The above table illustrates the range of inflows that may be possible from current (14000 cms-d) to the conservation flow option (9400 cms-d); a change of over 30% year round. However, the bulk of the inflows into Indian Arm occurs between October and May, which is consistent with coastal watersheds. As the June to September period is the time most likely to see water quality problems in the arm, part of the operations summary investigated the inflows for June 01-September 31. Table 2 summarizes these results.

Table 2: Summary of average summer inflows (cms-d) into the Indian Arm from June 01-September 31.

Option	Average	Minimum	Maximum
Current	3335.67	1315.28	6569.45
Current with GVWD Requirements	2605.25	618.22	5750.38
4 Fish Valves (Currently 2)	1916.85	598.34	4673.31
4 Fish Valves - Successive	1916.85	598.34	4673.31
Coq R. Conservation Flow Regime	1753.72	598.34	3904.52
30% of Inflows Past Dam	1730.23	598.34	3885.59

From this table, we see that the summer inflow variations from a current maximum of 3300 cms-d may be reduced to almost half (1700 cms-d) under certain operations.

Appendix 1 summarizes monthly inflows expected for each option.

Indian Arm Water Quality as a function of Freshwater Inputs

(a) Flushing Impacts of Reduced Inflows:

The operations data presented above has questionable applications to the Indian Arm water quality issue (Judy Smith, pers. comm.; Paul Markey, pers. comm). Both sources from GVRD and Northshore Health groups maintain that water quality issues are dominated by localized problems associated with poor flushing and fecal inputs from summer-time geese populations, and that in each case, Buntzen releases would not contribute to flushing for these secluded areas.

With respect to the overall flushing of the water in the arm, Dr. Steve Pond from UBC Oceanography (retired) had conducted a study on the arm in the early 1980's (reference not sought), to examine the tidal flushing effects and the transfer of deep-water volumes out of the arm. His results indicated that while flushing volumes were restricted by the southern sill, the freshwater layer acts as a transport mechanism that draws deeper salt-water out. The mechanism is such that transport is more effective when the freshwater lens is relatively small. At the same time, there are periodic occurrences of high-density saltwater infiltration from the Georgia Strait which replenishes that which is removed. If the lens is small (i.e. freshwater inputs are small), then replenishment is more effective. If the lens is large, the disparity in salinity acts as a barrier to transport and achieves the opposite effect, and flushing is less frequent (high-density water exchange still occurs, but is less frequent). This process can replace the entire volume of

the arm over the year, every second or third year, depending on the depth of the freshwater lens, replenishing oxygen and nutrients (Pond, pers. comm.).

(b) Contamination-Induced Closures for Shellfish Harvesting:
Department of Fisheries and Oceans conduct testing for Indian Arm shellfish fisheries closures and are more familiar with water quality issues for the arm in general. Their website http://www.pac.dfo-mpo.gc.ca/ops/fm/shellfish/Biotoxins/biotoxins.htm lists closures for 1999-2001. No red-tide closures affect the Indian Arm (Area 28) exclusively, although several "All Areas" closures due to red tide/contamination affected the Indian Arm on several occasions. The "All Areas" closures were in no way linked to water quality issues in the Indian Arm.

(c) Effects of Reduced Inflow on the Indian Arm (Indian River) Estuary:
It is recognized that the Indian River estuary benefits outmigrant salmonids, which remain in the estuary 1-6 months, extending their territory from the confluence as their ion-exchange systems develop. The classic estuary is defined by its shallow-gradient bottom, brackish water, and flourishing biota. There, invertebrate fauna benefit from nutrient upwelling within the brackish water, the shallow depths, and calm waters. Outmigrant fry from the Indian River take advantage of the brackish water to acclimate to the saltwater environment, feasting on invertebrates and the nutrient rich water. The Buntzen outfall is classified as intertidal (Sneep, 2000), and while the freshwater outputs may contribute to the lens in the arm, it is doubtful that juveniles and invertebrates of the Indian River estuary derive any benefits from these outputs - certainly not proximal to the outfall. It is believed that the estuary benefits from freshwater inputs are limited to the confluence region of the Indian River (David Wilson, pers. comm.).

Conclusions and Recommendations:
Freshwater inputs into the Indian Arm, as a consequence of operating options proposed under the COQ WUP may be reduced as much as 30% over the year, reaching as much as 50% change for the summer months. While this may have immediate impacts to the local area, the issue of water quality pertaining to the estuarine qualities of Indian Arm is still in question:

- What effect will reduced flows, and therefore a thinner layer of freshwater in the arm, have on the estuarine qualities of the arm; and
- What impacts on marine fauna will the effects have?

Next Steps:
Karen Calla of FOC has agreed to bring this brief to the Institute of Oceanographic Sciences for comment on the potential impacts described by the hydrographic analysis on the Indian Arm. Provided comment is timely, this matter should be concluded by January 22, 2001.

References:
Fisheries and Oceans Canada, Website. http://www.pac.dfo-mpo.gc.ca/ops/fm/shellfish/Biotoxins/biotoxins.htm, referenced January, 2001.

Coast River Environmental Consultants, 1999. Overview fish and riparian habitat assessment – Indian River watershed. Prepared for X Forest Products.

Frissel, David (ASL Technologies, Ltd), January, 2001. Personal communication

Markey, Paul (North Shore Health), January, 2001. Personal communication.

Pond, Steven (UBC Oceanographic Sciences). January, 2001. Personal communication.

Smith, Judy (GVRD), January, 2001. Personal communication.

Sneep, Dan (FOC), December, 2001. Correspondence to Coquitlam-Buntzen Consultative Committee RE: "Indian Arm Draft Study Brief".

Summit Environmental Consultants, 2000. Coquitlam River local inflow analysis. Prepared for BC Hydro WUP, Burnaby, BC.

Wilson, David (BC Hydro), January, 2001. Personal communication.

Appendix (a) Baseline Data:

Baseline Data for Watershed Analyses (Summit, 2000; Coast River, 199?; BC Watershed Atlas online)

	Area (m2)	Area (sq km)
Indian River WS	192384266	192.3843
Noons Cr	22000606	22.00061
West Shore WS	53735731	53.73573
East Shore Waters	49571842	49.57184

Watershed Analysis

Assumptions:
- Watershed outside of Indian River is rain dominated (no snow)
- Summit Environmental Assessments of flow/sq km used to reference the flow
- Only that watershed north of the Indian Arm "shelf" is considered
- Total cms-d/month summarized for each alternative

	Rain Dominated Flow: cms/sq km				Rain Dominated Flow: cms		
	"Ave" Mean	Average 10	Average 90%		"Ave" Mear	Average 10	Average 90%
Jan	0.1108733	0.049887	0.189443		13.89333	6.251247	23.73872
Feb	0.0972273	0.05298	0.168742		12.18337	6.63887	21.14476
Mar	0.0797182	0.04162	0.146644		9.989346	5.215297	18.37573
Apr	0.069331	0.038585	0.106078		8.687742	4.834967	13.29246
May	0.0500737	0.028021	0.087855		6.27464	3.511215	11.00899
June	0.0304123	0.014486	0.05409		3.810909	1.815216	6.777929
July	0.0223485	0.006939	0.052687		2.800452	0.869503	6.602146
Aug	0.0130394	0.003173	0.034907		1.633945	0.39762	4.374193
Sept	0.0279619	0.004603	0.065658		3.503853	0.576744	8.227504
Oct	0.074021	0.020605	0.137659		9.275437	2.581935	17.24985
Nov	0.1163705	0.063624	0.198633		14.58218	7.972665	24.89031
Dec	0.1248429	0.059712	0.228875		15.64383	7.48242	28.67994
				CMS-d	3110.987	1464.493	5607.694

Indian River	Mean	Min (5%)	Max (95%)
Jan	9.9	2.1	18
Feb	9.5	3.3	22.2
Mar	9.4	3.9	16.1
Apr	12.3	4.8	19.7
May	17	4.1	25.8
Jun	17.2	6.5	25.1
Jul	10.9	4.8	19.9
Aug	5.5	2.5	8.1
Sep	8	2.2	25.1
Oct	12.9	1.9	26.8
Nov	16.2	10.8	27.5
Dec	13.2	3.3	24.9
CMS-d	4319.1667	1526.917	7884

Check:	
Area Ratio	1.535289
Flow Ratio	1.388359
Error	0.095702

Appendix (b) Monthly Flow Analyses

Coquitlam Diversion into Indian Arm (current)					TOTAL Inflow (cms-d)					
	Average	5th	95th	Days/mo	Average	5th	95th			
Jan	26.007684	14.46223	35.20255	31	1543.831	707.2176	2385.179			
Feb	23.362766	8.320107	35.94636	28	1261.292	511.2514	2220.151			
Mar	26.595451	15.65265	35.89894	31	1425.529	767.8062	2181.615			
Apr	20.683444	7.5014	30.84393	30	1250.136	514.091	1915.092			
May	5.8755749	0	15.04929	31	903.6567	235.9477	1607.607			
Jun	7.3756496	0	22.30033	30	851.5968	249.4565	1625.348			
Jul	13.234359	3.479032	32.67352	31	834.9791	283.6046	1834.446			
Aug	15.127428	8.222032	24.94145	31	690.1025	344.7092	1159.885			
Sep	20.462427	11.80687	31.66487	30	958.9884	437.5083	1949.771			
Oct	16.511497	1.951226	30.79903	31	1199.295	199.428	2320.315			
Nov	17.213291	0.6903	36.00333	30	1439.864	583.8889	2651.809			
Dec	25.631803	6.531871	37.84374	31	1688.745	536.743	2834.134			
Sum	6633.3085			Sum	14048.01	5371.652	24685.35			
				Summer sum	3335.667	1315.279	6569.45			
Alternative: Alt1_4fv_141_39_new_rating.csv					TOTAL Inflow (cms-d)			% Change from Current		
	Average	5th	95th	Days/mo	Average	5th	95th	Average	5th	95th
Jan	18.783251	6.805677	31.48758	31	1319.874	469.8646	2270.015	-0.145066	-0.335615	-0.048283
Feb	14.472866	0	34.59129	28	1012.375	278.2884	2182.209	-0.197351	-0.455672	-0.01709
Mar	16.732407	7.622581	34.07603	31	1119.774	518.8742	2125.105	-0.214485	-0.324212	-0.025903
Apr	9.0958803	0	19.85313	30	902.5087	289.049	1585.368	-0.278071	-0.437747	-0.172171
May	0.8830108	0	6.32929	31	748.8872	235.9477	1337.287	-0.17127	0	-0.168151
Jun	1.518	0	9.950033	30	675.8673	249.4565	1254.839	-0.206353	0	-0.227957
Jul	3.9490405	0	19.58416	31	547.1343	175.7546	1428.676	-0.344733	-0.380283	-0.221195
Aug	2.7596361	0	11.90174	31	306.701	89.8262	755.654	-0.555572	-0.739415	-0.34851
Sep	1.4009231	0	7.810633	30	387.1433	83.30233	1234.144	-0.5963	-0.809598	-0.367031
Oct	5.4952026	0	15.92703	31	857.7898	138.94	1859.283	-0.284755	-0.303307	-0.198694
Nov	7.6309744	0	29.39053	30	1152.395	563.1799	2453.425	-0.19965	-0.035467	-0.074811
Dec	14.522349	1.053161	33.83777	31	1344.352	366.903	2709.949	-0.203934	-0.316427	-0.043818
				Sum	10374.8	3459.386	21195.95	-0.283128	-0.344812	-0.159468
				Summer sum	1916.846	598.3396	4673.313			
Alternative: Alt1_4fv_141_39_new_rating_sucessive.csv					TOTAL Inflow (cms-d)			% Change from Current		
	Average	5th	95th	Days/mo	Average	5th	95th	Average	5th	95th
Jan	18.355012	0.266806	34.1669	31	1306.599	267.1596	2353.074	-0.153665	-0.622238	-0.01346
Feb	14.493947	0	34.56461	28	1012.965	278.2884	2181.462	-0.196883	-0.455672	-0.017426
Mar	16.427006	6.284484	34.05542	31	1110.307	477.3932	2124.466	-0.221126	-0.378237	-0.026196
Apr	9.0649829	0	19.85313	30	901.5817	289.049	1585.368	-0.278813	-0.437747	-0.172171
May	0.8830108	0	6.32929	31	748.8872	235.9477	1337.287	-0.17127	0	-0.168151
Jun	1.518	0	9.950033	30	675.8673	249.4565	1254.839	-0.206353	0	-0.227957
Jul	3.9490405	0	19.58416	31	547.1343	175.7546	1428.676	-0.344733	-0.380283	-0.221195
Aug	2.7596361	0	11.90174	31	306.701	89.8262	755.654	-0.555572	-0.739415	-0.34851
Sep	1.4009231	0	7.810633	30	387.1433	83.30233	1234.144	-0.5963	-0.809598	-0.367031
Oct	5.4952026	0	15.92703	31	857.7898	138.94	1859.283	-0.284755	-0.303307	-0.198694
Nov	7.6309744	0	29.39053	30	1152.395	563.1799	2453.425	-0.19965	-0.035467	-0.074811
Dec	14.522349	1.053161	33.83777	31	1344.352	366.903	2709.949	-0.203934	-0.316427	-0.043818
				Sum	10351.72	3215.2	21277.63	-0.284421	-0.373199	-0.156618
				Summer sum	1916.846	598.3396	4673.313			
Alternative: Alt2_conservationQ_39_new_rating.csv					TOTAL Inflow (cms-d)			% Change from Current		
	Average	5th	95th	Days/mo	Average	5th	95th	Average	5th	95th
Jan	9.0875765	0	22.61684	31	1019.308	258.8886	1995.022	-0.339754	-0.633934	-0.163576
Feb	11.420751	0	28.31743	28	926.9154	278.2884	2006.541	-0.265106	-0.455672	-0.096214
Mar	4.1606865	0	14.765	31	730.051	282.5742	1526.463	-0.487874	-0.631972	-0.300306
Apr	3.1124274	0	11.14117	30	723.0051	289.049	1324.009	-0.421659	-0.437747	-0.308645
May	4.4968569	0	13.98345	31	860.9164	235.9477	1574.566	-0.047297	0	-0.020553
Jun	0.6634359	0	0.823967	30	650.2303	249.4565	981.0569	-0.236457	0	-0.396402
Jul	1.9278081	0	12.35794	31	484.4761	175.7546	1204.663	-0.419775	-0.380283	-0.34331
Aug	0.9730108	0	5.890581	31	251.3156	89.8262	569.308	-0.635829	-0.739415	-0.509169
Sep	0.7528205	0	4.988867	30	367.7002	83.30233	1149.491	-0.616575	-0.809598	-0.410448
Oct	4.8537386	0	14.82035	31	837.9045	138.94	1824.976	-0.301336	-0.303307	-0.213479
Nov	11.240368	0	33.85193	30	1260.676	563.1799	2587.267	-0.124448	-0.035467	-0.024339
Dec	11.698759	0	30.86268	31	1256.82	334.255	2617.721	-0.255767	-0.377253	-0.076359
				Sum	9369.319	2979.462	19361.08	-0.34599	-0.400387	-0.238567
				Summer sum	1753.722	598.3396	3904.519			
Alt3_30%_1LLO.csv					TOTAL Inflow (cms-d)			% Change from Current		
	Average	5th	95th	Days/mo	Average	5th	95th	Average	5th	95th
Jan	15.742175	5.241581	27.99594	31	1225.601	421.3776	2161.774	-0.206131	-0.404175	-0.093664
Feb	11.429881	0.291214	29.55564	28	927.171	286.4424	2041.211	-0.264904	-0.439723	-0.080598
Mar	13.58962	5.80629	28.54471	31	1022.348	462.5692	1953.634	-0.282829	-0.397544	-0.104501
Apr	5.3903932	0	14.6437	30	791.344	289.049	1429.085	-0.366993	-0.437747	-0.253777
May	0.2353763	0	0.225387	31	728.8105	235.9477	1148.066	-0.193487	0	-0.285854
Jun	0.3912308	0	2.359567	30	642.0642	249.4565	1027.125	-0.246047	0	-0.368058
Jul	1.1854094	0	8.038032	31	461.4617	175.7546	1070.746	-0.447337	-0.380283	-0.416311
Aug	1.1460132	0	8.206355	31	256.6787	89.8262	641.097	-0.628057	-0.739415	-0.447275
Sep	0.8304615	0	4.8932	30	370.0294	83.30233	1146.621	-0.614146	-0.809598	-0.41192
Oct	3.5632589	0	11.32926	31	797.8996	138.94	1716.752	-0.334693	-0.303307	-0.260121
Nov	5.5611709	0	24.67017	30	1090.3	563.1799	2311.814	-0.242775	-0.035467	-0.128212
Dec	11.267974	1.025677	30.97077	31	1243.466	366.051	2621.072	-0.263674	-0.318014	-0.075177
				Sum	9557.174	3361.896	19269	-0.340923	-0.35544	-0.243789
				Summer sum	1730.234	598.3396	3885.589			
Current_MA.csv		(Power Friendly)			TOTAL Inflow (cms-d)			% Change from Current		
	Average	5th	95th	Days/mo	Average	5th	95th	Average	5th	95th
Jan	23.40263	12.21435	34.74419	31	1463.075	637.5336	2370.97	-0.052309	-0.098533	-0.005957
Feb	19.870943	4.685714	35.58961	28	1163.521	409.4884	2210.162	-0.077517	-0.199047	-0.004499
Mar	23.023689	12.13271	35.21923	31	1314.804	658.6882	2160.544	-0.077673	-0.142117	-0.009658
Apr	16.173675	3.941467	26.86733	30	1114.843	407.293	1795.794	-0.108223	-0.207741	-0.062294
May	3.2426799	0	11.50068	31	822.0369	235.9477	1497.6	-0.090322	0	-0.068429
Jun	4.3934615	0	16.6152	30	762.1311	249.4565	1454.794	-0.105056	0	-0.104934
Jul	8.1251696	0	27.322	31	676.5943	175.7546	1668.549	-0.189687	-0.380283	-0.090434
Aug	8.5733995	0	17.44532	31	486.9277	89.8262	927.505	-0.294413	-0.739415	-0.200347

Item #4 Fish Friendly Flow Alternative

The following Information Sheet, compiled by the FTC, provides background on the operating alternative referred to for the trade-off analysis as a "Fish Friendly Flow". This information should be used in conjunction with Chapter 5 ("Operating alternatives") and Section 6.4 ("Uncertainty regarding fish PMs") in the CBWUP Consultation report.

COQ WUP FTC INFORMATION SHEET

Fish Friendly Flow Alternative Development and Discussion

Background:
On June 11, CBWUP Consultative Committee (CC) requested that the FTC develop a "fish-friendly flow" alternative that would demonstrate the best possible outcome for the Coquitlam River fish performance measures. To that end, the FTC met on the 18th and 28th of June to develop a monthly flow criteria that would meet fish flows. Additionally flows were identified which would lead to minimal habitat loss, but would provide flexibility during trade-off analysis.. This information sheet documents the steps taken in developing the fish-friendly alternative.

Methods:
Plots of weighted usable width (WUW) versus flow were are used by this PM to represent fish preference. The "fish friendly flow" is therefore constructed using the peak of these curves (i.e. most preferred flows) using the following steps:

1. Reaches 2A, 2B and 3 were selected as the basis for the analysis since these reaches provide the greatest fish habitat potential;
2. For each month, a species-life history stage was identified as the primary "driver" for the analysis. For months with overlapping requirements between species, the highest requirements were deemed most appropriate.
3. In some cases, species overlap may not be for the entire month – the species dominant for the largest portion of the month was chosen as the driver in those instances.
4. Where possible, the FTC also determined the minimum acceptable flow which would be associated with the species driver, or with a minimum threshold based on other factors, such as incubation stranding.
5. Using the species life history "driver" identified in step 2 the peak habitat values were identified for each reach from plots of WUW versus flow (see Figures 1 and 2).
6. Flows were averaged over the three reaches, weighted by their respective lengths.
7. In the cases of minimum thresholds, the highest minimum threshold of the three reaches was deemed the minimum criteria for the entire reach set.
8. Average inflows for each month into the three reaches were subtracted from the fish friendly flow targets to describe the flows in terms of release requirements from the dam.

Minimum flow requirements for driver species were described as the "shoulder", of the PM lookup function (highlighted in figures 1 and 2), where approximately 10% of the habitat would be lost. Minimum flow thresholds were described as the portion of the riffle wetted width curves where lower flows would rapidly dewater riffles. Figure 2 highlights those thresholds for selected reaches.

Results:
Originally, the possible drivers throughout the year were reduced to the performance measures:

(1) Steelhead spawning;
(2) Coho spawning;

(3) Chinook spawning;
(4) Steelhead parr;

The following driver was also included for those months where fish PMs did not assess fish habitats, or where minimum thresholds would be suitable:

(5) Spawning incubation – based on riffle analysis conducted for invertebrate PM development. Figure 2 illustrates reach riffle analysis results (preliminary).

In the second iteration of fish-flow discussions, coho spawning requirements in January and February were questioned for their perceived flow requirements for maximum habitat benefits. DFO representatives suggested that coho would utilize marginal habitats (coho are known to be sidechannel spawners) during spawning, which PMs were clearly optimizing at only high flows. Therefore, the FTC agreed to forego coho spawning analysis as a PM, opting for extending chinook spawning duration to the end of coho spawning (November to January). All agreed that this would instill a conservative estimate of habitat benefits for fish, because flow requirements for chinook spawning are quite high.

Table 29 summarizes the results of the analysis. Figure 3 illustrates the results in comparison with the "conservation flow" alternative.

Conclusions and Recommendations:

The FTC has attempted to make considerations for the PMs representing fish interests in the river in developing the fish friendly flow. The following recommendations will be helpful in finalizing the fish flows if further considerations are required:

1. Daily time steps: fish periodicity governs the evaluations of fish PMs, which do not coincide necessarily with month changes. For example, the first week in June represents the end of steelhead spawning, but the fish flow is currently set up to change at the beginning of the month, which can be treated as either a month dedicated to spawning or to rearing. Daily time steps in developing flows will be helpful in fixing this problem.
2. Finalizing the riffle analysis: it is recognized that the riffle analysis is based on transect modeling, and may not be accurate. Further work can still be done to refine the minimum thresholds required for maintaining incubating eggs after spawning periods. Minimum flows of 20% of mean annual discharge are the acceptable minimum flows for optimal spawning success, but riffle analysis would be better suited for defining criteria, if it were finalized.
3. Minimum flows should not be considered an absolute minimum, nor an automatic trade-off from fish benefits. Minimum flows also represent the confidence interval boundaries for the PMs. It is meant to help make trade-offs in future CC meetings, and not meant to automatically replace peak habitat flows. Once it is obvious that high flows will not be considered for certain time frames, minimum flows may be a source of flexibility in fish flow options.

Table 29: Fishery analysis results.

Month	Peak Fish Flow Drivers	Minimum Fish Flow Drivers	Reach Specific Fish Flow Requirements (Reach Lengths in m.)						Weighted Flow Requirements (Average)		Weighted Inflows to Reaches	Dam Releases to Meet Reach Requirements	
			Peak			Minimum							
			R2A	R2B	R3	R2A	R2B	R3					
			3100	3200	1700	3100	3200	1700	Peak	Minimum		Peak	Minimum
Jan	Chinook spawning	Chinook incubation	8.5	8.5	8.0	2.3	8.0	12.0	8.39	6.62	5.05	3.34	1.57
Feb	Chinook incubation (use 20% MAD or inflection point)	Chinook incubation	2.3	8.0	12.0	2.3	8.0	12.0	6.62	6.62	3.70	2.92	2.92
Mar	Steelhead spawning	Steelhead spawning	13.0	19.0	10.0	10.0	11.0	8.0	14.76	9.98	4.54	10.22	5.43
Apr	Steelhead spawning	Steelhead spawning	13.0	19.0	10.0	10.0	11.0	8.0	14.76	9.98	5.29	9.47	4.68
May	Steelhead spawning	Steelhead spawning	13.0	19.0	10.0	10.0	11.0	8.0	14.76	9.98	5.85	8.91	4.13
Jun	Steelhead parr	Steelhead spawning (first week of June)	12.0	12.0	6.5	10.0	11.0	8.0	10.83	9.98	5.23	5.60	4.75
Jul	Steelhead parr	Steelhead incubation or parr (whichever is higher)	12.0	12.0	6.5	2.3	8.0	12.0	10.83	6.62	3.22	7.61	3.40
Aug	Steelhead parr	Steelhead incubation or parr (whichever is higher)	12.0	12.0	6.5	2.3	8.0	12.0	10.83	6.62	1.70	9.13	4.92
Sep	Steelhead parr	Steelhead parr	12.0	12.0	6.5	5.5	5.0	3.8	10.83	6.62	2.18	8.65	4.44
Oct	Chinook spawning	Chinook spawning	8.5	8.5	8.0	6.5	5.5	6.0	8.39	5.99	4.89	3.51	1.11
Nov	Chinook spawning	Chinook spawning	8.5	8.5	8.0	6.5	5.5	6.0	8.39	5.99	6.99	1.41	0.00
Dec	Chinook spawning	Chinook spawning	8.5	8.5	8.0	6.5	5.5	6.0	8.39	5.99	5.97	2.42	0.02

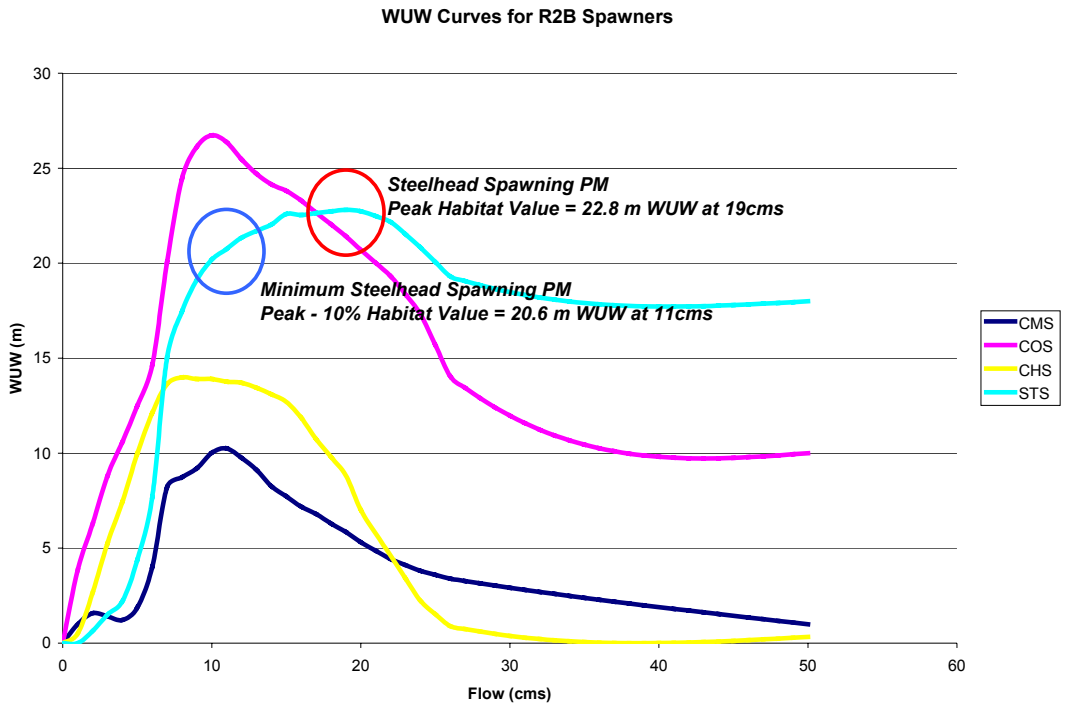


Figure 16: Illustration of identifying peaks and minimums for flow targets.

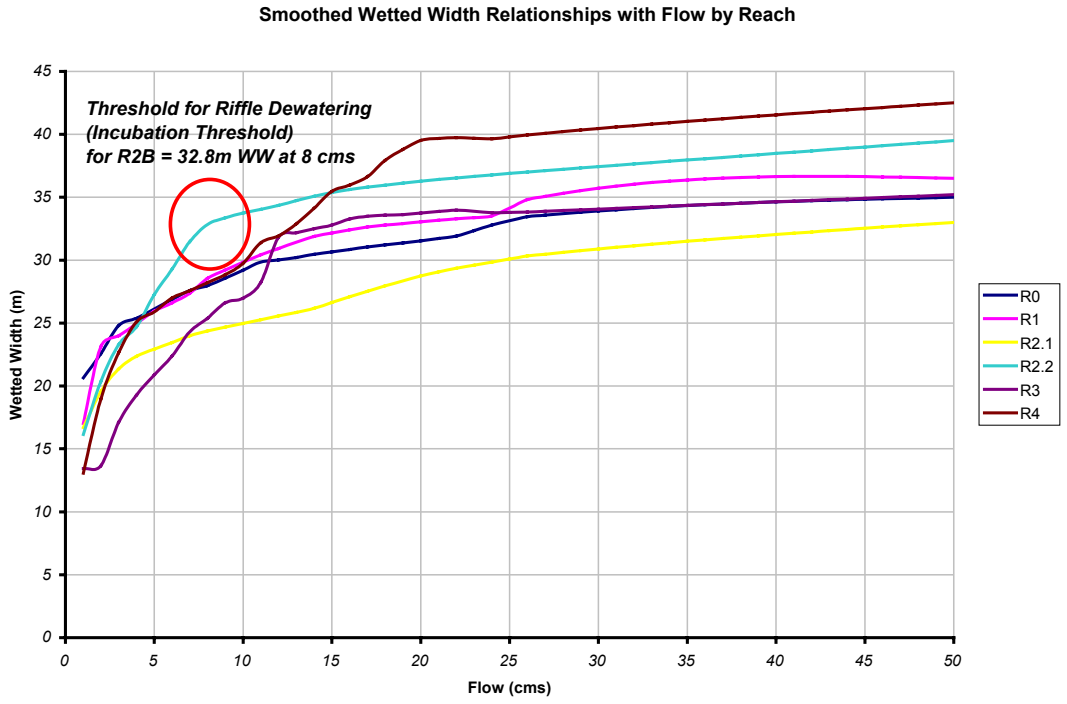
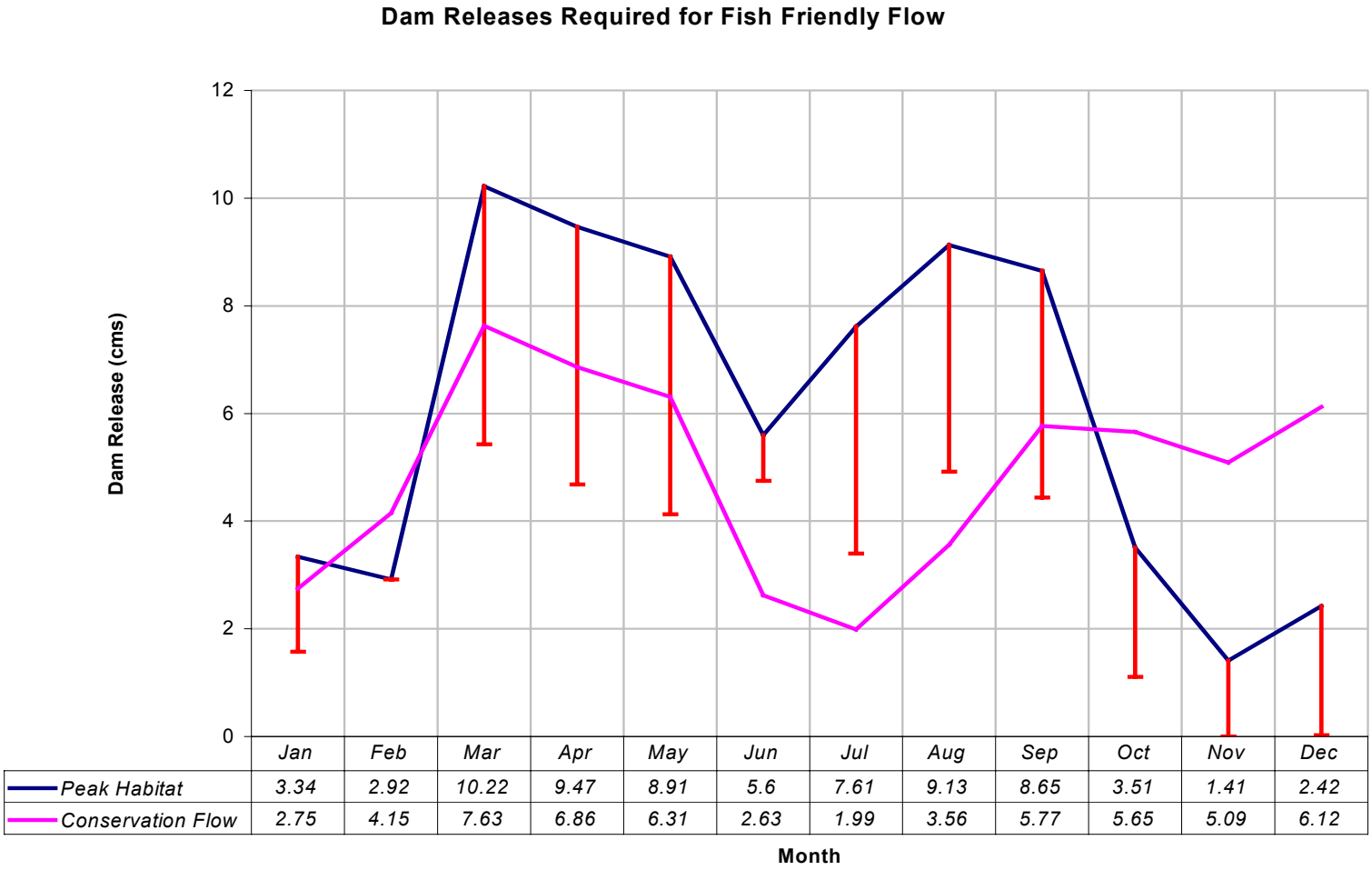


Figure 17: Illustration of identifying thresholds for riffle dewatering



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Peak Habitat	3.34	2.92	10.22	9.47	8.91	5.6	7.61	9.13	8.65	3.51	1.41	2.42
Conservation Flow	2.75	4.15	7.63	6.86	6.31	2.63	1.99	3.56	5.77	5.65	5.09	6.12

Figure 18: Recommended fish flow releases to optimize performance measure output (blue).

Red “error” bars indicate room for flow decreases that would compromise a maximum 10% of the predicted habitat value. The pink line is the conservation flow regime, for comparison.

Item #4 FTC Flushing Flow Recommendation

The following Information Sheet, compiled by the FTC, provides background on the development of the recommendation for a flushing flow on the Coquitlam River. This information is meant to provide context for the recommendation summarized in Section 5.2.

COQ WUP FTC DISCUSSION PAPER

Addressing Comments on Emergent Flushing Flow Information

Background:
The COQ FTC met on May 30th to discuss performance measures and to look again at flushing flow benefits to the river under new operating alternatives. Prior to the meeting, a summary of flushing flow alternatives was provided to the FTC for general comment.

As the meeting wound down, Matt Foy (FOC) raised important issues about impacts of flushing flow on fish utilization of riverine habitats

History:
In January, 2001, the FTC received a "final draft" in hardcopy (and electronically) which identified both the current state of the river by reach, and the recommendations for restoring or enhancing the substrate condition. With FTC guidance, NHC recommended flushing flows that would (a) minimize damages in non-target reaches (reach 4) (b) be released from the dam under current conditions, and (c) would mobilize fines from the upper layer in reaches 2 and 3.

In reviewing the January version, several FTC members were concerned that the recommendation of (a) 110cms release for 8 hours, or (b) 50cms release for 4 or 5 days, would not adequately remove fines in the river, and would not restore the river's function to a more natural state. A spill of less duration, but similar magnitude, in 1995 appeared to do little in terms of restoration, while causing some erosion in reach 4 and reducing the year class success of both coho and steelhead fry (Decker, 1997). Based on the lack of success of similar flows, new criteria for flushing flows were defined to mimic natural river functions. Mobilizing fines in the upper 50cm layer for reaches 2 and 3 became the new objective, to maximize productivity of both salmonids and invertebrates in the system.

NHC provided an updated version in April, recommending flows of 200cms (met by dam releases combined with inflow) to meet the objective of mobilizing fines from the 50cm upper layer in reaches 2 and 3. This was described as the minimum flow required in reach 2 and 3 to meet the fisheries objective. The release has obvious consequences on the surrounding physical environment, and some fisheries consequences; such as habitat displacement and possible impacts on fish in the river. The FTC provided this recommendation to the CC as a means of meeting fisheries objectives for the Coquitlam River.

In March, April and May, I provided comments to Ken to provide a summary of recommendations to date, in terms of the new objectives (depth of disturbance). The April version contained all of the references to previous recommendations, but was not consistent in the discussion in terms of effectiveness of each flow release on substrate condition, although the data was all there. In May, Ken provided a table, at my request, that adequately described the flushing flow effects in terms of depth of disturbance. This was sent to the FTC for discussion.

What does the "new" table say?
Basically, the summary of recommendations illustrates the effectiveness of each flow release in terms of depth of disturbance. This was never categorically explicit for the previous flows, and this was the opportunity to provide this summary:
- 1-day 200cms flow would disturb the upper 30-50cm,
- 1-day 110cms flow would penetrate as much as 30cm, and
- multi-day 50cms release may provide cleaning in the upper 10cm,

all in terms of reach 2 and 3. The important thing is that all three releases provide "some" benefit to substrate maintenance.

If all releases provide a benefit, was the FTC recommendation to the CC in error?
No. The original recommendation was made in the context of maximizing fisheries productivity in the Coquitlam River. Based on the professional opinion of FTC members, 50cm of substrate "cleaning" would maximize productivity - unless this is no longer the case, the original recommendation is still consistent with the results Ken provided. What has changed is the opportunity to provide incremental benefits with reduced flushing flow releases, or at least a suggested benefit that could be tested in any flushing regime. These sub-optimal flushing flows are an extension of "maximizing the minimum benefits".

What can the FTC do to include these results in CC considerations?
The FTC provided fisheries benefits in terms of square metres of habitat for the 200cms flushing flow, integrating professional opinion, stock assessment results on the Coquitlam River, and considerations on the Coquihalla River. For the two sub-optimal regimes, the FTC can again apply the same criteria to determine these benefits in terms of fish habitat. On June 18, we have the opportunity to talk to Ken Rood, and amongst the group to determine weighting factors to apply to sub-optimal flushing benefits.

Appendix F NON-FISH INFORMATION SHEETS

The information in this appendix addresses CBWUP interests other than fish and provides background on the CC's choice of performance measures and operating alternatives.[124]

This appendix contains the following items:

Item #1. **Archaeological** Study Presentation to CC

Item #2. **Domestic Water** Summary of background material provided by GVRD

Item #3. **Flood** Summary: Main Issues and Recommendations (Brief by Flood Working Group for CC)

Item #4. **Recreation** Study Brief: Analysis of Recreation and Tourism Activities Affected by Water Levels on the Coquitlam River (Brief by Recreation Working Group for CC)

Item #5. **Environment** Study Brief: Preliminary Analysis of Environment & Wildlife Habitat Affected by Water Levels in the Coquitlam River (Brief by Environment/Wildlife Working Group for CC)

Item #6. Maps: **List of Available Maps** of Coquitlam Watershed and Area South of the Watershed

Item #7. **Suspended Sediment/turbidity**: Comparison of Proposed Flow Scenarios for Managing Coquitlam River Sediment (Chart presented by outside expert)

[124] Fisheries information is in a separate appendix.

Item #1 - Archaeological Study Presentation to the Consultative Committee

1. ARCHEOLOGICAL STUDY – RESULTS OF FIRST NATION REVIEW

- A meeting was held at Kwikwetlem First Nation on April 12, 2001. All participating First Nations were invited.
- Only Kwikwetlem First Nation attended the meeting. Comments were received in writing from Tsleil Waututh First Nation.
- Results for the Archeological Study documents the discovery of new archeological sites Coquitlam Reservoir study area. In addition, known sites were confirmed in the Coquitlam Reservoir study area.
- Substantial and widespread disturbance was noted within virtually every section of the Coquitlam Reservoir study area.
- No sites were discovered in the Coquitlam River study area or the Buntzen Reservoir study area.
- Both Tsleil Waututh First Nation and Kwikwetlem First Nation noted that only a broad and initial assessment was conducted in these study areas. The limited scope of the archaeological study suggests the need for further investigation and analysis. The assessment was constrained to areas directly influenced by BC Hydro operations.
- No heritage (non-archeological) sites were discovered or are expected to be impacted by reservoir or river levels in the Coquitlam-Buntzen system.
- Kwikwetlem First Nation identified the need for a management plan to address archeological issues.
- No changes to BC Hydro operations are expected, therefore Kwikwetlem First Nation requested that confidentiality of the sites and the report be respected by the Coquitlam Buntzen Consultative Committee.
- Because there are no changes to operations anticipated as a result of archeological objectives, there are no trade-offs to be made regarding archeological objectives and, therefore, Kwikwetlem First Nation recommends that archeological issues no longer be considered by the Coquitlam-Buntzen WUP CC.
- However, because there is ongoing erosion due to future operations, archeology is still considered a WUP issue by Kwikwetlem First Nation. Therefore, an archeological management plan should be developed with BC Hydro and other participating First Nations and included as part of the WUP submission.

2. ARCHEOLOGICAL SITES AT IR2

- Kwikwetlem First Nation has recently made important archaeological discoveries at IR2. These were not documented in the Archeological Study.
- The sites are located outside the old dyke and are not protected.
- Kwikwetlem representatives noted that these sites are very significant.
- They further noted that had Kwikwetlem know the location of the sites at the time the dykes were built they would not have allowed the dykes to built where they are (if they were consulted. Kwikwetlem First Nation also stated that they were not consulted in 1967 when a location for the dyke was decided.
- It was stressed that planned or manmade floods from flushing flows that impact these sacred sites are not acceptable.

Item #2 - Domestic Water: Summary of Background Material Provided by GVRD

Information on this sheet was complied by the authors of this report using information that GVRD provided during the consultation process with regard to domestic water performance measures and the trade-off analysis.[125] The Information sheet addresses the following four topics:

- Clarification of performance measures
- Rationale for GVRD securing additional water supply from Coquitlam Reservoir
- Rationale for GVRD's domestic water demand forecast
- GVRD's water conservation measures

1. BACKGROUND TO DOMESTIC WATER PERFORMANCE MEASURES

GVRD provided the following clarification about monthly water allocations under the current and proposed GVRD agreements.

Maximum allocation: With full use of the current agreement with BC Hydro, the GVRD allocation of Coquitlam Reservoir water will increase to a maximum of 7.88 cms on an annual basis, which would be about 34 percent of the average annual reservoir inflow of 23.3 cms. Under the proposed GVRD/BC Hydro agreement the future allocation to the GVRD could increase to about 14.36 cms (or 62 percent of the average annual reservoir inflow). The proposed agreement was developed assuming that the GVRD continues with its existing water conservation programs in particular the restriction on outdoor sprinkling to two times a week during the summer period.

Minimum allocation: Performance measures make reference to a minimum monthly flow allocation that could occur in a very dry year if there was a shortage of water in the Coquitlam Reservoir. In a water shortage situation then the GVRD could enact Stage 4 of the GVRD's Water Shortage Response Plan (WSRP) which includes a total ban on outdoor sprinkling to reduce the GVRD water demand. It must be emphasized that imposing a total ban on outdoor sprinkling (Stage 4 of the WSRP) is a response to water shortages that is only intended to be used in extremely dry years. For example, Victoria imposed a total ban on sprinkling in the year 2001 in response to low reservoir levels caused by the driest winter in 100 years.

Domestic Water performance measures also include the number of days the proposed agreement GVRD allocations are not met (this is the true GVRD performance measure). **If the proposed agreement GVRD allocations are not met in an average year the GVRD will have to develop a new water supply source with (undesirable environmental and financial implications) sooner then expected.**

2. WHY DOES GVRD NEED TO SECURE ADDITIONAL WATER SUPPLY?

The GVRD needs to secure additional water supply capacity for two reasons:

- To ensure adequate supply of good quality (low turbidity) water during a prolonged period of turbid water in the Capilano and/or Seymour sources during the winter season.
- To meet the drinking water needs of a growing population.

[125] Sources:
1. Information on non-operating alternatives (eg. water conservation) provided by GVRD for handout to CC at Dec 11, 2000 meeting.
2. Memo from Stan Woods and Paul Archibald (GVRD) to CB CC, May 4, 2001
3. Memo from Stan Woods (GVRD) to Ross Neuman (MWLAP), Sep 6, 2001

2.1 More Supply to Manage Winter Turbidity Events

On occasion, the three watersheds can experience events such as landslides, which can increase the turbidity in the source reservoirs above safe drinking water levels. The probability of such turbidity events is highest in the winter. Capilano has the most turbidity events and Coquitlam the fewest. During turbidity events the turbid reservoir is taken out of service and the GVRD's consumers are supplied with drinking water from the other two reservoirs.

The GVRD is moving to filtration of the Seymour source by 2005. Assuming the GVRD secures an agreement for significantly more water from Coquitlam as part of the WUP process it should not need to filter the Capilano source until 2020 or later. This is because the new agreement would provide for enough volume of Coquitlam water (in the winter and also on an annual basis) for Capilano to be taken out of service during a prolonged winter turbidity event (with the GVRD's water supply needs provided from Seymour and Coquitlam).

If GVRD does not secure an agreement for more water from Coquitlam (or some other source) it will be necessary for water quality protection to build Capilano Filtration by about 2015. As the cost of building the Capilano Filtration plant is estimated at $250 million there are large financial implications with having to build the Capilano Filtration plant five or more years sooner because the GVRD can not secure an agreement for more water from Coquitlam. The Net Present Value Cost of having to build the Capilano Filtration plant five years sooner is about $80 million.

2.2 More Supply Capacity to meet the Water Needs of a Growing Population

The population in the GVRD is expected to increase from about 2 million in 2001 to about 4.8 million in 2100. A dry summer period is normally the limiting period in the capacity of the Capilano, Seymour, and Coquitlam systems to supply the GVRD's drinking water needs. In a year with no significant turbidity events, or once the Capilano and Seymour sources are filtered, the water supply capacity of the GVRD system (Coquitlam-1987 agreement flows) is estimated to be sufficient to meet GVRD needs until about 2030. The GVRD's preferred choice is to get more water from Coquitlam in accordance with the proposed agreement.

Studies have also shown that raising the existing Seymour dam and expanding the existing Seymour Reservoir ranks highly among the other water supply options (based on criteria such as environmental impact, water quality, cost, etc.). Knowing this, the GVRD Board has delayed doing a seismic upgrade of Seymour dam until the new Coquitlam agreement with BC Hydro (influenced by the WUP) is secured. Providing the GVRD is allocated significantly more water from Coquitlam the GVRD will just do a seismic upgrade of the existing Seymour dam. If the GVRD doesn't get more water from Coquitlam the GVRD would consider raising Seymour dam as well as doing the seismic upgrade at the same time.

The potential sources of additional water supply that are being considered should the GVRD not get more water from Coquitlam include:

- Raising the level of the existing Seymour dam;
- Constructing a new dam in the Upper Seymour watershed;
- Constructing a new dam in the Lower Seymour Conservation Reserve;
- Constructing a new dam in the Upper Capilano watershed;
- Extracting water from the Fraser River and providing extensive treatment;
- Extracting water from Pitt Lake;
- Developing a source to the East of the GVRD boundaries such as Harrison Lake.

All of these projects have undesirable environmental impacts and significant financial implications. For example, raising the level of the existing Seymour dam would

expand the reservoir and flood an additional 390 ha of valley floor ecosystem as well as costing about $100 million (net present value) more than the option of securing the proposed agreement water allocation from the Coquitlam Reservoir.

3. RATIONALE FOR GVRD'S DOMESTIC WATER DEMAND FORECAST

The GVRD's Livable Region Strategic Plan for growth management is rooted in the conservation of strategic resources - water, land, air, energy and finance. Managing how the region grows and our drinking water system evolves play a critical role in determining the magnitude of future water demand. Over the longer term, the implementation of the Livable Region Strategic Plan will continue to reduce residential water demand by increasing population densities and reducing average single family lot sizes.

As an initial baseline scenario, assuming current population growth and water consumption rates, the total average daily demand for water in the Greater Vancouver area could increase from about 1150 million litres per day in 2001 to about 2770 million litres per day in 2101. This assumes population grows from two million to about 4.8 million, that the municipalities of Belcarra, Bowen Island and White Rock continue to get their water from their own sources, and the member municipalities in the Greater Vancouver Water District gradually service their entire areas from the regional sources. The total daily amount that can be supplied from the existing watershed reservoirs (and with the existing agreement with BC Hydro) without major improvements is about 1640 million litres per day, which at current rates of consumption would begin to exceed supply in about 2030.

4. WATER CONSERVATION MEASURES AT GVRD

One of the first steps the GVRD takes when planning to meet a future need is to consider whether the demand that is generating the need can be modified in any way. In the water supply field, this "demand side management" approach focuses on water conservation as a way of reducing the cost of supplying water and postponing the need for system improvements and their associated environmental, social and financial impacts. The GVRD's existing water conservation program includes educational and partnership initiatives tailored to the residential, business, and institutional sectors as well as the lawn sprinkling restrictions implemented every summer since 1993. These conservation programs, along with other factors have contributed to a reduction in the average per capita water consumption in Greater Vancouver by about 12 per cent and peak daily flow per capita by about 27 per cent.

4.1 Improving pipes and infrastructure to stop leaking

The GVRD's water supply system is a high pressure (up to 300 psi) and high volume transmission system. About the only piping material around that can cost effectively handle such pressure is welded steel pipe. Our system is about 95% welded steel pipe in which the pipe joints are also welded. The pipe is also coated and lined to protect it from corrosion. Lined and coated welded steel pipe with welded joints is well know for having a very low leak incidence. Furthermore, in a high pressure, high volume system such as ours, leaks (and we do have them) are immediately evident (if not spectacular) and are repaired quickly. In summary, our system is very tight and experiences very little leakage on an ongoing basis.

However, our member municipalities' systems are not as tight since much of the piping is joined by mechanical means (which are more prone to leaks). In addition, the municipal systems operate under much lower pressures, making leaks more difficult to identify, as they do not show themselves quite so quickly. To the best of our knowledge, all municipalities served by the GVRD have a leak repair program but few, if any, municipalities have carried out a leak audit. Nevertheless, the goal to improve piping systems and reduce the amount of leakage is one that is shared by both the GVRD and its member municipalities. Municipalities

pay for all water provided to them and hence have a significant financial incentive to minimize leakage.

Like water metering, leakage control and UFW (unaccounted-for water) programs may be implemented for reasons other than just water conservation (e.g. billing accuracy). Technical consultants have been hired to help determine Best Management Practices for leakage control and UFW programs, and to determine the costs associated with implementing them.

4.2 "Water Smart" Program

The GVRD is committed to finding and implementing water conservation measures which are:

- environmentally sound
- equitable, and
- cost-effective relative to increasing the supply of drinking water.

The GVRD also has a demand side management policy that puts considerable emphasis on water conservation and reducing the overall demand for water. Water conservation was one of the considerations in developing the growth management strategies (population and land use targets) contained in the GVRD's *Livable Region Strategic Plan* that have contributed to the ongoing increase in more compact and water efficient communities and a reduction in per capita water consumption in the region. One of the GVRD's best know water conservation programs is the summer restriction on lawn sprinkling that has been implemented every summer since 1993.

The GVRD has also incorporated water conservation into its residential and business recycling programs. Specifically, this includes:

Residential Water Conservation

- development and distribution of new residential water conservation guides (e.g. "Waterwise Gardening")
- Inclusion of residential water conservation segments within our composting training workshops for municipal staff, master gardeners, etc.
- Partnerships with community groups such as the Van Dusen Flower & Garden Show and the BC Home & Garden show to promote waterwise gardening
- Partnerships with municipalities and others to design and promote public waterwise demonstration gardens
- Coordination of regular meetings between water coordinators from every municipality
- 'Train-the-trainer' water conservation workshops for local community organizations and schools

Business Water Conservation

- Development of new water conservation resource materials and guides for businesses

e.g. adding listings of water conservation fixtures to our Building Products Directory
e.g. development of industry-specific water conservation guides (for three industries, printed in four languages)

- Developing partnerships with local building industry associations (e.g. Greater Vancouver Homebuilders Association, Architectural Institute of BC) for seminars and workshops on designing for water conservation
- On-site water conservation advice to businesses on request
- Developing water conservation codes of practice for 3 business sectors
- Research and pilot projects for water conservation
    - e.g. pilot on ULF toilets in residential and commercial settings
    - e.g. dual flush toilets pilot trials
    - e.g. research into cost-effectiveness of water conservation measures across North America (for eventual determination of a regional water conservation strategy)
    - e.g. research into current local market trends and market penetration of water

conserving appliances and plumbing fixtures

The GVRD is also undertaking a drinking water management planning process that will address water quality, water supply and demand management from the source watersheds to the consumer's tap in a comprehensive integrated fashion. One of the key components of the planning process is further improvement in the water conservation strategy for the region. Related to this are the water conservation policies and commitments made under the GVRD's Stage 2 Liquid Waste Management Plan (LWMP).

The GVRD's Stage 2 Liquid Waste Management Plan was recently approved by the Minister of Environment and lists water conservation as one of its key strategies, and the promotion of water conservation initiatives as one of its policies. More specifically, the Stage 2 LWMP includes commitments to:

- investigate methods to reduce demand for wastewater treatment capacity (e.g. methods to reduce the volume of wastewater generated by reducing the consumption of drinking water)
- develop and implement an educational program for the residential, commercial and institutional sectors for pollution prevention and demand management (e.g. water conservation)
- investigate incentives to achieve reductions in water usage and wastewater generation (e.g. loading-based permit limits, recognition programs) (Stan Woods)

4.3 Water Meters

As a wholesaler of water, the GVRD meters all the water delivered to each member municipality. Municipalities pay for all water provided to them and hence have a significant financial incentive to minimize leakage, and consumption by municipal facilities (e.g. City Hall) and departments (e.g. sprinkling of sporting fields). At the consumer level, currently about 40 percent of the GVRD's water consumption is metered. This includes:

- essentially all of the Industrial, Commercial, and Institutional consumption,
- some of the agricultural and multiple family consumption, and
- a small percentage of the single family consumption.

Water metering provides many benefits such as equity in billing, improved system management, and leak detection in addition to reducing the demand for water. However, metering also carries significant costs. Therefore, water metering is only one of many water conservation measures that are being considered at this time. The cost-effectiveness of water metering relative to other alternatives for reducing water use is difficult to determine because it is highly dependent on the locale, the rate at which metering is retrofitted, and the fact that metering can be implemented for reasons other than water conservation. The GVRD is continuing to examine the costs and benefits of expanding the number of consumers that are metered, particularly the single and multiple family residential consumers.

Item #3 - Flood Summary: Main Issues and Recommendations

Prepared by: The Flood Working Group
Prepared for: The Coquitlam-Buntzen Water Use Plan Consultative Committee

Submitted: March 1, 2001 for the March 5 CC meeting

The following brief is the review of main issues and summary pulled directly from the Flood Working Group meeting minutes. Full minutes are available by contacting Joanna Brownell at EcoPlan International (228-1855 or cbwup@ecoplanintl.com). These issues will be discussed at the March 5 CC Meeting.

REVIEW OF MAIN ISSUES

- The main WUP flood constraint clearly identified so far is the IR2 cemetery overflow level of 140 cms.
- The two Port Coquitlam trails would overflow at a level of 140 cms; however, given that the flooding of these trails alone would incur no permanent damages, it was agreed that the flood threshold of 140 cms should not be reduced for the sake of the trails, on the condition that all necessary and appropriate safety procedures are applied.
- There are concerns that certain areas of IR1 and IR2 may be at risk of overflow at flood levels below 140 cms; these elevations/overflow points must be clarified in order to confirm the critical flood threshold PM.
- Given what has been learned, the 85 cms threshold PM discussed so far is not a concern, and may even be considered slightly conservative (depending on the overflow threshold once confirmed, it may even be desirable to consider a higher PM threshold). BC Hydro Operations Engineer Vlad Plesa noted that BC Hydro would like to store more water now, but that they do not given the potential impact of higher releases. In his opinion, 100 cms at the dam would be a threshold goal.
- Under current flood control operations, BC Hydro looks ahead five days and opens the low level outlets if the 1 m flood buffer may be encroached. The seasonal draw down already employed is another major operations procedure undertaken to reduce the risk of flood. Both the 1 m buffer and the seasonal draw down are being incorporated into the WUP model.

Concern was raised by some CC members of the Flood Working Group that they don't know well enough the flood risk involved with a 140 cms threshold to begin to make recommendations to the rest of the CC. Vlad explained that the combined 1 m buffer and seasonal draw down reduce the risk of spilling to 1 in 42 (i.e. once in forty-two years). As far as uncertainty regarding the actual buffer applied, Vlad stressed that likely nothing less than a 4 m buffer would actually provide real flood attenuation during a major storm event, but that a 4 m buffer would mean a massive loss of water needed in winter before the freshet, and not just by Hydro (i.e. may also be needed by agencies such as Fish and GVRD). Therefore, in his opinion a 1 m buffer is sufficient for safety protocol, and an increase for instance to 2 m would provide no more flood attenuation, but would really just boil down to a waste of water.

CC members agreed that it is important simply to recognize the risk of spill under both current operations and the model, and that further consideration of the options will reveal whether the 1 in 42 risk analysis

may change. In response, Vlad noted that all the WUP alternatives currently under consideration entail greater than current flows, and therefore less than the current flood risk.

SUMMARY

The Group agreed that:

- The current 1 m buffer, with its acknowledged 1 in 42 risk level, is acceptable.
- It is possible that the PM threshold could be increased above 85 cms, but confirmation is needed first regarding the critical overflows of IR1/IR2.
- Adequate flood safety protocol must be ensured for the Port Coquitlam trails.
- The 200 year flood protection requirements should be reviewed (outside WUP) and, if necessary, GVRD and Port Coquitlam should seek improved protection at IR1, IR2, and other at-risk dykes.

The point was made that seepage should also be considered if increasing from an 85 cms PM, given that waterfront homes may be at some risk of damage. Hydro staff responded that pre-spill amounts could be increased, if operating at greater than an 85 cms threshold, in order to balance this risk, although they also acknowledged that increased pre-spills could also worsen any seepage issues.

Item #4 - Recreation Study Brief

Analysis of Recreation and Tourism Activities Affected by Water Levels on the Coquitlam River

Prepared by: The Recreation Working Group
Prepared for: The Coquitlam-Buntzen Water Use Plan Consultative Committee

Submitted: December 11, 2000

The following study brief has been prepared by the Recreation Working Group to help address the questions put forth by the Consultative Committee (CC). A more comprehensive report is in progress and, if needed, it will be finalized and made available to the CC later this year. Any outstanding issues related to Buntzen reservoir will be addressed at a later date as needed.

What are the dedicated recreational facilities adjacent to the Coquitlam River?

There are several municipal parks adjacent to the river, a major regional park at the southern end of the river and developed and informal trails along both banks of the river throughout its length. There are four road bridges (consisting of fourteen lanes) and three pedestrian bridges crossing the river, with one additional pedestrian crossing proposed linking trails on the east and west banks of the river. Facilities are as shown on Map 1 and as described in Table 30 below.

Table 30: Recreation Facilities on the Coquitlam River

Facility/Site	Lead Agency	Comments
Pinecone/Burke Provincial Park	Provincial Parks	Informal hiking and mountain biking trails.
Upper Coquitlam River Park	City of Coquitlam	Trails, fishing access, and paved area for remote controlled airplane flying.
Coquitlam River Park	City of Coquitlam	Hiking and mountain biking trails, fishing access, viewpoints and access to the Trans Canada Trail
Westwood Park	City of Port Coquitlam	Hiking and mountain biking trails, fishing access, viewpoints and access to the Trans Canada Trail
Lions Park	City of Port Coquitlam	Children's play area , picnic shelter, open areas, paved and informal unpaved trails, fishing and shoreline access, viewpoints, interpretive displays.
Reeve St. Park	City of Port Coquitlam	Open areas, paved and unpaved trails, playing fields, tennis courts, fishing and shoreline access, viewpoints and interpretive displays.
Colony Farm Regional Park	G.V.R.D. Parks Dept.	Hiking and biking trails, picnicking, community gardens, interpretive displays, birdwatching.
Coquitlam River Wildlife Mngmnt Area	MoE – Fish and Wildlife Branch	Trail access to Fraser River for fishers.
Coquitlam River Greenway and PoCo Trail	City of Coquitlam, City of Port Coquitlam	15.8 km of trails on the Coquitlam River connecting the Pitt River Road Bridge to the North Ridge Greenway near Burke Mountain.
Colony Farm Greenway	G.V.R.D. Parks, City of Pt. Coquitlam	8.7 km. Trail connecting Colony Farm Regional Park to Pitt River Road Bridge Staging area.

What is the tourism potential of the Coquitlam River?

The tourism potential, especially related to river rafting, is poor. Other activities such as wildlife viewing at Colony Farm and fishing may be regionally attractive but are not considered commercially viable. The Coquitlam River is not a highly desirable rafting/kayaking/canoeing at any river level and cannot compete with other rivers in the lower mainland in the area of tourism due to quality of experience (e.g., shortness of floatable reaches). The primary attraction for rafting/kayaking/canoeing is local use, primarily in the lower reaches of the river.

What are the primary activities that take place in and around the Coquitlam River and what are the relative levels of use?

The working group identified a total of nine recreation activities. The relative use levels of these activities are distinguished by the primary purpose of a recreation visit or 'event' to the river. An estimated 500,000 recreational visitors events take place in the Coquitlam River area. By comparison, Buntzen Recreation area experienced 558,365, Pacific Spirit Park had 809,683 and Burnaby Lake had 284,800 visitors events in 1999. The majority of events, approximately 70%, are for walking, hiking and jogging, followed by biking and mountain biking at approximately 13% (See Table 31).

What activities do flow levels affect?

After much deliberation, the Working Group concluded that swimming, wading, fishing, kayaking, canoeing, rafting, tubing and floating were affected by water levels. Combined, these represent about 5% of the total visitor events of the Coquitlam River (See Table 2). The other activities would not be significantly affected by differing flow levels.

Table 31: Coquitlam River Recreation Activities

	Activity	Percent	Visitor Events	Affected by Flows
1.	Walking/hiking/jogging/equestrian	70%	350,000	N
2.	Biking/mountain biking	13%	65,000	N
3.	Picnicking	7%	35,000	N
4.	In-line skating/skate boarding/scootering	2%	10,000	N
5.	Swimming/wading	1%	5,000	Y
6.	Fishing	2%	10,000	Y
7.	Wildlife/river viewing (Nature study)	3%	15,000	N
8.	Kayaking/Canoeing/Rafting	1%	5,000	Y
9.	Tubing/floating	1%	5,000	Y
	Total	***100%***	***500,000***	
Affected by flows		**5%**	**25,000**	

* grey indicates activity directly affected by flow levels

What are the flow levels on the Coquitlam River and how would they look (e.g., a description)?

Table 32 provides a description of the base flow levels on the Coquitlam River in an average year. Efforts were made to coordinate the Recreation Working Group's initial analytical efforts with other working groups (e.g., fish); therefore the use of MAD (mean annual discharge) is utilized as a reference measure for flow levels to provide consistency with the Fish Working Group. For the purpose of this analysis, the

descriptions were primarily relied on in order to gain insight into the impacts on recreational activities and the associated flow preferences.

Note that MAD is the mean (more or less average) annual discharge and is a function of instantaneous flow measurements, including peak flows, base flows, storm events, etc., throughout the year. So the actual range of flows is very large: storm events for 1999-2000 went as high as 35 cms at the Port Coquitlam gauge (located at the Lougheed highway bridge). Flows can be much higher during a spill. Flows were also as low as 1.5 cms in early September, 2000 (over 1 cms of this was release from the dam, so there were very little tributary inflow). This picture shows that the Coquitlam River MAD is dominated by storm events; i.e. 2 days of storm events = 30 days of low flow. Therefore, more/less storms than average could alter the MAD by as much as 15-20%. [126]

It is important to note that the constructed scale in Table 32 was produced in order to conduct a preliminary analysis of flow levels impacting recreation and to focus future efforts and dialogue. More specific understanding of flows and impacts is anticipated to result from the IFN study, and the Recreation Working Group reserves the opportunity to conduct more detailed analysis if warranted based on these results.

Table 32: Flow Levels and Descriptions[127]

Flow Level	Description
Extreme low flows	Surrounding area inflows during summer dry period with minimal releases from the dam. All gravel bars and bank areas exposed. (defined by FTC as approx. 5% of MAD)
Low flows	Current summer period flows. Many gravel bars and bank areas exposed. (defined by FTC as approx. 10% of MAD)
Intermediate 1 flows	Current spring period. Some gravel bars and bank areas exposed. (Defined by FTC as approx. 20%-30% of MAD)
Intermediate 2 flows	Flows experienced with current fish valve releases from the dam and extremely heavy rain conditions (1 in 4 November flood conditions). Still well below bankfull levels but most gravel bars covered. (Defined by FTC as approx. 40%-50% of MAD)
High flows	Flows experienced with controlled low level outlet releases from dam and extremely heavy rain conditions.[3] Still below bankfull levels but all gravel bars covered. (Defined by FTC as approx. 90-100% of MAD)
Extreme high flows	Bankfull conditions. Water flowing in trees along river banks, within the channel. (Defined by FTC as approx. 200-400%MAD)

FTC=Fish Technical Committee

When are the activities affected and what are the preferred flow levels?

Swimming, wading, tubing and floating were considered summer only activities (May 24 – September 30). Fishing takes place between October and May and kayaking, canoeing and rafting are year round activities. Increases in flow from the status quo were desired by all activities. However, swimming, wading, tubing and floating preferred intermediate 1 flow over low flows, although both flow levels still provided opportunities -- intermediate 2 flow levels were considered very damaging to these recreational

[126] The reference gauge for MAD measurements is at Port Coquitlam, located at the Lougheed Highway bridge, about 5 km upstream of the confluence with the Fraser River. The MAD at PoCo is 27 cms. The other gauge for MAD measurements is at the Dam, where MAD = 23 cms. The Fisheries Technical Committee uses the PoCo as the reference gauge, and BC Hydro uses the dam.

[127] Note to Recreation Working Group: Names of flows and % of MAD were changed to be consistent with other working groups. Descriptions are still valid.

opportunities. Fishing, kayaking, canoeing and rafting would benefit most from intermediate 2 flow levels at all times of the year, but intermediate 1 levels would also provide benefits to these opportunities.

Table 33: Activities Affected by Flow Levels an Preferred Level

Activity	Period Affected	Preferred Flow Levels	Description
Swimming/Wading	May 24 – September 30	1. Intermediate 1 2. Low	Although gravel bars and banks are exposed with low flows, intermediate 1 flows create better swimming conditions. Intermediate 2 flows create dangerous conditions and limit access.
Fishing	October - May	1. Intermediate 2 2. Intermediate 1	The more water the better for fishing, all year round. However, very little fishing takes place in the summer months and intermediate 1 flows would be an improvement over current.
Kayaking/Canoeing/Rafting	Year round	1. Intermediate 2 2. Intermediate 1	Very minor improvements would occur from intermediate 1 flow increases due to the number and size of exposed rocks in the upper reaches. These conditions would be affected by intermediate 2 flows.
Tubing/Floating	May 24 – September 30	1. Intermediate 1 2. Low	See swimming/wading.

How were these opportunities analyzed?

A preliminary analysis, including an understanding of the trade-offs involved within the recreation sector, was conducted in three steps, briefly described below.

Step 1:
The analysis began reviewing four basic flow alternatives (Table 34).

Table 34: General Alternatives Analyzed

Status Quo	Alt 1	Alt 2	Alt 3
sum=low	**sum=**inter 1	**sum=**inter 1	**sum=**inter 2
fall=low	**fall**=inter 1	**fall**=inter 2	**fall**=inter 2
winter=inter 1	**winter**=inter 1	**winter**=inter 1	**winter**=inter 2
spring=inter 1-inter 2	**spring**=inter 1	**spring**=inter 2	**spring**=inter 2

Summer (sum)	=	May 24 - Sept 30
Fall (fall)	=	October - November
Winter	=	December-February
Spring	=	March – May 23

Step 2:
Second, a relative scoring system based on a constructed scale was developed (Table 35).

Table 35: Constructed Scale of Impact to Recreation Opportunities from Flow Changes to Status Quo

Adverse Impact			Benefit	
Level	***Description***		***Description***	***Level***
-10	permanent loss or highly restricted opportunity	**High**	opportunity greatly enhanced or new opportunity created with high expected use	**10**
-5	significant and/or seasonal loss of opportunity	**Moderate**	significant and/or seasonal gain of opportunity	**5**
-2	minor loss of opportunities	**Low**	minor gain of opportunity	**2**
0	no net gain/loss	**No Impact**	no net gain/loss	**0**

Step 3:
The Working Group generated the results by applying a technical score from Table 35 to an alternatives-by-activities matrix (Table 36).

What were the general results of the analysis?

The Working Group determined that all activities would benefit from increase flows, with the most significant gains coming from improved fishing opportunities from year-round intermediate 2 flows. The greatest benefits for fishing would be realized from intermediate 2 flows in the fall-winter-spring seasons; while canoeing and kayaking would benefit most during the summer season. Swimming, wading, tubing and floating opportunities would significantly suffer from intermediate 2 flows in the summer.

What are the key trade-offs within the recreation sector?

The most significant trade-off between activities is the gain in kayaking, canoeing opportunities during the summer from intermediate 2 flows --- as opposed to the losses in swimming, wading, tubing and floating opportunities.

What is the preferred general flow alternative for recreation considering trade-offs?

Based on this preliminary analysis, the Working Group identified a new alternative, Alternative 4, that suggests intermediate 1 flows in the summer and intermediate 2 flows the rest of the year as being most beneficial to recreation. Table 36 shows an overview of the results of the analysis.

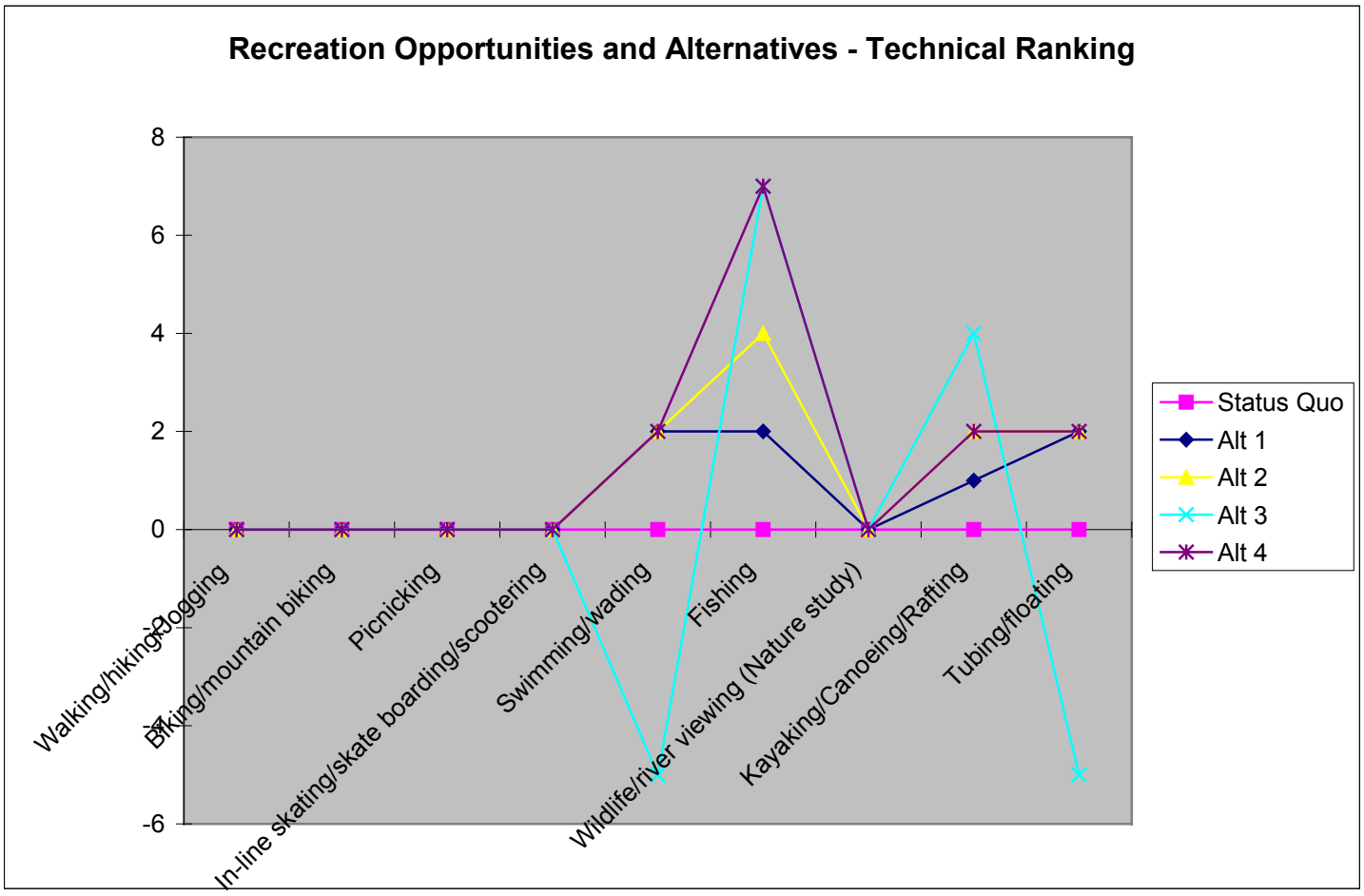
Table 36: General Flow Level Alternatives by Recreational Opportunity Matrix Analysis

Activity	Status Quo **sum/fall**=low **winter**=inter 1 **spring**=inter 1-inter 2	Alt 1 **sum/fall**=inter 1 **winter**=inter 1 **spring**=inter 1	Alt 2 **sum**=inter 1 **fall**=inter 2 **winter**=inter 1 **spring**=inter 2	Alt 3 **sum/fall**=inter 2 **winter**=inter 2 **spring**=inter 2	Alt 4* **sum**=inter 1 **fall**=inter 2 **winter**=inter2 **spring**=inter2
Swimming/wading	0	2	2	-5	2
Fishing	0	2	4	7	7
Kayaking/Canoeing/Rafting	0	1	2	4	2
Tubing/floating	0	2	2	-5	2

*Alternative 4 was developed through discussion by the Working Group
Note: Weighting of different activities by use level has little impact on the overall results as all activities affected by flows are between 1-2% of total use.

Figure 19 displays graphically the effects of different alternative flow regimes on each activity. The activities with the greatest movement (highs and lows) are of the greatest interest to the CC, as these are affected by the WUP recommendations. As is apparent from this figure, Alternative 3 shows some of the strongest positive gains, but also the only negative impacts on recreational activities (swimming, wading and tubing). Meanwhile, Alternative 4 is able to capture most of the gains with none of the negative impacts.

Figure 19: Graph of Coquitlam River Recreation Opportunities Affected by Alternative Flow Levels



Conclusions and Additional Parameters

After reviewing the results of the analysis, the Working Group agreed that recreation would not be a primary 'driver' in the analysis and that it is likely most alternatives would benefit or, at least, not negatively impact recreation. Information from the IFN study may cause the need for revisiting in greater detail some of the analysis presented here. Still, recreation should not be dismissed, and should be included when considering consequences and trade-offs. Especially important are several flow alternatives that would 'trigger' the need for greater consideration of recreational impacts. These are:

- Extremely low flows at any time of the year
- Intermediate 2 flows during the summer months
- The timing of potential flushing flows

Finally, several operating considerations were mentioned:

- Weekends more important than weekdays
- Day more important than night
- Consistent flows – reasonable knowledge what the flow level will be during a given period of time or based on natural signals (e.g., intermediate 2 flows after a storm event).

Item #5 - Environment/Wildlife Study Brief

Preliminary Analysis of Environment and Wildlife Habitat Affected by Water Levels in the Coquitlam River

Prepared by: The Environment/Wildlife Working Group
Prepared for: The Coquitlam-Buntzen Water Use Plan Consultative Committee

Submitted: December 11, 2000

BACKGROUND

This study brief explains the performance measure and preliminary operating parameters developed for the Coquitlam River by the Environment/Wildlife Working Group at a workshop on November 28, 2000. Additional detail is available from the workshop minutes and from background materials provided to the working group prior to November 28th. For copies of these, please contact Karen Peachey at EcoPlan International (email: kpeachey@ecoplanintl.com (preferred) or phone: 228-1855).

The working group recognized that not all riparian areas along the river are a community resource and that, during the trade-off process, ownership issues may positively or negatively influence the value attributed to preserving riparian areas for wildlife. At this stage of the analysis, however, discussion focused on ecological considerations and the flows that would be required to meet the environment/wildlife objective.

It was previously agreed by the consultative committee that fish objectives and performance measures would be reviewed and assessed as to their adequacy as a proxy for aquatic habitat. Discussion at this workshop focused on riparian/wetland habitat.

Table 37: Recommended environment/wildlife performance measures for the Coquitlam River

	SPECIFIC OBJECTIVE[128]	PERFORMANCE MEASURES	UNITS
Wildlife & Environment	To maximize the area and suitability of aquatic and riparian habitat for indigenous wildlife, including species at risk and organisms not captured by fish objectives.	1. Loss of low bench ecosystems due to sustained root zone flooding of low bench during growing season (April – October) 2. Beneficial recharging of subsurface wetland water tables 3. Fish objectives and performance measures as a proxy for aquatic habitat * Fish performance measures to be further reviewed and assessed as to adequacy in this regard	1. percent (or hectares) permanent loss of low bench 2. yes/no

How did the group arrive at this performance measure?

1. Agreed that initial focus should be on persistent ecosystem root zone flooding
2. Identified flows which are expected to benefit or harm ecosystems along the Coquitlam River
3. Identified conditions under which concerns other than low bench loss may need to be taken into account in the assessment of operating alternatives.

Why focus on ecosystem root zone flooding?

Why focus on ecosystems? Overall ecosystem health under different flows provides a good measure of the area and suitability of riparian/wetland areas for indigenous wildlife. Once it is established which ecosystems are likely to be affected by flows, specific wildlife considerations (eg nesting requirements, habitat area for species at risk) can be factored into the development of operating alternatives and incorporated into the assessment of alternatives.

Why focus on root zone flooding? It is primarily through changes in the soil water regime of active floodplain ecosystems that the Coquitlam-Buntzen Water Use Plan can influence ecosystem health and hence the area and suitability of riparian habitat for indigenous wildlife. Changes in the soil water regime occur through both surface and sub-surface flooding. [129]

There are 7 different riparian ecosystems along the Coquitlam river. The following 5 occur along the active floodplain and are therefore directly impacted by water levels in the river:

- high bench
- medium bench
- low bench
- forested swamp
- sedge fen.

[128] Agreed to by CBWUP Consultative Committee, June 5, 2000
[129] Details in September 2000 draft report of CBWUP mapping study by Oikos Ecological Services Ltd, p.5.

Other types of riparian ecosystems also exist along the river, but they are located outside the active floodplain.

Would increased flows likely trigger permanent loss of ecosystems?

The critical issue is whether higher flows would result in permanent ecosystem loss due to persistent flooding of the root zone. It was concluded that:

- permanent loss of forested swamp and sedge fen as a result of increased releases from the dam is improbable
- persistent water levels high enough to result in permanent loss of medium and high benches are also improbable .[130]
- persistent water levels high enough to result in permanent loss of low bench ecosystems may occur and should be considered as part of the trade-off process. The details of this relationship are currently being worked out, but as a starting point, we are using the following relationship:

Persistent 5cms = 25% permanent LB loss
Persistent 10cms = 75% permanent LB loss

Related discussion points:

- From the Fraser to the Red Bridge, water level in the rooting zone of the floodplain ecosystems is determined mainly by Fraser River influences and by tides. Therefore, higher flow releases from the dam would probably have little if any impact on these low bench ecosystems.
- Above the Red Bridge, the value of low bench ecosystems in terms of vegetation composition and structural stage (viz. age of ecosystem) varies. Along the entire stretch from the dam to the Red Bridge there are low bench ecosystems on cobble and gravel bars and the lowest portion of these support less vegetation than higher portions. In addition, there are "pole-sapling low bench ecosystems" on terraces along the length of the river above the Red Bridge. The vegetation and structural stage of these differ from the cobble and gravel bars (more mature ecosystems) and this may influence the value attributable to the loss of low bench.

What flows might benefit ecosystems along the Coquitlam River?

The group concluded that existing flows are satisfactory but may be improved by flushing flows (up to 150 cms) with conditions regarding season, and duration of flow. The purpose of flushing flows would be to recharge the water table in floodplain habitats. However, the potential benefits on adjacent wetlands need to be considered once we determine from study results how large an area of wetlands can be affected and what access floodwaters have to backchannel wetlands. [131]

[130] There may actually be some short-term positive impact due to snag creation on middle benches with persistent flows about a foot above current levels during growing season,April to October. (Snags will not stand forever and if there is no recruitment then this benefit will be lost once they all fall down.) The middle benches affected are situated between the Red Bridge and the Pedestrian Bridge.

[131] Potential benefit to amphibians in wetland areas was specifically mentioned.

Conclusions and additional parameters

In summary, the Working Group concluded that existing flows are adequate to maintain floodplain ecosystem health and may possibly be improved with flushing flows to recharge water tables in some floodplain habitats. Persistent higher flows will likely result in the permanent loss of some low bench ecosystems and the valuation of these losses would take into consideration their:

- Present health (generally good, considering the urban-suburban setting and past logging in the area)
- Vegetation (degree of vegetation differs dependent on elevation and area of the river)
- Structural stage (Increasing value if existing ecosystems are permitted to age rather than reverting to different ecosystem type and starting again at young seral age)[132]
- Red and blue listed plant and animal species and ecosystems in the area[133]
- Ownership (eg. First Nations, private, public)

Other considerations in relation to wildlife/environment when assessing flow alternatives are that:

- flushing flows during nesting season (April to July?) should be avoided if possible (to prevent loss of nests/dens in low bench areas)
- Obligates (animals that rely on fish and aquatic organisms for food) would benefit from flows that increase fish production in the river

Finally, flow alternatives that would trigger the need for greater consideration of wildlife/environmental impacts include:

- lower flows than current levels so that middle and high bench ecosystems do not receive sufficient subsurface flooding and backchannel wetlands do not receive groundwater recharge
- flows that cause erosion of floodplain ecosystems

[132] Increase in water table that submerges low bench does not result in medium bench reverting to a low bench.
[133] Red and blue listed species are discussed in the CBWUP wildlife literature review prepared by Robertson Environmental Services Ltd.

Item #6 - GVRD Maps of the Coquitlam Watershed & Area South of the Watershed[134]

GENERAL (1:25,000)
- Topography
- Slope, Aspect, Elevation

FOREST ECOSYSTEMS (1:25,000)
- Biogeoclimatic zone; Variant
- Disturbance regime
- Seral stage
- Site series
- Red & Blue listed ecosystems

TERRAIN (1:25,000)
- Surficial materials
- Stability rating
- Landslide tracks
- Landslide density

HYDROLOGY (1:25,000)
- Stream reach classification (S1 - >S4)
- Riparian zones
- Fish inventory

RESERVOIR BATHYMETRY (1:5,000)

NOTE:
- 10m resolution colour Landsat / SPOT mosaic imagery, and 1m pan-chromatic ortho-photo imagery is available.
- Wildlife habitat suitability classifications can be derived from Forest Ecosystems data.

GVRD Maps for the areas south of the Coquitlam watershed

1. GVRD watershed boundaries
2. GVRD watershed classification – health assessment
3. GVRD watershed imperviousness
4. GVRD watershed population densities 1996/2036
5. GVRD land use
6. Major streams some fish data
7. Minor streams some fish data

These maps outside the Coquitlam watershed are available on the GVRD website:

http://www.gvrd.bc.ca/services/sewers/drain/Reports%20and%20Publications.html#Strmwater

[134] These maps are available from GVRD and from other sources, as indicated. List provided to CC by Derek Bonin, GVRD.

Item #7 - Suspended Sediment/Turbidity[135]

Issue	Discussion	Effectiveness of Proposed Flow Scenarios for Management				Comments
		Flushing Flow*	**ALT 2:** Conservation Releases	**ALT 4:** Power Friendly	**ALT 0:** Current Operations, as of 1999	
Suspended Sediment and Turbidity	Sediment sources are in Or Ck, other tributaries and gravel mines. Most flow from tributaries; most transport in winter	increase turbidity during their release	slightly higher turbidity in summer	no effect	no effect	Sediment source management probably more effective than flow releases
Substrate in Back and Side Channels	The entrances are blocked with berms with restricted inlets. Flushing would require overtopping of the berms at flows of about 400 m^3/s which would greatly damage the channels	no effect	no effect	no effect	no effect	A better approach may be to modify the inlets to allow larger flows in the channel or to undertake mechanical cleaning
Sediment Deposition in upper layer of substrate in main channel	releases of at least 50 m^3/s required over five days to clean upper layer in Reaches 3 and 2. Little success is expected in Reach 1 because of deposition from sediment mobilized in Reaches 3 and 2	effective with annual releases	may provide some minor flushing; may help flush pools	no effect	no effect	Large releases would use shorter duration; however, maximum controlled release from dam is about 50 m^3/s. This release also prevents damage to Reach 4. Effectiveness increased with settling pools along Reaches 3 and 2.
Sediment Deposition in lower layer of substrate in main channel	Flushing required in Reach 1; lower substrate about 50% sand and granules. Requires bed mobilization or flows that are greater than 400 m^3/s	no effect	no effect	no effect	no effect	Uncontrolled release; damage to Reach 4, modification to channel in Reaches 3 and 2. Deposition of mateial from Reaches 2 and 3 may make flushing ineffective. Mechanical cleaning may be better approach. Long term aggradation may require removal of deposits to prevent flooding
Channel Width Maintenance and Riparian Vegetation Control	Channel has narrowed substantially over the past 30 years with riparian vegetation encroaching on bars. Flows of greater than 200 to 300 m^3/s are required for bed mobilization and channel rearrangement	no effect	no effect	no effect	no effect	Uncontrolled release; damage to Reach 4, deposition in Reaches 1 and 0. May not be a good approach to maintain or develop fish habitat

* Current operations + Flushing flows of different magnitudes

This information was provided to help the CC evaluate whether changes in dam flow releases are expected to have an impact on managing sediment concentration, transport, and deposition. The table makes reference to a selection of preliminary flow alternatives considered by the CC. Although, most of the flow scenarios shown here changed later in the process, conclusions drawn from this table did not change.

[135] Source: Ken Rood, Northwest Hydraulics Consultants (invited speaker at February 1, 2001 Information Session and consultant retained to carry out "Coquitlam River Channel Morphology and Substrate Condition Study" for the CBWUP

Appendix G RECORD OF NON-WUP ISSUES & ALTERNATIVES[136]

COQUITLAM RIVER

Gravel Operations

- Reduce silt flows from gravel mines
- Filter water releases from gravel operations
- Stop sediment from gravel mines entering the river by enforcing/changing DFO regulations
- Decommissioning of gravel mines
- Work with gravel operators at developing storm water management solutions that work, i.e. remote settling ponds
- Channel gravel pit runoff / discharge away from river to large remote settling area (i.e. Lafarge Lake) before returning it to Coquitlam River
- Better control sediment release from gravel mines
- Regulate gravel operators to better control silt e.g. a series of settling ponds with only one outlet to River
- Enforce DFO regulations regarding amounts of sediments entering the river
- Enforce the Fish Act and use money for habitat restoration

Urban Development & Controls

- Improve storm drain management
- Improve industry/municipal efforts for managing storms and discharge issues
- Seriously restrict development adjacent to the river
- Halt development along riverside
- Purchase land subject to flooding
- Appropriate private land
- Move houses out of flood plain (compensation)
- Remove all man-made structures from flood plain
- Separate channel for storm water and gravel operators discharge
- Encourage habitat enhancement on riverside property; tax breaks for "greening" riverfront property
- Use of pervious materials, where possible, in new developments (cost effective)
- Pressure city councils to develop more environmentally friendly developments i.e. impervious concrete etc.
- Place an upper limit in OCP on "effective impervious area" (amount of concrete/blacktop)
- Greening property initiative

Dykes

- Increase the height of the dykes for flood control
- Move dykes away from the river
- Upgrade dykes
- Remove dykes
- Assessment of dykes: are they built to current standards?
- Restore IR1 & IR2 to pristine conditions (dykes to protect burial grounds and sacred sites)

Dredging

- Dredge river downstream of Pitt River Rd. Bridge
- Dredge lower river
- Dredge silt from river bottom
- Dredge mouth of Coquitlam River regularly
- Controlled gravel extraction to re-build the river bed for fish habitat to 1930 levels (minimum) and build separate channel for storm water. Gravel royalty could pay for some or all of the costs.
- Restore IR1 & IR2 to pristine conditions (i.e. depth of river substrate

Habitat Enhancement

- Fertilize river to bump start insect production
- Include mitigative measures such as improving habitat as an alternative to flow release increases; or fertilize river (e.g. Keogh River Program)

[136] Transcribed from worksheets filled out by Consultative Committee members during initial brainstorming session on operating and non-operating alternatives, CBWUP CC meeting, October 30, 2000 and compiled during the process. GVRD followed up with information on its water conservation programs – summarized under heading of Domestic Water in Appendix F ("Non-Fish Information Sheets").

- Develop more spawning channels and rearing channels
- Habitat enhancement in river/obstructions/rip-rap/holes/boulders etc.
- Habitat enhancement (more side channels, LWD)
- Addition of large woody debris
- Provide fish "blinds" (concealed fish viewing platforms at spawning areas)
- Enhance tributaries into Coquitlam River (more fish)
- On an annual basis introduce spawning gravel (compliments of Allard) to Coquitlam River below the dam
- Gravel replacement from dam to Or Creek
- Add substrate
- Use thinning, plantings and other techniques to improve the riparian zone
- Increase wetland habitat and side channels
- Replanting riparian zones: place trails outside of riparian zones. Use plants to keep people, horses and pets on trails (blackberry, devils club)
- Consider local reshaping to maximize habitat
- WUP to include a "buy back option" whereby BC Hydro can purchase back a portion of planned fish flow releases at market value. Proceeds can then be used to support fish initiatives and enhance BC Hydro SVA.
- Support hatchery
- Increase fish/wildlife habitat enhancement programmes
- Undertake watershed restoration activities to reduce sediment (fine material) entering Coquitlam River thereby improving fish habitat/water quality
- Restore "swimming holes" in river bed
- Diversions into Coquitlam River

Other

- Redirect Tower Creek to flow into Coquitlam River all the time, not just when water is cloudy. This will naturally increase the amount of water in the river.

COQUITLAM RESERVOIR

Fish Population

- Fish ladder
- Fish Ladder to Coquitlam Reservoir for fish access (assumes no impacts to drinking water quality)
- Create fish passage to reservoir and reintroduce sockeye (from Pitt River)
- Restore sockeye runs, after the river is "cleaned" up (could re-establish to commercial levels?)
- Re-establish Coquitlam Lake sockeye
- Sockeye hatchery below/above reservoir and fish ladder for exit only i.e. only fry in reservoir

Habitat Enhancement

- Fertilize reservoir (if no fish ladder)
- Maintain forest/upper watershed health – GVRD
- Stabilize old clear cut areas and slides from logging roads
- Build marsh areas at mouths of inflow streams
- Re-vegetating the draw down zone to enhance wildlife habitat
- Install nest boxes
- Create appropriate spawning habitat through enhancement work: cost covered by power generation

Infrastructure Changes

- Remove dam
- Raise the dam (including seismic repairs to the existing structure). Costs retired through increased revenues.
- Install fish valve(s) at dam to allow additional releases
- Add 10 more fish flow valves
- Increase capacity of fish valves
- Install low pressure power generators below the dam and the water would enter Coquitlam River
- Build power plant so fish flow releases into river can be used to generate power
- Generate power on water that's being returned to the Coquitlam River
- Generate power at Coquitlam dam through whatever means available, return water to Coquitlam River
- Produce power at Coquitlam dam and shut down one or both of the Buntzen generators
- Install low-pressure turbines
- Improve LLO valve operation
- Increase capacity of power system so that you don't waste peak flows with spills
- Replace sluice gates to better control release rates
- Make tunnel bigger (storm surge control)
- Move location of GVRD intake deeper into reservoir to make elevation operating range bigger

Other

- Recovery of arch/heritage resources as opposed to avoiding disturbance
- Divert additional streams into reservoir such that all objectives can be better met
- Increase alpine? water storage to moderate? Coquitlam Reservoir

BUNTZEN RESERVOIR

- Remove dam
- Cease hydro operation
- Restore spillway on Buntzen Reservoir
- Install nest boxes and platforms
- Install mechanism to discourage fish from entering Buntzen power plant intakes
- Consider alternatives to cover safety issues (buoys, reshaping)
- Increase alpine? water storage to moderate? Buntzen Reservoir
- Micro hydro at Buntzen Tunnel
- Install low pressure turbines
- Low wattage turbines in tunnel

INDIAN ARM

- Increase public access for recreation
- Decommission LB1 and LB2 and clean up site
- Remove or restore LB2 site

GENERAL COMMENTS

Water Conservation

- Water conservation measures to retain water for additional uses (water consumption, fish flows, power, etc.)
- GVWD "water smart" program to decrease demand rather than assume increased population means increased water demand
- Water meters
- Improve GVRD pipes and infrastructure

Regional / Watershed Plans

- The Coq/Buntzen system needs to be part of a larger decision making matrix for the South Coast
- Do a proper watershed management plan for the whole of the Coquitlam River watershed, over and above this WUP process
- Logging / maintenance road repair in watershed
- Limit regional growth

Education / Knowledge

- Better education re: water use, water restrictions, fish, habitat, storm drains
- Improved weather forecasting to reduce risk of flood

Governance / Partnerships

- Government regulations require revision to allow First Nations and watershed societies to be represented on any boards or committees set up to control municipal or provincial development, mining or forestry undertakings.
- Hydro support of volunteer groups on the river would encourage the community to be environmentally friendly and improve the physical environment through active stewardship
- Annually allocate BC Hydro revenues from Coquitlam system for habitat enhancement but not to be used for gravel mining mitigation
- Frustration with Land Claims process

Appendix H LIST OF REFERENCES

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Appendix I GLOSSARY AND ACRONYMS

TERM	DESCRIPTION
2FVC	2 Fish Valves always open with the GVRD current agreement reflects the current situation under existing agreements (though the GVRD does not typically use all their water allocations at present as allowed under their current agreement).
4FVN	The 4 Fish Valves New (Optimized) with GVRD proposed agreement river flows is the equivalent to a doubling of water from the current flows, but flow releases are optimized monthly for fish requirements.
Aggrade	To fill with detrital material (loose rock fragments/organic particles).
Anadromous	Fish species such as coho salmon and steelhead trout that hatch in freshwater, migrate to and mature in the ocean, and return to freshwater as adults to spawn.
ATUs; See also Incubation	Accumulated thermal units – a determinant for the duration of incubation, generally from spawn to fry emergence. Daily average temperatures are cumulatively added together to assess the degree of incubation.
Bank Full	Maximum river flow before bank is over topped and flooding could occur.
Bedload	A term identifying the range of substrate that makes up the channel bed material without defining the true nature of composition.
Benthic Invertebrates	Bottom dwelling organism with no backbone or spinal column.
Black Start Capability	The ability of a generator to start operations independent of any outside electrical power source. Most generation units require external auxiliary power to start.
CC	Consultative Committee
Cfs	Flow measurement: Cubic feet per second (1 cfs equals 0.028317 cms)
Cfs-d	Volume measurement: Cubic feet per second-days (an average cubic feet per second flow for 24 hr)
Channel morphology	The form and structure of a stream channel.
CMS or m3/s	Flow measurement: Cubic meters per second (1 cms equals 35.315 cfs)
Cms-d	Volume measurement: Cubic meters per second-days (an average cubic meters per second flow for 24 hr)
DCP	Data collection platform
Deposition	The depositing or settling of suspended matter.
DFO	Department of Fisheries and Oceans – Federal Government (now known as Fisheries and Oceans Canada)
Effective Littorial Zone (ELZ-PM)	The area of a lake or reservoir near the shore within a depth of approximately 10 metres to which light can penetrate.
Electrofishing	The use of electrical current to capture fish.
Embeddedness	Term used to describe the degree to which larger substrate particles (gravel/cobble/boulder) are buried in the substrate. An example would be a piece of gravel where the observer can only see the top half of the gravel due to sediment accumulation. This material is deemed to be 50% embedded.
Emergence	The movement of salmonids out of the gravel.
Entrainment	The action whereby fish are drawn through or over a dam structure.

Enumeration:	The process of collecting and identifying fish species and characteristics typically for the determination of productivity of a reference stream.
Erosion:	The process or wearing away by the action of water, wind or glacial ice.
ESOR	BC Hydro's Electric Systems Operations Review – completed in 1994
Eutrophic:	Refers to those lakes and reservoirs which contain high concentrations of nutrients (typically in nitrogen and phosphorous forms).
Fines	Defined by the Resource Inventory Committee (BC) as clay silt and/or sand under 2 mm in diameter.
Fish weir	A manmade construction spanning the width of a river which diverts fish into a holding trap for the purpose of counting; generally used for smolt (see Smolts) enumerations but can also be constructed to capture upstream and downstream migrating adults.
Flushing flows	Also known as maintenance flows; describe the range of freshet or storm flows that maintain physical or biological processes. Fish benefits of maintenance flows may include: cleaning substrate of interstitial sediment, reforming channels for gravel recruitment and distribution of erosive power, and distribution of allochtonous (riparian) or autochthonous (instream) nutrients.
Fluvial/Ad-Fluvial:	Refers to habitat use of resident fish species. Fluvial species reside wholly in streams and flowing water. Ad-fluvial species spend only certain life history periods in flowing systems (e.g. spawning).
Fry	Salmonid life stage following the alevin stage.
FTC	Fish Technical Committee – subcommittee of the Consultative Committee.
Fyke Net	A specially designed net for out-migrant enumeration which diverts and funnels juveniles into a collection bin for sampling.
GVRD	Greater Vancouver Regional District
GVWD	Greater Vancouver Water District; a subsidiary of GVRD.
HSI (Hydraulic Suitability Index); Also referred to as Preference or Probability of Use curves	HSI curves describe the relationship between a hydraulic attribute (usually depth and velocity, but may also include substrate and meso-habitat aspects) and life history requirement. Developed by observing fish in their habitats and documenting the hydraulic attributes. Defined for almost all life histories of BC resident and anadromous fish species.
Hydrograph	Refers to the typical flow regime for a point along the reference stream. Natural hydrograph is the pre-impoundment regime, and regulated hydrograph is the post-impoundment hydrograph. A hydrograph can be illustrated across accuracies ranging from within day variations to monthly averages.
In Stream Flow Needs Assessment (IFN)	A study to be completed within the next two years with the information used to finalize the second test flow (STP#5) parameters.
Incubation	Is the life history period where eggs develop in spawning grounds, followed by fry emergence. The length of timing for incubation is temperature dependant, and is normally measured in accumulated thermal units (ATUs).
Interstices	Spaces between materials in the substrate--fine suspended material may fill in the interstices of the upper layer.
Life History Periods	See Periodicity

Littoral Zone:	The area of a lake or reservoir near the shore within a depth of approximately 10 metres to which light can penetrate. Effective littoral zones are those portions of the littoral zone not hampered by reservoir fluctuations.
LB1/LB2	Buntzen Generating Stations No. 1 and 2.
LLO	Low Level Outlet – 3 gates in the dam which allow water releases from the reservoir to the Coquitlam River.
MAD; See also naturalized MAD	Mean annual discharge – the expected or measured flow averaged over a year.
Mainstem	The major portion of a river excluding side channels and tributaries.
Meso-Habitat	Habitats described by attributes not defined by flow, such as substrate, cover, and instream vegetation.
Migration	The movement of fish in a river; Adult movement into the system (in-migration), or juvenile movement out of the system (out-migration).
Minnow trap; Also referred to as "Gee-Traps"	A small trap, usually baited with roe (fish eggs) to capture juvenile fish
MSRM	Ministry of Sustainable Resource Management
Naturalized MAD	Is the pre-impoundment MAD. Generally referenced as the "MAD at the point of diversion".
Oligotrophic:	low levels of nutrients such as nitrogen or phosphorus in a lake or reservoirs. Typical coastal lakes and reservoirs are ultra-oligotrophic.
Parr	Salmonid life history stage following the fry stage. All fish remaining in the river over 1 year are termed parr.
Pelagic Zone	Deep water area (over 10 feet).
Penstock	The tube through which water flows from the reservoir to the turbines in a hydroelectric generating system.
Periodicity; Also referred to as Life History Period	Refers to the timing and annotation of portions of fish species life cycles. Life history periods are generally broken into: spawning migration, spawning, egg incubation, fry (rearing), parr (rearing), smolt (out-migration), and adult (rearing).
Preference Curve	See HSI
Pre-impoundment	Prior to dam installation.
Probability of Use Curves	See HSI
Productivity/secondary productivity	Productivity is the rate of formation of organic matter averaged over some defined time period. Primary productivity relates to the rate of creation of new organic matter – associated with photosynthesis. Secondary productivity is the formation of organic matter in invertebrates and vertebrates from consumption of the primary producers (plants and animals).
Ramping (rate)	Regulated changes in flows over time. Down ramping and up ramping refer to the controlled changes in flow downward and upward respectively. Natural ramping rates are those rates of change that best represent those that would naturally occur on the (a) same but unregulated; or (b) similar, river systems.
Reach	A section of river length distinguished by channel geometry, barriers to fish migration, and/or the confluence of a stream tributary.
Redds	An area where adult salmon have laid eggs (or trout).

Resident	Refers to fish species that spend their entire life cycle in freshwater.
RST (rotary screw trap)	Metal trap placed instream and secured by cables. This type of trap rotates while catching a portion of juveniles migrating downstream. Mark recapture estimates are then used to ascertain population estimates
Sediment	Deposited material.
Sediment transport	Describes the mechanics of substrate movement under varying flow conditions.
Silt	Loose sedimentary material with rock particles usually .05 mm or less in diameter.
Smolts	Salmonid life history stage after the parr stage when a juvenile undergoes physiological adaptations to survive a saltwater habitat. A juvenile reaches this stage just prior to migrating to the ocean.
Snorkel surveys:	Method for enumerating and observing fish use in river, by visual, in-river counts.
Spawning	The act of two salmon mating (suggest you not use the word salmon, but fish in general). Effective spawning refers to that which occurs at a flow sustained through egg incubation.
SQM	area measurement: square metres.
STP#5	The "Sharing the Pain" (STP) alternatives were designed to provide a target flow nomination to both the river and GVRD on a monthly basis. To try and accommodate both domestic water objectives and in-stream flow objectives more equitably during dry water years and therefor 'share the pain'. The STP#5 varies according to target flows, seasonal priorities and yearly rainfall between domestic water, water for fish down the Coquitlam River and water for power. When reservoir operations deviate from the prescribed levels (i.e. reservoir elevation drops below target reservoir elevation), BC Hydro diversion from Coquitlam Reservoir is the first to be restricted (approximately 1 m below target elevation). When the reservoir elevation drops further (approximately 2 m below target elevation) depending on the priority of the water user, nominations are gradually reduced to the minimum targets for both/either GVRD and river flows.
Substrate	The mineral and/or organic material that forms the bed of the stream.
Suspended load	Refers to the amount of substrate of varying sizes entrained or suspended in the water column of a river channel.
Suspended sediment*	Matter suspended in waters may be inorganic or organic in origin. The type and concentration of this suspended matter, and dissolved material, controls the turbidity and transparency of water.
Suspended Solids	Suspended solids are that fraction of material retained on a 0.45 μm pore-diameter glass-fibre filter through which only fine and very fine clays can pass through. That non-filterable residue (which may contain both organic and inorganic components) is referred to as suspended sediment. It is typically measured in terms of (mg·L–1).
tailrace	The portion of a weir or dam immediately downstream from a powerhouse. A pool of water into which a plant or a non power release facility discharges its water
Total Gas Pressure (TGP):	The concentration of gas (nitrogen and oxygen) entrained in water is measured in percent or pressure, and can be exacerbated by hydroelectric operations such as spilling or synchronous condense. Elevated TGP levels
Transect	A cross section of a river, measured perpendicular to the flow.

Tributary	A stream or water source contributing to the flow of a reference stream.
Turbidity*	Turbidity is a measure of the lack of clarity or degree of transparency of water caused by inorganic and organic suspended or dissolved substances. Turbidity is an expression of the optical properties of substances that cause light to be scattered and absorbed.
Water Licence	The authority granted by the Comptroller of Water Rights of the Province of British Columbia to store, divert or use water for any purpose including the generation of electricity.
Watershed	Drainage area of a given waterway (same as river basin)
WLAP	Ministry of Water Land and Air Protection
WSC	Water Survey Canada; government bureau responsible for climate and hydrology monitoring for Canada.
WUA (Weighted Usable Area)	Area associated with particular species and life history stage weighted by preference for each variable associated with that area. Weighting is typically geometric: WUA = Area · Preference (see HSI)

Appendix J CC MEMBER FINAL WRITTEN COMMENTS

Submission #1: Joe Pauker (CC Member)

From: J. Pauker jpauker@primus.ca
To: EcoPlan International epi@ecoplanintl.com
Att'n: William Trousdale

Subject: February 10, 2002 Draft Report of the Consultative Committee
Coquitlam-Buntzen Water Use Plan

Further to my fax of February 2, 2002, some factors outside the WUP Programme Scope that are directly affecting the objectives of the programme are:

A) The existing lower mainland sewage and drainage system is totally inadequate to handle the existing population and developed areas let alone additional population and more developed areas. New growth areas should use the technology that has been developed to have smaller local treatment plants and gravel disposal fields for several houses or buildings in the local area. No large trunk sewer systems would be required. Storm water from developed areas can be treated and allowed back into the original natural waterways. There are experiments being carried out on South Vancouver Island for porous hard surface parking areas to absorb the surface water without extensive drainage system piping, also reducing the severity of run off.

B) The existing Municipal planning departments must have environmentalists added that have equal authority to govern the issuing of development permits.

C) In view of the rising energy costs, on a personal basis, we decided to install a new energy efficient furnace to reduce our expenses for heating our home. To satisfy our curiosity I checked our consumption and costs from 1998 to 2001. The results are startling.

TABLE OF CONSUMPTION AND COST

YEAR	1998	1999	2000	2001
ANNUAL CONSUMPTION G.J.	113.60	128.80	118.90	92.70
AVERAGE COST / G.J.	5.81	6.02	7.49	11.39
ANNUAL COST	660.48	776.05	901.30	1056.41

Results: 1) The furnace is more efficient based on the average consumption in the years 1998 to 2000. If we hadn't changed the furnace we would have paid at least $230 more in 2001. The new furnace will pay for itself in 12 years.

2) The increased amount charged over the three years from 1998 to 2001 is $751.92

Conclusions: The conclusion can be made that every household in the G.V.R.D. has experienced an increased expense at the same ratio for heating, depending on individual use patterns. Our home is a modest three-bedroom home and is probably on average for the area.

It is not out of line to conclude that the price charged by B.C. Gas in 1998 was set by the B.C. Utilities commission to cover exploration, capital, and operating costs as well as profit. What has happened to justify the price increases and when were the hearings held by the B.C.P.U.C. to allow the increases?

There was an item I the news recently that adjustment of a 10% reduction in gas rates because there is no longer the "demand" for gas. How has this changed in our area? The percentage increase for gas from 1998 to 2001 was 96%. The recent reduction of 10% should reduce the increase to 86% from 1998for the balance of 2002.

It is also a reasonable conclusion to assume that the $751.92 increase we have experienced in our household would be close to the average amount other G.V.R.D. households have experienced. There are 692,900 households in the G.V.R.D. according to the 1996 census (G.V.R.D. source). Without taking into account the increases paid by other customers; i.e., commercial and public buildings, nurseries, and recreation facilities, a good guess of the amount of increase collected by B.C. Gas is (750.00 x 699,900) $579,675,000.00.

If the present pricing escalation continues from 1998 rates our household will pay an increase of 1056.41 (2001) – 660.48 (1998) = 395.93 (if our consumption is constant) less 10% or approximately (395.73-39.57) $350.00 / year. The total for G.V.R.D. households is (350.00 x 699,900) $242,515,000.00.

Even if the average consumption of the G.V.R.D. households were 50% of ours the annual increase collected would be $121,000,000.00.

This is an obscene gouge!

If the government can control labour price increases even though there is a strong "demand" for their services why can't the government control the "demand" for price increases for (utilities) auto and heating fuel?

D) Considering the financial problems our provincial government is having why is this looting of the public purse allowed? The media and unions have been very quiet about this matter, but when Translink wanted to collect a $75.00 fee from auto owners everyone was ready to set their hair on fire.

In light of B.C. Gas charges it is ridiculous that C.C. members (volunteers and dedicated G.V.R.D. hydro members) are struggling with whether 7 to 10 million dollars should be spent on the Coquitlam River for fish habitat, flood control, and addressing First Nations concerns regarding sockeye return to Coquitlam Reservoir and G.V.R.D. domestic water supply.

No public utility should be privately owned.

Instead of going into private hands the funds listed above, even if the estimated revenues as shown in item C) were 50% too high, would finance stream and forest rehabilitation, stop hospital closures, stabilize public sector wages, and help finance the coming First Nations Treaties.

I will be unable to attend the March 11th meeting, but there should be at least one more meeting after everyone is heard from.

Regards,
J. Pauker jpauker@primus.ca

Submission #2: Brent Hilpert (CC Member)

Position Statement on Coquitlam-Buntzen Water Use Plan Consultative Committee Report

Brent Hilpert February 21, 2002

Introduction

While the WUP CC agreement has merit in it's provisions to examine whether greater fish benefits can be realised, I nonetheless am in disagreement with the allocation of water to the GVRD.

Section 1 of this statement presents a comparitive analysis of the process which I believe exposes some procedural shortcomings. Section 2 is a summary statement of disagreement.

1. Procedural shortcomings:

Figures 1 and 2 present an overview of the modelling relationships and evaluation streams utilised in the Coquitlam-Buntzen WUP process, focussing on the three primary interests: hydro-electric, fish and domestic water.
The "values" assigned to each interest in Figure 2 are my own words, however they are derived from the primary objectives of each interest as expressed in it's chosen performance measures and the modelling it uses.
The population growth model is shaded in Figure 2 because it has held a unique and unexamined place in the process.
Following is an examination of several aspects which distinguish these evaluation streams.

1.1 Transparency in Use of Human Values in Model

Ideally the models would be free of human values so that participants would have purely objective performance measures upon which to base their value judgements in the assessment/negotiation stage. In the absence of such pure objectivity the issue becomes one of transparency: whether or not the participants are aware of the human values which have been used in the models.
For the primary interests' models:

- **Hydro-electric:** While the CC hasn't seen much of the details of this model and there may be some use of human values in the electric-generation model if it includes choices about system-wide use, my expectation would be that the human value content here would be zero to minimal.

  B.C. Hydro has chosen to add an additional modelling module for financial benefits, which is essentially value-based. However the performance measures for the financial model (being in dollars) are discernible as human values and are distinguished from the other performance measures coming out of the modelling.

- **Fish:** In theory there shouldn't be any human values in the model unless one wishes to bring into question the objectivity of the people carrying out the studies which the modelling is based on. One way or the other, this model has been highly scrutinized by the CC.
- **Domestic Water - Supply/Use:** There are some human values in this model such as the per-capita water use rate. This has been discussed in the proceedings. Supply options have also seen some discussion. Of course, the comment above regarding the financial portion of the model also applies here.
- **Domestic Water - Population Growth:** The CC has seen nothing of the GVRD population growth model, it's existence has not even been mentioned until now. I was going to make conjectures about the sources of it's rules and parameters here but I'll leave it at this: it is an assessment of human values (how many people there are is largely up to us people). These values have not been seen by the CC participants and are not discernible in this interest's performance measures. (Alternatively: not having seen this model, there is no reason to give it's outcomes and the performance measures dependant upon it any credence.)

1.2 Uncertainty of Model

Any model has some degree of uncertainty or variability associated with it. The use of human values as parameters to the model, as discussed above, will contribute to uncertainty. The degree of proof of the rules on which the model is based and other parameters also contribute to uncertainty.
For the primary interests' models:

- **Hydro-electric:** The modelling rules are based primarily in the hard sciences giving them a high degree of proof and low uncertainty.
- **Fish:** The rules are science-based, albeit with a lesser degree of proof. There is uncertainty in this model but this has been acknowledged throughout the proceedings and in the agreement.
- **Domestic Water - Supply/Use:** The per-capita water use rate mentioned above will contribute uncertainty to the model. I will presume the remainder of the (non-financial) model is of relatively low uncertainty. However, because the outcome of the population growth model flows through this model the next comment applies to the outcome of this model.
- **Domestic Water - Population Growth:** With a large basis in human values and being a projective model the uncertainty here is high. Remarkably, this uncertainty or variability has not been discussed or considered during the proceedings.

1.3 Consideration of Societal Benefits/Detriments

The absence of the population growth model from the proceedings has led to insufficient consideration of the societal benefits/detriments of meeting that model interest's value. The significance is the tremendous difference between the growth interest and the others. For the following the domestic water interest's value is broken into two portions although it has not been characterised as such in it's performance measures:

- **meeting Hydro-electric value (maximise electric energy generation and $):** Societal benefits are existing and ongoing; detriments are low, aside from those being negotiated.
- **meeting Fish value (optimise/maximise fish habitat/production):** Benefits at least a segment of the population; little risk or detriment, aside from those being negotiated. As an example, in these proceedings fish benefits have been limited due to flood risk.
- **meeting Domestic Water (Current) value (supply requirements of current population):** As with hydro-electric, societal benefits are existing and ongoing; detriments are low, aside from those being negotiated.
- **meeting Domestic Water (Growth) value (supply requirements of population growth projections):** Benefits to some, detriments to others; high risk or opportunity for significant societal detriment.

That last statement alludes to what I will refer to as extended societal benefits/detriments: those beyond those being directly traded off between the interests. Is it reasonable in the WUP proceedings to consider the extended benefits/detriments of meeting an interest's values? If an objective of the WUP proceedings is to reach consensus, where each individual negotiates with full awareness of the implications of their choice to their values as well as those of others and society, so as to give their informed consent to the agreement, then yes it is, as considering the extended benefits/detriments goes directly to being aware and informed from a societal perspective.
One consequence of not having this scrutiny or awareness of the extended benefits/detriments is that the impediments to an interest's objectives can be knocked off one-by-one in isolation. There will probably be a detriment to someone's values at each point (as there is resulting from this WUP), but having been negotiated in isolation, the true or total cost to individuals and to society remains hidden.
While such an argument may be raised for any interest - that they have not fully disclosed their objectives and the resultant consequences - the measure for requirement of opportunity for consideration in the proceedings becomes whether those objectives and consequences follow from the modelling which that interest has brought into the process. So for the "other" interests to assert or claim their value, such extended objectives do not arise to any great degree from their modelling. However for the growth interest to assert it's value, it has to bring into the process a model which has much wider implications for society.
During the proceedings the test for inclusion of an issue in the process has been whether it is subject to influence by the operating parameters or water allocation (Draft CBWUP Report, Fig. 4, pg. 14). The question for consideration of the extended benefits/detriments of growth then is: Is population growth affected by the allocation of water, that is, does the parameter WPG in Figure 2 exist? In the wider reality, of course, it does; in this process it has been treated as if it doesn't, in that the GVRD has presumed that it will be able to get water no matter what, and that only

costs relating to options of supply are at issue. The degree of influence which these costs exert on population growth then becomes the question, and is arguable. Ultimately however, the decisions that would fulfill that presumption of availability are based in human values which must also be accounted for.

1.4 Commentary:

The preceding assessments are summarised in the following table. The domestic water supply/use model, although not an interest, is included to show the assessments pertinent to that model.

Summary Table of Assessments					
Interest	**Hidden human value injection**	**Relative model uncertainty**	**Uncertainty as presented in proceedings**	**Potential for extended societal detriment**	**Relative scrutiny of model by CC**
Hydro-electric	0 to minimal	low	low	low	some
Fish	0 to minimal	medium/high	medium/high	low	lots
(Dom. water supply/use)	0 to minimal	some	some	-	some
Dom. water (current)	0	low	low	low	implicit
Dom. water (growth)	large	high	low	high	nil

The population growth parameter (PG in Figure 2) throughout these proceedings has been treated as an absolute rather than the outcome of a projective, human value based model. As such, it has obtained a unique status in the modelling: the primary (if not all) parameters to the other models, such as generator efficiency, height of water head to generator, usable area for fish habitat, etc., are measurements of the current state of physical reality.
This contrast is exemplified in the draft WUP CC report in which there are many mentions of the uncertainty associated with the fish model but not a single consideration of the uncertainty associated with the population growth model. Observe the GVRD's information sheets to address domestic water use concerns (Draft CBWUP Report, Appendix [F]): while the population targets are at least referred to as estimates, they are nonetheless treated as absolutes; all other parameters, including people's values (!), are subject to influence and variation - everything except for the population growth parameter.

Curiously, the result of the CC WUP agreement is that the value with the weakest basis in certainty (and that uncertainty extends all the way to societal benefit/detriment) is to be provided not only a large allocation, but a high certainty of allocation. While this may reduce the uncertainty to that interest, the distributed but connected nature of benefits and detriments associated with growth means that their uncertainties are not mutually exclusive. Providing certainty to that interest may increase the certainty of (it's) benefit but it also increases the certainty of societal detriment.

1.5 Conclusions:

With the large degree of hidden human values in the population growth model, it is not unreasonable to suggest that no one on the CC, other than perhaps the GVRD participants, is truly in a position to provide their informed consent to the WUP agreement, because without knowing what those hidden values are, one is unable to assess to what degree they are in agreement with one's own.
Whether or not the CC or the Water-Comptroller warrants these arguments significant enough to be given any action for the Coquitlam-Buntzen WUP, they might be considered as recommendations for other processes:

- **1.5.1 Hidden injection of human values into model:**
  All model rules and parameters should be scrutinized so as to ensure transparency. The injection of human values at the modelling stage should be acknowledged and made plain, otherwise it is effectively a circumvention of the process. Consideration of all human values utilised in the modelling is required for a participant to be aware and informed from a personal perspective.

- **1.5.2 Degree of uncertainty or variability of model:**
  At least a qualitative assessment should be presented or acknowledged for all models.
- **1.5.3 Extended societal benefits/detriments:**
  Opportunity for consideration of such should be given based on an exposure of complete model streams. Such consideration is required for a participant to be aware and informed from a societal perspective. This consideration may result in performance measures being brought forth to the assessment/negotiation stage which reflect more completely the societal implications of the modelling which an interest has introduced to the process.

None of these issues has been met for the GVRD interest in the Coquitlam-Buntzen WUP CC proceedings.

2. Summary Statement of Disagreement:

Too much of the water allocation is assured to the GVRD. Even at the lower bookend of the agreement the allocation is a large increase over the current GVRD allocation. The intent of this increase and of a portion of the current allocation is to meet future drinking water demands of regional population growth.

- **2.1** This growth will have detrimental effects on the region and will present conflicts with other's values. Future technological developments are commonly presented as solutions to many of the foreseen detriments. However, to believe those developments will occur is a matter of faith, not science or reason.

- **2.2** While the GVRD will not use the full allocation immediately, the act of guaranteeing them the (future) allocation at this time will:

  - **2.2.1** Facilitate or enable the growth. This growth is neither necessary to, or inevitable in, a well-functioning society.

  - **2.2.2** Be used to justify the growth, or make it more difficult to avoid the growth. The expenditure of monies, contracts undertaken (of which the one between GVRD and BCHydro which would result from this agreement is one), etc., based on this guarantee will, in part, necessitate the growth. As with plans in other arenas of society, the existence of the plan will become the justification for the implementation of the plan.

With a high probability of a significant societal detriment and absence of capability or proof of means to deal with the detriments, and with existing and ongoing beneficial alternative uses of the water, assuring the GVRD an allocation beyond existing requirements is not a wise use of the public water resource.

Brent Hilpert 604-469-1888
hilpert@cs.ubc.cs

Fig 1. Evaluation Stream for an Interest

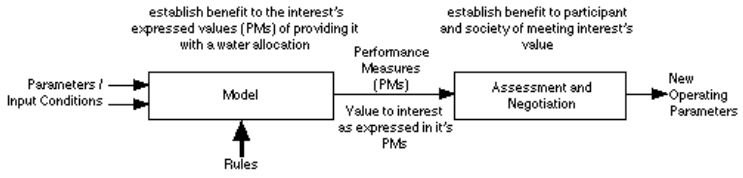
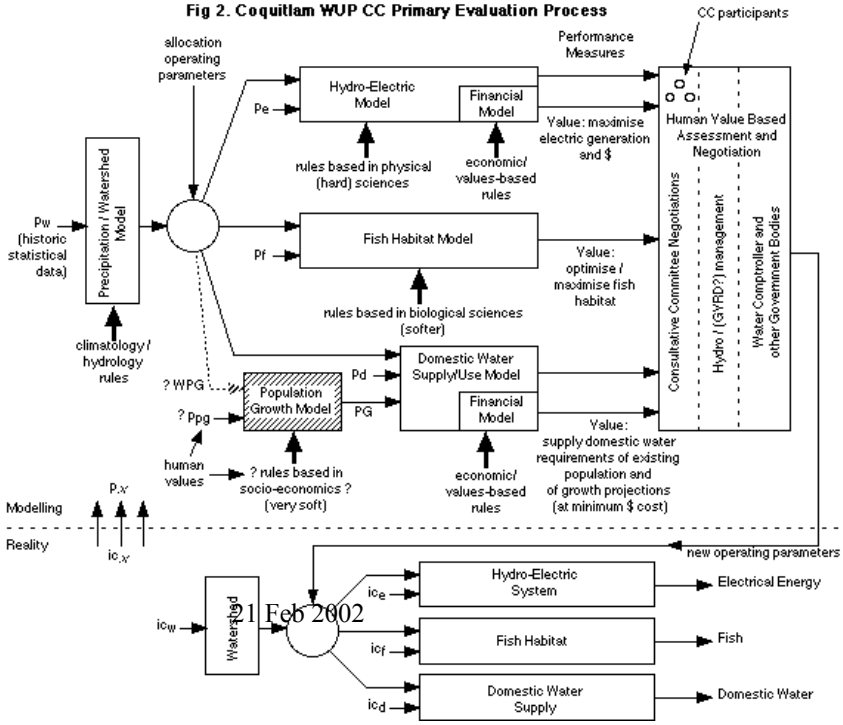


Fig 2. Coquitlam WUP CC Primary Evaluation Process



Appendix K MINUTES FROM FINAL CC MEETING, MARCH 11, 2002

Final Meeting Minutes – March 11, 2002

Consultative Committee Meeting
For
Coquitlam-Buntzen Water Use Plan

On Monday, March 11th, 2002, the Consultative Committee of the Coquitlam-Buntzen Water Use Plan (CBWUP) met at the BC Hydro District Hall in Coquitlam. The meeting started at 5:10 p.m. and concluded at approximately 10:00 p.m. The following attended the meeting:

Consultative Committee Members

1. Nancy Aichberger, Port Moody Ecological Society
2. Paul Archibald, GVRD
3. Lawrence Bojczuk, Buntzen Ridge Wilderness Recreation and Parks Association
4. Derek Bonin, GVRD
5. Sherry Carroll, Resident
6. Kirsten Doucette, Watershed Watch Salmon Society
7. David Dunkley, GVRD
8. Don Gillespie, Burke Mountain Naturalists
9. Dr. Don Gillespie, Resident
10. Wayne Goeson, PoCo Hunting & Fishing Club
11. Elaine Golds, Burke Mountain Naturalists
12. Brent Hilpert, resident
13. Eunice Hodge, Coquitlam River Watershed Society
14. Janice Jarvis, Habitat Conservation & Stewardship Program, Maple Ridge-Coquitlam
15. Ian McArthur, resident
16. Tony Matahlija, North Fraser Salmon Assistance Project-CRWS
17. Bruce Misewich, BC Hydro
18. Ross Neuman, Ministry of Water, Air, Land Protection
19. Craig Orr, Watershed Watch Salmon Society
20. Rick Simpson, Port Moody Ecological Society
21. Dan Sneep, DFO
22. Walter Udell, BC Hydro
23. Stan Woods, GVRD

First Nations

24. George Chaffee, Kwikwetlem First Nation (until ~8:00 pm)
25. Glen Joe, Kwikwetlem First Nation (until ~8:00 pm)
26. Nancy Joe, Kwikwetlem First Nation (until ~8:00 pm)
27. John Peters, Kwikwetlem First Nation (until ~8:00 pm)

BC Hydro Resource Staff

28. Charlotte Bemister
29. Michael Harstone
30. Al Geissler
31. Ed Hill
32. Janie Hutchings
33. Alf Leake

Observers

34. Bijou Kartha, Ministry of Sustainable Resource Management
35. Steve McAdam, Ministry of Water, Land, & Air Protection
36. Diane Ramage, Maple Creek Streamkeepers
37. Brian Shields, City of Coquitlam

Consultants

38. William Trousdale, EcoPlan International (Facilitation)
39. Maria Harris (Minutes)

40. Diana Nikolic, EcoPlan International (Assistance - Minutes)

1.0 Distributed Materials

Please contact EcoPlan International if you require any of the following documents.

1. Meeting agenda
2. Water Use Planning Monitoring Program: Principles, Decision Tree, and Required Information – Background Provided by BC Hydro Resource staff
3. Evaluation Sheet for Ranking Monitoring Plan Items
4. Draft of Monitoring Committee Representation, Purpose, Mandate, and Meeting Schedule
5. CC member comments on the February 10, 2002 Draft Consultation Report:
    a. Compilation of written comments (distributed prior to meeting)
    b. Additional comments from Joe Pauker (distributed at meeting)
6. Community Information and News:
    a. Announcements:
        i. Water and the Future of Life on Earth Workshop and Think Tank, May 22-23 (Craig Orr)
        ii. World Summit on Salmon, Simon Fraser University, Feb 19-21 (Craig Orr)
        iii. Environmental Festival, Colony Farm Regional Park, April 21 (Elaine Golds)
    b. News articles on draft CBWUP report Tri-City News & Maple Ridge-Pitt Meadows News (Charlotte Bemister)

2.0 Introduction and Agenda Review

The facilitator reviewed the proposed meeting agenda, the objectives of which were to:

1. Review and evaluate the FTC's monitoring proposals; and
2. Review and discuss CC member and observer comments on the Draft CC Report.

The intended outcome of the meeting was, if possible, to obtain acceptance of the CC Report for submission to the Comptroller of Water Rights. The meeting agenda was agreed to as proposed.

The facilitator asked for comments or changes to the second draft minutes of the previous Consultative Committee meeting. There were no comments and the second draft (dated November 26th) was approved. Outstanding action items were addressed later in the meeting.

3.0 Fish Monitoring Plan

At the request of the Consultative Committee, the FTC developed a monitoring program based on flow and time constraints agreed upon by the Consultative Committee. [137] Prior to the meeting, CC members were given the opportunity to review a preliminary version of the proposed monitoring program in the February 10th, 2002 draft CC report. The FTC subsequently revised some aspects of the program and Alf Leake of BC Hydro provided CC members with a presentation of the updated monitoring plan and of outstanding issues. His presentation reviewed:

[137] Constraints include: a) 15 year time cap; b)2 Flow Trials: 4FVN and "STP5" (determined by IFN results) for 6 years each; and c) Assessment of "opportunistic flushing flow" impacts.

1. Timing and flow constraints reflected in the October Consultative Committee operating recommendations;
2. Selection criteria used to screen monitoring requests (these are common to all BC Hydro Water Use Plans);
3. Monitoring plan components (including also monitoring requests that were rejected by the FTC);
4. The status of ongoing work that will assist in refining the design of the monitoring plan; and
5. Key Issues presently surrounding the monitoring program. These relate to trade-offs between:
    a. Benefits and costs associated with inclusion of a control stream in two components of the monitoring plan; and
    b. The value of information that can be expected from the proposed monitoring experiments, specifically regarding meaningful distinction between the two proposed flow alternatives: 4FVN and STP#5. Statistical power analyses to help address this issue are currently underway and should be complete by mid-summer 2002.

Proposed monitoring plan components are listed in this section of the minutes under the heading of "Evaluation Worksheet". Criteria and rationale for selecting monitoring plan components (items #2&3 above) are not reproduced here but will be in the final CC Report. Status of ongoing work (item #4) and issues related to control streams (item #5a) and statistical power analysis (item #5b) are discussed below. It was noted at the meeting that the monitoring plan proposed by the FTC to the Consultative Committee represented a short list of studies: the FTC had already screened many studies which did not meet criteria based on amount of learning, duration of study, cost effectiveness, the probability that competing hypotheses may be correct, and expected impact on future water use plans. The resulting monitoring plan was specifically developed to meet the core objective of distinguishing between fish benefits of the proposed trial flows within the review period.

Aside from discussion about control streams (see separate heading), CC members made no objections at the meeting either to components of the fish monitoring plan or to monitoring requests the FTC "rejected".

Several CC members highlighted the need of the monitoring program to work with and monitor actions of other activities and factors that might affect the monitoring results, such as habitat rehabilitation work.

Status of Ongoing Work

The CC received the following update about work that is currently underway and is relevant to refining the monitoring program design:

Instream Flow Needs (IFN) Data Collection

- December spills provided Reach 2 and 3 data for linear habitat mapping and transect studies;
- Analysis and data summary in progress;
- IFN draft expected by end of March with data collected to date - interim report.
- Missing data for Reaches 0, 1, and 4 - will be added when possible.
- Ministry of Water, Land, and Air Protection recommendations on transect selection will refine IFN study output (ie. Weighted Useable Area predictions) further.

Ramping Rate Updates

- Spill ramp-downs from 45cms to 10cms and from 10cms to base flow releases were conducted in late December

- Crews on site and 2 data-loggers recorded water levels and observed impacts
- Data to be summarized by Bridge River Coastal group by end of March
- Next assessment will target DFO recommended ramp rates.

Flushing Flow Assessments

- The FTC proposed data collection of recent (Jan/Feb) events to assess impact of natural "flushing flows" that occurred during this winter's storms. This information would contribute to the assessment of flushing flow benefits.

Key Issue: Use of Control Stream

An important outstanding issue before finalization of the CBWUP monitoring plan is whether to include a control stream as part of monitoring invertebrate and fish productivity. The CC reviewed biological rationale, selection criteria, and possible options for including a control stream and it became clear that there are cost-benefit trade-offs to be made. The following costs and benefits associated with a control stream for assessing invertebrate and fish productivity were provided by the FTC as part of the evaluation worksheet given to the CC by BC Hydro Resource staff:[138]

Benefit/Cost Information About Use of A Control Stream for CBWUP Monitoring

(Excerpt from Monitoring Evaluation Worksheet)

Monitoring Item	Impact Hypotheses *(Uncertainty being Addressed)*	Amt of learning expected through monitoring (L/M/H)	Estimate Costs ($000's) Based on 12 years
Invertebrate Productivity Index	Flow releases from the dam affect invertebrate productivity and is related to habitat availability	High (with control stream)	$576
		High (with control in Upper Coq R.)	$451
		Medium (no control stream)	$296
Fish Productivity Index	Coquitlam River flow treatments (dam releases) affect Fish productivity (as described by the habitat-flow curves predicted in the IFN assessment results)	High (with control stream)	$2,905
		Med (w/ control stream every 2yrs)	$2,276
		Low (no control stream)	$1,647

FTC members explained to the CC that a control stream is statistically required to isolate natural variation from changes arising as a result of dam releases and that without a control stream, the effects of the proposed dam releases may not be quantifiable within the proposed review period. It was noted that natural variation is expected to come from several sources, including:

- Ocean survival shifts due to changes in food availability/temperature
- Localized impacts due to water quality issues, climate (urban drainage, sediment loading, CMS example)

[138] 10-12 year duration proposed for both the invertebrate and fish productivity studies.

- Fish management changes – over-fishing/ conservation efforts affect numbers of returns.
- Availability of habitat - increased habitats mean that cohort survivals will gradually increase, and response time may increase due to limits on spawning recruitment.
- Hatchery programs, habitat enhancements, etc.

BC Hydro representatives on the Committee noted that when they agreed to the CBWUP operating plan last October, they did so with the expectation that monitoring costs would be in the order of $1.8 million for the 12 year period (approximately $150,000 per year). They clarified that the estimated cost of the monitoring was required to understand the level of commitment associated with potential agreements being discussed at the consultative table. In order to do this they had relied on information being developed for the FTC on what their best estimate of the monitoring program would be. The BC Hydro representatives pointed out that the issue of control streams had not arisen as an issue until after the October CC meeting, and that costs excluding the control streams were in the range of what they had understood the potential monitoring would be.

Several members expressed concern with BC Hydro's statement about monitoring cost, suggesting that it could undermine the monitoring program. They also pointed out that no cost expectations were ever discussed, this was the first time this information had been brought forward by BC Hydro, and that the FTC did screen all monitoring components in an attempt to meet the Committee's requirement to provide meaningful information between the two flow trials for decision making at the next review period.

The BC Hydro representatives noted that they did not want to stand in the way of the control stream monitoring if the technical and WUP management and policy reviews supported the need. Since the Power Analysis and management reviews of the issue would likely take some months to resolve, they wanted to remain with the schedule to finalize the Consultative Report and the Water Use Plan and submit them to the Comptroller of Water Rights within the next month. They indicated that they would be recommending that the Water Use Plan which BC Hydro submits to the Comptroller of Water Rights *should not* include control stream monitoring but that it *should* include a recommendation that the Comptroller reconsider this point in the event that technical and WUP management and policy groups end up supporting additional monitoring. (Note: The BC Hydro Water Use Plan referred to above is a separate report from the CBWUP Consultative Committee Report.)

Key Issue: Effectiveness of Proposed Monitoring Experiments

Resource personnel from BC Hydro reviewed statistical power analyses that are presently underway to determine whether two of the proposed monitoring studies (i.e. the River Fish Productivity Index and Flushing Flow Assessment) will yield statistically significant results. Statistical power analyses determine the probability on a scale of 0-1 that a study will be able to detect expected change. Power analyses are also being used to test other scenarios to determine whether the CBWUP monitoring studies can be changed to yield more reliable conclusions. Results of statistical power analyses are expected by mid-summer of 2002.

It was pointed out that monitoring programs assessed by statistical power analyses historically score around 0.4-0.6 in other river systems (meaning that a monitoring plan would have somewhere between a 40% to 60% ability to differentiate a change in the river). A score above 0.6 was suggested as a minimum threshold for the proposed treatment schedule to remain unchanged, but the CC did not agree to a threshold. Rather, the FTC was tasked with reviewing the results from the power analysis to determine effectiveness of the monitoring plan and recommend any changes, if needed.

The FTC's proposed treatment schedule was reviewed and consisted of the following: 6 years for Flow Trial #1:4FVN; 6 years for Flow Trial#2: STP5 (or lower depending on the IFN results); to be completed

within 15 years or less (based on 3 years for approvals, LLO modification, and ongoing seismic work at the dam). Opportunistic flushing flows will not be carried so as not to confound trial flow results. Instead, flushing flow effectiveness will be assessed when natural high flows occur. Specifically, the monitoring plan includes measuring the state of the substrate before flow trial one, and evaluating the substrate a further two times (one per flow trial) in the event of high natural flow events (similar to the one which occurred this past Jan 7th, 2002).

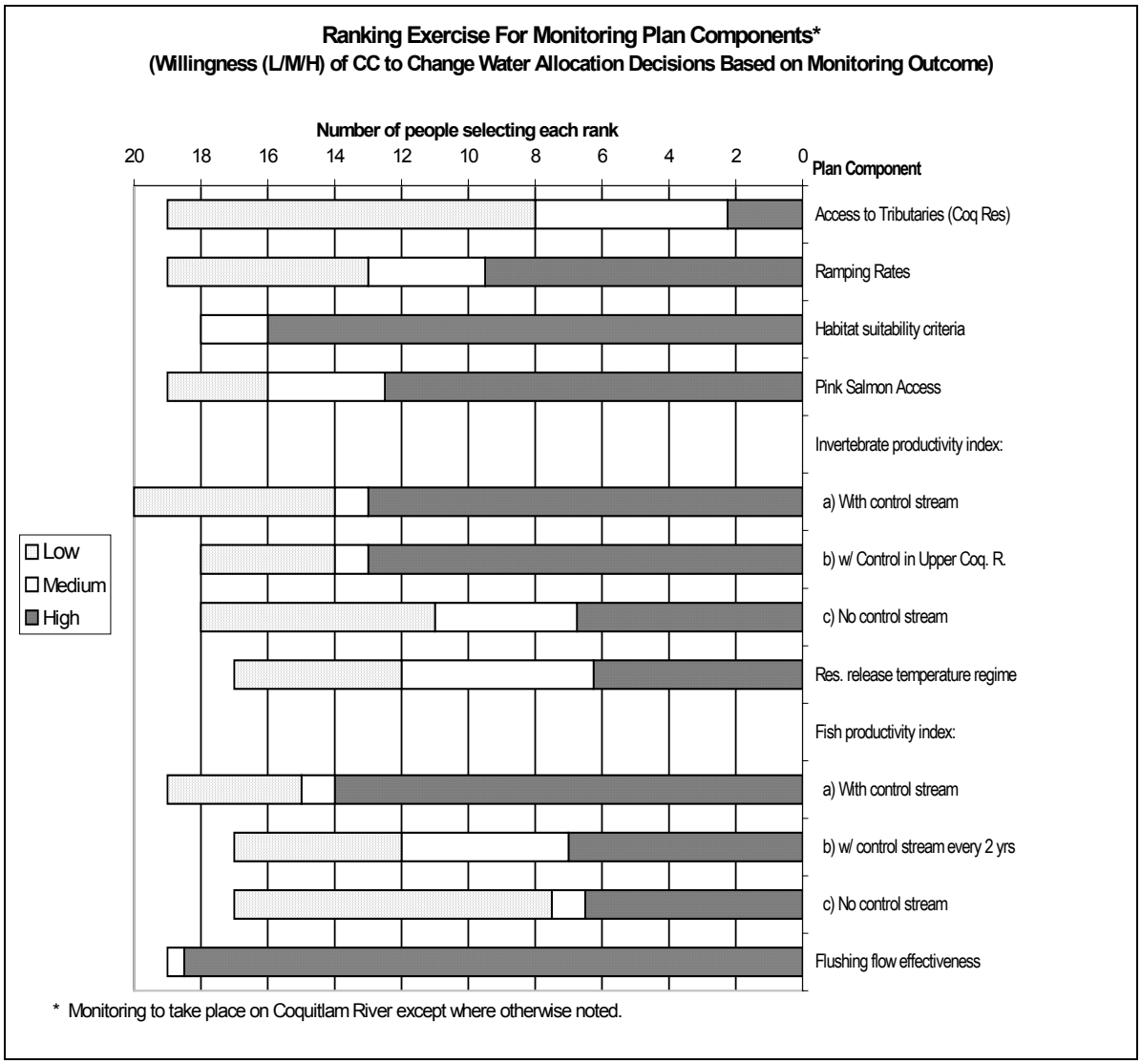
CC members discussed the statistical power analysis and agreed that:

1. A monitoring program that is capable of providing information that distinguished between the fish benefits of two trial flows as agreed to by the CC in October 2001 is an essential component of the recommended CBWUP operating plan;
2. Before investing in a monitoring program for the CBWUP, there must be a reasonable probability that it will yield meaningful results;
3. The CC was not comfortable recommending a minimum threshold "score" for the power analysis as being acceptable or unacceptable to distinguish between the two proposed flows; and,
4. There will continue to be significant uncertainty associated with design of the monitoring program at least until statistical power analyses are completed in mid-summer. Even then, uncertainty in monitoring biological systems is to be expected and concern was expressed by some committee members about the value of power analysis and whether it will lead to implementation of less expensive but also less meaningful monitoring.

Evaluation Worksheet

CC members were asked to rank each component of the proposed monitoring program on a scale of high, medium, or low based on the impact they expect its outcome to have on their own water allocation choices. While many CC members had not expected to do a ranking exercise for the monitoring plan, it was mentioned that this is a new procedure that the Water Comptroller will be looking for with all new WUPs. The rationale behind the ranking exercise is to better represent CC members' support and values for different monitoring components. It was explained that if a component would not sway a CC member's ranking of an alternative, then the Water Comptroller may not fund this study as it would not necessarily inform the next round of water use planning. Due to the technical nature of the information and some CC member's unfamiliarity with it, some members were not comfortable filling out the worksheet. The CC developed options including filling out some or all of an evaluation worksheet, depending upon their personal preference and confidence in their ranking and/or discussing the rankings with each other and members of the FTC. Of the 23 CC members at the meeting, 20 filled out evaluation forms although some completed them only partially.[139] Ranking and comments for each monitoring plan component are summarized below:

[139] Respondents include: Paul Archibald, Stan Woods, Janice Jarvis, Tony Matahlija, Wayne Goeson, Rick Simpson, Ian McArthur, Lawrence Bojczuk, Sherry Carroll, Elaine Golds, Nancy Aichberger, Derek Bonin, Don Gillespie, Bruce Misewich, Walter Udell, Dave Dunkley, Kirsten Doucette, Eunice Hodge, Ross Neuman, Dr. Don Gillespie.



CC Member Comments From Monitoring Plan Ranking Worksheet

C Coquitlam Reservoir	***Access to Tributaries***	
	Habitat Conservation and Stewardship Program	I don't believe impacts to the reservoir will affect too many decisions. However, it's important to watershed productivity and therefore affects downstream habitat as well.
	Watershed Watch Salmon Society	Not as likely to provide decision making evidence as other studies.
	Port Coquitlam Fishing and Hunting Club	Not until Sockeye introduction above dam.
	Burke Mountain Naturalists	Not a river issue
	GVRD	Generally the lower reaches of these streams are on lower gradient alluvial fans. Bathymetric data available.
	Resident	Possible remedial measures in some streams; will not change flow regime selected, but very good idea
	BC Hydro	Highly unlikely to impact decisions on most appropriate operating regime in 12 to 15 years time.
	Ramping Rates	
	Habitat Conservation and Stewardship Program	Important, but take a conservative approach rather than spending big bucks to tweak the rate to get it exactly right for the Coquitlam
	Watershed Watch Salmon Society	Important and must be done/determined
	Port Coquitlam Fishing and Hunting Club	Ramping must be done with as little impact to fish as possible.

Port Moody Ecological Society	Fish are too valuable to loose by implementing large/fast ramping rates.
BC Hydro	Highly unlikely to impact decisions on most appropriate operating regime in 12 to 15 years time.
Ministry of WLAP	Essential to set proper ramping rates; therefore very important to study. But ramping rate will not affect flow decisions.
Resident	Will not change flow regime but very important for **all** flow regimes.
Habitat suitability criteria	
Watershed Watch Salmon Society	Part of original WUP design and needs to be finished.
GVRD	Supports the recommendation for which ultimate flow.
BC Hydro	Habitat is a primary performance measure.
Ministry of WLAP	The development of HSI criteria are important to fish productivity index but, of themselves, will not affect flow decisions; should be completed as part of IFN, not monitoring.
Resident	May be very important and assist with evaluation of fish productivity.
Pink Salmon Access	
Habitat Conservation and Stewardship Program	May only have to monitor for a few years until we get a dry year. If Pink migration OK in a dry year-could assume it's OK at higher levels.
Port Coquitlam Fishing and Hunting Club	Do with as little impact to fishery as possible.
Ministry of WLAP	Probably not an issue on the river, BUT if it was an issue its effect on flow decisions would be high.
Resident	May affect flow regime, important science. Likely to result in simple, easy to define flow requirements.
Invertebrate productivity index (with control stream, w/ control in Upper Coquitlam River and with no control stream)	
GVRD	I assume invertebrate productivity is a good indicator of ecosystem helath. Hence this seems to be a cost/effective study.
Habitat Conservation and Stewardship Program	Should look to share control stream with other WUPs if possible to save money. Ron Ptolemy mentioned another sampling method (electro-shocking) which could significantly save money with same or better results.
Watershed Watch Salmon Society	With or without control there is great value and benefit to this study. In combination with other study results can give very good idea of flow benefits
Port Coquitlam Fishing and Hunting Club	Yes. Go ahead with long term study
PoCo Hunting and Fish Club/Port Moody Ecological Society	Extensive work all over North America (Index of Benthic Invertebrates - IBI)
Burke Mountain Naturalists	These monitoring programs have a faster "response time" and would yield better data than looking at tertiary production. Good controls are important but what about gravel mines.
Port Moody Ecological Society	It would be good to explore "sharing" a control stream with other water use plans. Invertebrate production index- absolute necessity.
GVRD	With control stream: cost/benefit low. Without control stream: use other WUP monitoring as the control.
BC Hydro	Control stream benefits not enough to offset additional costs. There is still too much uncertainty on control stream benefits and selection of suitable control stream.
Resident	This performance measure is important but not direct enough. It is more important to focus on fish productivity; defer to fish productivity index.
Reservoir release temperature regime	
Habitat Conservation and Stewardship Program	If needed to save money-monitor in-stream only
Watershed Watch Salmon Society	Notes for both Invertebrate and flow may be able to do for less money. Utilizing funding from other sources etc. And in-kind work.
Port Coquitlam Fishing and Hunting Club	Try to adjust discharge temperatures to maximize fish production.
GVRD	A few measurements should be able to determine this.
BC Hydro	Not likely to impact operating regime.
Ministry of WLAP	Probably not an issue on the river, but if it is an issue it would play large role in flow decisions.
Resident	Will not change selected flow rates.
Fish productivity index (with control stream, with control stream every 2 years and with no control stream)	
GVRD	Am concerned by high costs. However, this type of information is critical.
Habitat Conservation and Stewardship Program	Share control streams if possible to save money.
Watershed Watch Salmon Society	With or without control there is great value and benefit to this study. In combination with other study results can give very good idea of flow benefits

Port Coquitlam Fishing and Hunting Club	Habitat and hatchery improvements to the river are not to be stopped for the purpose of studies. A method of adding these changes must be created.
Burke Mountain Naturalists	These are very expensive programs and data obtained from them could be confounded by other events - El Nino, variations in ocean survival. Therefore, I would be worried about decisions being made based on these studies.
GVRD	With control stream: cost/benefit low. Without control stream: use other WUPs monitoring as the control, cost/benefit high.
BC Hydro	Control stream benefits not enough to offset additional costs. There is still too much uncertainty on control stream benefits and selection of suitable control stream.
Resident	Necessary science in order to determine success of flow changes. Will impact future WUP.
Flushing flow effectiveness	
Habitat Conservation and Stewardship Program	Important to monitor carefully to determine effectiveness of various flows in terms of depth of cleaning etc. Consultant very uncertain as to magnitude and duration required to affect a positive change. Smaller flows or shorter *could* be of some benefit.
Port Coquitlam Fishing and Hunting Club	After flushing actions have been evaluated, alternative methods of substrate cleaning should be looked into.
Resident	High priority after both flows have been run (12-15 years)
Burke Mountain Naturalists	It is important to examine impacts of flushing flows.
GVRD	The information during this WUP has indicated that the best benefit for the Coquitlam River fish habitat is from the flushing flows.
BC Hydro	Expect direct impact on suitability of habitat, our main PM.
Ministry of WLAP	Very important – flushing flows likely to have large effect on fish productivity.
Resident	If flushing flow achieved, then very important study.
General comments	
Coquitlam River Watershed Society	I believe that either the FTC or the monitoring group should be deciding on what should be monitored, or how to monitor. Perhaps a budget should be set for that particular monitoring plan (a suggested 1.8 million was mentioned) Then that group should work out what can be afforded, what is important. A CONTROL STREAM IS IMPORTANT.
Watershed Watch Salmon Society	"high' means to me this will have a significant impact on any future decision and is highly necessary in future decision making.

Action: *Copy of evaluation worksheet to be distributed to CC members along with meeting minutes.*

4.0 Wildlife/Environment Monitoring

It was reported to the CC that, because of overlap between FTC and wildlife working group members, the FTC evaluated a monitoring request for riparian ecosystem mapping. The purpose of the request was to determine effects of flow treatments on the extent of Coquitlam River low bench riparian habitat. The FTC recommended that this request be dropped from further consideration because:

- Results would not change CC's flow choices
- Probability of quantifying changes in low bench is low
- Impacts of possible changes in low bench ecosystem on wildlife are unknown

Decision: *CC members agreed with the FTC recommendation that riparian mapping be dropped from further consideration as a monitoring plan component for this WUP.*

5.0 Monitoring Committee

Charlotte Bemister (BC Hydro) reviewed draft terms of reference for a CBWUP Monitoring Committee. It was suggested by a committee member that the terms of reference should include a rationale for the monitoring program.

Action: *Charlotte Bemister will revise and distribute Monitoring Committee terms of reference, incorporating rationale for monitoring..*

CC members were also asked to consider Monitoring Committee membership, specifically what public representation is being recommended. It was noted that Janice Jarvis and Tony Matalijha indicated their interest in being involved on the Monitoring Committee when this was discussed at the previous (October 2001) CC meeting. BC Hydro resource staff pointed out that the issue about participation on the monitoring committee is still open and will be addressed by BC Hydro later on, after submission of the Consultative Committee Report. Until there has been further discussion on the monitoring committee (probably by email) the CC participants are all eligible.

Action: *Charlotte Bemister will follow up with CC members to determine their views about public representation on the Management Committee.*

POST-MEETING NOTE: Elaine Golds indicated that she is interested in participating on a Monitoring Committee, should her schedule allow (email: March 26, 2002).

6.0 Comments on the Consultative Committee Draft Report

Prior to the meeting, CC members were provided with a compilation of other members' written comments about the draft Consultative Committee Report. The facilitator summarized the nature of these comments as:

- Requests for clarification;
- Grammatical corrections; and
- Suggested wording changes.

To address these comments, the consultants would refer to meeting minutes for wording and, on that basis, either incorporate suggested changes or record comments in footnotes with reference to when and by which organization they were made.

Oral statements about the draft report were presented at the CC meeting by:

- Kwikwetlem First Nation;
- Brent Hilpert (Coquitlam resident and CC member); and
- Michael Harstone (on behalf of the FTC).

Kwikwetlem First Nations Statement

A Kwikwetlem First Nations member raised objections to outcomes of the CBWUP process on the grounds that "decisions" made by the Consultative Committee do not address aboriginal rights and legal issues even though these are affected by water use planning.

BC Hydro resource staff provided the CC with a review of the scope of the Consultative Committee's terms of reference and of the post CC review period. It was explained that the Consultative Committee is engaged in a planning exercise that results in recommendations rather than decisions about water allocation. After submission of the CC report and of BC Hydro's Water Use Plan, the Comptroller of Water Rights conducts a review process that will include consultation with Kwikwetlem First Nation and an opportunity for appeal.

After some discussion, a representative of the Kwikwetlem First Nation read the following statement to the Consultative Committee:

Final Comments Regarding the Coquitlam/Buntzen Water Use Plan
March 11,2002

During our presentation to the consultation committee on June 11/01, Kwikwetlem First Nation expressed our dissatisfaction with the fact that restoration of salmon into the watershed of Coquitlam Lake was not being considered. Our position at that time received the support of many members of the consultative committee. That general position was recorded in the minutes of the committee as:

" Recommendation: the CC supports the idea of restoring sockeye to the Coquitlam River if it is found to be technically feasible. This WUP will incorporate operational issues regarding sockeye form the mouth of the Coquitlam River to the dam. IF restoration of sockeye to the system is found to be technically feasible, then this should trigger re- opening of the WUP and consideration of operation issues relation to sockeye upstream of the dam."

The contrary position, taken by BC Hydro, is that the terms of reference of the Water Use Planning process do not embrace such things as salmon restoration. Consequently, that central issue is not addressed here. We disagree with both Hydro's' interpretation of the terms of reference and its decision not to consider the salmon issue.

In BC Hydro's document titled " WUP Guidelines", the provincial government describes the scope of the WUP as follows:

" The licensee or proponent will meet with regulatory agencies, First Nations, local governments, and key interested parties to:

1. *Identify issues and interests associated with water management;*
2. *Review and summarize available information on water used impact;*
3. *Identify gaps in information and the need for further studies to develop a WUP; and*
4. *Explore appropriate approaches to consultation."*

Plans are intended to clarify how rights to provincial water resources should be exercised, and to take account of the multiple uses for these resources. WUP must recognize existing legal and constitutional rights and responsibilities as set out in legislation and court decisions.

In our view, the commitment to consider legal and constitutional issues, and to take account of both legislation and case law bringing the salmon issue squarely within the ambit of the WUP process.

There is no need at this point to go into detail about the source and nature of our constitutional right to fish for food, social and ceremonial purposes. We have explored these matters at length with Hydro, and they are aware of our position. At this point, we wish to go on record as protesting Hydro's decision not to consider salmon restoration in the Coquitlam Lake Watershed as part of the WUP, and to advise the committee that we are continuing to pursue the issue in other venues.

We fully anticipate that this WUP will be re–convened to consider the issue in the not-distant future.

Thank You
Kwikwetlem First Nation

Kwikwetlem First Nations representatives left the meeting after reading this statement.

Presentation by Brent Hilpert, Resident

Prior to the meeting, CC members were sent a statement by Brent Hilpert explaining his reservations about the CC's recommended operating plan for the CBWUP. At Brent's request, he was given the opportunity to provide an oral summary of his written statement. The presentation took place toward the end of the meeting as part of a discussion of comments on the draft report. Brent expressed concern that, in his opinion there is significant uncertainty about population projections underlying the GVRD's proposed domestic water requirements, that population projections tend to be a self-fulfilling prophecy, and that this causes him to attribute low value to water allocation for domestic use.

In response to the presentation, the GVRD representative pointed out that water from Coquitlam would only be used if it is required and that the intention of allocating water to domestic use at this time is to ensure that it is available in case population projections turn out to be correct.

Other Comments

Michael Harstone (BC Hydro) summarized other suggested changes to the draft CC report. These included suggestions from BC Hydro project resource staff as well as FTC recommendations regarding ramping rates and operating constraints around target flows. One FTC recommendation on the need for a more coordinated approach—e.g. watershed approach—for the activities in and around the Coquitlam was recommended to be put in the Non-WUP appendix in the CC Report. There were no comments as a result of shortage of time at the meeting and BC Hydro resource staff were asked to supply a copy of the overhead used by Michael for his presentation.

Action: *A copy of the overhead summarizing Michael's presentation of comments on the draft CC report to be distributed to CC members along with meeting minutes.*

7.0 Consultative Committee Process Conclusion

The Consultative Committee was asked to decide how to bring the CBWUP process to conclusion in light of outstanding issues regarding the monitoring plan, ongoing information collection and statistical power analyses that will assist in refining the monitoring plan, and the need to submit a consultation report and Water Use Plan to the Comptroller of Water Rights.

Having agreed on the importance both of designing a monitoring plan that is capable of distinguishing between the fish benefits of the two trial flows agreed to by the CC and of determining the probability that the proposed monitoring plans will return statistically useful results, CC members were asked to consider whether they wished to reconvene in the event that these conditions are not met.

Decision: *Committee members agreed to recommend the following process for submitting CBWUP recommendations to the Comptroller of Water Rights:*

REPORT FINALIZATION AND SUBMISSION

- *The Consultative Committee Report will be finalized using the monitoring plan that was presented to the CC on the understanding that this monitoring plan is subject to change (as explained below) and that this will be clearly articulated in the revised CC Report. .*
- *The CC Report will be submitted to the Comptroller of Water Rights along with BC Hydro's Water Use Plan as soon as possible. The CC Report will clearly state that recommendations*

included in the CC Report are subject to possible changes pending the development of an effective monitoring plan (as explained below).

- *Before submitting the report, CC members will be provided with a final copy of the CC report and will be asked to email acceptance or not.*
- *Minutes of this meeting are to be included as part of CC report.*

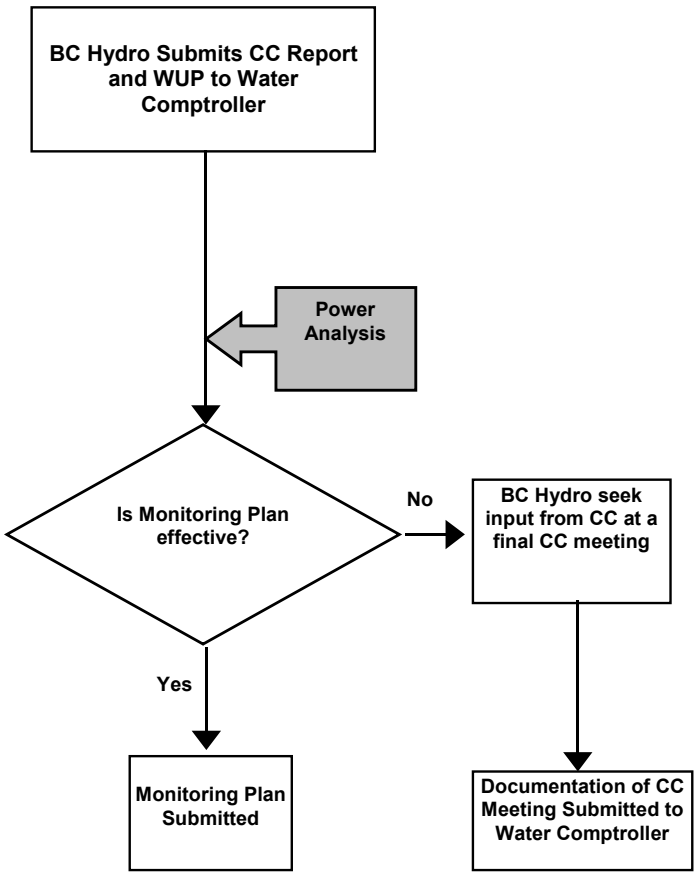
MONITORING PLAN FINALIZATION AND CBWUP PROCESS CONCLUSION

The CC report will be submitted with assurance that one of the following two conditions (#1 ***or*** *#2) will be met:*

1. *An effective monitoring plan will be implemented. "Effective" is defined as being cost effective and having sufficient statistical power to distinguish between the two flow trials as documented in the CC Report. Modification to the proposed monitoring plan can be made (i.e. based on review by the Fish Advisory Team) but the FTC will determine effectiveness. Any changes will be submitted to the Comptroller of Water Rights and the CC will be informed of the result.*
2. *If an effective monitoring plan cannot be implemented, the CC will be reconvened for one final meeting to discuss alternatives. The results of this meeting will be submitted to the Comptroller of Water Rights.*

One of the CC members specifically requested an assurance that the Comptroller of Water Rights will respect monitoring plan revisions that would be sent, if required, as an addendum to the consultative committee report.

Process for CC Submissions to Water Comptroller



8.0 Other

Thanks

Numerous committee members as well as members of BC Hydro's Project Team and the consultants expressed their appreciation and thanks for efforts made by all participants during the consultation process. Charlotte Bemister extended a dinner invitation to CC members and their guest. Details will be announced as soon as they are available.

Action: *Charlotte to provide CC members with details regarding appreciation dinner.*

Communication/Consultation Follow-up

Action: *Charlotte confirmed that she will provide wrap-up communications material for review by the CC. She will confirm the interest of the City of Coquitlam, Port Coquitlam in having a presentation. Also, Coquitlam River Watershed Society suggested it may be appropriate for them to host a presentation at one of their regular meetings. CC members should advise Charlotte of their interest in participating and/or giving presentations.*

The meeting ended at approximately 10:00 p.m.

Appendix L DETAILED MONITORING PROGRAM SUMMARY

This Monitoring Program has been organized into the following Sections:

- Item #1 Treatment Schedule
- Item #2 Control Stream Selection
- Item #3 Monitoring Program Component Detail
- Item #4 Monitoring Committee Terms of Reference

Monitoring Program Rationale

The monitoring program for the Coquitlam WUP was recommended to ensure that there is sufficient information in place by the end of the review period to determine the fisheries benefits of two test flows and to enable a better understanding of trade-offs between fisheries, domestic water and power generation. Understanding the benefits to fish between the two test flows will assist a future review committee to make more informed tradeoffs when determining a river flow regime. The two test flow regimes would be conducted within bookends established by the "Four Fish Valve New" (4FVN) and "Share the Pain 5" (STP5) alternatives: the first test flow will be 4FVN, while the second flow will be set at STP5 or less, depending on the results of the Instream Flow Needs (IFN) study.

Item #1 Treatment Schedule

The Coquitlam-Buntzen WUP CC agreed to an adaptive management program consisting of two flow treatments, each of which will require 6 years to complete. An opportunistic flushing flow experiment will be undertaken following the adaptive management program, time permitting. Table 38 describes the releases and the species drivers by month.

Treatment A: Four Fish Valves "New"

The Coquitlam Dam infrastructure can presently release up to 1.3cms total (depending on reservoir elevation) through two valves situated between the 3 low-level outlets. Treatment A will provide twice the annual average volume of flow available presently, but redistributed each month to optimize for salmon and trout spawning and rearing requirements. As Table 38 describes, flows in some months will exceed the capacity of "4 fish valves", and will therefore be delivered through a modified low level outlet. This flow regime will continue for 6 years, depending on the success of previous monitoring years (see Section .3 for criteria).

Treatment B: Share the Pain 5

As illustrated in Figure 20, the second test flow will be defined by the results of the Instream Flow Needs Assessment (IFN) study, but will not exceed the "Share the Pain 5" flow regime, outlined in Table 38. The IFN study will provide updated versions of the habitat vs. flow curves used in developing fish flow requirements for the Coquitlam-Buntzen WUP. Figure 20 provides an example of spawning flow curves from Reach 2B of the Coquitlam River. Monthly flow recommendations based on an updated version of these curves will define the Treatment B release schedule.

Share the Pain 5 was developed whereby inflows dictate the actual monthly flows provided to water users. If inflows are sufficient to maintain general reservoir operations, each user will be guaranteed their nominations. Where insufficient inflows exist, BC Hydro will curtail generation; if inflows still do not meet GVRD and river requirements, each party has a minimum monthly flow requirement that will be met under these conditions (monthly river flows are summarized in Table 38). In July, August and September, river flow targets are the first to be reduced to their minimum requirements, and then GVRD targets are reduced if necessary. However, current GVRD targets are expected to be much higher than water demand in the coming years, and river flow targets are not likely to be reduced as a result.

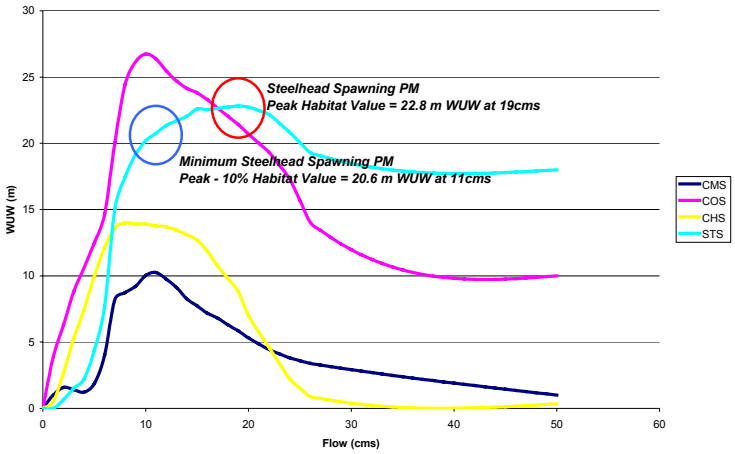
Table 38: Flow release schedules for the two flow treatments. Note GVRD water requirements for the next 15 years will not likely lead to curtailments in either flow release.

	4 Fish Valves "New"	"Share the Pain 5"*		Species Driver and Priority
		Target	Min	
Jan	1.1	3.3	3.0	Chinook Spawning
Feb	2.3	2.9	2.9	Chinook Incubation
Mar	4.3	7.6	3.0	Steelhead Spawning
Apr	3.5	6.9	3.0	Steelhead Spawning
May	3.0	6.3	3.0	Steelhead Spawning
Jun	4.9	5.0	4.0	Steelhead Parr
Jul**	1.7	4.6	4.0	Steelhead Parr
Aug**	3.3	6.1	4.0	Steelhead Parr
Sep**	1.0	5.6	4.0	Steelhead Parr
Oct	1.1	3.0	3.0	Chinook Spawning
Nov	1.1	3.0	3.0	Chinook Spawning
Dec	1.1	3.0	3.0	Chinook Spawning
Priority	1	1**		River Priority
	2	1		Domestic Water Priority
	3	3		Generation Priority

[1] To be revised upon completion of IFN

[2]* STP5 River priority is 2 behind domestic water in ** months.

Figure 20: Weighted Usable Width curves for spawners in reach 2B of the Coquitlam River. Peak and "10% off Peak" habitat values are highlighted.



Opportunistic Flushing Flows Experiment

Flushing flows are defined for the Coquitlam-Buntzen WUP as those opportunistic releases that provide peak flows to Reaches 2 and 3 of between 70 and 100cms, for three to five consecutive days. Pre-spill dam releases (through the low level outlets) are limited to 30-50cms (depending on reservoir elevation), and therefore the releases would have to be timed with storm events from Or Creek. Preliminary analysis indicates that these events will happen every 3-5 years.

On October 22, 2001, the CC recommended that the FTC incorporate a flushing flow test into the monitoring program for the Coquitlam-Buntzen WUP. Since that time, the FTC has considered how an opportunistic flushing flow may confound biologic responses of the adaptive management program and the flushing flow. The scheduling of the flow trials is discussed below.

Treatment Schedule and Decision Criteria

Figure 21 illustrates the expected treatment schedule

Statistical Power Analysis: For each Water Use Plan developed, statistical power analysis will be conducted to ensure the methods and effort proposed will detect the expected effect of flow changes for the relevant component of the monitoring plan. BC Hydro has incorporated traditional statistical functions into a software package to help assess the reliability of fish productivity assessment methods, and to test possible changes to the methods for enhanced effectiveness. As discussed in Section 7.5, the consultative committee may be reconvened if the power analysis suggests that changes to the monitoring program and/or the treatment schedule outside of the scope set by the consultative committee are required to detect productivity changes between respective flow treatments. The following understanding with regards to a monitoring program and the results from the power analysis has been agreed to by the CC:

1. *An effective monitoring plan will be implemented. "Effective" is defined as being cost effective and having sufficient statistical power to distinguish between the two flow trials as documented in the CC Report. Modification to the proposed monitoring plan can be made (i.e. based on review by the Fish Advisory Team) but the FTC will determine effectiveness. Any changes will be submitted to the Comptroller of Water Rights and the CC will be informed of the result.*

2. *If an effective monitoring plan cannot be implemented (within the requirements set out in the CC Report), the CC will be reconvened for one final meeting to discuss alternatives. The results of this meeting will be submitted to the Comptroller of Water Rights.*

Given the level of knowledge currently available to the COQ WUP FTC, the following monitoring program is summarized under the assumption that the methods proposed will be effective in detecting changes in productivity for the treatment schedule proposed.

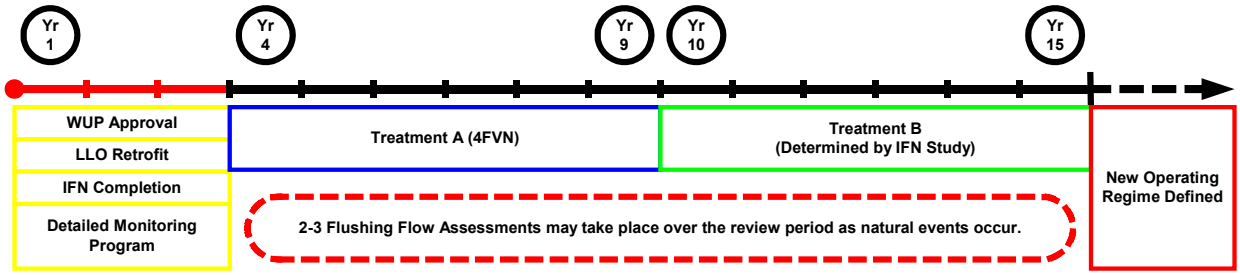


Figure 21: Schedule for flow trial implementation.

Treatment Period Duration: The two flow treatments will be tested for a period of 6years, based on the expected return period of steelhead (4-6 years) and salmon species (3-5 years). Smolt enumeration experiments undertaken on the Coquitlam River in recent years (Decker, 1997-2000) have been devised with the assumption that spawning habitats were fully seeded (Foy, pers. comm, 2001b). This assumption may not be accurate when flows are increased under the new flow treatment, because the increased spawning area may not be fully utilized by returning adults. Power analysis of the methods used in the river fish productivity study will estimate the precision of results expected from the study.

Flushing Flow Experiment: The effects of flushing flows on the Coquitlam River on fish productivity are expected to be great, if such flows provided benefits similar to those seen on the unregulated systems. For the adaptive management monitoring program to be successful, each component must be able to isolate and understand the nature of the biologic response to changes in habitat. The FTC concluded that since we cannot control the provision of natural events, the monitoring plan should provide for assessment of natural events which meet the criteria of a flushing flow as summarized in section 5.2. Because of the uncertainty in the provision of such flows, the FTC has recommended that contingencies for additional natural flushing flow assessments be included in the budget estimates for the Coquitlam WUP monitoring program.

Item #2 Control Stream Selection

Use of a Control Stream

Biological responses to the two flow treatments will be difficult to interpret unless efforts are taken to reduce the uncertainty associated with factors outside of BC Hydro's control. These factors include ocean survival (temperature factors and fish management), hatchery enhancement programs, habitat enhancements and urban drainage contributions.

To address these concerns, the FTC strongly supports the inclusion of a control stream in the program design. The control stream will be monitored for those components of the program where additional information needs are anticipated, as described in this document. In the examples below, the value of having a control stream to infer fish productivity changes in light of changing climate conditions detected in both the control and treatment streams.

Figure 22: Three possible changes in the Cheakamus River and a monitored control system under a poor regional climatic regime. (A) both rivers show similar declining trends (B) Cheakamus does worse; and (C) Cheakamus does better .

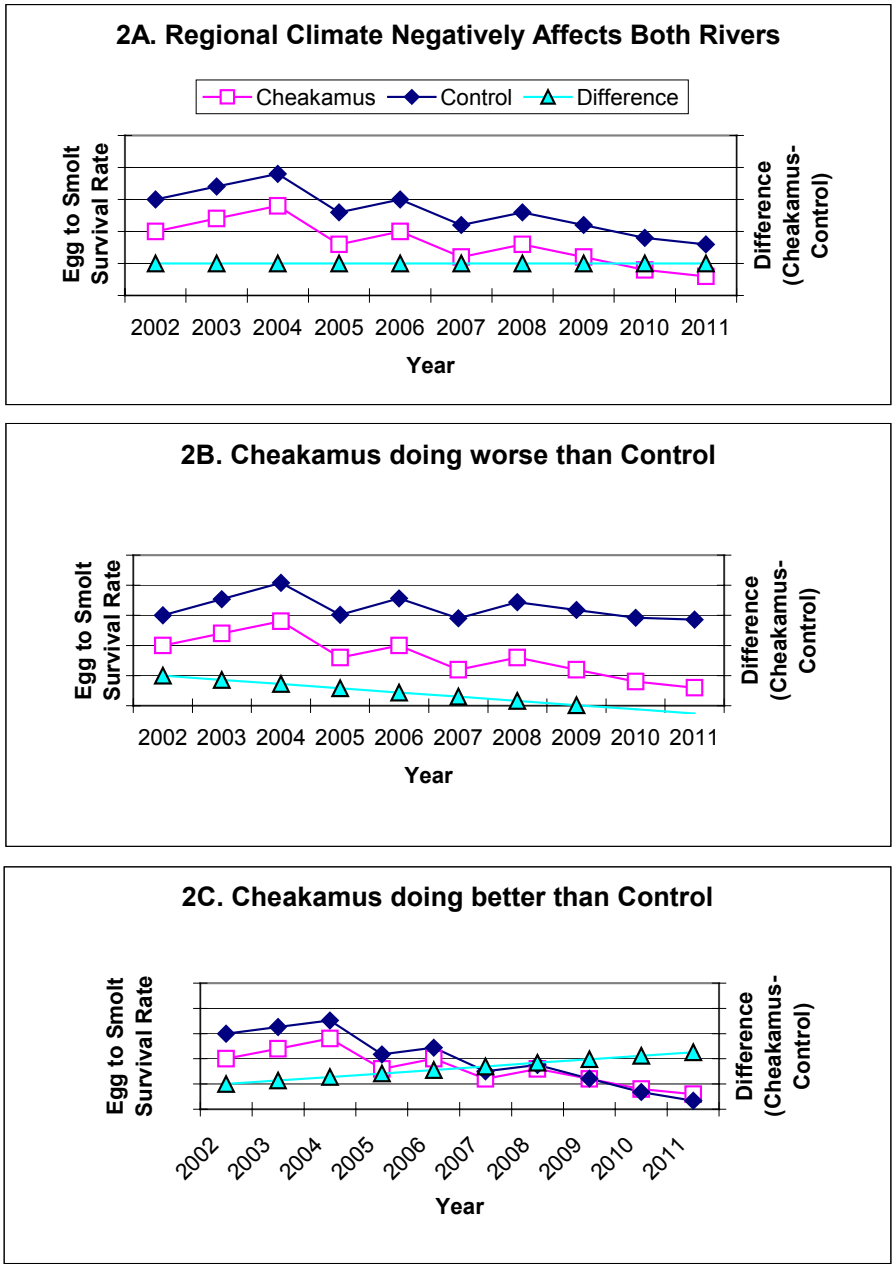
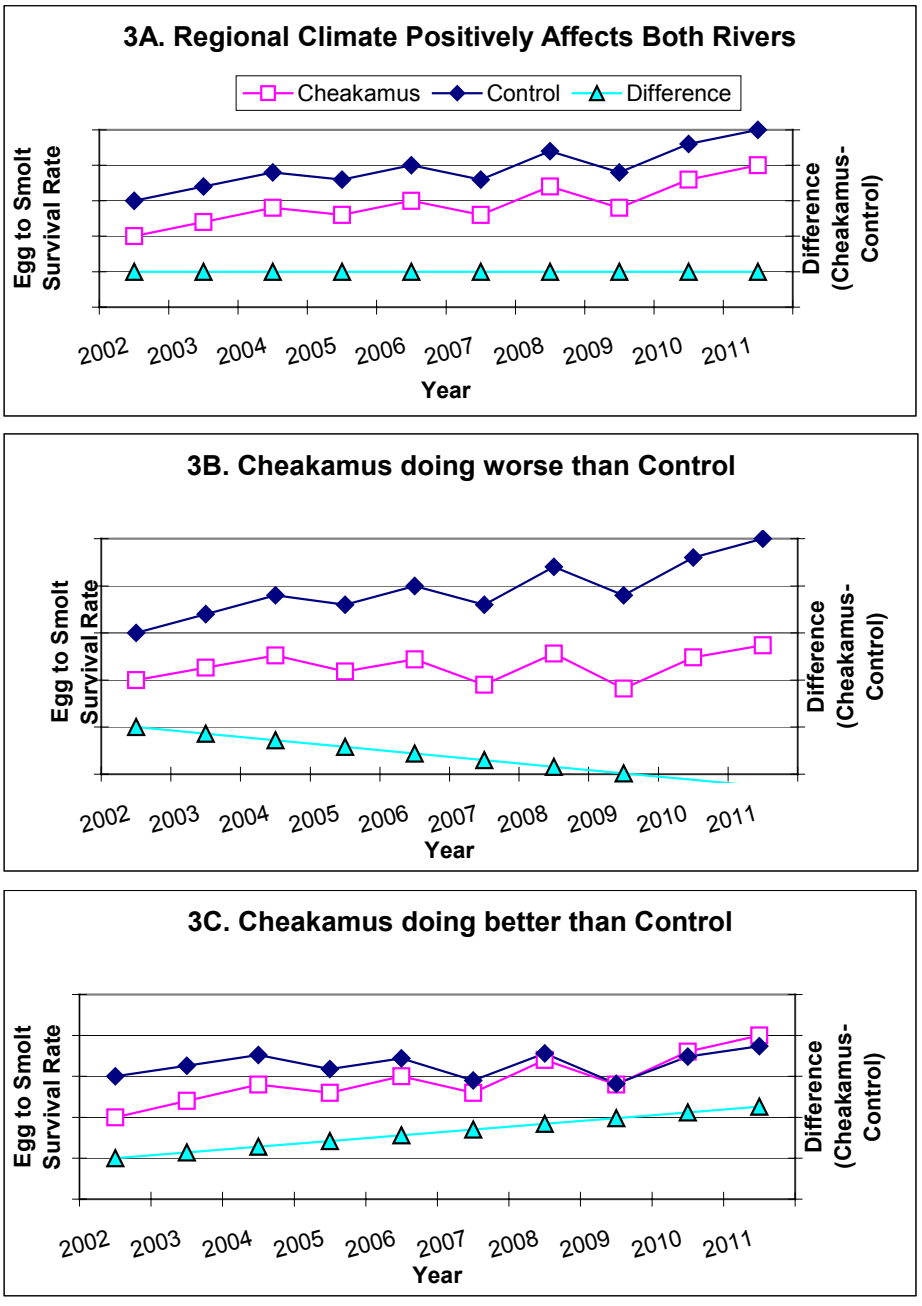


Figure 23: Three possible changes in the Cheakamus River and a monitored control system under a good regional climatic regime. (A) regional climate affects both rivers equally; (B) Cheakamus does worse; (C) Cheakamus does better.



Selecting a Control Stream

Conquest, et. al. (1994) insist that monitoring of streams with similar watershed features to the experimental streams is required to distinguish natural/unnatural variations from changes that result from experimental manipulation.

It is important that the control and experimental (Coquitlam River) streams (Hughes, 1995; Hughes, et al., 1994):

- be of similar hydrology;
- share or have the same bio-geoclimatic zone;
- be similar in drainage type;
- is minimally disturbed; and
- be within the same ecoregion

Based on these criteria, the FTC has proposed several streams be considered for use as a control for components of the monitoring program:

- Kanaka Creek, Maple Ridge, BC
- North Alouette River, Pitt Meadows, BC
- Salmon River, Langley, BC
- Scott/Hoy Creek, Coquitlam, BC
- Indian River, North Vancouver, BC
- Capilano River, West Vancouver, BC

Of the above alternatives, only Capilano River and the North Alouette River have significant steelhead production for relevant comparison. These are the only urban streams that will not confound results due either to different hydrological regimes (Indian River; Scott/Hoy Creek), or to highly disturbed watersheds (Salmon River; Scott/Hoy Creek). Table 39 describes the relevant attributes associated with each stream, in consideration of studying responses to flow changes.

Table 39: Relevant watershed attributes for Coquitlam, Kanaka and North Alouette Rivers.

Attributes	*Watershed Attribute Descriptions*		
	Coquitlam River	**Kanaka Creek**	**North Alouette River**
Watershed Area	80 km^2	48 km^2	40 km^2
Drainage Use	Urban/Rural	Rural/Urban	Rural/Urban
Hydrology	Rainfall dominated, regulated at Coquitlam Dam	Rainfall dominated, unregulated	Rainfall dominated, partially regulated below confluence with S. Alouette River
Biogeoclimatic Zone	Coastal Douglas Fir	Coastal Douglas Fir	Coastal Douglas Fir
Receiving Waters	Fraser River, North	Fraser River, North	Pitt River, East*

Both rivers provide opportunities to build on existing data; stream groups and Fisheries and Oceans Canada (FOC) have collected significant data on salmon stocks in both systems (Foy, pers. comm., 2001). It is recommended that both systems be reviewed to determine which would be the best control stream for the Lower Coquitlam River.

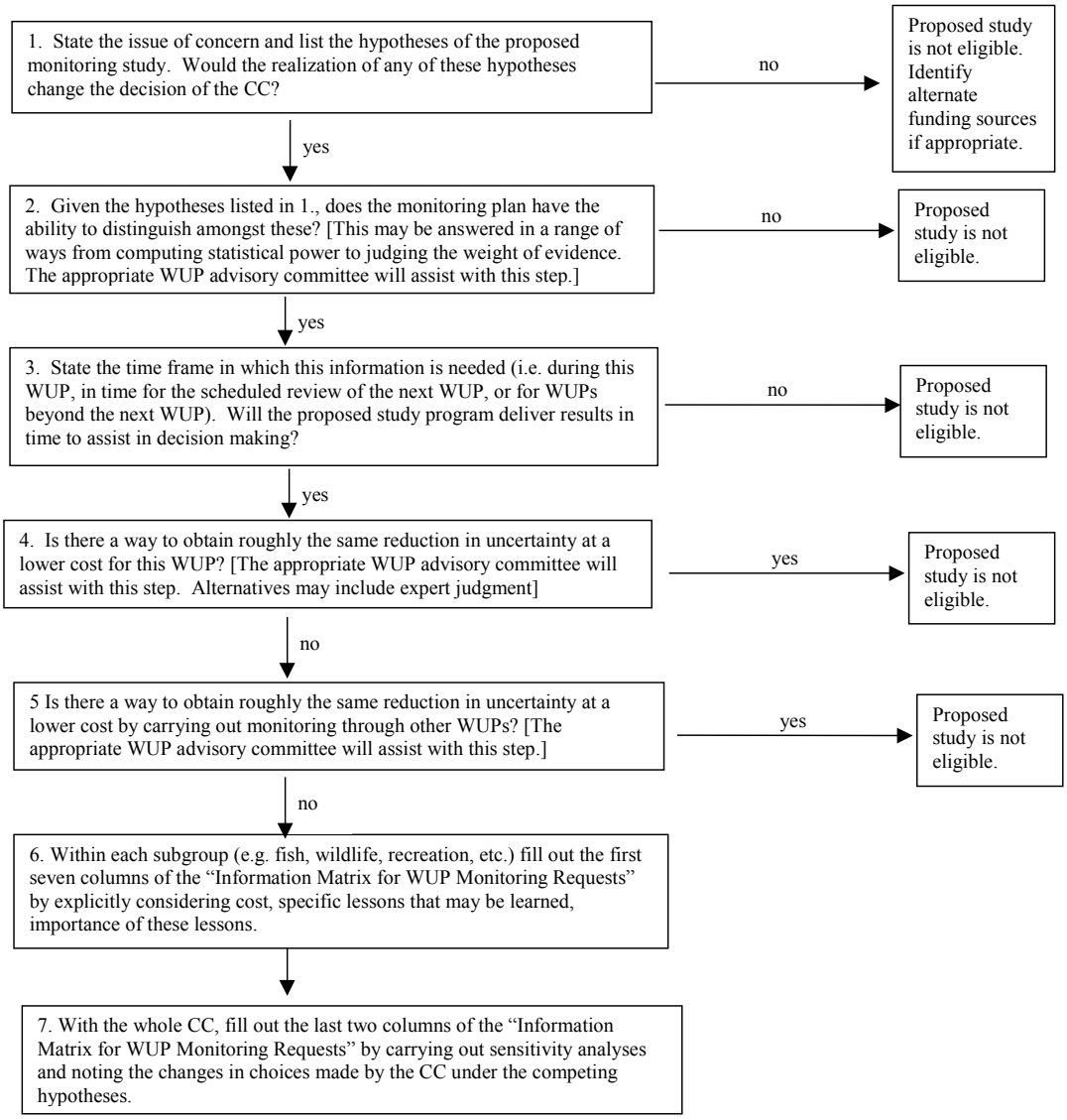
Item #3 Monitoring Program Component Detail

Introduction

While productivity in the Coquitlam River will be the focus for monitoring all portions of the generation system were reviewed by the FTC. Proposed monitoring of biological responses was given a priority

rating according to the rationale provided above.. The sections below review monitoring opportunities in Indian Arm (Buntzen Outfall), Coquitlam Reservoir, and Coquitlam River. Monitoring effects of operations on Buntzen Reservoir was not considered due to the expected operational stability of that reservoir.

Each section below describes the proposed studies considered by the FTC in more detail than what was provided in Table 26 of Section 7.0: with additional information on study timing and costs, as well as rationale for priority rankings based on decision tree below.



Each study was evaluated and described according to the following categories:

Impact Hypothesis:	Describe the expected response of biologic system to operational changes being measured.
Description:	Describe the study in relative detail.
Issue Status:	Most recent information collected to this issues
FTC Study Rating:	This is the rating of the study as assessed by the FTC. Rating was based on a high/medium/low basis according to criteria which considered: study methodology, type and quality of information from the study, study duration, study costs, and the level of importance this study has in helping to define future operating decisions.
Study Rating Rationale:	Summary of reasons for study rating above.
Methodology:	For those studies with medium/high study ratings, a brief summary of expected methods is provided.
Proposed Plan:	A tabular summary of costs and timing is provided for each study with a medium/high study rating.

Studies Considered are arranged by Study Area

A. Indian Arm (Buntzen Outfall)

Each issue summarised below was reviewed by the FTC throughout the WUP process, due to the expected changes in freshwater inputs into the Indian Arm (Coquitlam-Buntzen WUP FTC, 2001).

Table 40: Summary of average summer inflows into the Indian Arm (sum of Buntzen, Indian River and runoff flows) from June 01-September 31.

Units measured in cubic meters per second-days or cms-d

Option	Average	5th %ile	95th %ile
Current	3336	1315	6569
Current with GVWD Requirement:	2605	618	5750
4 Fish Valves	1917	598	4673
Coq R. Conservation Flow Regime	1754	598	3905
30% of Inflows Past Dam	1730	598	3886

Impacts identified and considered for Indian Arm are summarized below. It should be recognised that each option includes “proposed” GVRD nominations, which will not be required until several years into the future. Therefore, each option will have far less immediate impact on the arm than is summarised above.

Nearshore Community Impacts Proximal to the Buntzen Outfall

Impact Hypothesis: Changes in freshwater outputs at the Buntzen Outfall into the Indian Arm will cause disturbance in marine habitats proximal to the outfall.
Description: Determine the impact (if any) of changing freshwater releases from LB1/LB2 on the nearshore marine community in Indian Arm.
Issue Status: Dropped from Coquitlam-Buntzen WUP fish issues list.
FTC Study Rating: Low (Do not monitor this component)
Study Rating Rationale: This issue was dropped from the list during the WUP process , based on evidence collected by DFO in the Georgia Basin suggesting that the nearshore community at the Buntzen outfall is not presently disturbed compared to similar areas in the Indian Arm (Sneep, 2000).

Chinook Fish Impacts due to Outfall Attraction Flows: Indian River

Impact Hypothesis: Wildstock chinook salmon returning to the Indian River will be attracted to the freshwater inputs from the Buntzen outfall, making them susceptible to over fishing by sports fishermen.
Description: Determine the extent to which LB1/LB2 releases contribute to the attraction of returning wild Indian River chinook salmon and to overfishing in the tailrace area.
Issue Status: Dropped from Coquitlam-Buntzen WUP fish issues list.
FTC Study Rating: Low (Do not monitor this component)
Study Rating Rationale: The FTC determined that this is a regulatory issue with DFO, and that the returning adults are most likely hatchery releases (Sneep, pers. comm, 2000). In either case, the Coquitlam-Buntzen WUP will not consider this impact as an operational issue.

Fish Impacts due to Outfall Attraction Flows: Stock Partitioning

Impact Hypothesis: Coquitlam River returns will be attracted to the Buntzen outfall in Indian Arm, instead of returning to the Coquitlam River via the Fraser River.
Description: Determine the extent to which LB1/LB2 attraction flows contribute to the partitioning of salmonids returning to Coquitlam River.
Issue Status: Not initially on the Coquitlam-Buntzen WUP fish issues list, this was flagged by WLAP representatives.
FTC Study Rating: Low (Do not monitor this component)
Study Rating Rationale: The FTC acknowledged that this may be an impact on the fish, especially if operational changes led to *more* flows into the Indian Arm. However, the recommendations from the CC will lead to less flows into Indian Arm, and therefore studying the issue will not likely help future operating decisions avoid this issue.

Water Quality Impacts due to Reductions in Buntzen Discharges

Impact Hypotheses: (a) Reductions in freshwater inputs will reduce flushing within Indian Arm, thereby adversely affecting water quality; (b) Reductions in freshwater inputs will reduce the estuary capacity in the Arm and affect rearing salmonids.
Description: Determine the impact of changing freshwater releases from LB1/LB2 on water quality in the Indian Arm estuary for rearing salmonids.
Issue Status: The information sheet for this issue completed in 2001 (Coquitlam-Buntzen WUP FTC) outlined several monitoring options:

- Investigate juvenile rearing species and use of the Indian Arm, in particular the habitats around the Indian River and Buntzen outfall, and attempt to classify use by season between

the two key areas (to articulate possible habitat migration during low flow months in the Indian River);
- Investigate the physical nature of the freshwater lenses resulting from Buntzen and Indian River outflows; and
- Investigate the invertebrate communities in the two estuaries.

FTC Study Rating: Low (Do not monitor this component)

Study Rating Rationale: The FTC reviewed both hypotheses and were satisfied that the first was not affected by operations, but rather by tidal flushing (Coquitlam-Buntzen WUP FTC, 2001). The second hypothesis may represent a real impact to the Arm, but would require a high degree of effort to detect, and would not likely lead to a change in operations. The FTC also agreed that the impact was "restorative" in that natural inflows into the arm did not include water diverted from Coquitlam River; therefore this may be considered an issue outside the scope of WUPs.

B. Coquitlam Reservoir

The FTC did not provide recommendations to the CC on operations on the reservoir for various reasons:
- The reservoir does not currently have "fishery" value, in that access to the watershed is closed to ensure water quality is not compromised.
- Information available on access to tributaries, and on the effective littoral zone, was incomplete and therefore inadequate to make informed operating decisions.
- No reservoir alternatives were discussed, and therefore operations are only expected to change in consideration of flood management, river, GVRD and generation requirements.

Based on the above reasons, the FTC is not proposing to review any operational impacts on the reservoir in great detail. However, in the interest of providing information to future water planning committees, the FTC has recommended that the effective littoral zone model and access to tributaries database be revised and monitored over the review period.

Reservoir Fluctuation Impacts: Access to Tributaries

Impact Hypothesis: Fluctuations in reservoir water surface elevations will result in limiting salmonid access to those tributaries where passage is inhibited below a certain reservoir elevation.

Description: Within the range of operations, determine the extent of habitat loss reservoir fluctuations create by limiting access to tributaries (if any exist).

Issue Status: Data collected for GVRD (Acres Intnl, 1999) and for BC Hydro (Coquitlam-Buntzen WUP FTC, 2000) suggested that reservoir fluctuations will not affect access to fish bearing tributaries. However, the source data defining the fish-bearing status of streams (Acres Intnl, 1999) was deemed incomplete. A performance measure (PM) was not pursued, for the following reasons:
- Fish bearing status was designated after collecting information on juvenile trapping for September/October, 1998. Seasonal use and adult use were not considered in this assessment;
- Data collected by White Pine, 2000, recorded only those impacts seen at the reservoir elevation of that period, about 147.5m; this is about 10m above the minimum operating level for the reservoir.

FTC Study Rating: Medium (Monitor this component)

Study Rating Rationale: Future water planning committees should be informed about the impacts of reservoir operation on tributary access. The FTC expects the results of this study to have bearing on future water planning decisions, and proposes a low cost approach to assessing these data needs.

Methodology: Complete tributary data collection at minimum operating level and determine fish use of streams where access issues exist within the drawdown zone.

Proposed Plan: The table below details the methods, timing and costs expected in filling the data gap.

Monitoring Item Details	*Timing* Details	Costs (1000's)*
Develop TOR (stream list and methods)	*Year "0"*	$2.0
Investigate Tributary Access	*Year "0"*	
Field study of drawdown zone	Low-Pool	$5.0
Fish Habitat Assessment	Low-Pool	$5.0
Data write-up	Year "0"	$3.0
Investigate Fish Use of Impacted Streams	*Review Period*	
Field study of fish use	Seasonal	$5.0
Write-up of monitoring results	End	$5.0
Total		***$25.0***

*Costs are represented for the entire review period

Reservoir Fluctuation Impacts: Effective Littoral Zone

Impact Hypothesis: Fluctuations in reservoir water surface elevations will result in a loss of effective littoral habitat by limiting the amount of stable, wetted habitat within the euphotic zone.

Description: Complete development of ELZ model through integration of findings/conclusions from other monitoring programs and site specific data.

Issue Status: The effective littoral zone (ELZ) model, as applied to the Coquitlam Reservoir, assumed that productivity within the euphotic zone was affected only by light and water availability (Coquitlam-Buntzen WUP FTC, 2001). However, subsequent discussions (WAH WUP FTC, 2001) have led to an updated model with more responsiveness to the impact of dessication and inundation on periphyton growth rates. Stave River WUP (SRWUP) is in the midst of monitoring the effects of drawdown on littoral habitats (Bruce, 2001), the results of which can then help improve model response.

FTC Study Rating: Low (Do Not Monitor this component)

Study Rating Rationale: Littoral productivity is one of the only measurable impacts of operations on aquatic productivity. Typically, an updated ELZ model would provide useful information for future water planning decisions. However, the COQ WUP fisheries interests are focused on river benefits, and additional ELZ information will not likely influence reservoir operations in future water use plans.

Impacts of Reservoir Operations on Fish Production

Impact Hypothesis: The cumulative impacts of reservoir operation on tributary access, effective littoral zone, entrainment of fish/fish food, and other fish related issues will reduce fish productivity in the reservoir.

Description: Determine the cumulative impacts of reservoir operations on the productivity of fish in the Coquitlam Reservoir.

Issue Status: This issue was initially part of the Coquitlam-Buntzen WUP fish issues list, but creating a functional relationship between operations and fish productivity in the reservoir was viewed as too complex to establish within the time frame of the WUP. The issue was deferred to the monitoring program.

FTC Study Rating: Low (Do not monitor this component).

Study Rating Rationale: Fish productivity in the reservoir was recognised as an important interest in the WUP process. However there are several issues that hinder our ability to assess fish productivity effects over the review period:

- There are no reservoir restrictions, or set operations to monitor or compare or control. The WUP process did not limit reservoir operations beyond those considerations for flood control;

- Variation in fish production will not likely be detectable between the two operations being compared, nor could we compare between present state and future, simply because there is no data available on the current fish status;
- The cost of delivering a monitoring plan of questionable value would be in order of $100K/year, and other data collection initiatives of higher importance may be compromised if this were considered.

C. Lower Coquitlam River

The Lower Coquitlam River represents aquatic habitat with the most potential for enhancement by operational changes recommended by the CC. However, during the WUP process, data deficiencies related to fish studies made it very difficult for the CC to make informed decisions about optimizing salmonid habitats in the Coquitlam River. The following issues were raised during the WUP process in this regard:

- Modelled flow properties, and the habitat vs flow relationships derived from the modelled data and habitat use curves were considered only for the interim in developing a WUP. Post-WUP monitoring will focus on establishing an empirical linkage between habitat and flow, and more importantly, fish productivity and flow, to aid in future water planning decisions.
- Flushing flow benefits to fish habitat and productivity were not defined during the WUP, and the CC's recommendations included a need to evaluate these benefits for future decisions.
- Protocols, such as ramping rates during flow changes, were not adequately discussed or analyzed. Consideration of these issues over the review period will help future planners make better decisions.

Impacts During Flow Changes: Ramping Rates

Impact Hypothesis: Changing flow rates due to dam operations will adversely affect adult and juvenile fish. Reducing flow rates, will lead to stranding, as a function of channel morphology and rate of change.

Description: Through assessment of impacts of changing dam operations, determine rates of flow change for the Coquitlam River that reduce fish mortality.

Issue Status: The current WUP has not developed a ramp rate protocol for the river, although wetted area vs. flow relationships suggest that rapid habitat dewatering will occur as flows drop below 8cms (Coquitlam-Buntzen WUP FTC, 2001c). Until this issue has been properly addressed, DFO has recommended a ramp rate reduction of 2.5cm/hr (day) and 5cm/hr (night) to avoid severe impacts.

FTC Study Rating: High (Monitor this component in priority areas)

Study Rating Rationale: Monthly gate changes are expected under the new WUP, and rampdowns will undoubtedly cause stranding downstream at flows <8 cms. As the system is small and reliant on dam releases to provide baseflows, particularly in the summer, productivity can be adversely affected by these ramp rates. Ramping rates should be studied for immediate incorporation into the delivery of the WUP flows.

Methodology: Complete opportunistic assessment of rampdowns at selected "index" sites along the Coquitlam River, determine acceptable rates of flow change and incorporate them in future operational changes.

Proposed Plan: As the adjacent table shows, the $15K assessments should

Monitoring Item **Details**	***Timing*** **Details**	**Costs (1000's)***
Investigate Index Stranding Sites	*Year "0"*	$2
Develop TOR (index sites and methods)	*Year "0"*	$1
Opportunistic Ramping Studies	*Review Period*	
Field study during rampdowns	Monthly?	$10
Protocol Write-Up	Early	$2
Total		***$15***

*Costs are represented for the entire review period

be covered by BR/C Environment group OMA.

Habitat Suitability Criteria

Hypothesis: Changes in habitat suitability indices (HSI) will result in different habitat vs flow relationships for the Coquitlam River, and therefore interpretations of operational impacts. The HSI changes will be precipitated by changes in availability of meso-habitats at different flows, whereas current indices are characteristically collected at low flows.

Description: Refine available HSI data by collecting in-situ fish habitat use data at varying flow, mesohabitat and seasonal conditions.

Issue Status: While the IFN study included an component of this data collection, it was not completed over the WUP process. Subsequent to the development of the IFN study TOR, it was understood that the methods suggested in the TOR would not lead to proper assessment of biologic sensitivity to flow changes. This is because proper assessment will require stable base flows before assessing HSI changes – not possible given fiscal and time constraints within the WUP.

FTC Study Rating: Low (Do not monitor this component in the monitoring program. Defer to FAT)

Study Rating Rationale: The development of HSI data is of importance to all WUPs in the province, specifically those coastal systems which use the same HSI curves. This provides an opportunity for another WUP to collect this information, or for the Fish Advisory Team (FAT) to ensure this study is completed.

FTC Recommendation: Do not include in monitoring program. Defer all generic data requirements to the Fish Advisory Team (FAT).

Developing the Habitat versus Flow Relationship for the Coquitlam River (Instream Flow Needs Study)

Hypotheses: Revising the habitat-flow relationships for the Coquitlam River will result in changes to interpretations of impacts of operations on fish habitats in the river.

Description: Complete the data requirements outlined in the IFN Assessment TOR, to refine the flow regime for Treatment B (STP 5).

Issue Status: The WUP CC has recommended that BC Hydro complete the IFN prior to the WUP being implemented. High flow assessments are anticipated over the next seasons. BC Hydro's Dam Safety department will cover the $20K costs of completing the IFN, the results of which will help determine the second flow treatment schedule, as discussed in section 0. Since this is not a monitoring study per se, the IFN study costs will not come out of the monitoring study budgets.

FTC Study Rating: High (Complete this study)

Study Rating Rationale: The completion of this study is critical in defining operational and study approaches in the review period.

Methodology: See IFN Assessment TOR (COQ FTC, 2000)

Proposed Plan: See IFN Assessment TOR (COQ FTC, 2000)

Pink Salmon Access to Mainstem Habitats in September

Impact Hypothesis: Proposed flows in September will not provide adequate flows for pink salmon accessing spawning habitats in the mainstem Coquitlam River.

Description: Determine if pink salmon passage in the Coquitlam River mainstem is hindered, and if so, the flow at which passage is successful.

Issue Status: The FTC has suggested releases of 1cms in September to provide rearing flows under the 4FVN alternative. There was inadequate information collected over the WUP process duration to assess low flow impacts on pink access in September, although the FTC summarised access issues in their information sheet on this issue (COQ FTC, 2000b)

FTC Study Rating: High (Monitor this component)

Study Rating Rationale: Pink spawning returns continue to increase in the Coquitlam River, and as a developing stock, it is important that water use decisions address their migration needs. Future water planning decisions will require this information to provide adequate flows for spawning.

Methodology: Assess pink salmon access each spawning year, relating reach flow with migration success. If there are no issues under 4FVN scenarios, do not continue assessing at higher flows.

Proposed Plan: The adjacent table outlines the plan for assessing pink migration requirements.

Monitoring Item **Details**	***Timing*** **Details**	**Costs (1000's)***
Develop TOR (index sites and methods)	*Year "0"*	$2.0
Investigate Index Passage Sites	*Review Period*	
6-week flow & spawning observations	Sept/BiAnnu	$24.0
Write-Up and Flow Requirements	End	$3.0
Total		***$29.0***

*Costs are represented for the entire review period

Invertebrate Productivity Index

Impact Hypothesis: Secondary (invertebrate) productivity is affected by operations of the Coquitlam Dam, similar to the invertebrate habitat-flow relationship developed for the Coquitlam-Buntzen WUP (Coquitlam-Buntzen WUP FTC, 2001c).

Description: Through direct measurement, refine modelled habitat-flow relationships for invertebrates for the Coquitlam River, in the context of control stream results.

Issue Status: The habitat-flow relationship will be revised following the completion of the IFN, as it is currently based on modelled flow properties.

FTC Study Rating: High (Monitor this component)

Study Rating Rationale: Secondary productivity has been shown to be very responsive to flow changes in other flow studies (Bruce, 1997). The WUP will introduce not only two new flow releases, but will also investigate the effects of flushing flows. For both situations, secondary productivity response is more likely to be more immediate and recognizable than fish response, and should therefore be included in the program.

Methodology: Assessing secondary productivity should be incorporated into the monitoring program for both the control stream and the Coquitlam River, including assessments above and below the gravel pits. Monitoring will include both standing crop estimates and drift rate assessment on a seasonal basis.

Proposed Plan: The adjacent table outlines the plan for assessing secondary productivity response to flow treatments.

Monitoring Item **Details**	***Timing*** **Details**	**Costs (1000's)***
Develop TOR (index sites and methods)	*Year "0"*	
Power Analysis		$2
Lit review and index site selection		$3
Develop TOR		$1
Monitor Productivity	*Review Period*	
Data Collection (Coq. R. & control)	Seasonal	$400
Write-Up and Recommendations	End	$10
Total		***$416***

*Costs are represented for the entire review period

Primary Productivity Index

Impact Hypothesis: Marginal operations will negatively impact the Coquitlam River's primary productivity, which then affects the food available to fish.

Description: Through direct measurement, refine modelled habitat-flow relationships for periphyton and algal growth in the river, in the context of control stream results.
Issue Status: This issue was identified in the Coquitlam-Buntzen WUP fish issues list, but was not addressed during the WUP due to inadequate time to assess productivity relationships with flow.
FTC Study Rating: Low (Doe not monitor this component)
Study Rating Rationale: The CC indicated that maximizing primary productivity in the Coquitlam River was an objective under the WUP process. However, important components of river productivity are already being integrated into the WUP monitoring program, and ~~by~~ including this component will not improve operating decisions.

Assessing effects of Flushing Flows

Impact Hypothesis: Flushing flows in the Coquitlam River will increase the quality of aquatic habitat for both salmonids and invertebrates, leading to increases in productivity for both groups. A corollary to this hypothesis is that the absence of flushing flows in the Coquitlam River has led to lower quality of habitat for fish and invertebrates.
Description: Measure the benefits of flushing flows on habitat quality and fish production by comparing various indicators before and after natural flushing flow releases.
Issue Status: The WUP CC recommended an opportunistic flushing flow of 70-100cms, to be provided by the release of 30-50cms from the dam during high inflows into the river. However, such releases will confound the assessment of base flow effects on productivity in the river, so this component will focus on assessing natural events as they occur throughout the review period.
FTC Study Rating: High (Monitor this component)
Study Rating Rationale: Although the implementation of this monitoring plan is dependant on the consequences of monitoring flow treatments during the review period, evaluating flushing flow benefits is considered a very high priority in that the expected benefits of flushing flows are high. Therefore future operating decisions will require information on flushing benefits
Methodology: Collect and summarise

- baseline information on the substrate characteristics of sample sites along the mainstem, and
- comparative information every year within the review period *after* a flushing flow is delivered.

NHC (2001) have supplied several indices for monitoring in their report, including bed material size distribution.

Proposed Plan: The adjacent table details the approach and costs of capturing the effects of flushing flows.

Monitoring Item **Details**	***Timing*** **Details**	**Costs (1000's)***
Develop TOR (Ken Rood)	*Year "0"*	
Develop TOR		$5.0
Collect Baseline Information	*Year "0"*	$25.0
Collect Flushing Flow Information	*Review Period*	
Substrate Assessment (2 Field Tests)	Each Trtmt	$50.0
Write-up of monitoring results	End	$20.0
Total		***$100.0***

*Costs are represented for the entire review period

Effects of Release Temperature Regimes on Mainstem Habitats

Impact Hypothesis: Reservoir operations affect the temperatures of release flows into the Coquitlam River, and therefore will alter the temperature regime in the river, impacting egg incubation, juvenile rearing and spawning success.
Description: Determine the relationship of reservoir elevations with dam release temperatures and the extent of impacts on river ecosystems.

Issue Status: The Coquitlam Reservoir Water Quality Monitoring Report (White Pine, 2001b) illustrated potential issues with release temperatures from the dam, whereby thermocline depths are maintained even though water surface elevations change. The potential result is higher temperature releases during low reservoir elevations.

FTC Study Rating: High (Monitor this component)

Study Rating Rationale: It is unknown what the impacts of flow releases will be on the temperature regime in the Coquitlam River. It is anticipated that if reservoir management is implicated, this study could lead to recommendations for reservoir operations to promote fish health in the river.

Methodology: Monitor temperature profiles in the Coquitlam Dam forebay, and at previously established monitoring sites (McAdam, pers.comm., 2000). Determine the seasonal impacts of various reservoir operations on release and river temperatures.

Proposed Plan: See adjacent table for a description of costs and timelines for this study.

Monitoring Item **Details**	***Timing*** **Details**	**Costs (1000's)***
Develop TOR (index sites and methods)	*Year "0"*	$5.0
Monitor Forebay and Index (River) Sites	*Review Period*	
Equipment and Installation	Beginning	$5.0
Data collection and final summary	2yrs	$10.0
Total		***$20.0***

*Costs are represented for the entire review period

Water Quality Concerns (except Temperature)

Impact Hypothesis: Changes in flow regulation in the Coquitlam River will reduce water quality in the Coquitlam River.

Description: Evaluate the effects of changing dam releases on water quality parameters along the Coquitlam River.

Issue Status: The issue of oxygen and total gas pressure (TGP) concentration in the Coquitlam River was raised by the Coquitlam-Buntzen WUP CC at the start of the process. The release structure from Coquitlam Dam has been shown in previous measurements not to elevate TGP concentrations. Furthermore, the FTC hypothesised at the time that oxygen concentration issues in the Coquitlam River were related to temperature, which is being reviewed in this monitoring program.

FTC Study Rating: Low (Do not monitor)

Study Rating Rationale: Depleted oxygen levels in summer low flows, turbidity, and total gas pressure (TGP) related concerns are considered either not an issue or not an operational issue by the FTC. TGP levels during spills and during low flow releases did not exceed BC guideline limits, Turbidity is a land use related issue, with poor commercial gravel and logging practices contributing suspended sediment to the river. Oxygen issues are temperature related, which is being recommended for monitoring over the review period.

Fish Productivity Index

Impact Hypothesis: Fish productivity response to Coquitlam River flow treatments will be habitat related, as described by the habitat-flow curves predicted in the IFN results.

H1.1: Habitat area is a surrogate for fish productivity.

Description: Through direct counts of adults and outmigrant smolts, determine the productivity-flow relationship for key fish species in the Coquitlam River, in the context of control stream results.

Issue Status: Coquitlam River smolt assessments 1997-2000 suggest an increase in smolt productivity for steelhead and coho as river flows were increased, and enhancement works were built (Decker, 2000). Population response to flow increases proposed for 4FVN and STP5 are expected, although it is anticipated that the difference in responses will be difficult to detect.

FTC Study Rating: High (Monitor this component in the Coquitlam River and a control stream)

Study Rating Rationale: The development of a fish productivity index is the main objective of this monitoring program. The results of the productivity studies will provide the essential information for making future planning decisions. A control stream is required to detect, and therefore isolate, fish responses to impacts outside of BC Hydro operations.

Methodology: Fish productivity index is the ratio of smolts produced per adult spawner, to be determined each year of the review period for an indicator salmon (coho) and steelhead on both the Coquitlam River and the control stream.

- *Coquitlam River:* Smolts will be enumerated as per Decker (2000). Adult counts by snorkel observation (Korman, 2001).
- *Control Stream:* Smolts enumerated using trap mark recapture formats. Adult counts by visual estimation/counting fence.

Monitoring Item **Details**	***Timing*** **Details**	**Costs (1000's)***
Develop TOR (Leake, Higgins, Korman)	*Year "0"*	
Power Analysis		$5.0
Study Design		$5.0
Control stream selection		$5.0
Site selection for trapping		$5.0
Evaluate Baseline Data	*Year "0"*	
Smolt enumeration (both streams)	Yr 1-3	$270.0
Adult enumeration (both streams)	Yr 1-3	$270.0
Summarize Data	Yr 1-3	$35.0
Collect Monitoring Information	*Review Period*	
Adult enumeration (both streams)	Sprng/Wntr	$1,080.0
Smolt enumeration (both streams)	Spring	$1,080.0
Summarize yearly data - revise PMs	Yearly	$120.0
Monitoring Impacts	*Review Period*	
Analyze and Write-Up data	Yr 6/Yr 12	$30.0
Total		***$2,905.0***

*Costs are represented for the entire review period

Proposed Plan: The above table describes the steps, schedule and cost for this component.

Item #4 Monitoring Committee Terms of Reference

Review Period

The CC recommended a 15-year review period starting from October 2001. This review period included 2-3 years assumed necessary for approval of the WUP and to make the necessary infrastructure changes to one of the low-level outlets. It was recommended by the CC that if efforts are undertaken to return sockeye to the Coquitlam Reservoir, that this should trigger the re-opening of the WUP.

Monitoring Committee

The CC recommends that a Monitoring Committee (MC) should be formed, whose membership should include:

- BC Hydro
- Fisheries and Oceans Canada
- GVRD
- Kwikwetlem First Nations
- Ministry of Water, Land and Air Protection
- Municipal Governments – Coquitlam & Port Coquitlam
- Signatories of this CBWUP consultative committee – need to determine appropriate representation?

The Monitoring Committee's purpose is to ensure that there is:

- continuity of expertise and knowledge derived from this CC WUP consultative process and the proposed study program to ensure the transference of knowledge to facilitate a decision by those responsible for the 15 year WUP review.
- make study program adjustments as noted below within preset budget limits approved by the Comptroller of Water Rights.

The Comptroller of Water Rights is responsible for approving the proposed study program (within the set time period and budget) and will also be responsible for approving any program changes which result in a budget increase or adjustment or have any operational impact beyond what is originally directed by the Comptroller.

The Monitoring Committee's mandate should include:

Determination of Treatment B (2nd Flow Trial):

- The CC has authorized the Monitoring Committee to define Treatment B target flows according to flow-habitat information provided by the Instream Flow Needs (IFN) study. Monthly species life history requirements will be dictated by peak-habitat relationships defined by the IFN study. Target flows must be greater than 4 FVN and no greater than STP5 monthly flow targets. The MC will approve the regime within the terms expressed by the CC.

Definition of Treatment Periods:

The applicability of a 6th year for each Flow Trial based on whether the results to date adequately describe the productive response to the flow regime.
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- In the 5th year of monitoring Treatment A (1st Flow Trial), the Monitoring Committee will convene to recommend either additional monitoring of Treatment A for a 6th year, or to proceed with Treatment B (2nd Flow Trial) regime and associated monitoring.

- Similarly for Treatment B (2nd Flow Trial) regime, the Monitoring Committee will convene in the 5th year to determine the need for additional monitoring of Treatment B for a 6th year,

Timing of Flushing Flow Assessments:

- After a significant inflow event (1:3 year storm event or greater) the Monitoring Committee will convene to determine if a flushing flow assessment is warranted based on the CC recommended criteria of an Opportunistic Flushing Flow (30 – 50 cms from the dam?), within each Treatment Period.

- The Monitoring Committee will consider the timing, magnitude, available hydrologic information, and budget, before approving or delaying the assessment in anticipation of other opportunities. This is likely to occur once within each treatment period and assessment costs must be within the set budget approved by the Comptroller of Water Rights.

Monitoring Committee's Meeting Schedule

The Monitoring Committee may be convened to discuss restoration projects pending for the Coquitlam River, to ensure appropriate consideration of consequences to Water Use Plan parameters being monitored, and to make recommendations to project proponents for monitoring. In general, Monitoring Committee representatives will continually support the monitoring program by bringing such proposals to light, for consideration by the committee.

One annual public meeting to provide study program results and plans and meeting(s) as proposed to address key milestone events identified above.

Additionally, depending on the results of the power analysis, the Monitoring Committee may be required to meet once to refine the above Study Program and to provide a recommendation to the CC. Subsequently, the CC may be required to meet once to provide a recommendation for changes to the Water Use Plan, as per the decision framework recommended by the CC. Recommendation for submission to, and approval by, the Comptroller of Water Rights.