EXECUTIVE SUMMARY

Water use planning is a new process in BC, introduced by the Ministers of Employment and Investment and Environment, Lands and Parks to ensure that provincial water management decisions better reflect changing public values and environmental priorities. A water use plan (WUP) is a technical document that defines how water control facilities (e.g., powerhouses) will be operated. How these facilities are operated will affect many interests in the watershed, such as fisheries, recreation, First Nations, power production, industry, flood control, and others. The goal of water use planning is to develop an operating strategy that achieves the best balance among multiple interests through a participatory, consensus-based process.

The Stave Falls Powerplant is currently being upgraded through the Stave Falls Powerplant Replacement Project. One of the conditions of the Energy Project Certificate (June 1995) for the project requires that a water use plan be prepared for the water control facilities in the Alouette-Stave Falls-Ruskin hydroelectric system. The Alouette WUP was completed in 1996.

The purpose of this report is to present the recommendations of the Consultative Committee of the Stave River Water Use Plan to BC Hydro and the Comptroller of Water Rights. This report will be used by BC Hydro as input when preparing the water use plan that will be submitted to the Comptroller for approval. The Comptroller will consider the input of the Consultative Committee as well as the adequacy of the consultation process when reviewing the proposed water use plan. Accordingly, this report describes:

- the consultation process and analytical approaches used;
- the management objectives and alternatives considered to achieve them;
- the trade-offs associated with the short-listed alternatives;
- the process for reaching consensus; and
- the degree of support for the recommended alternative.

The water use planning process is a 13-step process. The report of the Consultative Committee addresses Steps 1 through 8. BC Hydro conducted the WUP Initiation and Issues Scoping in the fall/winter of 1997/98. At this stage, all interested parties were invited to participate in the Consultative Committee. In the spring of 1998, BC Hydro engaged Compass Resource Management to conduct the trade-off analysis and facilitate Consultative Committee meetings. All of the Stave River facilities are located on Kwantlen First Nation's traditional territory. Kwantlen participated on technical subcommittees, at the main Consultative Committee table and was also consulted separately on issues related to Heritage, Fisheries and Wildlife.

By summer of 1998, the Consultative Committee agreed on the following objectives of the Stave River Water Use Plan:

1. Avoid disruption to industrial operations
    - maintain access to loading/offloading equipment
    - avoid impacts from downstream flooding

2. Support recreational opportunities
    - support Stave Reservoir activities
    - support Hayward Reservoir activities
    - improve safety downstream of Ruskin Dam

3. Support viability of wildlife populations
    - maintain reservoir level stability
    - maintain downstream water level stability
    - ensure periodic flooding of riparian areas

4. Protect and preserve First Nations heritage values
    - protect sites from erosion and illegal collection
    - preserve access to sites
    - recover and interpret artifacts

5. Support viability of fish populations
    - increase spawning capacity
    - increase rearing capacity
    - reduce stranding
    - reduce risk of exposure to elevated levels of Total Gas Pressure
    - increase reservoir productivity

6. Avoid cost increases for electricity production
    - minimize cost of replacement electricity and/or additional programs or works

7. Maximize flexibility to respond to change
    - maximize resilience to and ability to respond to electricity market volatility, scientific uncertainties, etc.

8. Gain knowledge about the system and impacts
    - maximize learning about key uncertainties affecting decision making

For each objective, performance measure(s) were identified. Where possible, performance measures were modeled quantitatively. In other cases, impacts were described qualitatively.

The Consultative Committee generated twelve preliminary operating alternatives designed to meet the objectives (see inset: Summary of Alternatives Developed for SRWUP). The impacts of each alternative on each objective were estimated using the performance measures. The preliminary alternatives were then refined into a number of combination strategies. Eventually, two very distinct strategies – Combo 4 and Combo 5 – were short-listed and evaluated in detail.

Downstream of Ruskin Dam, both of the short-listed strategies contain the same components. This demonstrates the success of the process in finding joint gains through a creative option identification process. In Stave Reservoir, the short-listed strategies represent fundamentally different approaches to operations. The choice between them is value-based.

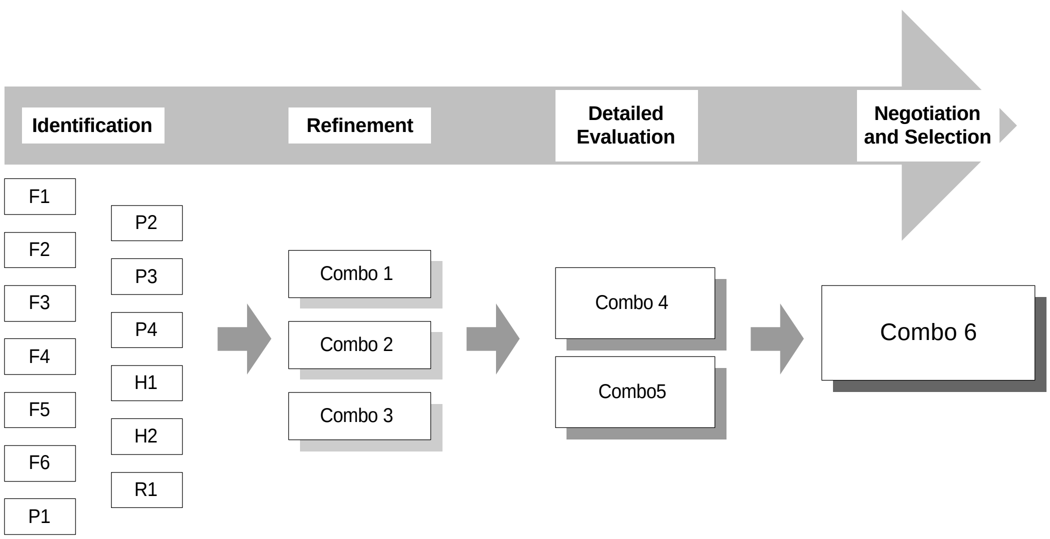
Combo 4 was specifically designed to increase the stability of the reservoir for the primary purpose of enhancing reservoir productivity. It was proposed that this strategy could also improve the viability of the riparian ecosystem in the drawdown zone, and thus improve the aesthetic and recreational value of the area. Because the upper and lower bounds (of the target water level) were allowed to be violated in order to protect minimum flows required for the protection of downstream spawning and rearing habitat, Combo 4 provided reduced fluctuations in reservoir elevations (reduced in magnitude and frequency), but not a fully stable reservoir. Evaluating the benefits of this alternative was complicated by scientific uncertainty about the magnitude of the benefits of a partial stabilization of the reservoir for fish and other ecosystem attributes.

Combo 5 was a refinement of baseline (current) operating conditions, with modifications specifically in consideration of heritage and recreation interests. Although Combo 5 does not set a year-round reservoir target in an explicit attempt to stabilize the reservoir, modeling indicates that in combination with the proposed downstream changes, this strategy would also improve the stability of Stave Reservoir, albeit to a lesser extent than Combo 4.

The Consultative Committee evaluated the trade-offs between these two alternatives in detail. In order to reach consensus, a new combination was developed, which is essentially the operating strategy from Combo 5 with the addition of a significant investment in monitoring to reduce key uncertainties related to reservoir productivity and First Nations heritage objectives.

The Consultative Committee reached a consensus agreement on the "Combo 6" package of recommendations on June 24, 1999.

Summary of Alternatives Developed During the Stave River Water Use Plan



In total, the package of recommendations of the Consultative Committee to BC Hydro includes recommendations on:

- an operating strategy;
- an on-going management plan;
- structure and membership of a management committee; and
- timing of implementation and review.

The recommended operating strategy consists of the following elements:

- maintain all of the constraints that had previously been implemented as part of the Electric System Operating Review (ESOR) in 1995, with the exception of the 130 cubic meter per second maximum Ruskin discharge constraint during the fall spawning period. This includes:
  - weekly block loading at Ruskin powerplant during the fall spawning period;
  - minimum water levels (tailwater elevations) year round;
- Implement daily block loading during the period of fry emergence (officially February 15 to May 15, but subject to annual adjustment if mutually agreed with DFO);
- Modify the block loading procedure to allow partial peaking (above 100 cubic meters per second) during both spring and fall block loading;
- Allow for lower than current normal minimum elevations on Hayward Reservoir during the spring and fall block loading periods;
- Provide a six-week deep drawdown on Stave Reservoir for heritage interests one year in three, on average, with timing and depth of drawdown dependent on opportunities provided by inflow conditions and the needs of Kwantlen First Nation;
- Set a soft target 80-81.5 meters for Stave Reservoir elevation during the peak recreation season (with priority given to maintenance of downstream flows).

The recommended management plan consists of four components.

- A fisheries management plan including:
  - Reservoir Productivity Monitor (Phase 1 and 2);
  - Limited Block Loading Monitor; and
  - On-going management activities, including mitigation or other response to information on impacts gained from the monitoring programs.
- A heritage management plan, including:
  - a heritage monitoring plan;
  - on-going inventory, monitoring and assessment of sites throughout the watershed;
  - drawdown work, including inventory, monitoring and assessment as well as mitigation and artifact recovery on sites located at lower elevations of Stave Reservoir; and
  - mitigation activities.
- A drinking water quality monitoring plan, which includes turbidity monitoring in Hayward Reservoir.
- Reporting and administration, which includes:

- preparation, production and distribution of an annual report on management committee activities
- a monitoring plan “custodian” to ensure continuity of the plan.

The management plan costs vary from year to year, but result in a levelized annual cost of about $390,000. (Note that the WUP as a whole has a net gain of $120,000 per year, which is the difference between annual gains in power value of $510,000 and the management plan costs – see Financial performance in the table below.)

The Consultative Committee recommends that a Stave Management Committee be formed, with membership to include the Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks, BC Hydro, Kwantlen First Nation and the District of Mission. Tasks of the Management Committee include:

- design, refine and implement monitoring programs and review results;
- identify and prioritize mitigation needs and implement related activities within the established budget;
- liaise with the Alouette Management Committee to make decisions when and if trade-offs in water allocation are required between Alouette Lake water levels and the Stave system;
- liaise with Kwantlen First Nation on issues related to heritage management;
- prepare an annual public report;
- conduct an interim review after five years.

The Consultative Committee also made recommendations related to the timing of implementation and review:

- Conduct a full review of the Stave River Water Use Plan (involving a comprehensive multi-party consultation process) after ten years. This recommendation is linked to the expected timing of results from monitoring programs addressing key uncertainties.
- Conduct a formal interim review (by the Management Committee) after five years based on monitoring results to date. The purpose is to identify any unexpected results, adjust mitigation plans and budgets accordingly, adjust monitoring plans as necessary to ensure adequate information will be available at the ten year review, and reconfirm the appropriateness of the timing of the ten-year review.
- Implement the recommended operating strategy immediately upon start-up of the Stave Falls Replacement Project.

The impacts from the recommended package are summarized below. Some of the impacts are uncertain. The most significant uncertainties were investigated and a range of values were considered by the Consultative Committee as the trade-offs were evaluated.

SUMMARY OF IMPACTS OF THE RECOMMENDED PACKAGE

OBJECTIVE	IMPACT OF COMBO 6
Fish – Downstream - *Spawning* - *Rearing* - *Egg Stranding* - *Total Gas Pressure*	▪ Slight improvement in overall productive capacity expected (Reductions in spawning habitat offset by improvements in rearing habitat and egg stranding risks)
Fish – Reservoir - *Reservoir Productivity*	▪ 21% increase in overall reservoir carbon production ▪ 830 hectare increase in effective littoral zone
Industry	▪ Better access to loading/off-loading equipment and woody debris on Stave Reservoir ▪ Reduced risk of incurring damage to downstream equipment due to spills
Recreation	▪ More days at preferred elevations during the recreation season ▪ Potential for an improved fishery ▪ No boating access in March, one year in three
Wildlife	▪ Slight improvement due to increased stabilization of Stave Reservoir
Heritage	▪ Improved access and protection for First Nations heritage sites and artifacts
Financial Cost (Relative to ESOR)	▪ Net gain of about $120,000 per year (levelized annual value, calculated as the difference between gains in power values of $510,000 (see Note 1) and on-going management costs of $390,000)
Learning	▪ Substantial knowledge will be gained about reservoir productivity processes and the impact of operations on littoral habitat and fish productivity ▪ Substantial knowledge will be gained about the impact of operations on First Nations interests
Flexibility	▪ On-going management structure and funding allows effective response to new information or priorities

Notes

1. $510,000 is an upper estimate. The actual value will be between $440,000 and $510,000. Lack of precision is due to difficulties in modeling the "opportunistic" one-in-three-year heritage drawdown. The $510,000 figure was used throughout the consultation, with the understanding that it was a slight overstatement of actual benefits. The lower bound of $440,000 was developed by BC Hydro after the consensus agreement of the Consultative Committee.

Eighty percent of Consultative Committee members reported that they "endorse" the package, while twenty percent "accept" it. (See inset on definition of terms.)

Of those recording "accept", the reasons that prevented them from "endorsing" the package included:

- several participants highly valued the potential for greater ecosystem, fish and aesthetic improvements that they believe could result from greater stabilization of Stave Reservoir;
- one participant had reservations about the high cost of monitoring programs in Years 1 and 2, and would only be able to "Endorse" the package if those were smoothed out (not necessarily to provide a lower overall investment, but to provide a more consistent level of investment from year to year).

Of those reporting “endorse”, minor reservations were expressed by three participants about the cost of the management plan, and the following recommendations made:

- limit the tasks to only those really necessary;
- manage the monitoring work closely to ensure it delivers the intended benefits.

In summary, the Stave River Water Use Plan Consultative Committee succeeded in achieving a consensus on an operating plan and related recommendations to BC Hydro and the Comptroller of Water Rights. The consultation process allowed the development of creative alternatives and the detailed evaluation of two distinctly different operating alternatives. It allowed each participant to apply their own values when making trade-offs among objectives. Through interest-based discussions and negotiation, a consensus agreement was reached which all participants support. The recommended operating strategy provides gains with respect to all objectives, relative to current operations.

Definition of Consensus Used in SRWUP

The following definitions were provided to the CC, and were used to gauge support for the short-listed strategies.

Endorse: You endorse the proposed alternative, either fully or with minor reservations.

Accept: You accept the proposed alternative. You may disagree that the alternative represents the best possible solution, but your minimum needs are met. You may want your views formally recorded, but you accept and support the decision of the group.

Block: You can not support the proposed alternative. Your minimum needs are not met.

“Endorse” and “Accept” both constitute consensus. The more people who are under the “accept” category, the weaker the consensus, but it remains a consensus decision. If anyone in the group finds it necessary to “block”, then consensus is not achieved. Where consensus is not achieved, areas of disagreement will be noted, and we will document what it would take to meet minimum needs.

The process was complicated by uncertainty about a number of impacts. As a result, the consensus agreement is contingent on the implementation of an adaptive management plan that will address key uncertainties and ensure that improved information is available for the next review of the Stave River WUP.

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APPENDICES

1. INTRODUCTION

1.1 Water Use Planning

Water use planning is a new process, introduced by the BC Ministers of Employment and Investment and Environment, Lands and Parks to ensure that provincial water management decisions better reflect changing public values and environmental priorities. A water use plan (WUP) is a technical document that defines how water control facilities (e.g., powerhouses) will be operated. How these facilities are operated will affect many interests in the watershed, such as fisheries, recreation, First Nations, power production, industry, flood control, and others. The goal of water use planning is to develop an operating strategy that achieves the best balance among multiple interests through a participatory, consensus-based process.

Water use planning is designed to address issues related to the operation of facilities as they currently exist, and to identify incremental changes to operations to accommodate other water uses. The process does not directly address issues such as treaty entitlements, historic grievances (dating from facility construction), environmental enhancements or compensation. The focus is on determining how water should be allocated to accommodate different uses[1].

1.2 The Stave River System

The Stave River flows south from the Coast Mountains through the Stave and Hayward Reservoirs, and into the Fraser River (see Map 1). Stave Reservoir is a deep, steep-sided reservoir covering 61.4 square kilometers, and provides the main storage for Stave Falls (52.5 MW) and Ruskin (105.6 MW) Power Plants. Hayward Reservoir is much smaller, providing daily storage for Ruskin Dam, and allowing for hydraulic balance between the two power plants.

The Stave system is hydraulically linked to the Alouette system (see map) via a diversion tunnel which allows flow from Alouette Reservoir into Stave Reservoir. A third generating station, the Alouette power plant (8 MW), produces power at the point of inflow into Stave Reservoir.

All of the facilities are located on the traditional territory of Kwantlen First Nation.

The Stave Falls Powerplant is currently being upgraded through the Stave Falls Powerplant Replacement Project. One of the conditions of the Energy Project Certificate (June 1995) for the project requires that a water use plan be prepared for the water control facilities in the Alouette-Stave Falls-Ruskin hydroelectric system. The Alouette WUP was completed in 1997.

1.3 About This Report

The purpose of this report is to present the recommendations of the Consultative Committee (CC) of the Stave River Water Use Plan to BC Hydro and the Comptroller of Water Rights. This report will be used by BC Hydro as input when preparing the water use plan that will be submitted to the Comptroller for approval. The Comptroller will consider the substantive input of the CC as well as the adequacy of the consultation process when reviewing the proposed water use plan. Accordingly, this report describes:

- the consultation process and analytical approaches used;
- the management objectives and alternatives considered to achieve them;
- the trade-offs associated with the short-listed alternatives;

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[1] In some cases, there may be opportunities to undertake physical works as a substitute for changes in flow. If such works are preferable to the flow changes, they may be considered within the WUP process.

- the process for reaching consensus; and
- the degree of support for the recommended strategy.

The Provincial Water Use Plan Guidelines were developed to guide license holders and participants through the process of plan development. The Water Use Planning process is a 13-step process (see inset). The report of the CC addresses Steps 1 through 8.

Steps in the Water Use Planning Process	
Step 1	Initiate a WUP process for the facility
Step 2	Scope the water use issues and interests
Step 3	Determine the consultative process to be followed and initiate it
Step 4	Confirm the 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 to meet different interests
Step 7	Assess the trade-offs between operating alternatives in terms of the objectives
Step 8	Determine and document the areas of consensus and disagreement
Step 9	Prepare a draft WUP and submit it to the 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

Section 2 of the report describes the consultation process (Steps 1-3). It describes the structure and mandate of the SRWUP CC and the specific consultation steps taken to meet the needs of Kwantlen First Nation.

Section 3 defines the objectives and performance measures (Step 4). It also includes a brief description of studies requested and funded in order to support the evaluation of alternatives and a description of the modeling methods used to estimate the impacts on the objectives/performance measures (Step 5).

Section 4 describes the process for generating and screening alternatives and provides a detailed summary of the two short-listed strategies (Step 6).

Section 5 describes impact of each short-listed strategy on each objective, and summarizes the key trade-offs between them (Step 7). This section ends by summarizing areas of agreement and disagreement of the CC and the eventual consensus which was contingent on development of a monitoring / management plan (Step 8).

Section 6 describes the management plan, which includes fisheries, heritage and water quality monitoring and management actions, as well as a reporting and custodial function (Steps 6, 7 and 8). The CC's recommendations on implementation and timing of review are also included.

Section 7 summarizes the consensus recommendations of the CC, the degree of support for the recommendations, and several additional considerations that the Committee noted.

2. THE CONSULTATION PROCESS

2.1 WUP Initiation and Issues Scoping

The Stave River WUP was initiated by government announcement in 1996, as one of three priority watersheds to be completed within three years. It was required as part of Energy Project Certificate Condition 14 of Stave Falls Power Plant Replacement Project, issued June 1995 and a condition of the Project water license.

In September 1997, the Stave Falls Powerplant Replacement Project Update announced commencement of the Stave River WUP process and invited individuals to contact a toll free 1-800 number for more details or to indicate their interest in participating in the review process. This notice was distributed to a mailing list of 1,100 people and via a postal drop to the Mission community (approximately 13,000). The notice was also published in the local newspaper.

In consultation with R. Penner (Office of the Comptroller of Water Rights), key stakeholders were identified as individuals or companies who are directly affected by BC Hydro's Stave River operations and/or who had a regulatory responsibility such as federal, provincial and municipal government agencies, First Nations and/or groups who were active in the watershed, as well as local residents.

In the fall of 1997, meetings with stakeholders in the Stave River watershed were held to identify issues and interests. These issues are summarized in the Stave River Water Use Plan Issues Identification Report (Cope Environmental Services, January 1998). The major issues were related to:

- fisheries
- recreation
- power production
- First Nations heritage sites
- industrial operations
- wildlife

A summary of available technical data of water flows and their impacts on water resources was also prepared (Stave Falls and Ruskin Power Facilities – Current Operating Systems Report, August, 1997).

At this stage, all interested parties were invited to participate in the CC. Committee members are listed in Appendix 1.

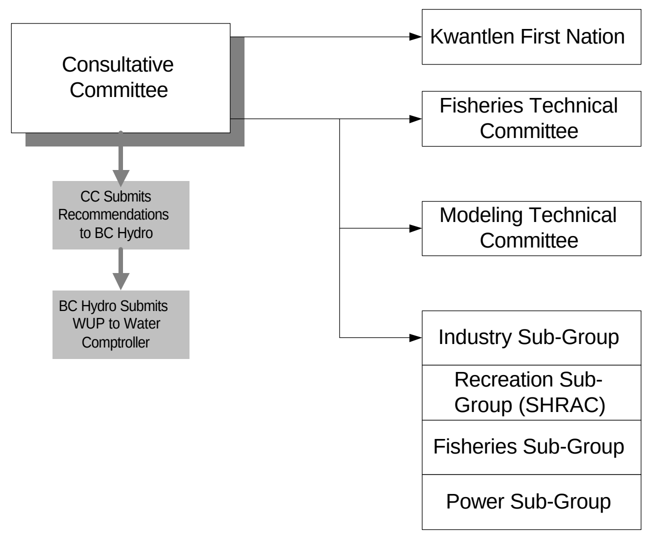
2.2 The Consultative Committee – Structure and Process

In spring of 1998, BC Hydro engaged Compass Resource Management to conduct the trade-off analysis and facilitate CC meetings. Compass's role was to support the quality of decision making by ensuring:

- that the stated objectives reflected the range of interests and that performance measures supported a structured approach to decision making;
- that information provided to the CC was relevant, drawn from reliable sources and correctly interpreted by the CC;

- that a range of alternatives were developed and given fair consideration;
- that key impacts, trade-offs and decision points were identified and clarified for the CC;
- that participants had an opportunity for constructive dialogue and principled negotiations through the meeting process.

Figure 2-2 SRWUP Consultative Committee Structure



Participants were eager to be involved in the SRWUP, but also expressed a desire for BC Hydro to streamline the process to minimize participant time commitments. As a result, the consultation made significant use of sub-committees and working groups (Figure 2-2).

Kwantlen First Nation was consulted separately on issues related to heritage, fisheries and wildlife (see Section 2.3).

A Fisheries Technical Committee (FTC) was formed to address complex technical issues related to fisheries performance measures and impact modeling. Membership of this committee included the Department of Fisheries and Oceans (DFO), the BC Ministry of Environment, Lands and Parks (MELP), BC Hydro, Kwantlen First Nation and local fisheries organizations (Alouette River Management Society and the Stave Valley Salmonid Enhancement Society). The main CC largely delegated issues related to the development of performance measures, modeling methods and assessment of impacts to the FTC.

A Modeling Technical Committee was also formed which addressed the methods used to model BC Hydro operations and power production. In addition to MELP, DFO, BC Hydro, Kwantlen, and the Stave Valley Salmonid Enhancement Society, an independent peer reviewer[2] sat on this committee and reviewed modeling results in detail. The purpose of this committee was to ensure that the modeling methods and results from BC Hydro Power Supply department adequately represented what the CC was asking to have modeled. The peer reviewer provided comment on the technical relevance and adequacy of the methods and tools used.

At various times, four additional working groups were convened:

Industry – This group represented industrial interests on Stave Reservoir and downstream of Ruskin Dam, primarily in forest products industry. It was convened to discuss objectives and brainstorm alternatives.

Recreation – This group represented recreational interests on Stave and Hayward Reservoirs and downstream of Ruskin Dam. The Stave/Hayward Recreational Advisory Council, a pre-existing community organization, was consulted on a variety of issues related to performance measures and the significance of impacts.

Fisheries – This working group included the Fisheries Technical Committee plus some additional non-technical participants with an interest in fish. It was convened to discuss objectives and to brainstorm alternatives.

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[2] Dr. Denis Russell, Department of Civil Engineering, University of British Columbia.

Power – This working group included BC Hydro, the Ministry of Employment and Investment, and various other agencies and participants, who met to develop creative alternatives to enhance power production without compromising non-power interests.

The timing of various consultation activities and milestone meetings is shown in Table 2-1. A full list of consultation meetings is included in Appendix 1.

Participants on the CC were initially confirmed at a 15 December 1997 meeting of interested parties. However, as a result of new initiatives occurring in the watershed, new representatives were welcomed onto the CC at various stages (e.g., Ducks Unlimited). The approach was to be as inclusive as possible while maintaining the integrity and creative balance required to undertake the work. At late stages of the process, if interested parties wished to participate, they were welcomed as observers to CC meetings (e.g., drinking water quality interests).

In addition to the CC, broader public consultation was provided by BC Hydro through the Stave Falls Project Newsletters Editions 6 and 7 (November 1998/99), library displays and an Open House. Newsletters were distributed to the Stave Project mail list (about 1100 recipients) and as a postal drop to the Mission community (roughly 13,000 people). Reports were also available in the Mission library. A final open house will be held in September 1999 to inform the public of the results of the Stave River WUP process.

2.3 Kwantlen First Nation Consultation

The Stave River system falls within the traditional territory of Kwantlen First Nation. The In-SHUCK-ch First Nations have identified an over-lapping claim for a portion of the northern tip of Stave Reservoir; however In-SHUCK-ch confirmed that Kwantlen would represent First Nations interests in the Stave River water use planning process.

Consistent with the scope of water use planning, the WUP consultation with Kwantlen dealt primarily with the impacts of operations and the alternatives for mitigating those impacts through incremental operating changes[3].

Initially, Kwantlen's WUP consultation was conducted parallel to the Consultative Committee process. A number of meetings were held between BC Hydro, Kwantlen and Compass RM to clarify Kwantlen's objectives, to establish performance measures and to identify key information gaps. At Kwantlen's request, studies were conducted in the spring/summer of 1998 to examine the impact of erosion on heritage sites[4].

In addition to their parallel consultation, Kwantlen sat on several working groups of the Consultative Committee, including the Fisheries and Modeling Technical Committees. After a cross-cultural training session for WUP participants in February of 1999, Kwantlen joined the main table of the Consultative Committee and participated in all discussions leading to the consensus agreement of June 24, 1999.

[3] Note that two other parallel processes were on-going throughout the WUP process. For the Stave Falls Replacement Project, Kwantlen continued to be consulted on issues and impacts related to the Project. After the WUP process was initiated, Kwantlen also participated in historical grievance negotiations with BC Hydro to address issues and impacts related to the original construction and inundation.

[4] As a result of the Stave Falls Powerplant Replacement Project, a significant amount of information gathering had been conducted prior to the water use planning process. See Section 3.3.

TABLE 2-1 KEY CONSULTATION ACTIVITIES AND TIMING

TIMEFRAME	ACTIVITY	MILESTONE MEETING(S)
Fall / Winter 1997	Steps 1-3: Initiate WUP and Scope Issues	December 15, 1997: General meeting to confirm issues and identify interested parties
Spring 1998	Step 4: Set Objectives	March/April, 1998: Sub-groups met to set objectives June 18, 1998: CC met to review objectives and consultative process
Spring / Summer 1998	Step 4: Define Performance Measures	FTC and other sub-groups met to define performance measures
Spring / Summer 1998	Step 5: Gather Information	Summer field studies were conducted to fill critical data gaps
Fall 1998	Step 4/5: Develop Models – Power and Habitat Modeling and Performance Measures	October 14, 1998: CC met to confirm performance measures January 21, 1999: CC met to confirm modeling approach
Winter 1999	Step 4/5: Cross Cultural Training	February 9, 1999: Hosted by Kwantlen First Nation
Winter 1999	Step 6: Identify Alternatives	February 18/19, 1999: Sub-groups (power, fish, heritage, recreation) met to brainstorm operating alternatives
Spring 1999	Step 6/7: Refine Alternatives	March 25, 1999: CC reviewed results and assigned sub-groups responsibility to refine alternatives March/April 1999: Various sub-group meetings
Spring 1999	Step 7/8: Evaluate Trade-offs	May 21, 1999: CC reached consensus on an operating strategy, contingent on development of an adequate management plan
Spring 1999	Step 6/7/8: Develop Management Plan	Various meetings of FTC and Kwantlen First Nation to develop management plan
Spring 1999	Step 8: Consensus Agreement	June 24, 1999: CC reached consensus on a package of recommendations

3. OBJECTIVES AND PERFORMANCE MEASURES

3.1 Objectives

Step 4 of the Water Use Planning process involves confirming issues and interests in terms of specific water use objectives and specific measures for assessing their achievement. A preliminary set of objectives was identified based on the issues as summarized in the Issues Identification Report, March 1998. This preliminary list was reviewed and refined with the CC (and sub-committees) to create the working set of objectives shown in Figure 3-1.

FIGURE 3-1 SUMMARY OF SRWUP OBJECTIVES

1. Avoid disruption to industrial operations
   - maintain access to loading/offloading equipment
   - avoid impacts from downstream flooding
2. Support recreational opportunities
   - support Stave Reservoir activities
   - support Hayward Reservoir activities
   - improve safety downstream of Ruskin Dam
3. Support viability of wildlife populations
   - maintain reservoir level stability
   - maintain downstream water level stability
   - ensure periodic flooding of riparian areas
4. Protect and preserve First Nations heritage values
   - protect sites from erosion and illegal collection
   - preserve access to sites
   - recover and interpret artifacts
5. Support viability of fish populations
   - increase spawning capacity
   - increase rearing capacity
   - reduce stranding
   - reduce risk of exposure to elevated levels of TGP
   - increase reservoir productivity
6. Avoid cost increases for electricity production
   - minimize cost of replacement electricity and/or additional programs or works
7. Maximize flexibility to respond to change
   - maximize resilience to and ability to respond to electricity market volatility, scientific uncertainties, etc.
8. Gain knowledge about the system and impacts
   - maximize learning about key uncertainties that affect decision making

Avoid Disruption to Industrial Operations

Industrial users of Stave Reservoir and the river downstream of Ruskin Dam were concerned about large spills that occur without sufficient notice to allow industry to take action to protect equipment from damage and excessively low reservoir levels that would prevent access to loading or offloading equipment or prevent the removal/collection of woody debris.

Support Recreational Opportunities

The Stave Lake Reservoir Integrated Recreation Plan (DLC, 1997) considered a wide range of recreation-related issues and identified preferred operating levels which best met recreational interests. Primary recreation interests on Stave and Hayward Reservoirs include family-oriented recreation, boating and fishing. Hiking, birdwatching and other activities also occur. Downstream of Ruskin Dam, family-oriented recreation, swimming and fishing are the dominant uses affected by operations[5].

[5] See also Hayward Lake Recreation Plan (BC Hydro, 1998).

Support Viability of Wildlife Populations

Based on the Stave River Valley orientation, logging history and stand structure, this area is of low priority relative to other areas of the province, according to both BC Hydro and MELP wildlife management assessments. (Wildlife values only increase on the south-facing slopes that look over the Fraser Valley at the very end of the Stave River Valley.)

As a result, each operating strategy was qualitatively assessed for its likely effect on the key factors affecting wildlife. It was agreed that if there was reason to expect significant negative impacts on wildlife as a result of a proposed strategy, further investigation would be undertaken. (This did not prove necessary.)

Protect and Preserve First Nations Heritage

The Stave River system lies within the traditional territory of the Kwantlen First Nation. Kwantlen First Nation, along with British Columbians, has an interest in understanding how Kwantlen's ancestors lived and in uncovering parts of their heritage. Kwantlen is interested in protecting heritage sites from erosion and illegal collection (pot-hunting), accessing sites (for mitigation and inventory purposes as well as cultural and spiritual activities), and recovering artifacts.

Support Viability of Fish Populations

Since the late 1980's, a significant amount of work has been done to enhance fisheries downstream of Ruskin Dam. Little has been done in the reservoir. The objectives of this WUP were to maintain or enhance the gains already achieved downstream of Ruskin Dam[6] and to improve fisheries in Stave Reservoir. The Fisheries Technical Committee established five sub-objectives which it felt needed to be addressed in the WUP. Four addressed maintaining or enhancing downstream fisheries – spawning habitat, rearing habitat, risk of egg stranding, and risk of mortality from Total Gas Pressure[7]. One of the sub-objectives, reservoir productivity, addressed the desire to enhance fish habitat in Stave Reservoir (specifically the littoral zone[8] and a limited area of cutthroat spawning/rearing habitat). The FTC felt strongly that the objectives should be related to habitat, and not summarized in a single measure of fish population since population modeling can be the subject of much scientific debate, and since the mandate of the fisheries agencies is specifically targeted to protect and restore fish habitat.

Avoid Cost Increases for Electricity Production

If operations in the Stave system are constrained, the amount and/or value of electricity from the three power plants – Stave Falls, Ruskin and Alouette – will be reduced. Since BC Hydro is a Crown Corporation, reductions in the value of electricity produced at Stave represent a cost to the province as a whole. The objective from a cost perspective is to meet non-power needs at the lowest possible cost in terms of power values.

Maximize Flexibility to Respond to Change

There are economic, scientific and technical uncertainties about electricity price forecasts and the impacts of operations on fisheries and other objectives. The flexibility objective simply states a desire to maintain the ability to respond to new information as it becomes available. The main implication of identifying this objective is that it suggests the need for a flexible form of on-going management structure.

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[6] The target species is chum salmon. It is assumed that other species will also benefit to some extent from improvements targeted at chum.

[7] When water falls from height into a deep pool (for example, over a waterfall or when spilled from a hydroelectric facility), air can be forced into the water producing elevated levels of Total Gas Pressure (TGP). Elevated TGP has the potential to cause gas bubble trauma disease in fish, which can lead to fish mortality and/or reduced productivity.

[8] The littoral zone is an important biologically productive area along the shore of a lake that can provide food and habitat for a range of aquatic life.

Gain Knowledge about the System and Operational Impacts

If the quality of decision making is hindered by a lack of knowledge, then it is possible that an investment in learning may be justified. That is, participants may be willing to trade-off financial or other benefits in order to generate better information for future decision making. This objective explicitly recognizes participants' interest in improving the information on which decisions are based.

Flood Control

The Consultative Committee did not explicitly identify any concerns with flood control, other than those expressed by industry with respect to damage of equipment if inadequate notification of spills was provided. Thus, generalized flood mapping and assessment were not considered necessary in this case and a general flood control objective was not identified. Note however that flood control implications for the recommended strategy were examined as a final confirmation that no adverse impacts on flood control capability would occur and these effects are reported in the Stave River Water Use Plan itself.

Water Quality

It was not initially anticipated that the WUP would have any effect on water quality and it was not stated as an objective. However, water quality issues were raised subsequently in an open house. Interested parties were invited to attend the remaining CC meetings as observers. Further, when a change was proposed to the Hayward Reservoir operations (the source of drinking water for a number of local residents), water quality interests were addressed through the recommendation of a water quality monitoring plan (see Section 6).

3.2 Performance Measures

For each objective, performance measures were developed. Performance measures define exactly how progress toward the objectives will be measured. They become the evaluation criteria when comparing alternatives.

Usually, performance measures are directly related to fundamental ends, not means. For example, it is theoretically better to measure the impact of an operating alternative on fish populations rather than on exposure to TGP, since it is population that we really care about and we only care about TGP insofar as it affects fish populations. However, there are usually practical limitations that force performance measures to be somewhat more means-oriented. (For example, the scientific uncertainty associated with modeling fish populations and the mandate of regulators to focus on habitat, as described above.)

Performance measures were developed through discussions with sub-groups of the CC. Influence diagrams were used to guide thinking about the factors that affected the objective, and these diagrams helped to drive the selection of performance measures. Figure 3-2 is an example influence diagram showing the drivers of reservoir productivity. The shaded circles show the factors that were developed into the "Effective Littoral Zone" performance measure. While they are not necessarily the most dominant factors affecting productivity, they are the factors most affected by reservoir operations (reservoir levels). Later in the process, as reservoir productivity became a key factor affecting preferences among alternatives, this performance measure was refined to better estimate the net effect on total reservoir productivity, including consideration of all factors (see below).

For each objective, one or more performance measures were identified. (See Tables 3-1 and 3-2 for fisheries and non-fisheries performance measures). Some performance measures (e.g., fisheries) had several components which were combined into a weighted normalized index[9].

[9] If the components of a performance measure differ in scale and/or data type, then normalizing is a mathematical technique that reports a unitless value between 0 (worst) and 1 (best) for the overall performance of each operating strategy under consideration. If the components differ in their relative

For example, to estimate the impact of operations on spawning habitat, it was determined that three impacts must be assessed (see row 1 of Table 3-1):

- quantity of spawning habitat (in hectares);
- variability in spawning habitat area from day to day;
- variability in spawning habitat area within-days (this reflects plant peaking operation).

The Fisheries Technical Committee assigned weights to each component. Scores for each alternative under consideration were normalized before calculating the weighted normalized index value. The index value represents the condition of the habitat and its capacity to support spawning. While total spawning capacity is not directly measured, the index effectively shows the preferred ranking of alternatives (with 0 being worst and 1 being best) from the perspective of spawning capacity only.

A normalized index was calculated for each of the five fishery objectives, as well as most non-fishery objectives. The normalized indices were used at the early stages of the evaluation process where a large number of alternatives were being screened. They were particularly useful for assessing the impacts on downstream fish, and were successfully used to screen out alternatives that risked compromising the gains already achieved in downstream fish populations. Once a small number of alternatives were short-listed, the Fisheries Technical Committee and the CC reviewed the detailed data underlying the normalized indices, and considered additional quantitative or qualitative data.

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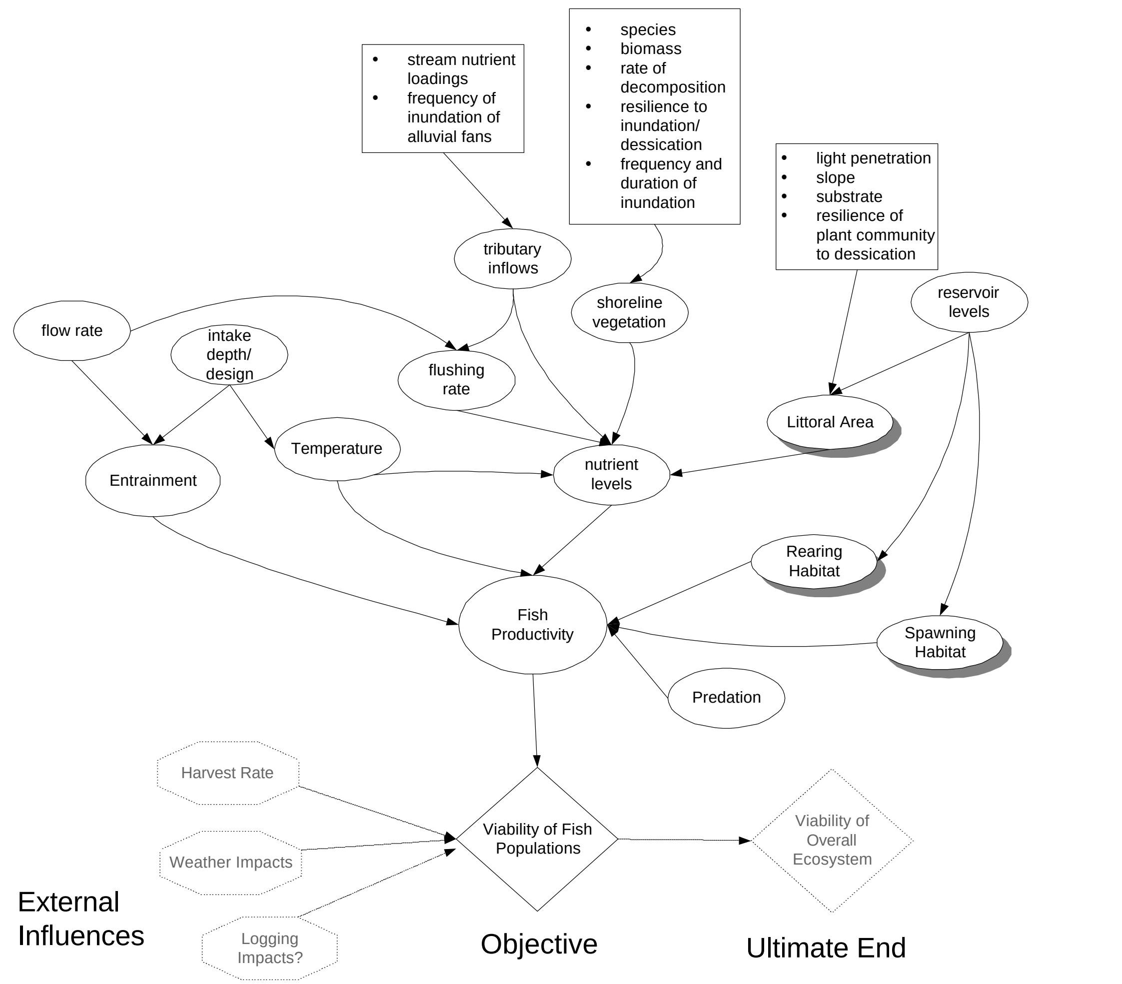
importance, then weighting functions are applied to ensure that relative importance is reflected. See the normalization information sheet in Appendix 2.

FIGURE 3-2 INFLUENCE DIAGRAM FOR FACTORS AFFECTING RESERVOIR PRODUCTIVITY



As noted above, the Effective Littoral Zone measure (or ELZ) is one of several drivers of reservoir productivity, and is the one most affected by reservoir operations. It was used to flag major differences among operating alternatives. When in fact an opportunity was found to significantly increase ELZ, further investigation was required to estimate how this would affect overall reservoir productivity. The performance measure that was eventually used to compare short-listed alternatives was the estimated carbon productivity of the reservoir – a measure of the overall biological productivity of the reservoir.

The performance measures and how they are calculated or modeled are described in detail in Appendix 2. These "Information Sheets" were issued to the CC in January 1999 as reference material[10].

[10] Some performance measures were refined after that time. In the case of discrepancies between the Information Sheets in Appendix 1 and the text of this report, the report is the more accurate representation of the information that was used in decision making.

TABLE 3-1 SUMMARY OF FISHERIES PERFORMANCE MEASURES (1)

OBJECTIVE	PERFORMANCE MEASURE COMPONENTS	INTERPRETATION OF THE INDEX VALUE
Spawning	▪ Quantity of habitat ▪ Daily Variability ▪ Within-day variability	Measure of the condition of spawning habitat downstream of Ruskin Dam and its ability to support spawning(2).
Rearing	▪ Daily Variability ▪ Within-day variability ▪ Side channel availability	Measure of the condition of rearing habitat downstream of Ruskin Dam and its ability to support rearing juveniles(2).
Egg Stranding	▪ Median risk ▪ Extreme Risk	Measure of the risk of dewatering incubating eggs or alevins(2).
Total Gas Pressure	▪ # of days on which TGP is between 103 and 110% after a period of 28 consecutive days of elevated levels ▪ # of days on which TGP exceeds 110% (no threshold).	Measure of the risk of direct mortality from exposure to elevated levels of TGP(2).

Reservoir Productivity (3)	▪ Effective Littoral Zone:
	  ▪ area productive at least 80% of year
	  ▪ area productive at least 50% of year
	  ▪ # days cutthroat spawning/rearing habitat is available
	➢ Overall Reservoir Productivity
	  ➢ tonnes of carbon
		▪ Measure of the productivity of the littoral zone of Stave Reservoir(2) - this measure used to screen preliminary alternatives.
		➢ Measure of the overall productivity of Stave Reservoir – this measure used to compare the short-listed alternatives

Notes:

1. For a detailed description of performance measures, see Appendix 2.
2. Weights for each component provided by the Fisheries Technical Committee.
3. Two performance measures were used to assess the impact of BC Hydro operations on the productivity of the reservoir, effective littoral zone and total carbon productivity. The Effective Littoral Zone performance measure assesses the quantity of potentially productive area in Stave Reservoir. The ELZ was used to screen a large number of alternatives. The total carbon productivity performance measure estimates the amount of carbon production in the reservoir as a whole, based on base assumptions about other factors driving productivity, and the different littoral areas estimated for each operating alternative. Total carbon productivity was estimated only for the short-listed alternatives.

TABLE 3-2 NON-FISH PERFORMANCE MEASURES (1)

OBJECTIVE	PERFORMANCE MEASURE COMPONENTS	INTERPRETATION OF THE INDEX VALUE
Industry	▪ # days of access to loading/offloading equipment on Stave Reservoir (dependent on water levels) - spring - summer/fall	Measure of effects on industry, with spring access and summer/fall access weighted equally (Note that downstream industrial interests are adequately addressed by the new spill notification protocol.)
Recreation	▪ Weighted average # days from May to Oct that Stave Reservoir level is between: - 80 - 81.5 m (highest weight) - 78 - 80 m - 76 – 78 m (lowest weight) ▪ Downstream safety ▪ Impact on Hayward Recreation	Measure of the degree of support for recreational activities on Stave Reservoir. (Index does not include downstream safety or Hayward impacts; these are considered qualitatively.)
Wildlife	▪ Changes in reservoir stability ▪ Changes in downstream fluctuations and flushing of riparian zones	No index value. A qualitative assessment of effects was conducted simply to look for anything that would flag a potential issue.
Heritage	▪ # site-days of access ▪ # site-days of protection (submergence in high recreation season) ▪ Risk of erosion	Measure of impacts on heritage sites on Stave Reservoir, with all sites equally weighted. (Erosion and submergence are not included in the index.)
Financial Cost	▪ Annual levelized value of replacement generation in 1998$	Measure of the average loss or gain in financial value of power production. Note that this value will vary widely from year to year; this is an average levelized value.
Learning	▪ Number of key uncertainties reduced	No Index
Flexibility	▪ Flexibility to respond to new information on environmental conditions, operational impacts and public values	No Index

Notes:

1. For a detailed description of performance measures, see Appendix 2.

3.3 Preliminary Information Gathering

As the performance measures were developed, a number of uncertainties related to fisheries impacts were identified. Studies to address these information gaps were proposed and prioritized by the Fisheries Technical Committee according to the following criteria:

- does the study provide information that is essential to build confidence that the performance measure accurately represents the impact of alternatives on the objectives?
- does the study provide information that could help weight performance measures (i.e., does it help answer the question "how important is this effect?")?
- does the study provide information that could change the ranking of alternatives (i.e., within a plausible range of values, could refinement of an assumption change the ranking of alternatives)?
- is the information expected to be transferable to other watersheds?
- is the information useful for evaluating the impacts on more than one performance measure or objective?

See Appendix 3 for a summary of the studies, their purpose and cost.

Studies related to the impacts of operations on First Nations interests were also identified and prioritized with Kwantlen First Nation. As a result the following studies were conducted:

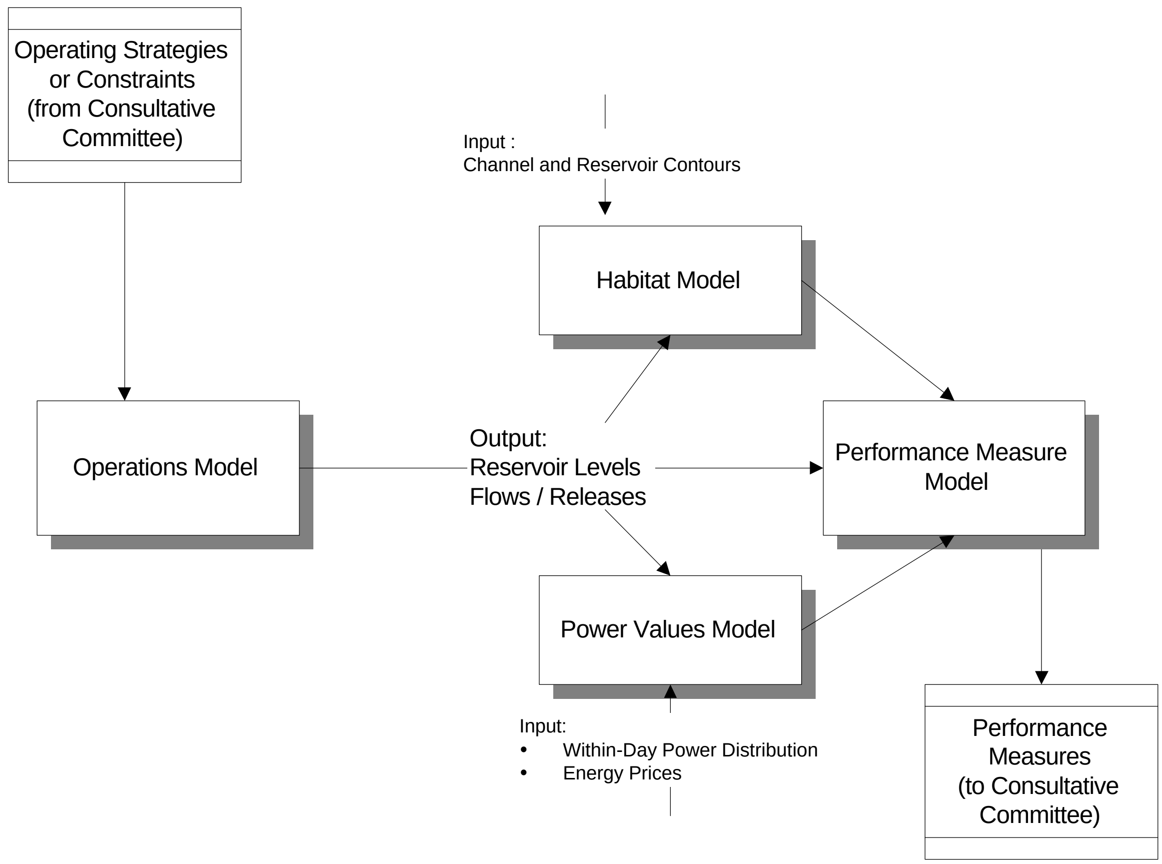
- Erosion Studies of First Nations heritage sites – Stave Reservoir and downstream of Ruskin Dam. The studies addressed: how are First Nations heritage sites being affected by erosion and to what extent is erosion caused by BC Hydro operations?

In addition to WUP-funded studies, substantial archeological investigations were funded through the Stave Falls Powerplant Replacement Project, as were studies on water quality, sediment contamination, mercury contamination in fish tissue, and a traditional use study.

3.4 Overview of Modeling

A variety of models were used to predict the impacts of alternative operating strategies on the objectives and performance measures (Figure 3-3).

Figure 3-3 Overview of Modeling Approach



Operating alternatives are created by imposing various combinations of constraints, within which the system is optimized. Once the CC developed an alternative to be modeled, the constraints were entered into an operations model[11]. The operations model optimizes operations for power production. It uses 27 different years of data on inflows to the watershed from which the median, average, 90th percentile or any other statistical value can be extracted.

The primary output of the operations model is a set of data describing reservoir levels and flows through or releases from dams on each day of each year, along with daily power production. These data are used as input to two additional models.

The habitat model combines information on plant discharge flows and water levels with information about the physical contours of the reservoir and the river channel to allow estimation

[11] The Small Reservoir Systems (SRS) model was used to model the majority of the operating constraints. SRS is a commercially-available model which was developed to assist hydro system planners and operators of multiple reservoir systems. The program uses stochastic dynamic programming for individual reservoirs and linear programming to coordinate storage between reservoirs. The model is run in daily time-steps. The Acres Reservoir Simulation Package was used to cross-check SRS results for a limited number of cases, to ensure there were no gross discrepancies. See the Stave River WUP Power Studies Report (Kerr, 1999).

of additional parameters such as water depth. These data are further processed to calculate the performance measures as defined in Section 2.2.

Plant discharge flow data are also routed through a power values model[12] which takes information about dispatchability[13], energy prices[14] and plant characteristics to calculate the value of the power that will be produced under each alternative. The performance measure for a given operating alternative is the difference between the value of power produced under that alternative, and the value produced under the "ESOR" base case.

"ESOR" is the mode of operation that was implemented after the 1994 Electric System Operating Review. In April 1995, operations were reviewed and changes implemented to provide some consideration for non-power interests. At Stave, it primarily provided better protection of downstream fish, and included:

- minimum flows for the river downstream of Ruskin
- weekly block loading (no peaking) and maximum discharge constraints at Ruskin during the fall spawning period

The ESOR base case was modeled assuming the new Stave Falls powerplant operating under the existing ESOR constraints. See the BC Hydro report Stave River WUP Power Studies Report (Kerr, 1999), Section 5.1.1, Existing Operating Constraints, for a full description of the ESOR constraints.

Additional information on how the fisheries and other performance measures are calculated are included in the Information Sheets in Appendix 2 and in BC Hydro's SRWUP Data Report: Habitat Modeling and Performance Measure Calculations (Bruce, 1999).

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[12] Actually, a series of models – see Figure 4 of BC Hydro's Stave River WUP Power Studies Report (Kerr, 1999).

[13] As the SRS model does not permit the redistribution of energy within each daily time step, a spreadsheet model was developed for this purpose. To reflect these within day variations in energy values, two daily prices are input into the spreadsheet (high and low). A "dispatchability" multiplier is applied to reflect the degree of flexibility plant operators have in dispatching the available generation at peak times. See BC Hydro's Stave River WUP Power Studies Report (Kerr, 1999).

[14] From BC Hydro's Value of Energy (VOE) spreadsheet. The VOE spreadsheet combines short-term price forecasts (derived from forward market prices) with medium-term price forecasts generated using the Henwood model. This is a proprietary model developed by Henwood Consultants and is used by many other utilities. The model forecasts data for 13 regions (over 15,000 generating stations) in Western North America. Forecasts beyond 2004 are based on the cost of new generation (assuming this generation comes from Combined Cycle Gas Turbines) with projections for long-term gas prices. To these annual costs a yearly energy price shape is applied. The annual price shape was derived from Henwood model results and historical market data. The Lower Mainland price forecasts were levelized over an assumed 70-year life of the agreement using a constant price beyond 2004 (in real dollars) and an 8% discount rate.

4. ALTERNATIVES

4.1 Actions Undertaken Immediately

Early in the consultation process, it became clear that most of the concerns of industry could be met by providing them with adequate notification in advance of spills. As a result, a fax-out spill notification system was established and implemented immediately. With adequate notification, industrial users of the river downstream of Ruskin Dam can avoid any damage to equipment and minimize disruptions to their business. No further alternatives were needed to address this interest.

In addition, local residents identified an opportunity to reduce fry stranding and improve public safety through a habitat enhancement project downstream of Ruskin Dam. This work was undertaken in partnership with DFO, Kwantlen First Nation, and BC Hydro (funded by the SRWUP project) in the fall of 1998.

4.2 Preliminary Operating Alternatives

Operating alternatives include rules or procedures for operating water control facilities, for example, constraints on peak or low flows, maximum or minimum reservoir water levels, etc.. These constraints may be valid for specific facilities, at specific times of the day or specific seasons of the year. Thus, individual constraints (or alternatives) are combined into an annual operating strategy that is then modeled to assess impacts on all objectives.

Once objectives and performance measures were established and BC Hydro developed the modeling capability to estimate impacts of operating alternatives on the objectives, four working groups of the CC met to brainstorm alternatives for meeting objectives. Each working group met for a half day. The mandate of each group was to think creatively about operating alternatives that would better meet their needs (e.g., the Fisheries group focussed on fisheries alternatives, the Heritage group on heritage alternatives). However, given what they already knew about other objectives, each group was to look for creative win-win alternatives that would improve all interests.

The emphasis in the sessions was on operating alternatives. However, non-operational options were also identified and recorded. Table 4-1 summarizes the operating alternatives that were brainstormed.

TABLE 4-1 PRELIMINARY OPERATING ALTERNATIVES

RUSKIN DAM	STAVE RESERVOIR	HAYWARD RESERVOIR
Base: ESOR constraints downstream of Ruskin F5: Add spring block load at Ruskin F6: Remove 130 maximum flow constraint at Ruskin P1: Modify block loading to allow partial peaking P3/P4: Reduce minimum flow downstream of Ruskin to 48/40 cms	F1: Stabilize Stave at 79-81 m F2: Stabilize Stave at 77-79 m F3: Stabilize Stave at 75-77 m F4: Stabilize Stave at 77-80 m H1: Annual Drawdown - 3 weeks H2: Annual Drawdown - 6 weeks R1: Target elevation at Stave of 80-81.5 m in summer	P2: Lower minimum normal water level at Hayward to 39.5 m

Notes to Table 4-1:

1. F1-F5 were generated by the Fisheries subgroup, H1 and H2 by Heritage, R1 by Recreation and P1-P4 by Power.
2. The components that were considered further are described in more detail in section 4.4.

These individual alternatives were refined into operating strategies. A “strategy” includes various combinations of constraints at each facility at various times of the year. Table 4-2 shows an example of an operating strategy. All strategies considered are described in this format in BC Hydro’s Stave River WUP Power Studies Report (Kerr, 1999).

TABLE 4-2 EXAMPLE OF AN OPERATING STRATEGY (1)

Op Mode	Timing		Season	Peak-ing	Flow Constraints		Reservoir Constraints		Remarks
	Start	End	Description	Y/N	Min	Max	Min	Max	
1	Jan 1	Feb 14	Incubation	y	55	-	-	-	
2	Feb 15	May 15	Fry Emergence	n	55	-	-	-	limited daily block loading
3	May 16	Jul 31	Fraser River Backwater and peak recreation season	y	-	-	80	-	recreation target
4	Aug 1	Sep 7	Summer rearing and peak recreation season	y	55	-	80	-	recreation target
5	Sep 8	Oct 14	Rearing	y	55	-	-	-	
6	Oct 15	Dec 2	Spawning	n	55	-	-	-	limited weekly block loading
7	Dec 3	Dec 31	Incubation	y	55	-	-	-	

Notes to Table 4-2:

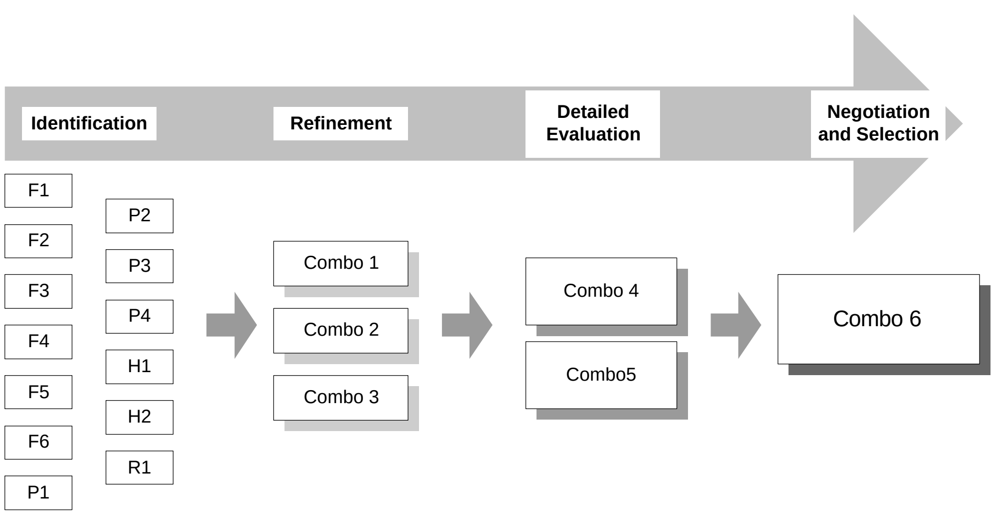
1. To Read Table 4-2: Under operating mode 1, in effect January 1 through February 14 for the incubation season, peaking is allowed and the only constraint is a minimum flow constraint of 55 cms through Ruskin Dam. During the period of fry emergence (February 15 to May 15), operating mode 2 comes into effect. During this period no peaking is allowed (a daily block load is in effect) and the minimum flow of 55 cms is maintained. During the period May 16 to July 31 (operating mode 3), fry are still emerging, but the Fraser River backwaters. As a result, peaking operations have limited effect on fish, so the minimum flow constraint is removed, and peaking is allowed. At this time, the peak recreation season begins and a target elevation is set for Stave Reservoir of 80m. Operating mode 4 starts by August 1 when the Fraser River backwater ends, and involves a return of the 55 cms minimum flow and a continuation of the recreation target. Operating mode 5 is in effect from September 8 to October 14, when rearing continues but the peak recreation season ends. Operating mode 6 starts with the spawning season on October 15. A limited weekly block load is in effect along with a minimum flow of 55 cms. Operating mode 7 is the same as operating mode 1.

4.3 Alternative Screening Process

Figure 4-1 summarizes the alternative development process. Twelve strategies were generated initially ("Identification") and presented to the CC as follow-up to the sub-group meetings. These were refined into three combination strategies, which combined various individual strategies into what became known as "combo" strategies (Refinement). The Committee, after reviewing the impacts of each of the individual and combo strategies, assigned a working group to further refine the combo strategies to better integrate power, heritage and recreation-related alternatives.

The working group reviewed the summary of performance measure results for each strategy (Appendix 4) and used it as a screening tool for eliminating clear losers and recombining alternatives. The result was the creation of Combos 4 and 5. These were distinctly different strategies which, while they had some common elements, represented fundamentally different ways of operating Stave Reservoir. Combos 4 and 5 underwent detailed evaluation. Combo 6 was created through the negotiation process, and essentially added an on-going management plan to the Combo 5 operating strategy.

FIGURE 4-1 ALTERNATIVES DEVELOPED FOR THE STAVE RIVER WATER USE PLAN



The trade-offs related to the short-listed alternatives (Combos 4 and 5) are presented in detail in the next section.

Two highlights of the discussions and refinements made to the preliminary alternatives prior to short-listing Combos 4 and 5 include:

- Kwantlen agreed to an opportunistic drawdown that occurs only when inflows are favorable, on average one year in three
- The relevance of the recreation performance measure was debated when used to evaluate an alternative which involves a significant change from current operation – although the preferred elevations were taken from the Stave Lake Reservoir Integrated Recreation Plan, some participants felt that they were short-sighted and did not adequately reflect the longer term benefits that could accrue from a significantly different operating strategy. This was addressed by augmenting the performance measure with a qualitative description of longer term impacts and uncertainties.

4.4 Short-Listed Alternatives

To refine the twelve preliminary alternatives, sub-group meetings of the Fisheries Technical Committee, Recreation, Wildlife, and Heritage interests were held. This section summarizes the short-listed alternatives – Combo 4 and 5.

The following components are used to create the Combo 4 and Combo 5 operating alternatives.

ESOR. Includes flow constraints downstream of Ruskin Dam, including "weekly block loading" for the fall spawning period. Block loading prevents peaking. Load (and flow) changes are allowed only once per week. These constraints are in place for the protection of spawning and rearing fish habitat.

Spring Block Loading. Daily block loading (allowing load changes only once per day) is in place to protect young salmon (emerging fry salmon), in effect from February 15 to May 15.

Limited Block Loading (LBL). Both spring and fall block loading is modified to allow peaking above a threshold (tentatively 100 cms, but subject to refinement); this modification is called "limited block loading" and increases the value of power produced during the block loading period. It is believed to have minimal effect on adult stranding and may even reduce egg stranding.

Remove 130 cms Maximum Flow Constraint. ESOR contains a constraint requiring that flows not exceed 130 cms during the spawning season. (This has since been removed under the Interim Flow Agreement.)

Minimum Elevation Change at Hayward. The minimum elevation of Hayward Reservoir is dropped by 1.5 m to 39.5 meters during the period October 15 to December 1 and February 15 to May 15. This component allows increased flexibility to produce power at Stave Falls Power Plant during periods constrained by block loading.

Six-week drawdown on Stave Reservoir. A six-week drawdown will be declared in years when inflow predictions appear favorable for a deep and extended drawdown. One month notice will be provided to Kwantlen, industry and other users of the reservoir, and the planned drawdown will not extend beyond March 31, or begin prior to January 1. Drawdown elevation to be determined by inflows and Kwantlen needs, but may be as low as 72 meters. On average, it will occur one out of every three years.

Recreation Season Target of 80-81.5 m. An elevation target of 80-81.5 meters is in effect from May 15 to September 7. The target is a "soft" target, which means it will be violated if necessary to meet downstream flow requirements as established under ESOR for the protection of downstream fish. This is the preferred elevation for recreational activity on the reservoir.

Year-round Reservoir Target of 77-79m. A reservoir elevation target of 77-79 meters is in effect year-round. The target is a "soft" target, which means it will be violated if necessary to meet downstream flow requirements as established under ESOR for the protection of downstream fish.

In practice, the upper bound will be frequently violated. Several target elevations were examined (see Table 4-1). This one had the best potential for eliminating negative effects on downstream fish and minimizing impacts on reservoir recreation.

Table 4-3 summarizes the components included in each short-listed alternative.

TABLE 4-3 COMPONENTS OF COMBOS 4 AND 5

	ESOR	COMBO 4	COMBO 5
ESOR	✓	✓	✓
Spring Block Loading		✓	✓
Limited Block Loading		✓	✓
Minimum Elevation Change at Hayward		✓	✓
Remove 130 cms Maximum Flow Constraint		✓	✓
Six-week Drawdown on Stave Reservoir			✓
Recreation Season Target of 80-81.5m			✓
Year-Round Reservoir Target of 77-79m		✓	

Combo 4 was specifically designed to increase the stability of the reservoir for the primary purpose of enhancing reservoir productivity. It was proposed that this strategy could also improve the viability of the riparian ecosystem in the area above 79 meters, and thus improve the aesthetic and recreational value of the area, ultimately increasing recreational use. Because the upper and lower bounds (of the target water level) are allowed to be violated in order to protect minimum flows required for the protection of downstream spawning and rearing habitat, Combo 4 provides reduced fluctuations (reduced in magnitude and frequency) relative to ESOR, but not a fully stable reservoir.

Combo 5 is a refinement of ESOR operations. The significant differences from Combo 4 are that it sets a soft target of 80-81.5 meters for the reservoir elevation from May 15 to September 7 to accommodate recreational interests, and it commits to a six-week drawdown one year in three (on average) to accommodate heritage interests. Although it does not set a year-round reservoir target in an explicit attempt to stabilize the reservoir, modeling suggests that in combination with the proposed downstream changes, this strategy will also improve the stability of Stave Reservoir, albeit to a lesser extent than Combo 4.

Downstream of Ruskin Dam, both of the short-listed strategies contain the same components. This demonstrates the success of the process in finding joint gains through a creative option identification process. In Stave Reservoir, the short-listed strategies represent fundamentally different approaches to operations. The choice between them is value-based.

Elevation profiles showing water levels in Stave Reservoir throughout the year illustrate the main differences between ESOR, Combo 4 and Combo 5. These are shown in Appendix 5.

5. TRADE-OFF ANALYSIS

5.1 Summary of Impacts Using the Performance Measures

Table 5-1 summarizes performance measures for ESOR, Combo 4 and Combo 5. ESOR is the base case (see Section 3.4). The performance measures shown are for the median year (median out of 27 years of inflow data). Note that higher values indicate better performance.

There are some reductions in spawning habitat relative to ESOR. This is offset by improvements in rearing habitat and egg stranding. On the whole, the Fisheries Technical Committee has indicated that they do not expect downstream fisheries to be negatively affected by either Combo 4 or Combo 5. The preservation of gains in downstream fish populations made over the past few years under ESOR was an important consideration in all FTC discussions.

TABLE 5-1 SUMMARY OF IMPACTS USING THE PERFORMANCE MEASURES

	ESOR	COMBO 4	COMBO 5
Rearing	0.66	0.83	0.81
Spawning	0.73	0.64	0.65
Egg Stranding **	0.54	0.70 (0.43)	0.58 (0.47)
Total Gas Pressure	1.00	1.00	1.00
Reservoir Productivity (ELZ)	0.31	0.74	0.58
Heritage	*	*	*
Industry	0.58	0.68	0.73
Recreation	0.37	0.33	0.42
Wildlife	*	*	*
Financial Cost	0.32	0.30	0.40

Notes to Table 5-1:

* Quantitative Performance Measure not used.

** In addition to median year data, we also tracked the 90th percentile data which tells what could happen in unusual inflow years (one year in ten). To avoid an overload of data, these data are shown only when they differ substantially from median. Here, they are shown in brackets for Egg Stranding. Note that under median conditions, Combo 4 is better than Combo 5 for Egg Stranding. However, in extreme conditions, Combo 5 is better than Combo 4 for Egg Stranding. In both cases (median and 90th percentile for egg stranding), the difference between combos is relatively small.

Combos 4 and 5 perform very similarly on several performance measures. Further discussion centered on the key differences or trade-offs. These are highlighted in Table 5-2. A "✓" indicates the combo that performs better for each performance measure. A "—" indicates the performance of the combos is the same. The ? opposite recreation under Combo 4 indicates that some participants felt that Combo 4 would be good for recreation in the long term if the improvements in reservoir productivity resulted in a better fishery.

TABLE 5-2 SUMMARY OF KEY TRADE-OFFS

	COMBO 4	COMBO 5
Fish - Downstream	—	—
Fish - Reservoir	✓	
Heritage		✓
Industry	—	—
Recreation	?	✓
Wildlife	—	—
Financial Cost		✓

Most of the discussion by the CC centered on the facts and value judgments surrounding these key trade-offs. Specifically:

- How big is the gain in littoral zone productivity under Combo 4 versus Combo 5? How do you value the gains given the uncertainty about how it will affect fish populations?
- How big are the gains in heritage, recreation quality and power value under Combo 5 versus Combo 4? Would recreation quality improve in the long term under Combo 4?
- How important are these losses and gains? On balance, which combo do you prefer? Which one do you think best meets all interests and objectives?
- Are there any opportunities to refine the combos to improve them?

The impacts of Combo 4 and Combo 5 are briefly summarized in Table 5-3. More detailed discussion is provided in Section 5.2.

TABLE 5-3 MULTIPLE ACCOUNT EVALUATION OF COMBO 4 AND COMBO 5

	COMBO 4	COMBO 5
Fish – Downstream - *Spawning* - *Rearing* - *Egg Stranding* - *Total Gas Pressure*	▪ No change from ESOR; no difference between Combos (Reductions in spawning habitat offset by improvements in rearing habitat and egg stranding)	
Fish – Reservoir - *ELZ (1)* - *Reservoir Productivity*	▪ 1440 hectares of ELZ (1) ▪ 33% increase in carbon ▪ Uncertain benefits for fish	▪ 840 hectares of ELZ ▪ 21% increase in carbon ▪ Uncertain benefits for fish
Industry	▪ No issues	▪ No issues
Recreation	▪ Accessible recreational area and number of users may increase, resulting in management issues related to access, noise, garbage and fire given existing resources ▪ Potentially improved fishery due to better littoral productivity ▪ Recreation interface likely changes from forest/water to willow-grass/water	▪ More days at preferred elevations; maintain forest/ water interface in peak season ▪ Potentially better fishery relative to ESOR; not as good as Combo 4 ▪ No boating access in March, one year in three
Wildlife	▪ No issues	▪ No issues
Heritage	▪ Poor access for artifact recovery; poor protection from illegal collection and ATVs ▪ Risk of Kwantlen being further alienated from their territory if the recreational use increases	▪ Good access and protection for sites and artifacts
Financial Cost (Relative to ESOR)	▪ Loss of $180,000	▪ Gain of $510,000

Notes:

1. Effective littoral zone

5.2 Impacts by Objective

Fish - Downstream (Spawning, Rearing, Egg Stranding and TGP)

When the net effect of all of the spawning, rearing, egg stranding and TGP performance measures are assessed, both Combo 4 and Combo 5 are expected to be no worse than ESOR for downstream fish, and probably somewhat better. The losses with respect to spawning habitat are expected to be more than offset by improvements in egg survival (reduced egg stranding)[15]. There are no significant differences between Combo 4 and Combo 5 for downstream fish.

[15] It is hypothesized (see Table 5-5) that limited block loading will discourage nesting at high elevations where eggs would be more likely to be dewatered in subsequent weeks. See BC Hydro's SRWUP Data Report: Habitat Modeling and Performance Measure Calculations (Bruce 1999).

TABLE 5-4 IMPACTS ON DOWNSTREAM FISH

	COMBO 4 AND COMBO 5 (COMPARED TO ESOR)
Rearing	Better than ESOR due to reduction in fry stranding
Spawning	Worse than ESOR due to elimination of 130 cms maximum flow and introduction of limited block loading that allows peaking above 100 cms
Egg Stranding	Expected to be better than ESOR due to limited block loading which interrupts spawning above 100 cms[16]
Total Gas Pressure	No change from ESOR

It was the opinion of the FTC that the limited block load would likely result in at least neutral and potentially positive benefits for fish – that is, that the limited block load would reduce egg stranding with little or no change in the stranding of spawning adults. However, the FTC conceded that it is possible that the opposite would be true. The cost of being wrong would be a net reduction in the number of emerging fry, instead of the expected net gain (Table 5-5).

The FTC elected to adopt an adaptive management approach. Acceptance of this option as a component of any combo strategy was contingent on implementation of a monitoring program designed to evaluate the net effect on fish populations.

TABLE 5-5 POSSIBLE OUTCOMES FROM LIMITED BLOCK LOADING

	ASSUMPTION/HYPOTHESIS	OUTCOME
Limited Block Loading (LBL)	- LBL reduces egg stranding with little or no change in stranding of spawning adults	Net gain in number of emerging fry
	- LBL reduces egg stranding but gains are offset by increased stranding of spawning adults	Net loss in number of emerging fry

Fish - Reservoir (Reservoir Productivity)

The littoral zone is an important biologically productive area along the shore of a lake that can provide food and habitat for a range of aquatic life. The original performance measure (effective littoral zone) is a measure of the number of hectares of littoral zone. However, overall reservoir productivity is a function of many factors, only one of which is littoral area. In order to understand the likely increase in overall reservoir productivity, an expert in reservoir productivity[17] was asked to provide an estimate of the change in carbon production of the whole reservoir that would result from Combo 4 and Combo 5, relative to ESOR. Carbon production is an indicator of overall biological productivity. Table 5-6 summarizes effective littoral zone area, and carbon production under ESOR, Combo 4 and Combo 5.

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[16] All participants agreed that this is an hypothesis that must be tested through a monitoring program (see Table 5-5, Section 6 and Appendix 8).

[17] Dr. John Stockner, Limnologist at Eco-Logics.

TABLE 5-6 IMPACT ON EFFECTIVE LITTORAL ZONE AND OVERALL PRODUCTIVITY IN STAVE RESERVOIR

	ESOR	COMBO 4	COMBO 5
Effective Littoral Zone (hectares)	30	1440	860
Total Carbon Production – Mean Estimate (tonnes of carbon per year)	3210	4108	3886
Total Carbon Production – Range of Uncertainty[18] (tonnes of carbon per year)	1928-3308	2610-4601	2448-4234

In sum, Combo 4 is expected to increase littoral area by 1420 hectares (over ESOR conditions), while Combo 5 increases it by 830 hectares. Combo 4 increases carbon production in Stave Reservoir by about 33% over ESOR, while Combo 5 is expected to increase it by about 21%. The impact on fish biomass or species composition is not known.

Both Combo 4 and Combo 5 have the potential to affect productivity in Hayward Reservoir as a result of increasing the fluctuation in the water level during periods of block loading. Dr. John Stockner was consulted to provide expert opinion about impacts on Hayward's littoral zone. In sum, he advised that:

- most littoral carbon at Hayward is likely produced by periphyton (tiny plantlife);
- periphyton are resilient to brief periods of desiccation (drying-out);
- littoral productivity at Hayward would likely be only minimally affected by the proposed change.

However, it was acknowledged that this was a professional judgement, and that there is some uncertainty about the impact.

Heritage

The major impacts of each Combo are described qualitatively in Table 5-7. In sum, Combo 5 provides improved access to sites and improved protection relative to ESOR operations. Combo 4 increases the risk from illegal collection (pot-hunting) and does not offer any predictable and prolonged access to conduct planned activities. Further, Kwantlen is concerned about concentrated wave attack on sites in the 77-79 m zone, and fears increased alienation from their territory if Combo 4 increases the recreational value of the land surrounding Stave Reservoir.

[18] Stockner provided estimates for upper and lower bounds on key parameters and the formulas describing the functional relationships among variables. The values shown were generated using a Monte Carlo simulation.

TABLE 5-7 HERITAGE IMPACTS

	COMBO 4	COMBO 5
Access to sites for artifact recovery and cultural/spiritual visits	▪ No predictable access	▪ Good access: planned 6-week access one year in three
Protection from illegal collection	▪ Lower reservoir elevations in summer decrease protection from illegal collection, and may increase recreational vehicle traffic which can damage sites	▪ High reservoir elevations in summer months protect sites from illegal collection
Erosion	▪ Concentrated wave attack in the 77-79 m zone may affect heritage sites in that area	▪ No change
Other Kwantlen Considerations	▪ May lead to increased recreational use, which creates risks for increased illegal collection, site damage and alienation of Kwantlen from their traditional territory in the long term	

Recreation

Stave Reservoir

The Stave River Integrated Recreation Plan identified preferred water elevations for improving the quality of recreation. The emphasis was on improving the quality of the recreational experience, rather than on increasing the quantity of recreational use (considerations included quality of forest/waterfront camping and picnicking experience, boating safety, aesthetics, management issues – e.g., noise, firearms, garbage, fire hazard). These elevations were refined through the WUP process and used for the recreation performance measure.

Combo 5 is preferred on the basis of the recreation performance measure. While Combo 5 has more days at preferred elevations (above 80 m), Combo 4 has fewer days on which the reservoir drops below 76m. For recreation, benefits are very high above 80 m, lower from 78-80 m and very low at 76-78m. Below 76, the reservoir is unusable for boating.

It was proposed that a more stable reservoir, at any elevation, would provide a better recreational experience in the long term, partly as a result of improved reservoir productivity (Table 5-3) and partly as a result of the recovery of the riparian zone and improved aesthetics. With a target elevation of 77-79m year round, Combo 4 is more stable than Combo 5. However, it frequently violates its target elevations. An expert in riparian vegetation[19] was asked to provide opinion on what changes in vegetation might be expected under ESOR, Combo 4 and Combo 5 conditions. The impact of each combo on reservoir elevation and riparian vegetation is summarized In Table 5-8.

[19] Will Carr, of CARR Ecological Consultants.

TABLE 5-8 IMPACTS ON STAVE RESERVOIR RECREATION

	ESOR	COMBO 4	COMBO 5
No. of days at 80-81.5m	45	23	53
No. of days at 78-80 m	33	51	43
No. of days at 76-78m	25	79	26
Total Days above 76m	125	153	122
Type and Location of Vegetation	▪ Willows extend to 79m; sedge-woolgrass to 78m ▪ Tree/shrub community exists above 82 m	▪ Through active planting, could achieve expansion of willow community to slightly below 79m and expansion of sedge-woolgrass to slightly below 78m ▪ No migration of the tree/shrub community into the 79 to 82 m zone	▪ No significant change from ESOR; if anything, slightly worse due to earlier inundation of riparian vegetation in May
Fish		▪ Potential recreation benefits if results in improved fishery	▪ Potential recreation benefits if results in improved fishery
Boat Access			▪ No access in March in drawdown years
Management Issues		▪ More difficult to manage noise, fire, garbage, vehicles, etc. due to larger foreshore	

Hayward Reservoir and Downstream of Ruskin Dam

There are several components that are included in both Combo 4 and Combo 5 that have implications for recreation on Hayward Reservoir and Downstream of Ruskin Dam. These are summarized in Tables 5-9 and 5-10.

TABLE 5-9 EFFECT ON RECREATION OF "P2: MINIMUM ELEVATION CHANGE AT HAYWARD"

ISSUE	IMPACT
Safety	Boaters have less clearance above standing debris. This is mitigated by the fact that low levels occur only during low use periods.
Aesthetics	Reservoir shoreline and shoreline stabilization works on the new island will be exposed during drawdown. This is mitigated by the fact that low levels occur only during low use periods.
Water Quality	There is no anticipated impact on water quality at the intake. Intake is located well below the minimum proposed elevation. Monitoring would be conducted to verify water quality during and after implementation.

TABLE 5-10 EFFECT ON RECREATION OF "P1: LIMITED BLOCK LOADING"

ISSUE	IMPACT
Safety / Convenience of Fishers	Peaking (above 100 cubic meters per second) would occur during peak fishing season. However, the strategy does not increase the maximum rate of change of water releases from current rates. Also, peaking occurs only above 100 cms; changes in water level or velocity at this elevation are slower and hence less dangerous than changes at lower elevations due to the physical contours of the channel.

Industry

Industry's primary concerns are met through improved notification of spill events and low reservoir levels. For Combo 5, an extended drawdown roughly one year in three was deemed to be acceptable, provided that the drawdown does not occur before January 1st or extend beyond March 31st, and provided that one month's notification is provided.

The performance measure and actual number of days above preferred levels are shown in Table 5-11.

TABLE 5-11 IMPACTS ON INDUSTRY

		ESOR	COMBO 4	COMBO 5
No. of days > 76m: Dec 1 and June 1	Median	128	182	157
	One year in ten	181	182	182
No. of days > 79m: June 1 to Dec 1	Median	78	69	109
	One year in ten	72	40	84

Combo 5 clearly provides more days of access during the period June 1 to December 1. Combo 4 provides more access from December 1 to June 1. However most of the additional access under Combo 4 is during the period January through March, a period with little or no industrial activity anyway[20].

Wildlife

No quantitative performance measures were established for wildlife. Instead, it was agreed that short-listed strategies would be examined for any indication of likely negative impacts on wildlife. These are summarized in Table 5-12.

TABLE 5-12 WILDLIFE IMPACTS

	COMBO 4	COMBO 5
Stave Reservoir Impacts	Better than ESOR. Magnitude of water level fluctuation is smaller (so less disruptive), but it occurs later in the summer nesting season which may be slightly more disruptive.	Better than ESOR. Elevations rise and stabilize earlier, which is likely better for the summer nesting season.
Downstream Impacts	No clear change from ESOR.	No clear change from ESOR.

[20] This information was provided late in the consultation. If it had been provided earlier, the industry performance measure could have been adjusted to account for this.

Financial Cost - Power Values

Table 5-13 summarizes the impact of each Combo on the average annual value of power produced at Stave, Ruskin and Alouette power plants. Figures in brackets indicate losses relative to ESOR; unbracketed figures are gains. There is a significant amount of inter-annual variability in expected in the value of power produced as a result of inflow variability (driven by weather). However, on average, Combo 5 is expected to produce an incremental $510,000[21] annually (over the value produced under an ESOR operation), while Combo 4 is expected to produce about $180,000 less than ESOR. The difference between the two alternatives is $690,000. Note that each combo is a package of individual components, each of which may incur losses or gains.

The range of values noted above is the result of inflow variability. However, power values can also be affected by uncertainty in price forecasts. The main factors affecting the price of electricity are the general availability of hydroelectricity in the market (a function of regional weather/inflows), natural gas prices and market demand (also a function of weather and the availability of different resources). Uncertainty in assumptions about inflows would have the effect of widening the range of inter-annual variability noted above, but would not necessarily affect the average annual value of power production, unless there is a long term change in regional weather patterns. Start-up or decommissioning of other powerplants could also temporarily affect hydro availability and prices, but unless a long-term trend occurred, would not significantly affect the average value of power produced under any alternative.

Higher/lower natural gas prices would increase/decrease the value of power produced under all alternatives. The difference between alternatives would change to a lesser extent.

The difference between operating alternatives is likely to be most affected by the spread between peak prices (heavy load hours) and non-peak prices (low load hours). The greater the difference between peak and non-peak prices, the greater the value of maintaining the flexibility to produce power at peak times (i.e., the greater the cost of increased constraints) and the greater the difference will be between Combo 4 and Combo 5. Conversely, the narrower the spread, the smaller the difference between the two alternatives. Unfortunately, price scenarios to put upper and lower bounds on hydro availability, natural gas prices or the spread between peak and non-peak prices were not available for this analysis[22].

TABLE 5-13 IMPACT ON POWER VALUE

	COMBO 4	COMBO 5
Average Annual (Loss) or Gain in Power Value Relative to ESOR	($180,000)	$510,000 (1)
Inter-annual Variability (due to inflow variability)	(1,400,000) - $1,680,000	($430,000) - $2,330,000

Notes:

1. See Footnote 21.

[21] $510,000 is an upper estimate. The actual value will be between $440,000 and $510,000. Lack of precision is due to difficulties in modeling the “opportunistic” one-in-three-year heritage drawdown. The $510,000 figure was used throughout the consultation, with the understanding that it was a slight overstatement of actual benefits. The lower bound of $440,000 was developed by BC Hydro after the consensus agreement of the Consultative Committee. Modeling shows that if the drawdown occurred every year, the overall value of the strategy would drop from $510,000 to $294,000. If it occurred regularly every three years without regard for inflows, the value of the strategy is estimated at about $440,000. In practice, the actual value will certainly be greater than $440,000 (since it will be done in favourable years), but likely less than $510,000.

[22] They are currently under development.

5.3 Preliminary Areas of Consensus and Disagreement

After a review of the performance of Combo 4 and Combo 5, a majority of those present at the CC meeting of May 21 1999 favored Combo 5, while a minority favored Combo 4.

For those favoring Combo 5, reasons stated included:

- Combo 5 achieves best balance among all objectives.
- Combo 5 has gains on all objectives relative to current (ESOR) while Combo 4 involves some difficult trade-offs for heritage, power value and recreation.
- The main driver of Combo 4 is improved reservoir productivity, but there is uncertainty about the magnitude of the benefits, and some question about whether the difference between Combo 4 and Combo 5 is statistically significant.
- Combo 4 may have irreversible effects (e.g., erosion damage to heritage sites), while Combo 5 does not. Therefore it is possible to move from Combo 5 to Combo 4 in the future if warranted, but not the reverse.
- Combo 4 seems high cost for relatively small gains – would it be possible to realize more benefits elsewhere (another watershed) for the cost of Combo 4?

Acceptance of Combo 5 was contingent on implementation of a monitoring program to ensure that no negative impacts from the relaxation of constraints occurred. Specifically, all participants agreed that the impact of the introduction of limited block loading and the elevation change at Hayward Reservoir must be monitored.

For those favoring Combo 4, reasons stated included:

- importance of re-establishing a natural ecosystem (for fish, recreation, and a healthy riparian zone);
- Stave is unique, close to a large urban population, and represents a small portion of BC Hydro’s assets and generation, therefore the opportunity to enhance recreational values should be given high priority;
- excess revenues from modifications downstream (limited block loading, etc.) should stay in the watershed;
- it could be possible to incorporate a heritage drawdown (as in Combo 5) without major loss of productivity, thus partially meeting heritage objectives;
- we don’t know what the response of the system will be to increased stabilization; this is an opportunity for learning.

When asked, “What would it take to move from Combo 4 to Combo 5?” All proponents of Combo 4 could agree to Combo 5 if Combo 5 included an adequate monitoring program to increase understanding of the impacts of operations on reservoir productivity. Upon further discussion it was noted that the preference for Combo 5 does not depend on the estimate of reservoir productivity benefits alone. Even if it were known that reservoir productivity increases were significant, there remain difficult trade-offs associated with a Combo 4-type operation. These include:

- significant loss of power value;
- recreational impacts – reduced time at preferred elevations;
- recreation management issues – resolution of issues that would arise under Combo 4 probably requires inter-agency planning and coordination, and possibly an increase in resources;

- access and aesthetic impact on lakefront property owners;
- risks to heritage sites from illegal collection and ATV traffic;
- risks to heritage sites from concentrated wave attack in the 77-79 m zone; and
- long term risk for Kwantlen First Nation that increased recreational use of the area could increase their alienation from their territory.

As a result of the above discussions, the Combo 5 operating strategy was accepted in principle, and Combo 6 was proposed, including:

- Implement the operating strategy outlined in Combo 5;
- Develop a monitoring program to assess changes in reservoir productivity and generate understanding of reservoir productivity processes and the effect of operations on productivity;
- Conduct a program of study to better understand how operations affect First Nations interests;
- Evaluate the need (timing) to revisit the WUP based on the findings of the monitoring programs.

The CC delegated the development of a monitoring plan to the Fisheries Technical Committee, specifying that the specific objective of the reservoir monitoring program should be: "To evaluate the benefits of Combo 5 over ESOR for reservoir productivity, and to provide information that will enable a better evaluation of the benefits of other operating strategies in the future". Participants specifically wanted information on how improvements would affect fish populations, not just carbon productivity. The Committee delegated the development of a Heritage Monitoring Plan to Kwantlen First Nation and BC Hydro.

Reservations were also noted by one participant about the potential for negative impacts on productivity in Hayward Reservoir. As a result, the monitoring program was designed to include assessment of impacts on littoral productivity in Hayward as well as Stave Reservoir.

6. MANAGEMENT PLAN

6.1 Summary

After consultation with the Fisheries Technical Committee (and consultant John Stockner) and Kwantlen First Nation, a proposal for a management plan was prepared. The management plan includes monitoring, mitigation and on-going management activities related to fisheries, water quality and First Nations interests. It includes the components and estimated costs listed in Table 6-1. Entries in Table 6-1 are the cost in thousands of dollars of each component for each year of a ten-year plan.

TABLE 6-1 STAVE WUP MANAGEMENT PLAN AND ESTIMATED COSTS (IN THOUSANDS OF DOLLARS)

	YEARS FROM START OF IMPLEMENTATION										
Component	0	1	2	3	4	5	6	7	8	9	10
Fisheries Management (1)	28	369	247	225	205	205	205	205	205	205	205
Heritage Management (2)	0	120	120	120	120	120	120	120	120	120	120
Water Quality Management (3)	0	5	5	5	5	5	5	5	5	5	5
Annual Reporting (4)	0	25	25	25	25	25	25	25	25	25	25
Total	28	519	397	375	355	355	355	355	355	355	355

Notes to Table 6-1:

(1) The Fisheries Management Plan includes:
- Reservoir Productivity Monitor (Phase 1 and 2)
- Limited Block Loading Monitor, and
- On-going management activities.

The estimates assume work done by consultants, not BC Hydro staff. For annual breakdown by component, see Table 6-2.

(2) Includes a heritage monitoring plan, inventory/monitoring/assessment, drawdown work, and mitigation. The final amount is still under negotiation between BC Hydro and Kwantlen First Nation. However, the CC recommends its inclusion provided it is somewhere between $100,000 and 120,000 on average.

(3) Includes turbidity monitoring.

(4) Includes preparation, production and distribution of an annual report on management committee activities and a monitoring plan “custodian” to ensure continuity of the plan.

The management plan provides:

- confirmation of the benefits and risks associated with the new operating strategy;
- ability (including information and funding) to mitigate any negative impacts;
- improved information on which to base future operating decisions (e.g., an understanding of how operations affect fisheries and heritage sites);
- flexibility and funding to address on-going management priorities;

- scientifically defensible information about reservoir productivity processes and the impact of reservoir operations on productivity that will be relevant to other coastal and, to a lesser extent, interior systems.

The monitors included in the plan are designed to address the questions in Table 6-2.

In addition to monitoring, the management plan includes funding for on-going management activities. This acknowledges that any operating strategy will continue to affect fisheries and heritage sites in some ways. Since it is not possible to predict and prioritize every need in advance, the solution proposed is to establish a small working group to manage priorities within a fixed budget, without having to reconvene a larger consultative committee.

The management plan as described in this section formed an integral part of the consensus agreement of the CC. Details of the Committee's discussions on the value of the monitoring plans are included in Appendix 6, which is the full minutes of their final meeting on June 24th 1999.

TABLE 6-2 MONITORING COMPONENTS AND RELATED RESEARCH QUESTIONS

COMPONENT	PURPOSE / RESEARCH QUESTIONS
Stave/Hayward Reservoir Monitor – Phase I and 2 (1)	▪ What are the productivity improvements in Stave resulting from Combo 6? ▪ What further improvements could occur through other operating changes? ▪ How does Combo 6 affect littoral productivity in Hayward?

Limited Block Loading Monitor (2)	▪ Do the benefits of limited block loading outweigh the risks?:
	    ▪ Does partial peaking succeed in deterring spawning at high elevations?
	    ▪ How much adult stranding occurs?
	    ▪ How much fry stranding occurs?
	    ▪ Is high velocity a deterrent to mid-channel spawning?
	    ▪ Could partial peaking be optimized given daily patterns of fry outmigration?

Kwantlen First Nation Heritage Monitor	▪ How are Kwantlen First Nation heritage sites affected by erosion? ▪ How would sites be affected by other operational strategies? ▪ How can they be protected or salvaged? ▪ Are there other Kwantlen sites in the area, including lands adjacent to the reservoir? How would these be affected by other operational strategies?
Hayward Water Quality Monitor	▪ Does the change in Hayward minimum water level increase the frequency or magnitude of turbidity events?

Notes to Table 6-2:
(1) For more details see Appendix 7: Summary of Stave/Hayward Reservoir Monitor.
(2) For more details see Appendix 8: Summary of Limited Block Load Monitor

6.2 Fisheries Management Plan

Summary of the Reservoir Monitor and Limited Block Load Monitor are included in Appendices 7 and 8. The full report of the consultant is also available (Stockner, 1999).

TABLE 6-3 ANNUAL COSTS, YEARS 0 THROUGH 10, IN THOUSANDS OF DOLLARS

	YEARS										
	0	1	2	3	4	5	6	7	8	9	10
Component											
Reservoir Monitor – Phase 1	10	145	145	145	0	0	0	0	0	0	0
Reservoir Monitor – Phase 2	0	0	0	0	100	100	100	100	100	100	100
Limited Block Load Monitor	18	174	52	5	5	5	5	5	5	5	5
Management Activities	0	50	50	75	100	100	100	100	100	100	100
Total	$28	$369	$247	$225	$205	$205	$205	$205	$205	$205	$205

The Phase I Reservoir Monitor is an intensive monitoring program designed to improved understanding of reservoir productivity processes. Once this understanding is in place, the Phase 2 Monitor begins, which is a more routine monitor. Details of the Phase 2 design will be finalized after Phase 1 results are analyzed.

The Limited Block Load Monitor is a fairly resource intensive monitor for the first two years after implementation, as it is necessary to ensure that the introduction of partial peaking does not result in negative impacts on downstream fish productivity.

Funding for management/mitigation activities rises over the first three years to level out for years four through ten. This recognizes that management/mitigation activity will be guided by monitoring results which will not be available immediately.

6.3 Heritage Management Plan

The heritage management plan was initially developed by Kwantlen, and refined through subsequent negotiations between BC Hydro and Kwantlen[23]. Kwantlen proposed a five year plan, after which the plan will be reviewed and new funding agreements made for the next five years of the plan.

The heritage management plan includes the upfront development of a planning document that will guide all activities, including regular annual work and drawdown-related work. Funding is included for drawdown work (which may include any combination of monitoring, assessment, mitigation/salvage and inventory work) twice in five years. In practice, since drawdowns are opportunistic, it is not known in advance in which years the funds will be required. All activities and estimated costs are shown in Table 6-4.

[23] At Kwantlen's request, the development of the heritage management plan was not subject to negotiations among participants at the main Consultative Committee. It was developed by Kwantlen in discussion with BC Hydro. However, once developed, the plan was presented to the Consultative Committee and was accepted as part of the consensus agreement.

TABLE 6-4 HERITAGE MANAGEMENT PLAN COSTS

ACTIVITY	ESTIMATED COST
Heritage Management Plan Development	$50,000 total (up-front)
Drawdown Work	$50,000, twice within a five year time frame
On-going Monitoring, Assessment, Inventories	$50,000 per year
Mitigation (capping, excavation, etc.)	$100,000 total
Total	$100-120,000 annual on average

Kwantlen and BC Hydro had not completed their negotiations on the heritage management plan before the final meeting of the CC. However, they were within $20,000 (per year). The CC therefore agreed to a heritage management plan at a cost of anything between $100,000 and $120,000 per year on average. The CC also noted the need for flexibility in providing this funding as a result of the uncertainty in drawdown timing, Kwantlen capacity and the need/priority of mitigation work.

6.4 Water Quality Monitoring Plan

For the altered operating regime in Hayward Reservoir, it is possible that there may be some erosion due to the increased water fluctuations. Routine monitoring is proposed at Stave and Ruskin forebays and tailraces, and from the Hayward Recreation Area. These surface samples would be taken on foot from the shore. In addition, a boat survey of the shoreline will be undertaken at least once per year to inspect for obvious signs of erosion. The total cost of this program is expected to be less than $5000 per year. It is considered a priority given the concerns of those local residents who draw drinking water from Hayward Reservoir.

Should any negative impacts be noted, the Management Committee (see section 6.5) will have responsibility for seeking mitigative options or re-evaluating the change in Hayward's minimum operating level.

6.5 Management Committee

The CC recommends that a Management Committee for Stave be formed that is separate from the Alouette Management Committee. This is based on the belief that the introduction of Stave issues to Alouette may disrupt the Alouette Management Committee which has been operating successfully to date, and that both Committees should be allowed to concentrate on their specific priorities.

The CC recommends that the Stave Management Committee should have a mandate to:

- conduct on-going management decisions with consideration of all objectives
- liaise with Kwantlen First Nation on heritage management issues
- liaise with the Alouette Management Committee on an as-need basis
- prepare annual public reports
- conduct an interim review after five years which will incorporate the feedback of local management/stakeholder groups

Specific tasks are shown in Table 6-5.

The CC recommends that the Management Committee membership should include DFO, MELP, BC Hydro, Kwantlen First Nation and the District of Mission. Technical experts and a monitoring program "custodian" should participate as necessary to provide input. Members of the public may attend and observe meetings, but should not be part of the decision making function of the committee.

A custodian is needed to ensure continuity in the monitoring program. Without this function, there is a risk that experimental/sampling methods and locations will be inconsistent and the ability to draw meaningful conclusions compromised. It was agreed that the function would best be served by BC Hydro.

Kwantlen indicated that their participation on the Stave Management Committee is contingent on capacity funding.

The CC recommends that consolidation of the Stave and Alouette Management Committees be considered at some point in the future.

TABLE 6-5 SPECIFIC TASKS OF THE MANAGEMENT COMMITTEE

TASK DESCRIPTION	

On-Going Tasks	▪ design, refine and implement monitoring programs and review results; some examples include:
	  ▪ design Phase 2 of Reservoir Monitor based on results of Phase 1- this should include specific hypotheses to be tested
	  ▪ refine the Reservoir Monitor to better address nutrient inflows from Alouette if necessary (once Alouette fertilization program has stabilized)
	  ▪ decide on need for ongoing monitoring of Hayward water quality
	▪ identify and prioritize mitigation needs and implement related activities within the established budget (see Table 6-3 Management Activities);
	▪ liaise with the Alouette Management Committee to make decisions when and if trade-offs in water allocation are required between Alouette Lake water levels and the Stave system;
	▪ liaise with Kwantlen First Nation on issues related to heritage management;
	▪ prepare an annual public report;

5-Year Review	▪ Conduct a formal review of monitoring results to date and adjust monitoring plans as required to ensure adequate information is available for ten-year review ▪ Adjust on-going management/mitigation plans and budget in response to monitoring information (too much? not enough?) ▪ Confirm the appropriateness of the proposed timing of the next full WUP review

In addition to the main Management Committee, the CC also recommends that a Heritage Management Committee be formed, but did not make specific recommendations on membership or tasks. These are to be determined by Kwantlen in cooperation with BC Hydro, and may consist of Kwantlen and BC Hydro only, or may have other representation as well (e.g., provincial Archeology Branch).

6.6 WUP Review Period and Implementation Timing

The CC recommends that the WUP be fully reviewed in ten years. However, it further recommends that the Stave Management Committee have a mandate to conduct a formal interim review of the plan after five years primarily to assess monitoring results to date and reassess management/mitigation funding needs (more/less required?). Based on this assessment, it should confirm the appropriateness of the proposed timing of the full review. Any recommendations (if any) should be made to the Comptroller of Water Rights (or his/her designate).

The review periods, both interim and full, are linked to the timing of expected results from the reservoir and heritage monitoring programs:

- it is expected that after ten years, it will be possible to draw some meaningful conclusions about the effect of operations on reservoir productivity;
- it is expected that Kwantlen will require at least ten years to gain new knowledge about heritage sites and impacts of operations, since drawdowns will occur only once in three years on average.

An interim review by the Management Committee after five years is critical to ensure that no major changes have occurred (either observed impacts or new science that identifies new risks) that need to be formally addressed or that would trigger a need for a more comprehensive multi-party review.

The CC recommends that the WUP be implemented immediately upon start-up of the new Stave Falls powerplant (expected October 1999).

7. SUMMARY

The Stave River Water Use Plan Consultative Committee succeeded achieving a consensus on an operating plan and related recommendations to BC Hydro and the Comptroller of Water Rights. The consultation process allowed the development of creative alternatives and the detailed evaluation of two distinctly different operating alternatives. It allowed each participant to apply his/her own values when making trade-offs among objectives. Through interest-based discussions and negotiation, a consensus agreement was reached which all participants support.

The process was complicated by uncertainty about a number of impacts. As a result, the consensus agreement is contingent on the implementation of an adaptive management plan that will address key uncertainties and ensure that improved information is available for the next review of the Stave River WUP.

7.1 Summary of Recommendations

In total, the package of recommendations of the CC to BC Hydro includes recommendations on an operating strategy, an on-going management plan, a management structure and the timing of implementation and review.

The recommended operating strategy consists of the following elements:

- maintain all of the constraints that had previously been implemented as part of the Electric System Operating Review (ESOR) in 1995, with the exception of the 130 cubic meter per second maximum Ruskin discharge constraint during the fall spawning period. This includes:
  - weekly block loading at Ruskin powerplant during the fall spawning period;
  - minimum water levels (tailwater elevations) year round;
- Implement daily block loading during the period of fry emergence (officially February 15 to May 15, but subject to annual adjustment if mutually agreed with DFO);
- Modify the block loading procedure to allow partial peaking (above 100 cubic meters per second) during both spring and fall block loading;
- Lower the normal minimum elevation on Hayward Reservoir during the spring and fall block loading periods;
- Provide a six-week deep drawdown on Stave Reservoir for heritage interests one year in three, on average, with timing and depth of drawdown dependent on opportunities provided by inflow conditions and the needs of Kwantlen First Nation;
- Set a soft target 80-81.5 meters for Stave Reservoir elevation during the peak recreation season (with priority given to maintenance of downstream flows).

The recommended management plan consists of four components.

- A fisheries management plan including:
  - a reservoir productivity monitor (phase 1 and 2);
  - a limited block loading monitor; and
  - on-going management activities, including mitigation or other response to information on impacts gained from the monitoring programs.
- A heritage management plan, including:
  - a heritage monitoring plan;
  - on-going inventory, monitoring and assessment of sites throughout the watershed;

  - drawdown work, including inventory, monitoring and assessment as well as mitigation and artifact recovery on sites located at lower elevations of Stave Reservoir; and
  - mitigation.
- A drinking water quality monitoring plan, which includes turbidity monitoring in Hayward Reservoir
- Reporting and administration, which includes:
  - preparation, production and distribution of an annual report on management committee activities
  - a monitoring plan "custodian" to ensure continuity of the plan.

The management plan costs vary from year to year, but result in a levelized annual value of about $390,000. (Note that the WUP as a whole has a net <u>gain</u> of $120,000 per year, which is the difference between annual gains in power value of $510,000 and the management plan costs – see Financial performance in Table 7-2 below.)

The Consultative Committee recommends that a Stave Management Committee be formed, with membership to include the Department of Fisheries and Oceans, Ministry of Environment, Lands and Parks, BC Hydro, Kwantlen First Nation and the District of Mission. Tasks of the Management Committee include:

- design, refine and implement monitoring programs and review results;
- identify and prioritize mitigation needs and implement related activities within the established budget;
- liaise with the Alouette Management Committee to make decisions when and if trade-offs in water allocation are required between Alouette Lake water levels and the Stave system;
- liaise with Kwantlen First Nation on issues related to heritage management;
- prepare an annual public report;
- conduct an interim review after five years.

The Consultative Committee also made recommendations related to the timing of implementation and review:

- Conduct a full review of the Stave River Water Use Plan (involving a comprehensive multi-party consultation process) after ten years. This recommendation is linked to the expected timing of results from monitoring programs addressing key uncertainties.
- Conduct a formal interim review (by the Management Committee) after five years based on monitoring results to date. The purpose is to identify any unexpected results, adjust mitigation plans and budgets accordingly, adjust monitoring plans as necessary to ensure adequate information will be available at the ten year review, and reconfirm the appropriateness of the timing of the ten-year review.
- Implement the recommended operating strategy immediately upon start-up of the Stave Falls Replacement Project.

The impacts from the recommended package are summarized in Table 7-1 and 7-2. All impacts are summarized relative to the baseline ESOR condition.

TABLE 7-1 SUMMARY OF IMPACTS

OBJECTIVE	IMPACT OF COMBO 6
Fish – Downstream - *Spawning* - *Rearing* - *Egg Stranding* - *Total Gas Pressure*	▪ Slight improvement in overall productive capacity expected (Reductions in spawning habitat offset by improvements in rearing habitat and egg stranding risks)
Fish – Reservoir - *Reservoir Productivity*	▪ 21% increase in overall reservoir carbon production ▪ 830 hectare increase in effective littoral zone
Industry	▪ Better access to loading/offloading equipment and woody debris on Stave Reservoir ▪ Reduced risk of incurring damage to downstream equipment due to spills
Recreation	▪ More days at preferred elevations during the recreation season ▪ Potential for an improved fishery ▪ No boating access in March, one year in three
Wildlife	▪ Slight improvement due to increased stabilization of Stave Reservoir
Heritage	▪ Improved access and protection for First Nations heritage sites and artifacts
Financial Cost (Relative to ESOR)	▪ Net gain of about $120,000 per year (levelized annual value, calculated as the difference between gains in power values of $510,000 and on-going management costs of $390,000)
Learning	▪ Substantial knowledge will be gained about reservoir productivity processes and the impact of operations on littoral habitat and fish productivity ▪ Substantial knowledge will be gained about the impact of operations on First Nations interests
Flexibility	▪ On-going management structure and funding allows effective response to new information or priorities

TABLE 7-2 SUMMARY OF FINANCIAL IMPACTS OF STAVE RIVER WUP (IN MILLIONS OF DOLLARS)

	TOTAL OVER TEN YEARS	LEVELIZED ANNUAL VALUE (1)(3)	NET PRESENT VALUE(1)
Power Benefits	$5.1	$0.51	$3.4
Management Costs (2)	$3.8	$0.39	$2.6
Net Benefits (3)	$1.3	$0.12	$0.8

Notes:
1. At 8% discount rate.
2. Assumes continuation of Year 1-5 heritage management plan costs through Years 6-10.
3. The annual levelized value of power benefits will be between $440 and $510. The lack of precision is due to difficulties in modeling the “opportunistic” one-in-three-year heritage drawdown. See Footnote 21. All values reported in the “net benefits” line are similarly overestimated.

7.2 Summary of Support for the Package

Of 19 members of the CC[24], roughly 80% reported that they "endorse" the package, while 20% "accept" it (see Figure 7-1 for definition of terms). Of those recording "accept", the reasons that prevented them from "endorsing" the package included:

- several participants highly valued the potential for greater ecosystem, fish and aesthetic improvements that they believe could result from greater stabilization of Stave Reservoir;
- one participant had reservations about the high cost of monitoring programs in Years 1 and 2, and would only be able to "Endorse" the package if those were smoothed out (not necessarily to provide a lower overall investment, but to provide a more consistent level of investment from year to year).

Of those reporting "endorse", minor reservations were expressed by three participants about the cost of the management plan, and the following recommendations made:

- limit the tasks to only those really necessary;
- manage the monitoring work closely to ensure it delivers the intended benefits.

Figure 7-1 Definition of Consensus Used in SRWUP

The following definitions were provided to the CC, and were used to gauge support for the short-listed strategies.

Endorse: You endorse the proposed alternative, either fully or with minor reservations.

Accept: You accept the proposed alternative. You may disagree that the alternative represents the best possible solution, but your minimum needs are met. You may want your views formally recorded, but you accept and support the decision of the group.

Block: You can not support the proposed alternative. Your minimum needs are not met.

"Endorse" and "Accept" both constitute consensus. The more people who are under the "accept" category, the weaker the consensus, but it remains a consensus decision. If anyone in the group finds it necessary to "block", then consensus is not achieved. Where consensus is not achieved, areas of disagreement will be noted, and we will document what it would take to meet minimum needs.

7.3 Considerations for Future WUPs

For WUPs at Other Facilities

At the beginning of the Stave River WUP process and several times throughout, some participants requested information relating to the historical productivity of Stave Reservoir (e.g., through coring samples). At the end of the process, this interest was reiterated. While participants acknowledged that the WUP process is focussed on incremental change to reallocate water among all uses and does not address issues related to the original inundation, it was still felt by some that this information would provide an important benchmark for making informed trade-offs[25].

For the Next Stave River WUP

There is a belief by some members of the CC that while this operating strategy represents a significant improvement over current conditions, there is an opportunity to do even better in the future. Trade-offs were complicated by uncertainty, including:

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[24] Although there were two representatives from each of MELP, BC Hydro and Kwantlen First Nation, the figures reported here count each only once. This also counts only those members who actively participated in meetings, not those who received minutes only (see Appendix 1).

[25] For Stave, agreement was reached between BC Hydro and MELP to jointly fund this activity (outside of WUP).

- uncertainty about reservoir productivity processes and the effect of operations on reservoir productivity;
- uncertainty about the extent to which fisheries would be enhanced by improved productivity;
- uncertainty about the effect on recreation in the long term, especially considering the preference of many recreationalists for a more “natural” environment;
- uncertainty about the effect on First Nations interests, including heritage interests, economic development, and the degree of security or alienation they experience with respect to their territory.

It is recommended that the monitoring program be carefully managed to ensure that there is more information with which to evaluate these interests in the future.

GLOSSARY

Stave River Water Use Plan Acronyms

CC: Consultative Committee - a committee consisting of representatives of all interested parties in the SRWUP

DFO: Department of Fisheries and Oceans

ESOR: Electric System Operations Review - A change in operating constraints at the Ruskin, Stave Falls and Alouette facilities implemented in 1995 in consultation with the fisheries agencies and the Office of the Comptroller of Water Rights. Used as the base case for comparing impacts of alternative operating strategies on SRWUP.

FTC: Fisheries Technical Committee – a subcommittee of the SRWUP Consultative Committee

MELP: BC Ministry of Environment, Lands and Parks

SRWUP: Stave River Water Use Plan

WUP: Water Use Plan

BC Hydro Operational Terms:

Operating strategy: a collection of operating constraints applied to the BC Hydro plants in the Stave River system

Peaking: a hydroelectric plant operating practice which involves adjusting turbine outputs to match daily variations in the demand for electricity

Daily Block Loading: a constraint applied to a hydroelectric plant which permits plant load (and therefore discharge) to be changed only once per day

Weekly Block Loading: a constraint applied to a hydroelectric plant which permits plant load (and therefore discharge) to be changed only once per week

LBL: Limited Block Loading - a modification to daily or weekly block loading constraints which permits the plant to peak at times when the block load flow would be greater than a threshold value provided that the threshold value is maintained as a minimum flow during the peaking operations

Dispatchability multiplier: a factor applied to HLH energy values to reflect the additional value to BC Hydro of energy which can be generated when and if required to coincide with the highest load hour(s) and greatest energy values

HLH: High Load Hours - the hours during which energy demand is the greatest (16 hours per day for 6 days each week)

LLH: Low Load Hours - the hours during which energy demand is relatively low (all non-HLH hours)