Consultative Committee Report

Capilano – Seymour Joint Water Use Plan

A Project of Metro Vancouver

Prepared on Behalf of:

The Consultative Committee for the Capilano – Seymour Joint Water Use Plan

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Acronyms

CC	Consultative Committee of the JWUP
cfs	Cubic feet per second
cms	Cubic metres per second
FTWG	Fish Technical Working Group of the JWUP
GHG	Greenhouse gas
GVWD	Greater Vancouver Water District
HB	Howell-Bunger (valves)
HSC	Habitat suitability criteria
JWUP	Capilano – Seymour Joint Water Use Plan
MAD	Mean annual discharge
ML/d	Million litres per day
MOE	BC Ministry of Environment
NHC	Northwest Hydraulic Consultants
PM	Performance measure
RTWG	Recreation Technical Working Group of the JWUP
RWSC	Reliable water supply capacity
WUP	Water Use Plan
WUW	Weighted useable width

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Executive Summary

Introduction

On July 19th, 2012 the Consultative Committee of the Joint Capilano – Seymour Water Use Plan (JWUP) reached consensus[1] and unanimously endorsed a package of water management recommendations for Metro Vancouver's existing water control structures and proposed hydropower facilities that are being contemplated for Cleveland Dam and Seymour Falls Dam. The endorsed JWUP Package includes operational recommendations for the timing and volume of water to be released from the dams, what studies and monitoring should be carried out during the implementation of the plan, design considerations for developing hydropower, when the components of the plan would be implemented, and a series of non-flow options that were agreed to.

The JWUP Consultative Committee process was initiated in January 2011 and completed in July 2012. The process followed the steps outlined in the Province's Water Use Plan Guidelines. The purpose of this Summary Report is to document the consultative process and present the recommendations of the JWUP Consultative Committee (CC). The interests and values expressed in this report will be used by Metro Vancouver to prepare the Capilano Seymour Draft Joint Water Use Plan. Both this CC Summary Report and Metro Vancouver's Draft JWUP will be submitted to the Comptroller of Water Rights for review and approval.

Water Use Plans

Water use planning was first introduced in the province of BC in 1996 as a way to help clarify how rights to provincial water resources should be exercised and to ensure provincial water management decisions reflect current public values related to social, environmental, and financial priorities.

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

[1] While the Consultative Committee reached consensus, many members expressed concerns that the anticipated fishery benefits for the Capilano system would not be realised for up to 10 years until a new intake structure is built in association with hydropower development at Cleveland Dam. The current facilities are not able to effectively augment and increase fish flows to the lower river until then.

Metro Vancouver Joint Water Use Plan

Metro Vancouver is developing a JWUP for the Seymour and Capilano Watersheds. This JWUP is about how the reservoirs and dams are operated, how water is released from the reservoirs and allocated for different uses (as examples: drinking water, fisheries habitat, proposed power generation, etc.). This plan will guide sustainable management of these important water resources. The planning process will also explore whether generating renewable hydropower from the existing reservoirs can be accommodated within Metro Vancouver's commitment to:

- continue to supply clean, safe drinking water,
- protect fish habitat,
- adapt to climate variability and climate change, and
- provide benefits to other community interests such as recreation, culture and heritage, and safety within the context of the planning process.

For Metro Vancouver's JWUP project the scope is broader than a typical WUP, as it includes consideration of water management effects associated with building possible hydropower facilities and consideration of seeking long term solutions for some historical issues associated with the construction of the original facilities (such as fish passage at Cleveland Dam).

Capilano and Seymour Systems

Situated on the North Shore (within the South Coast Mountains), the Capilano and Seymour reservoirs provide about two thirds of the water for Metro Vancouver's domestic water supply system. The Capilano system consists of a reservoir behind Cleveland Dam, and Palisade Alpine Reservoir located in the upper watershed. The Seymour system includes a reservoir behind Seymour Falls Dam, and two alpine reservoirs in the upper watershed (Burwell and Loch Lomond). Both systems have fish hatcheries located in the lower rivers. In addition, the recently completed Seymour Filtration Plant is located adjacent to the lower Seymour River. The two systems are also in the process of being connected via the Twin Tunnel Projects (discussed later in this document).

The management of water at both Capilano and Seymour Reservoirs follows a normal pattern being close to full during the fall, winter and spring months. During these periods the reservoirs fill to their maximum storage capacity with large amounts of water spilling from each reservoir (in the fall and winter as a result of rain storms, and in the spring mostly a result of snowmelt waters). During times when there is no spilling from the reservoirs, both dams release base flows (minimum flows) to the lower rivers for fish and ecological purposes year round.

The proposed hydropower projects are envisaged to make use of the existing dam infrastructure to produce electricity from water that would otherwise spill from the reservoirs. Energy generation from these proposed developments would be considered the 3rd priority for the water stored in the reservoirs after drinking water supply and environmental fish flows are provided for.

Consultative Committee

A Consultative Committee was struck and held their first meeting in January 2011. The CC consisted of 14 members (plus alternates) representing a broad cross section of potentially affected interests from government agencies; First Nations; community, recreational and environmental associations; and relevant Metro Vancouver municipalities. The CC held 8 meetings between January 2011 and July 2012 and was supported by two technical working groups – *fish and recreation* – who met for a total of 20 meetings during that same period. As well, an interagency JWUP Steering Committee met on an as needed basis to provide direction on any scope and schedule issues that were raised during the process.

The mandate of the CC was to identify and explore water use options and alternatives to current operating practices, and collaboratively develop recommendations for consideration by Metro Vancouver when preparing the JWUP for operation of the Capilano and Seymour water control facilities.

JWUP Planning Process

The planning process for the CC followed a structured and iterative path consistent with the steps outlined in the provincial WUP guidelines and included: defining water use issues and objectives (Step 4), collecting data on water use impacts (Step 5), creating operating alternatives (Step 6), assessing trade-offs between the alternatives (Step 7) with the aim of reaching consensus on a preferred alternative and documenting the outcomes (Step 8).

Issues, Objectives and Performance Measures

A preliminary list of issues and interests potentially affected by changes to water conditions in the watersheds was developed early in the process and these issues were updated and added to throughout the process. The issues were organized according to the following topic areas:

- Culture and Heritage
- Drinking Water and Operations
- Fish
- Hydropower
- Financial

- Recreation
- Safety
- Climate Change Mitigation

From the issues list, the CC developed a set of fundamental objectives that were used to guide the planning process. Performance measures were used to assess how well the water management options were meeting the objectives. A number of studies and analyses were undertaken to assist in the scoping of issues and in the development of meaningful performance measures.

JWUP Options

The JWUP considered a number of operational alternatives - *specific to setting targets for flow releases from the dams into the lower rivers or in relation to setting preferred water levels in the main reservoirs* – and a number of non-operational (non-flow) options.

- A total of 16 operating alternatives were developed and assessed for the lower Capilano River and a further 13 were considered for the lower Seymour River. As well, two joint alternatives that conceptually linked the two watersheds together were developed and reviewed. Other operating alternatives were considered for Palisade and Loch Lomond Alpine Reservoirs.
- Non-flow options were generally organized into those activities primarily associated with a WUP or those more aligned (or in response) to historical impacts from the construction of the original water control facilities or to address anticipated effects from the proposed new hydropower facilities. A total of 20 non-flow options were assessed during the JWUP.

Assessing the Options

The majority of the CC's deliberations and effort was focused on assessing operating alternatives in the lower Capilano and Seymour rivers and these discussions took place during their last four meetings (Meetings 5, 6, 7, and 8). The options assessment was an interactive process that began with the evaluation of modeled alternatives followed by a discussion towards new and improved alternatives to be modeled for the next meeting. Four rounds of options assessment were carried out during the JWUP process.

In general, the assessment of operating alternatives during each meeting consisted of a review of the modeled hydrographs for the rivers and reservoirs, then a review of the calculated performance measures summarized through consequence tables and PM graphs, and lastly through structured discussions by the CC. A number of decision analysis techniques were used such as scenario analyses, pair wise comparisons,

dominance and sensitivity analyses to help the CC highlight the main trade-offs and the opportunities to develop improved operating alternatives.

JWUP Package of Recommendations

During the final meeting, CC members were first asked to individually rank and assess the operating alternatives and monitoring studies separately as building blocks towards the development of a JWUP Package of recommendations that would consider other elements such as non-flow options or timing issues with implementing some of the activities. The concept of bundling various components together also allowed for better considering possible effects of the proposed hydropower facilities as well as making improvements to some historical impacts associated with construction of the original facilities. The components or building blocks for the packages included operating alternatives, monitoring studies, non-flow options, scheduling and implementation items, and a number of voluntary actions not necessarily linked to requirements within a water license (under the *Water Act*). At the meeting, the CC reached a consensus agreement and endorsed a package of recommendations for the JWUP (summarized in *Section 8 – Summary of Endorsed JWUP Package*). Some of the main elements included in the package are:

Capilano

- Capilano Reservoir hydropower project would be guided by a number of design criteria and objectives that would benefit fisheries resources in the watershed.
- Capilano Reservoir hydropower project, if built, would generate energy in the winter (November 1 to April 30) at reservoir elevations between full pool (145.9 m) and 4 meters down (141.9 m). In the summer, generation would only occur if water was spilling from the reservoir. Energy generation would assume the 3rd priority of the reservoir flow regime after drinking water supply and environmental/fish flows.
- New water control facilities would be built in conjunction with the proposed hydropower project[2] to enable the delivery of increased fish flow releases, as follows:
    - Summer and Fall: Current minimum flow release of 0.57cms from Cleveland Dam to the lower Capilano River would normally increase and vary from 0.57cms to 2.3cms depending on reservoir levels, reservoir spill volumes, inflows to the reservoir, alpine storage, and time of year between June 1 and November 30.

    - Winter and Spring: Current minimum flow release of 0.57cms from Cleveland Dam would increase to 1.2cms from December 1 to May 31 each year when lake levels are above 130m.
- Development and implementation of a comprehensive monitoring, research, and reporting program.
- Formation of a JWUP committee to provide feedback on implementation issues and in relation to the monitoring and research activities associated with the JWUP.
- A review period of 10 years after the hydropower facilities at Cleveland Dam are commissioned was recommended (i.e. expected in 2032).

Seymour

- Seymour Reservoir hydropower project, if built, would generate energy in the winter (November 1 to April 30) at reservoir elevations between full pool (212.9m) and 1 meter down (211.9m). In the summer, generation would only occur if water was spilling from the reservoir. Energy generation would assume the 3rd priority of the reservoir flow regime after drinking water supply and environmental/fish flows.
- Current minimum flow releases from Seymour Falls Dam to the lower Seymour River would increase under most conditions after JWUP approval and authorizations. The proposed new minimum fish flow releases are:
    - June 1 to November 30, releases vary from 0.7cms to 2.8cms, depending on the date, level of the Seymour Reservoir, and status of Alpine Lake storage;
    - December 1 to May 31, release of 1.36cms.
- Development and implementation of a comprehensive monitoring, research, and reporting program.
- Formation of a JWUP committee to provide feedback on implementation issues and in relation to the monitoring and research activities associated with the JWUP.
- A review period of 15 years after the JWUP approval was recommended (i.e. expected in 2029).

Anticipated Benefits

The CC's endorsed JWUP package, once approved and fully implemented, is expected to provide the following benefits relative to existing conditions:

- Metro Vancouver would have increased regulatory approval and public support for its activities in the two watersheds;

- the capacity to reliably supply drinking water would be maintained at current levels, in the June to November period, even in dry years with low reservoir inflows;
- improved passage around Cleveland Dam of out-migrating Steelhead trout and Coho salmon smolts;
- improved water temperatures in the Capilano River below Cleveland Dam to enhance aquatic productivity;
- improved conditions for fish in the lower Capilano River below Cleveland Dam under most conditions (on average approximately a doubling of the fish habitat in the summer);
- improved ability to control the rate of change in water flow from the Capilano Reservoir (ramping rates) to reduce the risk of stranding fish in the lower Capilano River;
- improved conditions for fish in the lower Seymour River below Seymour Falls Dam under most conditions (on average fish habitat is expected to increase by about 18% in the summer);
- reduced greenhouse gases through the generation of renewable, clean electricity from the proposed hydropower projects;
- significantly improved flows[3] for angling, kayaking and canoeing in the lower Capilano River below Cleveland Dam and more opportunities for paddlers to take advantage of preferred conditions through real-time flow gauges and access to forecast information on dam releases for the coming week; and
- improved flows for angling and kayaking in the lower Seymour River below Seymour Falls Dam and more opportunities for paddlers to take advantage of preferred conditions through real-time flow gauges and access to forecast information on dam releases for the coming week.

[3] Preferred paddling flows were estimated to almost double over current conditions.

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1 Introduction

1.1 Water Use Planning

Water use planning was first introduced in the province of BC in 1996 as a way to help clarify how rights to provincial water resources should be exercised and to ensure provincial water management decisions reflect current public values related to social, environmental, and financial priorities.

The product, a Water Use Plan, is a technical document that once authorized by provincial and federal authorities will define the detailed operating parameters to be used by facility managers in their day to day decisions. A WUP for a particular water control facility is prepared as part of the licensing process under the *Water Act*, with the end result being an order issued by the Comptroller of Water Rights to operate the works consistent with the plan. Other aspects typically found within a WUP include a research and monitoring program, an implementation schedule, a review period for when the WUP should be revisited, and there may be opportunities for physical works projects (i.e. non-flow options) as a substitute to making changes to flows or water levels.

The process for developing a WUP is governed by provincial Guidelines[4], which follow a structured approach consisting of 13 steps including a five step consultative process. The planning process seeks input from the full range of water use interests relevant at each facility through the initiation of a consultative committee. The plan's development is typically quite flexible and tailored to suit the scale and other circumstances of each facility and operator.

As specified in the Guidelines, the WUP process is intended to "address issues related to the operation of facilities as they currently exist, and incremental changes to operations to accommodate other water uses." The focus is on the identification and evaluation of water management alternatives, primarily consisting of flow changes (i.e. dam releases) and reservoir levels. Water Use Plans are not intended to be comprehensive watershed management plans or to deal with water management issues associated with other activities in the watershed such as forestry or mining. First Nations rights and title issues and historic grievances arising from the initial construction of the facilities are specifically excluded from WUPs but can be considered as part of other processes.

[4] Provincial Water Use Plan Guidelines (1998).

1.2 Metro Vancouver Joint Water Use Plan

Metro Vancouver is developing a Joint Water Use Plan (JWUP) for the Seymour and Capilano Watersheds. This JWUP is about how the reservoirs and dams are operated, how water is released from the reservoirs and allocated for different uses (as examples: drinking water, fisheries habitat, proposed power generation, etc.). This plan will guide sustainable management of these important water resources. The planning process will also explore whether generating renewable hydropower from existing reservoirs can be accommodated within Metro Vancouver's commitment to:

- continue to supply clean, safe drinking water,
- protect fish habitat,
- adapt to climate variability and climate change, and
- provide benefits to other community interests such as recreation, culture and heritage, and safety within the context of the planning process.

Aligned with Metro Vancouver's sustainability goals, the JWUP will seek to balance social, economic and environmental values. As well, the JWUP is expected to be consistent with the priorities established under the Drinking Water Management Plan for the GVWD and Member Municipalities.

Once approved and directed by regulatory agencies, the JWUP will direct the operation of water control facilities, including dams and any potential hydropower facilities that may get built in the future. The JWUP process is not intended to provide a full assessment of competing facility design options. Any new water control projects such as those proposed for hydroelectric generation at Cleveland Dam and Seymour Falls Dam would need to follow any regulatory provincial and federal approval processes that may be required.

For Metro Vancouver's JWUP project the scope is broader than a typical WUP, as it includes consideration of water management effects associated with building possible hydropower facilities and consideration of seeking long term solutions for some historical issues associated with the original facilities (such as fish passage at Cleveland Dam).

The JWUP Consultative Committee process was initiated in January 2011 and completed in July 2012. The process followed the Province's Water Use Plan Guidelines. The purpose of this summary report is to document the consultative process and present the recommendations of the JWUP Consultative Committee. The interests and values expressed in this report will be used by Metro Vancouver to prepare the Capilano Seymour Joint Water Use Plan. Both the CC Summary Report and Metro Vancouver's Draft JWUP will be submitted to the Comptroller of Water Rights.

1.3 Organization of Report

This summary report has been organized into sections that align with the steps outlined in the provincial WUP Guidelines (*see italics below*), as follows:

Section 2 describes the Capilano and Seymour watersheds, existing dams and water control facilities, and proposed hydropower projects being considered.

Section 3 describes the consultative process and committee structure for the JWUP *(related to Step 3 in the Guidelines).*

Section 4 summarizes the issues and interests, the objectives agreed to that guided the process, and the performance measures that were developed to assess the JWUP options *(Steps 2 and 4 in the Guidelines).*

Section 5 summarizes the information, studies, and analyses that were used and/or carried out in support of the JWUP *(Step 5).*

Section 6 describes the operating alternatives and non-flow options considered during the process *(Step 6).*

Section 7 describes the methods used to evaluate the options and the key outcomes from each round of the trade-off analysis discussions *(Step 7 and 8).*

Section 8 provides a summary of the final package of recommendations endorsed by the CC for the JWUP *(Step 8).*

The summary report also includes a number of supporting appendices providing additional details and context related to the consultative process, assessing impacts, monitoring, and the meeting notes from the final CC meeting.

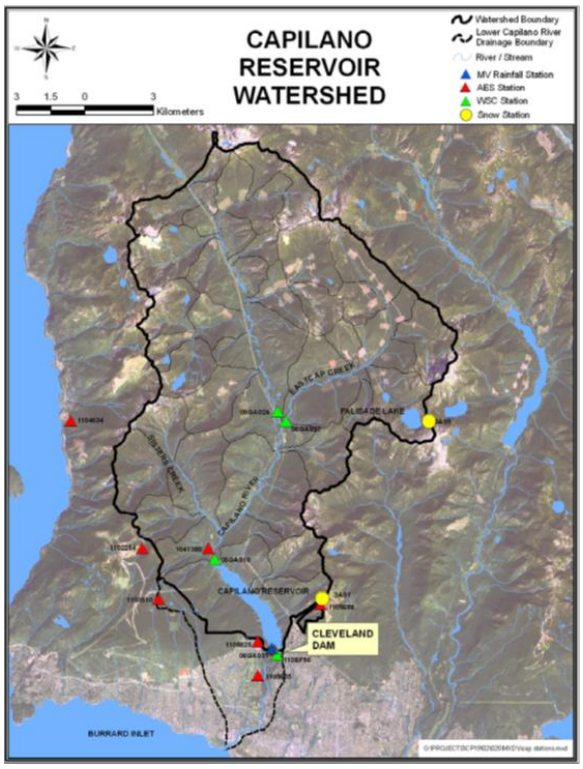
2 Project Description

2.1 Introduction

This section provides a brief overview of Capilano and Seymour watersheds, the existing dams and water control facilities, and a description of the conceptual designs for the proposed hydropower facilities that were shared with Consultative Committee CC members during the JWUP process.

2.2 Capilano System

The Capilano River basin is a mountainous catchment located in the South Coast Mountains of British Columbia. The Capilano River originates at Capilano Mountain, 33 km north of the Burrard Inlet and flows southward.



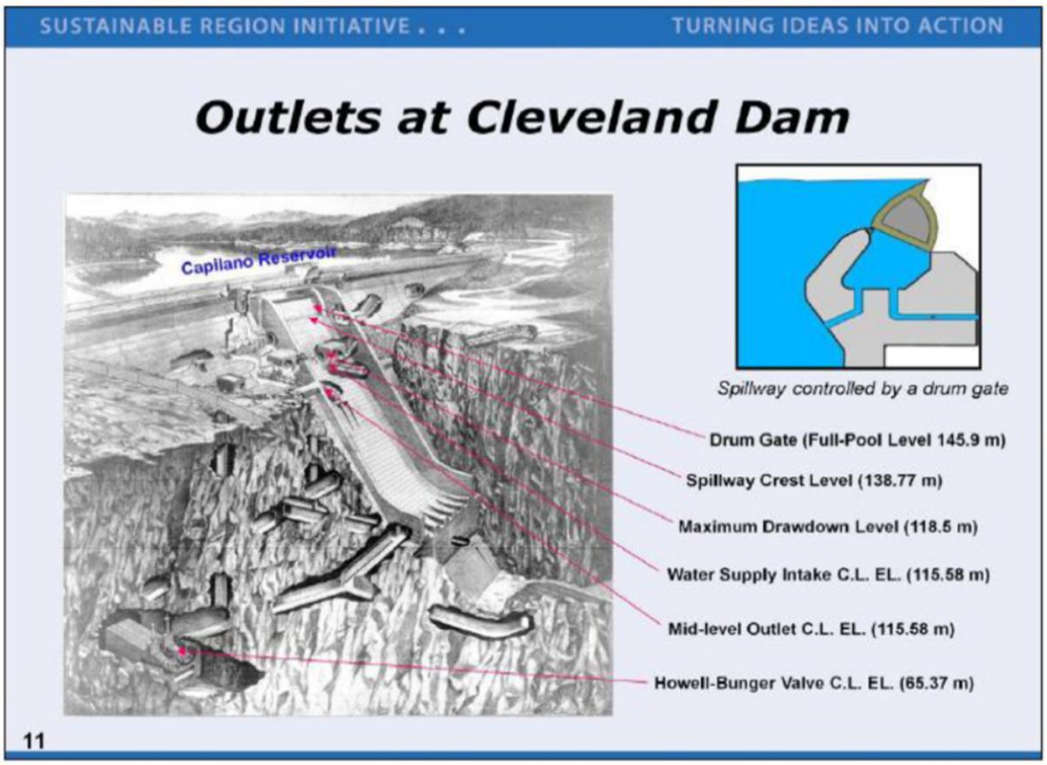
The Capilano River Watershed drainage area is 212 km^2 with approximately 7% of its area below the Cleveland Dam. Capilano River has a total length of 33 km, 6 km of which is below the dam. There are four main tributaries in this system, namely Eastcap Creek, Sister Creek, Brothers Creek, and Hollsgate Creek. The alpine lake reservoir for the Capilano system is Palisade Lake.

Capilano Reservoir and Cleveland Dam

The Capilano Reservoir is part of the Greater Vancouver Water District (GVWD) Watershed and has restricted access to the public. The reservoir was created through the construction of Cleveland Dam in 1954. The reservoir is approximately 6 km long and 800m wide on average. Upon the commissioning of the Twin Tunnels Projects that is currently being built, there will be a usable storage capacity of 55 million m^3 with an additional 8.5 million m^3 of useable storage available at Palisade Lake Reservoir. The Capilano Reservoir is normally full during the fall, winter and spring months. During these periods the reservoir fills to its maximum storage capacity with large amounts of water spilling from it.

Cleveland Dam is a 92m high and 195m long concrete gravity dam built into a narrow canyon approximately 6 km upstream from the terminus of the Capilano River. The dam has a number of gates, intakes and outlets (Figure 2-1).

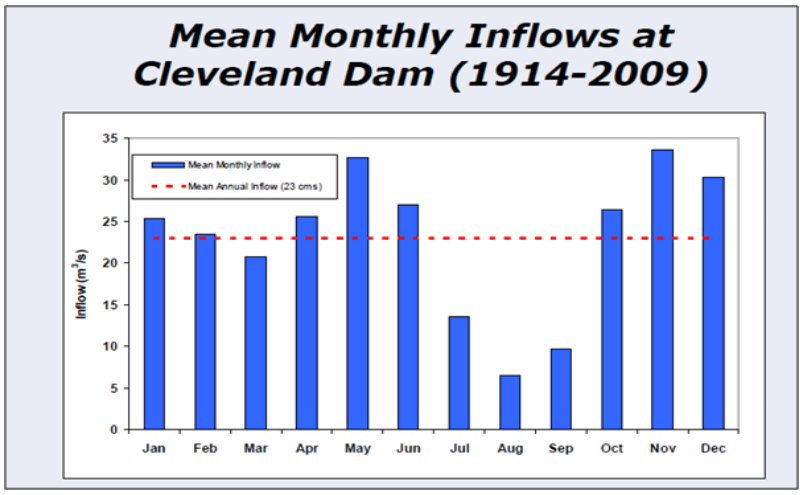
Figure 2-1 Outlets from Cleveland Dam



Inflows and Management

Reservoir inflows are affected by a variety of hydrological factors including snowpack, temperature, precipitation and the contribution of alpine lake reservoirs which drain into main reservoir. Accordingly there can be significant variations on a daily, monthly, seasonal, and annual basis. During storm events the reservoir is typically spilling water and has extremely limited capacity or flood control. Figure 2-2 provides a summary of mean monthly inflows to Capilano Reservoir.

Figure 2-2 Mean Monthly Inflows to Capilano Reservoir (1915 – 2009)



Palisade Alpine Reservoir

Palisade Lake Reservoir in the upper watershed has a usable storage capacity of 8.5 million m^3. Palisade Lake can be used for inflow augmentation and help maintain lake levels of Capilano Reservoir during dry periods and improve source water quality (clear, cold and well-oxygenated water).

Capilano Fish Hatchery

The Capilano Fish Hatchery is located approximately 340 m downstream of the Cleveland Dam on the east bank of the Capilano River. The hatchery uses water from the same intake as the domestic water supply, as well as filtered well water and groundwater seepage from drainage tunnels in the east end of the dam. All water used by the hatchery is discharged directly back into the Capilano River.

Existing Operations and Licensed Rights

Restrictions on the amount of water drawn from the reservoir for use in the regional water system are governed by water licenses issued by the Province of British Columbia.

Typical operations for Capilano Reservoir follow a seasonal pattern as follows:

Fall to Spring	Drum gate open, reservoir levels high and frequently overflowing via the spillway
Spring through Summer	Drum gate closed to keep the lake level close to its maximum capacity. Reservoir levels generally drop as a result of low inflows and high summer demand for

	drinking water and ecological base flows to the lower river.
Late Summer to Early Fall	Gradual refilling

Minimum dam releases of 0.57cms (20cfs) are provided year round as base ecological flows to the lower Capilano River via a by-pass line from the drinking water intake.

Fish Passage at Cleveland Dam

In collaboration with the Department of Fisheries and Oceans, adult Coho salmon and Steelhead trout are trucked around Cleveland Dam to allow the adult fish to spawn in the upper Capilano River. After hatching, fry remain in the upper Capilano River from one to two years (for coho) or two to three years for steelhead, then, as smolts, attempt to migrate to the ocean. Past studies have shown that a high percentage of the smolts do not survive going over Cleveland Dam's spillway and the long drop to the rocky pool at the base of the dam.

Metro Vancouver is working with senior governments on short-term and long-term solutions to increase the rate of survival of downstream migrating smolts past the Cleveland Dam on the Capilano River. In the short-term, smolts are caught in three rotary screw traps in the upper Capilano River and ten trap nets located along the shoreline in the Capilano Reservoir. The trapped smolts are then transported around the Cleveland Dam to the lower Capilano River.

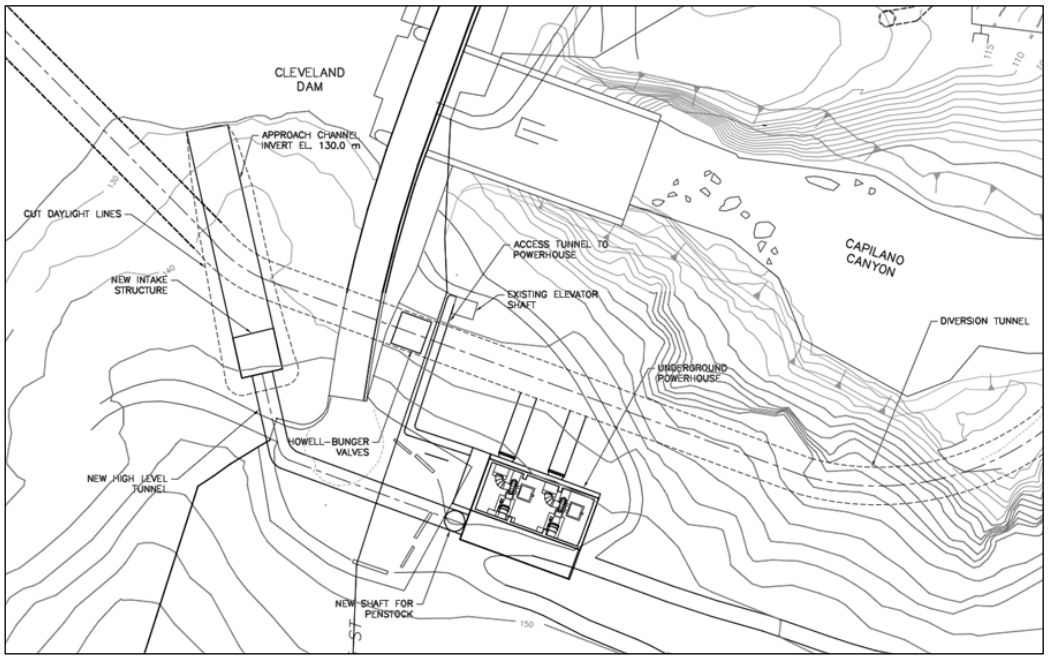
In 2012, the smolt trap and truck project completed its fifth year of operation. To date, this project has resulted in 128,000 Coho and 1,400 Steelhead smolts being transported that represents up to 30 percent of the Coho smolt yield and up to 10 percent of the Steelhead smolt yield from the upper watershed per year. This short-term initiative to reduce smolt mortality in the Capilano watershed is being combined with a parallel effort to collect information on fish patterns to use in determining a long-term strategy.

2.3 Proposed Hydropower Facilities at Cleveland Dam

As part of the water use planning process a hydropower consultant worked with Metro Vancouver staff to assess potential design options for the proposed hydropower project at Cleveland Dam. Towards the end of the JWUP process, Metro Vancouver had identified a preferred design option for the facilities, which included the following elements: a new surface intake on the west side of Capilano Reservoir, with an underground tunnel and shaft connecting to an underground powerhouse discharging to the existing diversion tunnel that in turn discharges to the west side of the lower end of the Cleveland Dam plunge pool (Figure 2-3). These elements are described in

further detail below. All facilities would be located on lands owned by the Greater Vancouver Water District.

Figure 2-3 Conceptual Layout of Capilano Hydropower Project



The general concept design was based on avoiding significant modifications to the existing dam infrastructure. The majority of the work is proposed to be done underground and requires significant amount of tunnelling. Other aspects currently envisioned for the main features of the project are:

Intake Structure

This project includes installation of a new near-surface intake with the invert of the approach channel at an approximate elevation of 130m. Water is drawn from near the surface of the reservoir and the maximum withdrawal rate for power generation is about 25cms. A dual-flow travelling fish-exclusion screen is included in the project. The screen would eliminate entrainment of fish into the intake and turbine. The design and construction of the screens is very similar to the screens currently used at the drinking water intake. Location of the intake in an excavated channel with accessible sides permits smolt capture for downstream passage. As part of the project, new water control facilities will be built to enable, in conjunction with existing facilities, the delivery of the proposed JWUP fish flow releases. These facilities will be designed to provide appropriate ramping rates and fish flow releases to the river whether or not the power project is operating through the widest possible range of lake elevations and down to 130m elevation if practical.

Hydraulic Conduit for Hydropower flows

A combination of high level tunnel and vertical shaft is planned to carry the water to the powerhouse. The high level tunnel under the gravity dam section is assumed to be lined and grouted to mitigate dam safety concerns. To carry internal pressure of water the vertical shaft is also assumed to be lined and grouted.

Powerhouse / Tailrace

The preliminary design calls for an underground powerhouse with two Francis turbine units. The placement of the powerhouse is relatively flexible and allows for changes if required after geotechnical investigations. Connection to the existing elevator shaft is desired to minimize costs associated with providing access. The tunnel from the elevator to the new underground powerhouse can be aligned to avoid moving of existing Howell-Bunger (HB) valves. The tailrace from the underground powerhouse will discharge to the existing diversion tunnel that in turn discharges to the west side of the lower end of the Cleveland Dam plunge pool.

Switchyard (not required)

Step-up transformers are not required as generators' will be generating at 12.47 kV. Busbars/buried cables will be used to carry the power to the existing Metro Vancouver 69 kV substation located to the West of Cleveland Dam.

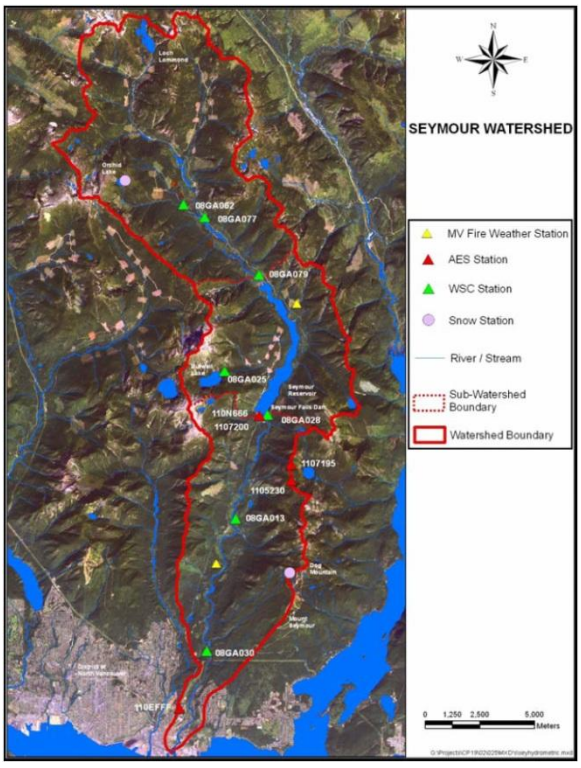
Total Annual Energy

System modeling during the JWUP CC estimates the average annual energy generation was about 57 GWh.

2.4 Seymour System

The Seymour River Watershed is a mountainous catchment located in the South Coast Mountains of BC. The Seymour River originates at Coastal Mountain near Loch Lomond and flows about 39 km to Burrard Inlet.

The watershed drainage area is 186 km² with approximately 32% of its area below the Seymour Falls Dam. Seymour River has a total length of 39 km, having 19 km below the dam. There are twenty tributaries in this system. Loch Lomond and Burwell Lake Reservoirs are the



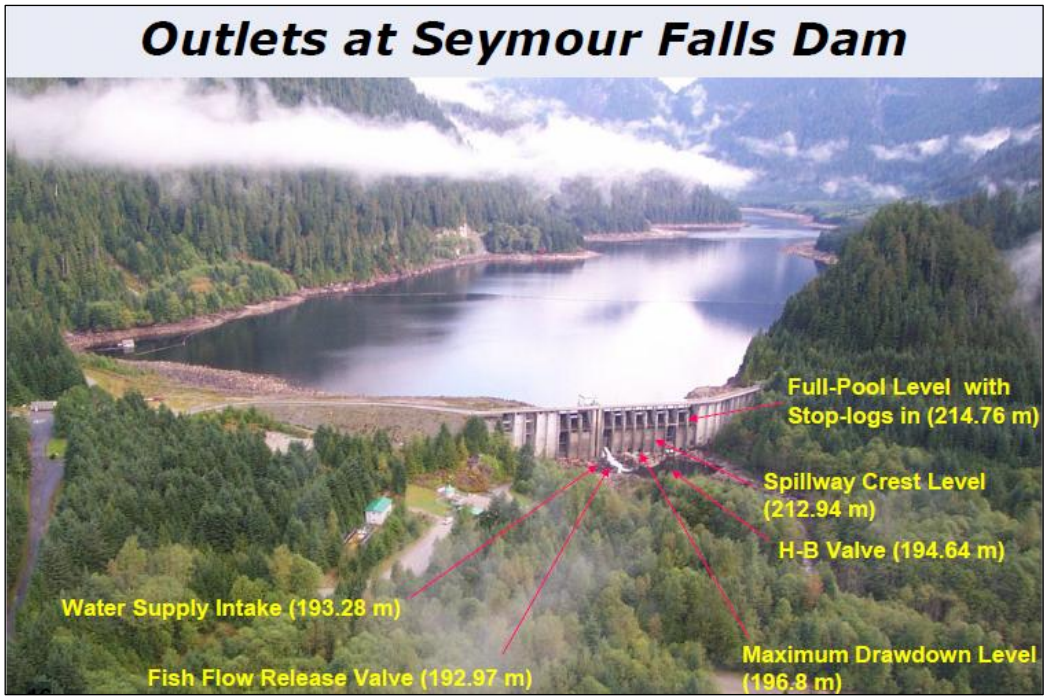
alpine lake reservoirs for the Seymour System.

Seymour Reservoir and Seymour Falls Dam

The Seymour Reservoir is part of the GVWD Watershed and has restricted access to the public. The reservoir was created through the construction of Seymour Falls Dam and is approximately 6.5 km long and about 500m wide. There is a usable storage capacity of 27 million m^3 in the main reservoir with an additional combined 19 million m^3 of storage available at alpine lake reservoirs. The Seymour Reservoir is normally full during the fall, winter and spring months. During these periods the reservoir fills to its maximum storage capacity with large amounts of water spilling over the dam.

There was a lower dam in the present location of Seymour Falls Dam, which was built in 1928. In 1962 this dam was expanded to create the 30m high and 450m long dam that sits there today. The dam is a composite structure consisting of both earth fill and concrete sections. The dam is equipped with stop logs (concrete beams) that are added each spring to add approximately 1.9m more height and increase the overall storage capacity of the reservoir. The dam has a number of gates and outlets (Figure 2-4).

Figure 2-4 Outlets from Seymour Falls Dam

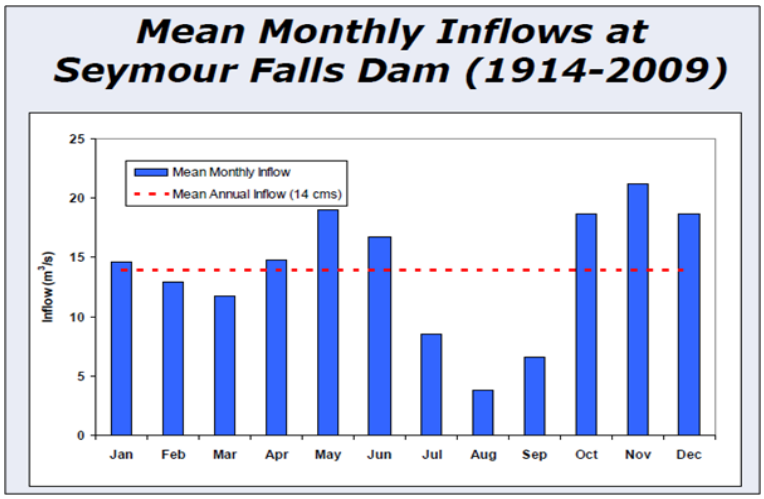


Inflows and Management

Reservoir inflows are affected by a variety of hydrological factors including snowpack, temperature, precipitation and the contribution of alpine lake reservoirs which drain

into main reservoir. Accordingly there can be significant variations on a daily, monthly, seasonal, and annual basis. During storm events the reservoir is typically spilling water and has extremely limited capacity or flood control. Figure 2-5 provides a summary of mean monthly inflows to Seymour Reservoir.

Figure 2-5 Mean Monthly Inflows to Seymour Reservoir (1914 – 2009)



Alpine Lake Reservoirs

Loch Lomond and Burwell Lake Reservoirs have a combined available storage of 19 million m^3. These alpine lakes can be used for inflow augmentation and help maintain lake levels of Seymour Reservoir during dry periods and improve source water quality. Moreover, they can improve source water quality (clear, cold and well-oxygenated water) and assist in the reduction of ammonia production in Seymour Reservoir.

Seymour-Capilano Filtration Plant

Seymour Capilano Filtration Project will provide a wide range of benefits in water quality and system reliability. It will also result in the potential for the Capilano and Seymour drinking water distribution systems downstream of the Filtration Plant to be operated as an interconnected system.

Seymour-Capilano Twin Tunnels

The Capilano Pump Station will be used to pump water approximately 7.1 km from Capilano Reservoir, via the untreated water tunnel, to the Seymour Capilano Filtration Plant. The Filtration Plant can also receive untreated source water from the Seymour Reservoir. Treated water leaving the Filtration Plant can be sent to the Capilano tap water distribution system via the treated water tunnel or piped south into the

Seymour tap water distribution systems. The tunnels linking the two tap water systems was one of the reasons why a JWUP was proposed for the two watersheds.

Seymour Fish Hatchery

The Seymour Fish Hatchery is located approximately 300 m downstream of the Seymour Falls Dam on the west bank of the Seymour River. The hatchery uses water from the same intake as the domestic water supply, at a rate of 0.2cms. All water used by the hatchery is discharged directly back into the Seymour River.

The hatchery is managed by the Seymour Salmonid Society which uses the hatchery to help sustain a viable sports fishery. Each year the hatchery produces approximately 30,000 steel head trout, 120,000 Coho salmon, 100,000 to 600,000 Chum salmon, and 1.0 to 1.2 million Pink salmon (every two years).

Existing Operations and Licensed Rights

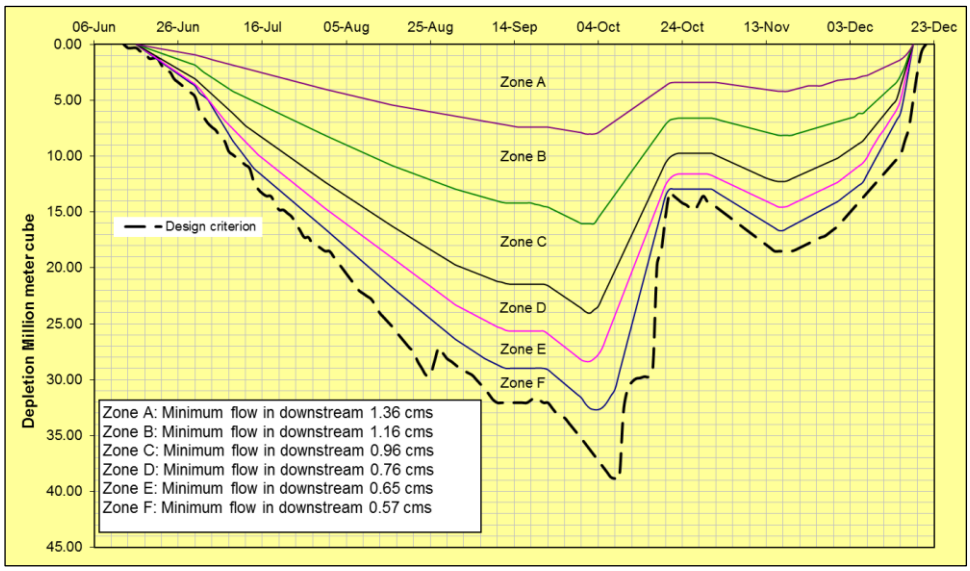
Restrictions on the amount of water drawn from the reservoir for use in the regional water system are governed by water licenses issued by the Province of British Columbia.

Typical operations for Seymour Reservoir follow a seasonal pattern as follows:

Fall to Spring	Reservoirs levels high and frequently overflowing via the spillway.
Spring through Summer	Lake level is kept to its maximum capacity: stop logs are installed. Then reservoir levels generally drop as a result of low inflows and high summer demand for drinking water and ecological base flows to the lower river.
Late Summer to Early Fall	Gradual refilling

Minimum dam releases vary between 0.57cms (20cfs) and 1.36cms (47cfs) as base ecological flows to the lower Seymour River through the low-level outlet. These minimum fisheries flows are governed by a rule curve based on time of year and water levels in the reservoir.

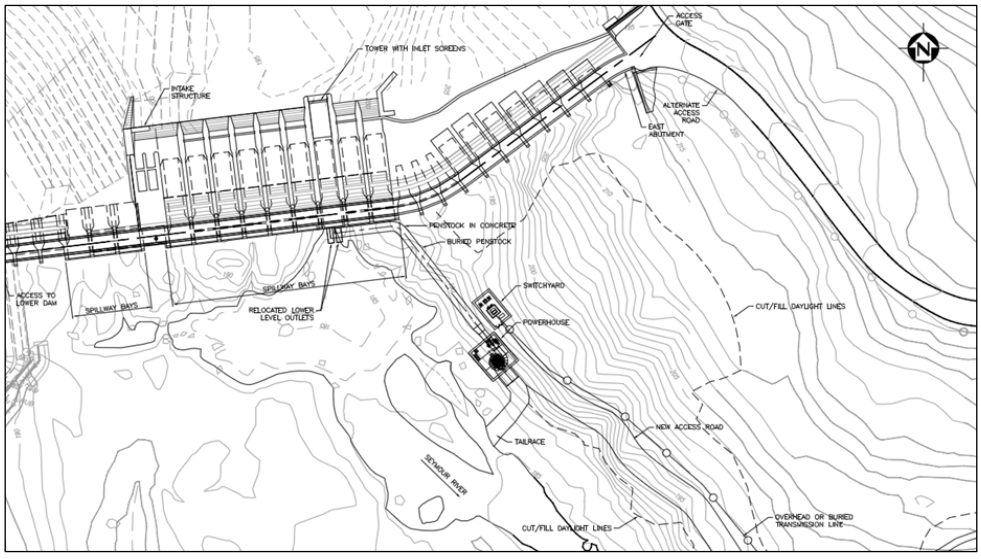
Figure 2-6 Minimum Dam Release Rule Curve for Seymour Falls Dam (Summer & Fall)



2.5 Proposed Hydropower Facilities at Seymour Falls Dam

As part of the water use planning process a hydropower consultant worked with Metro Vancouver staff to assess potential design options for the proposed hydropower project at the dam. The current design for the proposed hydropower project would divert water at the existing Howell-Bunger (HB) valves, using a new penstock routed along the downstream face of the dam, connected to a surface powerhouse on East Bank of the Seymour River that would discharge to a new tailrace channel that in turn discharges to the east side of the Seymour River (Figure 2-7). These elements are described in further detail below.

Figure 2-7 Conceptual Layout of Seymour Hydropower Project



The general concept design was based on avoiding significant modifications to the existing dam infrastructure. Water for power generation would be diverted at existing HB valves to a surface powerhouse on the East Bank of the Seymour River.

Intake – Located on the Face of the Dam

Water for power generation is diverted at the HB valves' intake and the maximum withdrawal rate for power generation is about 15cms. A two stage intake tower is envisaged as the Trashrack at the HB valve inlet will need to be upgraded to screen out smaller debris (50 – 100 mm clear spacing). Trash removal equipment will be required. Underwater construction will be required as this is the lowest point of the reservoir. Water diverted for power generation would be screened with a dual-flow travelling fish-exclusion screen. The design and construction of the screens is very similar to the screens currently used at the drinking water intake. A separate high-flow opening would be designed for operation of the HB valves. The two stage tower would connect to the opening through the dam at the HB valves' location. This also requires relocation of the HB valves to enable connection for the penstock take-off. (Note: roof to be extended above to protect the HB valves from spill flows.)

Hydraulic Conduit for Hydropower Flows

Penstock is routed along the downstream face of the dam and is protected with concrete against spillway flows and debris impact. The penstock would transition to a buried penstock prior to entering the powerhouse.

Powerhouse / Tailrace - Surface Powerhouse on the East Bank.

An access road to the powerhouse location is needed from the existing road on the East side of the Seymour River.

Switchyard

A surface switchyard with a step-up transformer is needed on the East side of the River near the powerhouse. An overhead or buried transmission line would be used to carry the power to the existing Metro Vancouver Seymour-Capilano Filtration Plant. Opportunities to reduce the eventual costs of the power-line through synergizes with installation of Seymour Main #5 (North) from Seymour Dam to the Filter Plant will be explored.

Total Annual Energy

System modeling for the JWUP CC estimates the average annual energy generation at about 7 GWh.

3 Consultative Process

3.1 Introduction

This section provides a summary of the consultative planning process followed in the lead up to and during the JWUP project. In general, the public process followed the provincial Water Use Plan Guidelines that were established in 1998 to enhance water management at hydroelectric power and other water control facilities in BC. These guidelines outlined 5 main steps where the public is involved in the development of a WUP, as follows:

Step 4 Define water use issues and objectives

Step 5 Collect data on water use impacts

Step 6 Create operating alternatives

Step 7 Assess trade-offs between alternatives

Step 8 Determine and document areas of consensus and disagreement

For the JWUP, a public Consultative Committee (CC) was established to follow and work through these steps with an aim of reaching consensus towards a recommendation for Metro Vancouver.

3.1.1 Metro Vancouver JWUP Engagement and Consultation

Metro Vancouver's engagement and consultation program for the Joint Water Use Plan (JWUP) followed the provincial guidelines and included outreach to the following audiences: government agencies and ministries, potentially affected First Nations, the public, and Metro Vancouver members. To meaningfully engage these audiences, Metro Vancouver completed the following key activities in the initial stages of the process:

- In September 2010, a JWUP Steering Committee was formed, which consisted of applicable regulatory agencies and ministries with a mandate to provide advice to Metro Vancouver on the content and process for developing the JWUP.
- In October 2010, Metro Vancouver publicly announced the JWUP process, and held a public meeting that was attended by approximately 125 people.
- In January 2011, following Metro Vancouver's request for expressions of interest and public advertising in October 2010, the JWUP Consultative Committee was formed with a mandate to identify and explore water use options and collaboratively develop recommendations for consideration by Metro Vancouver.

Following the October 2010 JWUP public meeting, individuals interested in volunteering on the JWUP CC submitted expressions of interest, and subsequently were asked to submit an application form. In December 2010, the JWUP Steering Committee selected the members of the JWUP CC based on a set of selection criteria. The CC has representatives from government agencies; First Nations; community, recreational and environmental associations; and relevant Metro Vancouver municipalities.

Terms of Reference were agreed to and guided the process and deliberations of the CC (see *Appendix C – CC Terms of Reference*). The CC represented a broad spectrum of interests affected by the operations of the Capilano and Seymour water control facilitates, such as drinking water, fisheries, wildlife, environment, recreation and culture. The CC held 8 meetings from January 2011 until July 2012 and were supported by close to 20 technical working group meetings during that same period (for a complete listing of all the committee meetings refer to *Appendix B – Schedule of JWUP Public Meetings*). As well the JWUP Steering Committee met on an as needs basis throughout the JWUP planning period to discuss and provide direction on scope and schedule issues that emerged during the project.

Throughout the planning process, Metro Vancouver hosted a JWUP website which reported on the progress of the consultative process and was regularly updated.

A final public meeting was held on October 10th, 2012 to present information and seek input on the key elements recommended and reached during the consultative JWUP process.

3.2 Consultative Committee

The mandate of the JWUP CC was to identify and explore water use options and alternatives to current operating practices, and collaboratively develop recommendations for consideration by Metro Vancouver when preparing the JWUP for operation of the Capilano and Seymour water control facilities. The anticipated tasks for the CC to make its recommendations included:

a. consider the needs and interests of all different water uses, including drinking water supply, fisheries, wildlife, the environment, recreation, heritage conservation, flood control, the net cost of water supply, energy self-sufficiency, and other uses identified during the planning process,

b. take into account the best available information about the consequences of proposed alternatives to current operating practices,

c. identify a preferred operating system and other considerations seen to be within the scope of the JWUP,

d. outline criteria for an ongoing monitoring and assessment program, where required and appropriate, and

e. establish timing for periodic review of the JWUP for the Capilano and Seymour Watersheds.

At the second CC meeting, the terms of reference was agreed to and posted on a project website (for more details see *Appendix C – CC Terms of Reference).*

The CC consisted of 14 members representing the following organizations or agencies:

- Metro Vancouver
- Squamish Nation
- Ministry of Environment / Ministry of Forests, Lands and Natural Resource Operations
- Fisheries and Oceans Canada
- District of North Vancouver
- District of West Vancouver
- Living Rivers Georgia Basin and Vancouver Island
- British Columbia Federation of Drift Fishers
- British Columbia Federation of Fly Fishers
- Recreational Canoeing Association of BC
- Beaver Canoe Club
- North Shore Community Association
- Seymour Salmonid Society
- Steelhead Society of BC
- Vancouver Kayak Club

For a complete listing of the CC members, alternates and observers to the JWUP process who received regular correspondence, updates, and meeting notes, refer to *Appendix A – JWUP CC Members, Alternatives, and Subcommittees.*

An independent facilitator was hired to support the CC's deliberations and provide assistance during the technical working group meetings.

3.3 Technical Subcommittees

Early on in the JWUP process, the CC established two technical working groups – *fish and recreation* – to respond to information requests and provide technical input during the planning process. The main emphasis of these technical committees was related to estimating impacts of the operating alternatives. CC members were invited to participate on these technical committees.

3.3.1 Fish Technical Working Group

The mandate of the Fish Technical Working Group (FTWG) was to respond to technical information needs of the CC, which generally consisted of:

- Helping to identify key issues and objectives,
- Developing performance measures and estimating the effects of the alternatives,
- Suggesting flow options to meet fisheries objectives,
- Prioritizing and addressing data gaps, and
- Recommending future studies and monitoring programs.

The FTWG held 14 meetings and consisted of about 9 members[5] representing the following organizations or agencies:

- Metro Vancouver
- Squamish Nation
- Ministry of Environment / Ministry of Forests, Lands and Natural Resource Operations
- Fisheries and Oceans Canada
- Living Rivers Georgia Basin and Vancouver Island
- British Columbia Federation of Drift Fishers
- British Columbia Federation of Fly Fishers
- Seymour Salmonid Society
- Steelhead Society of BC

An independent facilitator was hired to support the FTWG and a professional fisheries biologist was hired to attend and support the work of the committee. As well, a number of consultants attended and provided support at some meetings (for more details see *Appendix A – JWUP CC Members, Alternatives, and Subcommittees).*

3.3.2 Recreation Technical Working Group

The mandate of the Recreation Technical Working Group (RTWG) was to respond to technical information needs of the CC, which generally consisted of:

- Helping to identify key issues and objectives,
- Developing performance measures and estimating the effects of the alternatives,
- Commenting on operating alternatives, and
- Highlighting any needed data gaps.

[5] Participation on the FTWG varied over the JWUP process and many meetings did not have the full representation from each of the listed organizations and agencies.

The RTWG held five meetings and consisted of 4 members representing the following organizations or agencies:

- Metro Vancouver
- Beaver Canoe Club
- Recreational Canoeing Association of BC
- Vancouver Kayak Club
- BC Federation of Drift Fishers

An independent facilitator was hired to support the RTWG.

3.4 Facilitation and Decision Analysis

Compass Resource Management Ltd. was hired to facilitate the JWUP process and provide decision analysis support (also known as Structured Decision Making or SDM).

Ecofish Research Ltd. was hired to co-facilitate and provide technical support during the Fish TWG meetings.

4 Issues, Objectives and Performance Measures

4.1 Introduction

Consistent with Step 4 of the provincial WUP Guidelines, one of the principal first steps of the consultative JWUP process was the identification and scoping of possible interests and issues that may be affected as a result of proposed changes to current operations or as a result of possible hydropower development or changes to some of the ongoing programs associated with the construction of the original dam and control structures. The main emphasis was always on water management: *basically, how would interests be affected as a result of changes to water conditions in the Capilano and Seymour watersheds.* This section provides an overview of the issues discussed, the resulting objectives agreed to, and performance measures developed to support the CC's assessments and deliberations during the JWUP.

4.2 Issues and Interests

A preliminary list of issues for the JWUP was developed through a review of historical documents, feedback received during a public open house held in October 2010 and through consultation with regulatory agencies, First Nations, local government representatives, and stakeholders. The preliminary issues list was updated and refined throughout the JWUP planning process.

The issues were organized according to the following topic areas:

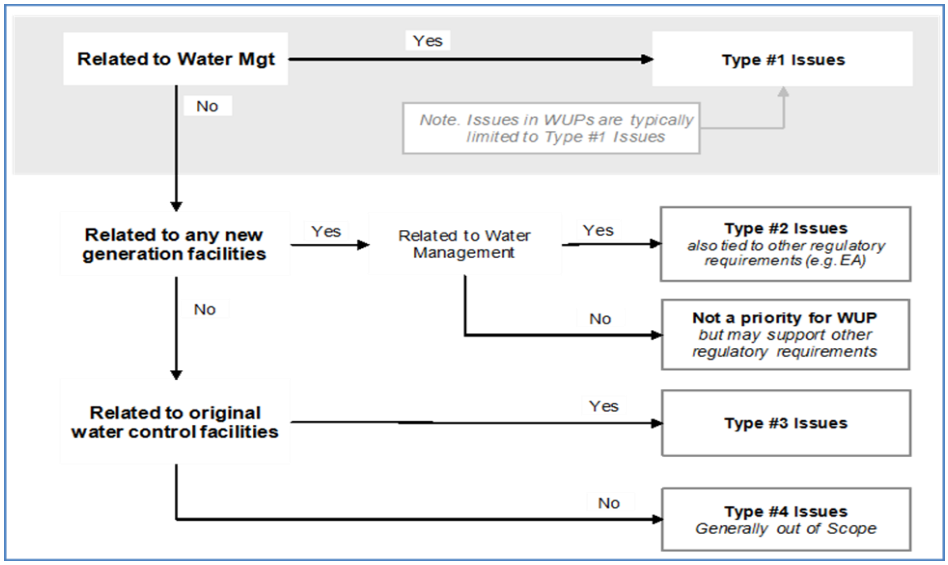
- Culture and Heritage
- Drinking Water and Operations
- Fish
- Hydropower
- Financial
- Recreation
- Safety
- Climate Change Mitigation

Given that the scope of Metro Vancouver's JWUP included consideration beyond purely operational issues to include water management effects associated with the proposed hydropower facilities and some historical impacts associated with the construction of the original facilities, a sorting process was followed to better help organize the issues (see Figure 4-1). Issues were grouped into four classifications or types based on their cause effect relationships, as follows:

Type #1 Issues — Related to flow management through the existing water control facilities (e.g. minimum flows)

Type #2 Issues	Related to flow management associated with any new hydro-electric facilities (e.g. tailrace design, smolt intake structure, variable level intake (temperature related), etc.)
Type #3 Issues	Related to historical flows and the construction of the original structures (e.g. fish passage)
Type #4 Issues	Considered out of scope and beyond the jurisdiction of the *Water Act* or the terms defined in this WUP process (e.g. DFO's harvest management plans, Metro Vancouver's Drinking Water Management Plan, etc.)

Figure 4-1 Issue Scoping Framework



Type #1 issues were considered flow dependent and tied to operational changes through the water control facilities. Type #2 issues were linked to the design of proposed hydropower facilities. Type #3 issues were associated with the construction of the original dams and water control facilities. The sorting exercise provided a useful starting point to better understand the issues and how they could be affected. It also served as a guide for focusing the CC's efforts early on in the process towards operational Type #1 issues before turning attention to other issue Types (i.e. #2 and #3) and possible non-flow options for mitigating and/or compensating for residual effects.

From the preliminary list of issues, the CC developed a set of fundamental objectives that would guide the planning and review of options. From these objectives, evaluation criteria or performance measures were created in order to assess the different operating alternatives and the degree to which the objectives were being met.

The remainder of this section briefly summarizes (a) the issues and how they were dealt with through the JWUP process, (b) the objectives, and (c) the performance measures created to assess the options.

4.4 Drinking Water

Table 4-2 provides a summary of the drinking water issues raised during the JWUP.

Table 4-2 Drinking Water Issues

Issue	Description	JWUP Relevance
Drinking water supply	A number of factors affect the amount of water available for domestic water supply needs such as the storage capacity of the dams, precipitation (rain and snow) in the watersheds on any given year, other seasonal weather patterns (e.g. temperatures), and how much water is released (and when) into the lower rivers for ecological or other reasons. Concerns were raised to ensure that the current capacity of the domestic water supply system is maintained and not put at risk, especially for the Seymour system which was associated with better quality water and seen	Led to JWUP objectives, performance measures, and operating alternatives.

Issue	Description	JWUP Relevance
	as more cost effective (requiring less pumping), given its higher elevation, which is further relied on during emergency conditions.	
Water Quality	For the most part it was recognized that water quality issues associated with potential changes in a WUP were mitigated by the recently completed filtration plant at Seymour. The one exception, however, was high ammonia levels associated with lower reservoir levels in the Seymour Reservoir which sometimes occur in the summer. This effect has been managed in the past through flow releases from the alpine systems – Loch Lomond and Burwell alpine reservoirs – which mitigates negative effects by raising water levels and lowering water temperatures in the main reservoir. Possible impacts to water quality associated with the reintroduction of adult salmon to the upper Seymour watershed were raised in the event that regulatory agencies made the recommendation.	This issue was aligned with Metro Vancouver's water quality objective of *"clean, safe drinking water",* which was adopted for the JWUP. No performance measure was developed for this issue area.
Operational flexibility	Metro Vancouver identified concerns related to additional constraints on their operations; particularly for the alpine reservoirs should they be recommended during a JWUP. These concerns were related to possible additional costs (operating and maintenance) and related to less flexibility to respond or adapt to future conditions (e.g. episodic events such as landslides or longer term trends such as climate change). Moreover it was mentioned that additional conditions or operating parameters of the alpine reservoirs may threaten water supply reliability of the system.	Led to a JWUP objective and consideration of a performance measures.
Demand Management / Water Shortage Response Plan (WSRP)	Concerns were expressed in relation to Metro Vancouver's demand side management of their domestic water system and how this should be a part of the JWUP discussions. In particular, how summer time low flows in the lower rivers should be tied to the levels found within the Water Shortage Response Plan that limit some water uses (e.g. summertime lawn sprinkling restrictions). Metro Vancouver mentioned that demand management is included within their Drinking Water Management Plan, which is informed through a separate public involvement process.	Led to an assessment to review the relationship between the WSRP and lower river flows
Miscellaneous	A number of miscellaneous issues were raised related to Metro Vancouver's water supply system, as follows: • The need for additional storage to augment summer time flows for fish in the lower rivers through the development of additional alpine reservoirs	These issues were documented.

Issue	Description	JWUP Relevance
	• Concern over the high pressure pipes in the distribution system • Reliability of electricity supply for Metro Vancouver operations • Operation and issues associated with the Seymour filtration plant	

4.4.1 Drinking Water Objectives and Performance Measures

The following objective areas and performance measures were agreed to by the CC and used during the JWUP.

Objective Areas	Sub-Areas
Sufficient and reliable supply of domestic water	• Water supply reliability
Clean, safe drinking water	• Water quality
Operational flexibility	• Constraints on operations

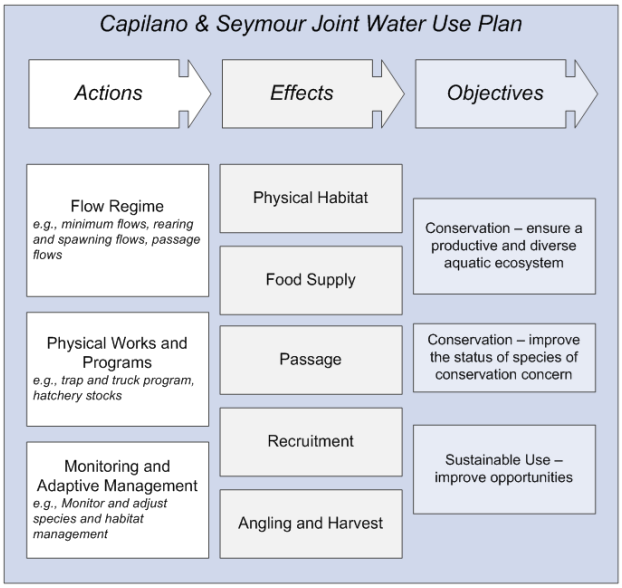
Performance Measures	Description
Reliable Water Supply Capacity (RWSC) PMs	*Reliability* is the ability of a system to perform its required functions under stated conditions for a specified period of time, often reported in terms of percentage. A *failure* in the context of the JWUP was defined as any month that the reservoirs reach its minimum level and full domestic water demand is unable to be supplied. *Percent reliability* is defined as the number of months or years a failure did not occur divided by the total number of months or years of operation. The RWSC PM was calculated using a Multiple Reservoir Simulation Model that was developed for Metro Vancouver. The PM reports the volume of drinking water (measured in millions of litres per day) that the system can deliver for the summer (June to October) and winter (November to May), with 98% and 50% reliability. The 98% reliability translates into 1 failure in 50 years; whereas the 50% reliability implies not meeting domestic water demand every other year.
Deep Reservoir Drawdown PM	While not tied directly to drinking water supply, this PM served as a proxy to characterize available water for both riverine fish and drinking water purposes. The PM was calculated by counting the number of years out of the 24 year modeled dataset that reservoir levels dropped below an operationally significant threshold (i.e. causing concerns for the

	drinking water intake). In Capilano this threshold was 121m and for Seymour it was 202m.
Operational Flexibility PM	A placeholder was assigned to this PM, but it was not developed during the JWUP as impacts to operational flexibility were not considered significant across the reviewed operating alternatives.

4.5 Fish

Table 4-3 provides a summary of the fish issues raised during the JWUP.

Table 4-3 Fish Issues

Issue	Description	JWUP Relevance
Fish populations	Fish populations in Capilano and Seymour watersheds are influenced by many factors[6]. These influences are depicted conceptually in the diagram below used by the FTWG and developed by Todd Hatfield[7].  Issues raised in relation to fish populations and overall aquatic productivity were: • Rearing habitat • Spawning habitat • Invertebrate production • Passage flows • Blockage of upstream and downstream passage • Access to side channels and tributaries	During the JWUP process over 17 impact hypotheses were developed by the Fish Technical Working Group to assess possible effects associated with changing flow conditions or from the proposed hydropower facilities or as a result of the construction of the original dams and water control structures. This work led to JWUP objectives, a number of assessments, operating alternatives, non-flow alternatives, and monitoring studies.

[6] In addition, there are a number of additional external influences such as climate change, marine harvest, ocean survival, land uses, etc.
[7] Todd Hatfield (Ecofish Research Ltd.) was a technical resource and co-facilitator during the FTWG meetings.

Issue	Description	JWUP Relevance
	• Geomorphic and channel-forming flows • Gravel condition • Gravel recruitment • Fish stranding • Effective littoral zone • Marine derived nutrients • Entrainment • Spills • Total gas pressure • Temperature	
Low flows in the lower rivers and the overall abundance and distribution of salmon and steelhead	The fishery issue cited most frequently during the JWUP process were the current minimum flow releases of 0.57cms (20cfs) below Cleveland Dam, which were considered substandard by many CC members particularly during extended low flow periods through hot dry summers and into the fall. These low flows were considered to be having a significant adverse impact on the suitability and availability of habitat for salmonids including both summer and winter runs of steelhead and other aquatic species at times in the lower Capilano River. This was deemed very important for rearing habitat for steelhead, coho and Chinook. Low flows were also associated with poor connectivity between pools and affecting spawning success. Low flow concerns were shared below Seymour Falls Dam, but to a lesser extent given the generally higher flow releases (from the existing rule curve) and as a result of tributary inflows in the lower Seymour River. Concerns were also expressed for the timing of when new agreed to operating alternatives may be delivered. For Capilano, the timing for implementing alternatives that increased minimum flows would be dependent on construction of new facilities (as envisioned for the proposed hydropower intake structure). For Seymour, the existing facilities already have the capability of delivering higher minimum flows associated with some of the operating alternatives reviewed during the JWUP. *Note. These low flow conditions were associated with the existing water licenses and not as a result of the possible development of hydropower facilities in these systems.*	Led to JWUP objectives, performance measures, assessments during the JWUP, operating alternatives, monitoring studies, and recommendations for implementing JWUP flows.
Low winter flows	While the majority of emphasis was on low and substandard flows for fish from the early spring to late fall, some concerns were raised in relation to whether periods of low winter flows may be more prevalent with changes to operations for hydropower.	Led to a JWUP objective, an assessment, and a performance measure.
Cold water temperatures in the lower Capilano	The typical cold water temperatures associated with flow releases from Cleveland dam were a concern for a number of reasons from the spring	Led to a JWUP objective, an assessment, and a performance measure.

Issue	Description	JWUP Relevance
	through to the early fall, as follows: • They affect growth rates of fry and therefore overall survivability • They delay the timing of winter steelhead spawning, which in turn can adversely affect egg incubation and emergence times. April temperatures are therefore critical in both rivers. • Delayed emergence for steelhead fry also may put them at greater stranding risk with decreasing summer flows. • Affect the reproduction rate of insects. • Low temperatures also affect hatchery operations (deep water outflows versus surface water releases (spillway) affects adult migration to hatchery in July to August period for Coho and summer steelhead) Cold water temperatures from Seymour Falls dam were also raised as a possible concern.	
Adult passage up the lower Capilano River	Issues were raised in relation to creating conditions to facilitate passage of adult salmon from the mouth of the Capilano River up the lower river all the way to the hatchery. Migration challenges were associated with natural and anthropogenic barriers to fish passage during low flows in the late summer and early fall period.	Led to a JWUP objective, an operating alternative, a non-flow option, and a monitoring study.
Flows released from the alpine reservoirs	Water is released from the alpine reservoirs on an as needs basis for domestic water supply purposes. Generally these releases occur during dry summers when water levels in the main Capilano and Seymour Reservoirs drop below set thresholds. The valves from these alpine systems are typically fully opened until the desired volume of water has been released. On many years the valves remain closed throughout the summer and fall time and the only water released is from inflows spilling over the dams. From a fishery perspective concerns were raised that these flow releases may be: • Adversely affecting fish habitat below the alpine dams as a result of cold water temperatures • Resulting in possible fish stranding issues • Negating opportunities to improve and increase suitable fish habitat (e.g. if flow releases were reduced but extended over a longer period of time) • Displacing some species (e.g. cutthroat), if flow regime changes were made below the alpine dams either as a result of hydropower development or for the purposes of providing improvement to fish habitat	Led to a JWUP objective, a habitat assessment during the JWUP, a historical temperature assessment, a flow recommendation for Loch Lomond Alpine Reservoir, and monitoring studies.
Reservoir littoral and pelagic productivity	Concerns were expressed that changes to reservoir operations could impact littoral and pelagic productivity, which could in turn affect the food	Led to a JWUP objective, an operating alternative, a performance measure, and

Issue	Description	JWUP Relevance
	available for coho. A related issue was whether lower reservoir levels in the spring time associated with proposed hydropower operations would adversely affect coho fry and parr that use the shallow areas in the upper reservoir for rearing and cover from fish predators, and/or lead to possible losses in habitat complexity and overall ecosystem functioning.	a proposed monitoring study.
Ramping rates	Ramp down rates associated with decreasing flow releases from both Cleveland and Seymour Falls dams and their potential to strand and harm fish were raised as possible concerns.	Led to a JWUP objective, a risk assessment, a non-flow option, and monitoring studies.
Fish stranding in the reservoirs	Fishing stranding at the upper end of Capilano Reservoir was raised as a possible concern depending on the rate of water level drops (particularly for coho).	Led to a JWUP objective, a preliminary assessment, and a recommended environmental assessment for the hydropower project.
Long term fish passage	A component for the JWUP was to assess viable long term fish passage options. Issues and opportunities were discussed in relation to improving the existing trap and truck program and whether there were more effective options, especially in light of new facilities associated with hydropower development.	Led to a JWUP objective, a scoping study and a preliminary options assessment, a non-flow option, and a monitoring study.
Entrainment and increased fish mortality	Concerns were raised in relation to diversion flows for the proposed hydropower facilities and whether an intake structure would lead to entrainment and fish kills or potential adverse effects on the existing trap and truck program.	Led to a JWUP objective, design criteria and objectives for the proposed hydropower facilities (screened intake structure), and a monitoring study.
Migration to tributaries in the reservoirs	Concerns were expressed that deep reservoir drawdowns could block or restrict migration to tributaries in the main reservoirs	Led to a JWUP objective, and a preliminary assessment.
Spawning habitat and gravel recruitment	Spawning areas below the dam, given the lack of gravel recruitment from the reservoir and upper watershed areas, was seen as a significant issue. This is most evident below Cleveland dam given the lack of any significant tributaries until Brothers Creek. The lack of spawning areas is a serious issue for resident stocks (winter steelhead, coho, chum, pink and Chinook). This is less significant on Seymour where it appears there was a small lake immediately upstream of Seymour Falls Dam and given the tributaries downstream (with the exception of from Spur 4 to the Twin Bridges).	Led to a JWUP objective, performance measures, a non-flow option, and a monitoring assessment.
Historical dam impacts	A number of additional issues were raised in relation to the construction of the original facilities and the resulting fisheries impacts, including: blocked migration to the upper watershed, habitat and connectivity issues, and reduced nutrients in the lower rivers.	Documented and considered during the impact hypotheses reviewed by the FTWG.
Capilano Hatchery	Concerns were expressed that deep reservoir drawdowns may affect the availability of suitable water used for hatchery operations, as follows: a)	Led to a JWUP objective and an assessment.

Issue	Description	JWUP Relevance
	the amount of warmer seepage water from the dam (i.e. drainage adit behind dam) when reservoir levels are low (January to May in particular), and b) effects pumping from the groundwater well (which helps provide cooler water for adults over the summer and provides warmer water for rearing Chinook and Steelhead in the late winter and early spring).	

4.5.1 Fish Objectives and Performance Measures

The following objective areas and performance measures were agreed to by the CC and used during the JWUP.

Objective Areas	Sub-Areas
Abundant, diverse and widely distributed wild salmonids	<u>Lower Capilano and Seymour Rivers</u> • Habitat productivity / suitability • Fish stranding / ramping rates • Temperature effects • Migration /opportunities • Adult migration • Juvenile migration • Water quality (suspended sediments, dissolved oxygen, nitrogen) <u>Capilano and Seymour Reservoirs</u> • Littoral productivity • Pelagic productivity • Fish stranding (upper reservoir area) • Connectivity to tributaries /migration barriers • Outmigration success • Entrainment (intake structures) • Water quality <u>Downstream of Alpine Reservoirs</u> • Habitat productivity / suitability • Fish stranding / ramping rates • Temperature effects
Maintain the fishery potential of the hatchery facilities	Impacts on hatchery operations, including • Brood stock • Water quality and quantity (e.g. adit, groundwater well) • Adult migration • Smolt outmigration

Performance Measures	Description
Stream Temperature PM *(Capilano River below Cleveland Dam)*	A PM was developed based on reservoir thermal stratification, and a simple mixing model that used water releases from three locations at Cleveland Dam: surface (i.e., spills), mid-

Performance Measures	Description
	level outlet, and deep-water outlet (i.e., Howell Bunger valve). The PM tracked the number of days each year ≥7° C, which is MOE's criterion for defining the growth period for salmonids.
Steelhead Parr Habitat PM and Chinook Fry Habitat PM *(lower Capilano and Seymour Rivers)*	Species-specific fish habitat PMs were developed for Chinook fry, Steelhead fry, Coho fry, and Steelhead parr. Habitat suitability criteria (HSC) used for the PM were from the Province's HSC database developed during BC Hydro Water Use Planning. Weighted useable width (WUW) vs. flow curves for Steelhead fry and parr, Coho fry, and Chinook fry. The analysis was based on two transects on the lower Capilano River, and transects on the lower Seymour River. The WUW vs. flow curves were used to transform the flow time series of each alternative into daily measures of WUW at each transect, and the average value was calculated for each river. Average WUW was then summarized from April through October (the approximate growing season for fish) for each year in the 24 year modeled dataset. Results for fry life stages indicated optimum flows that would be considered detrimental to other life stages, and this coupled with professional opinion that fish production in Capilano and Seymour rivers is not limited by the fry life stage led to FTWG consensus that evaluation of alternatives should focus on using the Steelhead parr PM.
Spawning PM *(lower Capilano and Seymour Rivers)*	Several species-specific spawning PMs were developed based on spawning times based on species periodicity and MOE's modified-Tennant approach to specifying appropriate spawning flows for salmonids. The critical thresholds used in the spawning PM were 11cms and 9.41cms for the Capilano and Seymour rivers respectively. The spawning PM produced two complimentary descriptors. The first was a count of the number of days in the spawning window that met or exceeded the threshold flow, and the second was the maximum duration (number of days in a row) that met or exceeded the threshold flow. The PMs were made species-specific by calculating them separately for the spawning windows noted in the periodicity tables. The Spawning PMs were calculated and presented for the lower Capilano and Seymour rivers, for Steelhead, Coho, Chinook, Chum, and Pink. The results for some species closely mirrored those for other species; Steelhead and Coho were selected to represent all the salmon species.
Invertebrate Habitat PM *(lower Capilano and Seymour Rivers)*	Two approaches to the PM were developed. The first calculated WUW based on HSC for benthic invertebrates; the second calculated mean velocity in riffle transects. A WUW vs. flow curve and a mean velocity vs. flow curve were produced. The curves were used to transform the flow time series of each alternative into daily measures of WUW and mean velocity at each transect, and the average value

Performance Measures	Description
	calculated for Capilano and Seymour. The analysis was based on two riffle transects in the lower Capilano River and three riffle transects in the lower Seymour River. Average WUW and mean velocity were then summarized for April through October, which represents the approximate growing season for fish. Results for the invertebrate habitat PM closely mirrored those for Steelhead parr, so evaluation of alternatives focussed on PM results for Steelhead.
Winter Wetted Width PM *(lower Capilano and Seymour Rivers)*	The purpose of the wetted width PM is to provide an assessment of winter flow releases and characterize possible benefits associated with increases to minimum dam releases during this time. The wetted width PM was developed separately for each month of November through March. Daily wetted width was based on two transects on the lower Capilano and three transects on the lower Seymour for each of the 24 years.
Reservoir Littoral Area PM *(Capilano Reservoir)*	A simple bathymetry-based PM was developed to describe differences among alternatives in availability of littoral areas. The PM defined littoral area as those portions of the lake ≤ 6m depth, based on MOE's working definition of littoral. Metro Vancouver provided a lake area vs. water elevation curve for Capilano Reservoir; the most sensitive (steepest) part of the curve was at the highest water levels. These inputs were used to transform the reservoir water elevation time series from each alternative into daily measures of littoral area in the reservoir. The littoral area PM was calculated and presented for the month of April, as an indicator of spring conditions in the reservoir.

For more information on the development and assessment of fish performance measures refer to *Appendix E – Assessing Fish Impacts.*

4.6 Hydropower Development

Table 4-4 provides a summary of the hydropower issues raised during the JWUP.

Table 4-4 Hydropower Issues

Issue	Description	JWUP Relevance
Hydropower generation	One of the motivations for the JWUP was to explore whether making renewable energy from the spilled water that typically occurs each year made sense, given the other water use interests in the watersheds. The potential amount of hydropower generation was an important factor in making this assessment. Questions were raised during the JWUP process whether the development of hydropower generation would pose additional risks to the domestic water supply system or the dam discharges to the lower rivers.	Led to a JWUP Objective, reservoir operating constraints, and performance measures.
Design of new hydropower facilities at Cleveland Dam	A number of issues were raised with the possible design of hydropower facilities and in particular the details surrounding the intake structure in relation to fisheries interests, as follows: • Preventing fish entrainment at the hydropower intake • Smolt collection system • Safe downstream passage for smolts • Avoidance of operating the spillway during the outmigration period • Suitable ramping rates and flows over the widest range of reservoir elevations to avoid fish stranding downstream • Exploring a smaller turbine design to generate power year round associated with minimum fish flows • Intake channel designed to improve water temperatures downstream • Loss or alteration of fish habitat as a result of new facilities (e.g. tailrace design) • Water quality issues associated with the intake or operations (such as increased turbidity, suspended sediments, and dissolved oxygen) Aesthetic concerns were also raised in relation to the design of the new facilities (e.g. power house, transmission lines).	Led to JWUP objectives, assessments during the JWUP, monitoring studies, and non-flow options.
Construction impacts	Construction impacts that might close or restrict access to park and recreation areas were raised as concerns.	This was referred to Metro Vancouver.
Ownership and operation	Concerns were raised about commercial ownership of the proposed hydropower facilities.	Documented during the JWUP process.

4.6.1 Hydropower Objectives and Performance Measures

The following objective and performance measures were agreed to by the CC and used during the JWUP.

Objective Areas	Sub-Areas
Hydro-electricity generation	No sub areas were identified

Performance Measures	Description
Hydropower Generation PM	The amount of energy produced at each proposed hydropower facility was estimated and reported in annual energy (in Giga Watts). Electricity generation was based on the amount of water available and diverted through the turbines on a daily basis across the 24 year dataset. Software was used to convert flows into energy (GWh) using existing software programs based on the characteristics of each facility.

4.7 Financial

Table 4-5 provides a summary of the financial issues raised during the JWUP.

Table 4-5 Financial Issues

Issue	Description	JWUP Relevance
Cost to ratepayers	Overall costs to ratepayers associated with the development of hydropower and for the costs associated with implementing the JWUP recommendations were raised as concerns. This included: • Capital costs for new facilities (e.g. hydropower development, enhancement and compensation physical works, etc.) • Operating and maintenance costs (associated with new operating procedures or other JWUP requirements such as studies). • Overall revenue from the hydropower generation (including GHG offsets)]. • Life cycle costs for any new facilities.	This led to a JWUP Objective, cost estimates, and performance measures.

4.7.1 Financial Objectives and Performance Measures

The following objectives and performance measures were agreed to by the CC and used during the JWUP.

Objective Areas	Sub-Areas
Costs to Ratepayers	• Operations and maintenance costs • New facilities or works (related to design of hydropower facilities and mitigation/compensation projects such as habitat enhancement) • Enhancement works • Revenues from hydroelectric generation
Local Employment Opportunities for First Nations	• Continue the ongoing watershed employment opportunities

Performance Measures	Description
Cost PMs	Costs associated with the JWUP in terms of possible non-flow options or monitoring studies were estimated in dollars (2012).
Pumping Cost PM	In order to estimate the effects of the joint alternatives, pumping costs were calculated based on the cost of electricity required to pump additional water from the Capilano Reservoir to the Seymour filtration plant. An electricity rate of $45.19/MWh (prorated for 2012) was used based on BC Hydro's stated electricity rates.
Revenue from hydropower generation	*The revenue generated from the proposed hydropower turbines was not calculated during the JWUP, as this would have double counted the benefit given the Hydropower Generation PM.*

4.8 Recreation

Table 4-6 provides a summary of the recreation issues raised during the JWUP.

Table 4-6 Recreation Issues

Issue	Description	JWUP Relevance
Quality and number of paddling opportunities	A number of flow related issues were raised by paddlers using the lower rivers during the JWUP process, including: • Information about current or planned flow releases in order to plan recreation activities (e.g. real time flow gauges or forecast information about the releases for the coming week) • The timing of flow releases in relation to weather patterns, day of week, time of day, etc. • Flow levels were too low for much of the year • Flows were too high sometimes in the winter • Aesthetic concerns associated with low	This led to JWUP Objectives, performance measures, operating alternatives, and non-flow options.

Issue	Description	JWUP Relevance
	river levels affecting the quality of the paddling experience	
Access by the Capilano hatchery	Currently access to the lower river near the Capilano hatchery is difficult and unsafe for recreation paddlers.	This was referred to Metro Vancouver.
Angling Experience	A number of factors were identified for preferred angling conditions in the lower river. Aside from access issues to preferred fishing sites and/or the abundance of fish species (which is considered under the fish category), this issue was more related to key water features that anglers prefer such as eddies and conditions at preferred fishing spots. Water conditions that facilitated these features provided more angling opportunities and increased the overall recreation experience.	Led to a JWUP objective and performance measures.

4.8.1 Recreation Objectives and Performance Measures

The following objectives and performance measures were agreed to by the CC and used during the JWUP.

Objective Areas	Sub-Areas
Number and quality of water based recreation opportunities	• Maintain or improve opportunities for recreational use of the rivers • Maintain or improve the quality of recreational use of the rivers • Maintain safety of recreational users

Performance Measures	Description
Kayak PM *(Lower Capilano and Seymour Rivers)*	This PM counted the number of days that flows below Cleveland and Seymour Falls Dams were at or exceeded a constructed preference rating of 70 (see below) measured at specific transects down the rivers during the shoulder seasons of March 1 to May 30 and October 1 to November each year.

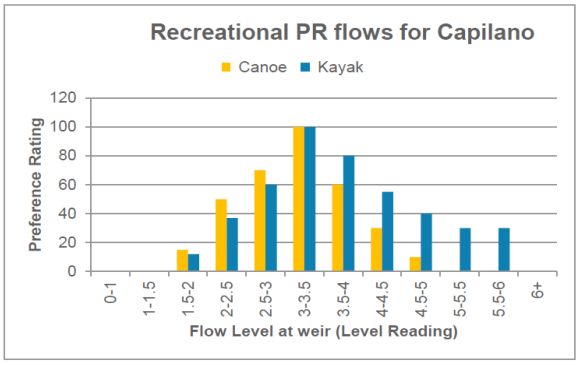
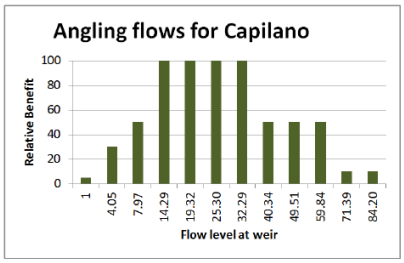


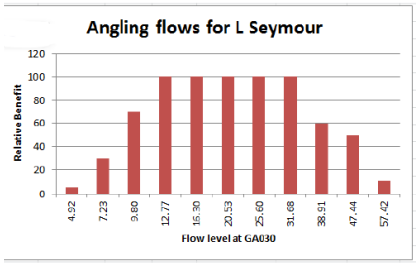
Table 1: Weir levels to cms

Weir stage	Discharge (cms)	
0-1	1	4.05
1-1.5	4.05	7.97
1.5-2	7.97	14.29
2-2.5	14.29	19.32
2.5-3	19.32	25.30
3-3.5	25.30	32.29
3.5-4	32.29	40.34
4-4.5	40.34	49.51
4.5-5	49.51	59.84
5-5.5	59.84	71.39
5.5-6	71.39	84.20
6+	84.20	

Canoe PM	This PM counted the number of days that flows

Performance Measures	Description
(Lower Capilano and Seymour Rivers)	below Cleveland and Seymour Falls Dams were at or exceeded a constructed preference rating of 70 measured at specific transects down the rivers from March 1 to May 30 each year.
Angling PM *(Lower Capilano and Seymour Rivers)*	This PM averaged the daily preference rating score each day for the 24 year modeled dataset based on flows in the lower rivers.





4.10 Climate Change Mitigation

Table 4-8 provides a summary of the climate change mitigation issues raised.

Table 4-8 Climate Change Mitigation Issues

Issue	Description	JWUP Relevance
Climate change	Having flexibility to adapt to possible changing precipitation patterns associated with climate change was raised as an issue for Metro Vancouver. The fewer operational constraints on their system, the more easily they would be able to respond to new conditions in the future.	This led to a JWUP Objective and a placeholder for a possible performance measure, if required.

4.10.1 Objectives and Performance Measures

The following objective areas and performance measures were agreed to by the CC and used during the JWUP.

Objective Areas	Sub-Areas
Emission of greenhouse gases	• Reducing the overall GHG generated

Performance Measures	Description
GHG Emission PM	In order to estimate the effects of the joint alternatives, tonnes of $CO_{2\ equivalent}$ was estimated based on the amount of electricity needed to pump additional water from the Capilano Reservoir to the Seymour filtration plant. This was based on BC Hydro's most recent published (2010) greenhouse intensity figure of 23 t CO2e/GWh.

5 Information Collection

5.1 Introduction

As per step 5 of the provincial WUP guidelines, the JWUP used information from a variety of sources to assess the impacts of water management alternatives. Existing information from past studies and monitoring carried out by Metro Vancouver and other parties was used. In addition, a number of technical analyses and studies were carried out during the JWUP to screen the significance of issues and inform the development of performance measures. This section provides a summary of the information sources that were available and relied upon during the evaluation and PM development process.

5.2 Data Sources

Metro Vancouver collects data on hydrology and water quality as part of its regular monitoring activities, and has extensive historic records, which in some cases extend back many decades. Metro Vancouver also commissions occasional specific studies in support of specific initiatives or to support specific data needs. The following key data sources from Metro Vancouver:

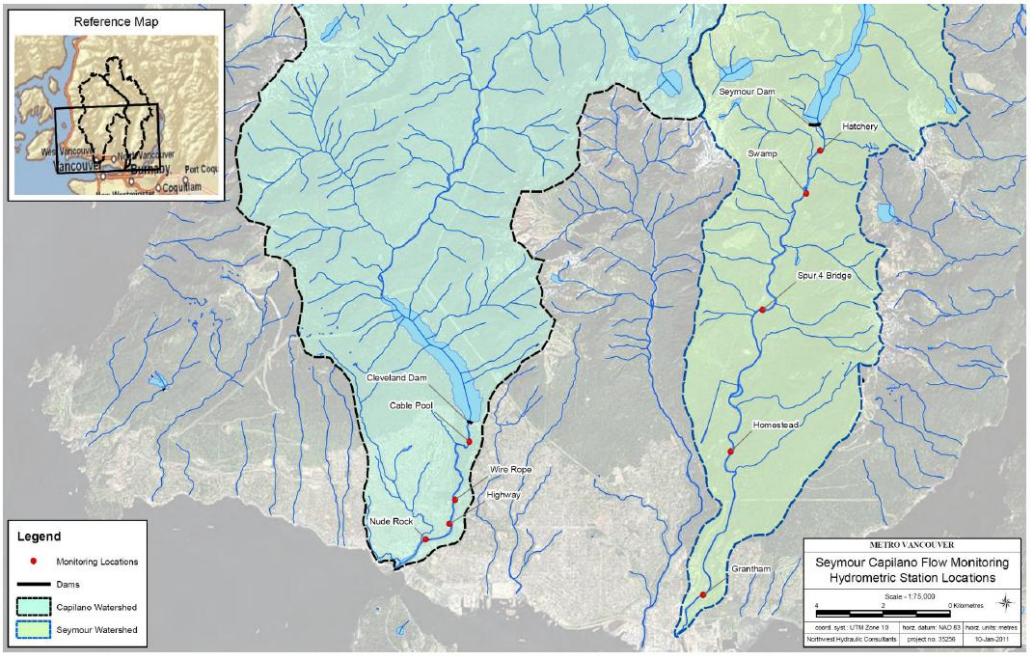
1. NHC transects. In support of the JWUP, Metro Vancouver contracted Northwest Hydraulic Consultants (NHC) to install and maintain hydrometric gauges at four transects on the lower Capilano River and five transects on the lower Seymour River (Figure 5-1). The FTWG made extensive use of the hydraulic measurements taken at these transects, and used these sites as geographic reference points for assessing the alternatives.

2. InStream transects. In support of the JWUP, Metro Vancouver contracted Instream Fisheries Research (InStream) to undertake several studies in the Capilano and Seymour watersheds. The key results used by the FTWG were hydraulic measurements taken at a range of flows at transects near the NHC transects. The InStream transects were established at representative fish habitat for each section of river, and were combined with habitat suitability criteria (HSC) to produce functions of weighted useable width (WUW) versus flow. These functions were used to model habitat availability at these sites in response to different alternatives; these functions were provided for several species and life stages of fish, and for macroinvertebrates.

3. Other InStream studies. In addition to transect work on the lower Capilano and Seymour rivers, InStream also undertook Fish Habitat Assessment Procedure (FHAP) studies in the upper Capilano and the upper Seymour rivers, and

completed initial temperature and fish habitat investigations in the upper Capilano related to water releases from alpine storage.

Figure 5-1 Locations of hydrometric stations installed by NHC for Metro Vancouver



4. Reservoir temperature profiles. Metro Vancouver collected daily temperature profiles in Capilano Reservoir in 2008 through 2009.

5. Reservoir bathymetry. Metro Vancouver has bathymetry data for Capilano and Seymour reservoirs, and surface area vs. water elevation relationships.

6. Reservoir water levels. Metro Vancouver collects information on water elevation at Capilano and Seymour reservoirs, and has historic information extending back decades.

7. Hydrometric gauging on Capilano and Seymour rivers. There are a variety of hydrometric stations in both watersheds and limnology stations in both reservoirs.

    a. Hydrometric stations contracted to Water Survey Canada include:

        i. 08GA077 Seymour River below Orchid Creek (stage, flow, temp, ambient weather)
        ii. 08GA010 Capilano River above intake (stage, flow, temp, turbidity, ambient weather)
        iii. Palisade Lake (stage)
        iv. Burwell Lake (stage)
        v. Capilano River below Cleveland Dam (stage, low flow)

b. Hydrometric stations operated and maintained by Metro Vancouver
    i. 08GA079 Seymour River above Seymour Reservoir (stage, temp, turbidity)
    ii. 08GA026 Capilano River above Eastcap Creek (stage, temp, turbidity, ambient weather)
    iii. 08GA027 Eastcap Creek near the mouth (stage, temp, turbidity)
c. Hydrometric stations operated by Water Survey Canada
    i. 08GA030 Seymour River Twin Bridges (stage, flow, temp)
    ii. Snow course stations operated by Metro Vancouver
    iii. Orchid Lake
    iv. Palisade Lake Reservoir
d. Discharge measurements and water withdrawals from gates and valves at the Seymour Falls Dam and the Cleveland Dam
e. Limnology for Capilano and Seymour Reservoirs
    i. Monthly profiles (temp, pH, specific conductance, dissolved oxygen, turbidity, chlorophyll a)
    ii. Monthly chemical and biological samples (bacteria, phytoplankton, zooplankton)
    iii. Continuous (ambient weather, temp profile, turbidity, stage, water)

8. Fish production estimates. Metro Vancouver undertakes annual smolt enumeration from the upper Capilano Watershed and from the lower Seymour Watershed (from Seymour Falls Dam to Twin Bridges).

Species Periodicity: Life history timing for salmonids in the Capilano and Seymour rivers was summarized by the FTWG (see *Appendix E - Assessing Fish Impacts*). To the extent possible this information was based on observations within each river, but information was supplemented with other sources such as information from nearby river systems. The timing windows in these tables indicate times during which approximately 90% of the total activity occurs, so that undue emphasis is not placed on very early or late events or inter-annual extremes.

MOE models and data: Where appropriate criteria and data from the BC Ministry of Environment was used. For example, target flows for spawning and migration were

not directly assessed by JWUP data collection efforts, instead predictions were based on MOE's modified Tennant approach[8].

Literature: Much of the analysis and data collection effort was informed by the primary science literature, and experience garnered from other Water Use Plans in western Canada.

Additional Technical Analyses and Presentations during the JWUP: A number of technical assessments and scoping studies were carried out and presented to the CC and/or technical working groups during the JWUP process. The following is a summary of some of these studies and presentations:

- *Capilano Reservoir: Potential Impacts to Reservoir Ecology from Installation of Hydro Electric Generation*. Presented by Jason McNair.
- *Fish habitat assessment evaluation and utilization study – Upper Capilano and Seymour Watersheds 2010.* Presented by Don McCubbing (Instream Fisheries Research Inc.).
- *JWUP FisheriesTechnical CommitteeYear 1 Flow Gauging and Hydrometrics Update. April 13 2011.* Barry Chilibeck and Piotr Kuras (Northwest Hydraulic Consultants Ltd.).
- *Loch Lomond Reservoir.* Presented by Don McCubbing (Instream Fisheries Research Inc.).
- *Preliminary Concepts for Smolt Passage at Cleveland Dam.* April 2011. Peter Troffe (Knight Piesold Consulting).
- *Steelhead smolt migratory behavior – Capilano Reservoir.* John Day and Erin Rechisky (Kintama Research).
- *Lower Capilano and Seymour Discharge Study*. Don McCubbing, Daniel Ramos-Espinoza (Instream Fisheries Research).
- *Steelhead trout smolt age analysis Capilano and Seymour Rivers 2009 and 2010*. Don McCubbing, C. Fell and J. Ladell (Instream Fisheries)
- *Estimating Steelhead Smolt Yield from the Capilano and Seymour Watersheds.* Don McCubbing, C. Fell, Daniel Ramos-Espinoza (Instream Fisheries Research).

[8] Ptolemy, R. and A. Lewis. 2002. Rationale for Multiple British Columbia Instream Flow Standards to Maintain Ecosystem Function and Biodiversity. Draft for Agency Review. Prepared for Ministry of Water, Land and Air Protection and Ministry of Sustainable Resource Management.

- *Historical Daily Dam Outflows for Representative Dry, Average and Wet Years for Capilano and Seymour Rivers.* Shafiqul Islam, S. Woods (Metro Vancouver).
- *Identify the Flow Sources near the Seymour Fish Hatchery. FTWG Meeting January 2012.* Shafiqul Islam (Metro Vancouver).
- *Cleveland Dam Plunge Pool. FTWG Meeting March 28, 2012.* Shafiqul Islam (Metro Vancouver).
- *Historical Information of Past Water Control Facilities (Dams/Weirs) on Capilano and Seymour Rivers. FTWG Meeting March 28, 2012.* Shafiqul Islam (Metro Vancouver).
- *Capilano Seymour Hydropower March 15th, 2012*. HDR Engineering.
- *Cleveland Dam Outlets Operation Protocol and Ramping Rates. FTWG Meeting July 5, 2012.* Shafiqul Islam (Metro Vancouver).

6 Options

6.1 Introduction

This section provides a summary of the options identified and considered during the planning process by the CC. These options were considered either operational - *specific to setting targets for flow releases from the dams into the lower rivers or in relation to setting preferred water levels in the main reservoirs* – or non-operational (non-flow). The non-flow options were generally organized into those activities generally associated with a WUP or those more aligned (or in response) to historical impacts from the construction of the original water control facilities or to address anticipated effects from the proposed new hydropower facilities. The categorization of non-flow options was not perfect and was meant as a guide to better sort the options based on their cause-effect relationships and subsequent regulatory reviews (this is discussed more in Section 7.8).

6.2 Operating Alternatives

6.2.1 Introduction

A total of 16 operating alternatives were developed and assessed by the CC for the lower Capilano River and a further 13 were considered for the lower Seymour River. As well, two joint alternatives that conceptual linked the two watersheds together were developed and reviewed. The FTWG also considered operating alternatives for Palisade Alpine Reservoir in the upper Capilano watershed and for Burwell and Loch Lomond Alpine Reservoirs in the upper Seymour watershed. These operating alternatives are summarized in the following sections.

6.2.2 Modeling

In order to assess the possible consequences of the various operating alternatives in the lower rivers, Metro Vancouver developed a hydrological model (known as the MIKE11 model, for more details see Box 1). The model served as a water balance tool to predict how much water was available to meet drinking water demand requirements and fishery flow requirements in the lower rivers on a daily basis. The model took into account inflows (rain and snow), trans-evaporation, reservoir characteristics (e.g. storage capacity), and physical parameters of the gates, valves and spillways at the dam for releases into the lower rivers and for diverting water into Metro Vancouver's domestic drinking water system. In addition, the model took into account flows from tributary rivers below the dams and predicted river flows for the entire length of the lower rivers until they were released into the ocean.

Box 1 Overview of the MIKE11 Model used during the JWUP

MIKE 11 is a 1-Dimensional hydraulic Modeling Software developed by Danish Hydraulic Institute and is capable of simulating both steady and unsteady flow in a network of open channels and reservoir systems including various hydraulic structures, such as dams, weirs, spillways, valves, sluice gates, etc.

The MIKE 11 model has the following basic components:

- Model Geometry: river network (drainage), cross sections, and hydraulic structures;
- Boundary Conditions: upstream, downstream, and internal (drinking water withdrawals, evaporation);
- Hydraulic Parameters: channel roughness (calibration);
- Numerical components: time steps, number of iterations;
- Integration of Operational Procedures: various reservoir and dam operational rule curves and operational logic.

During the JWUP CC process, the MIKE 11 model was utilized to produce the following outputs for the Capilano and Seymour systems:

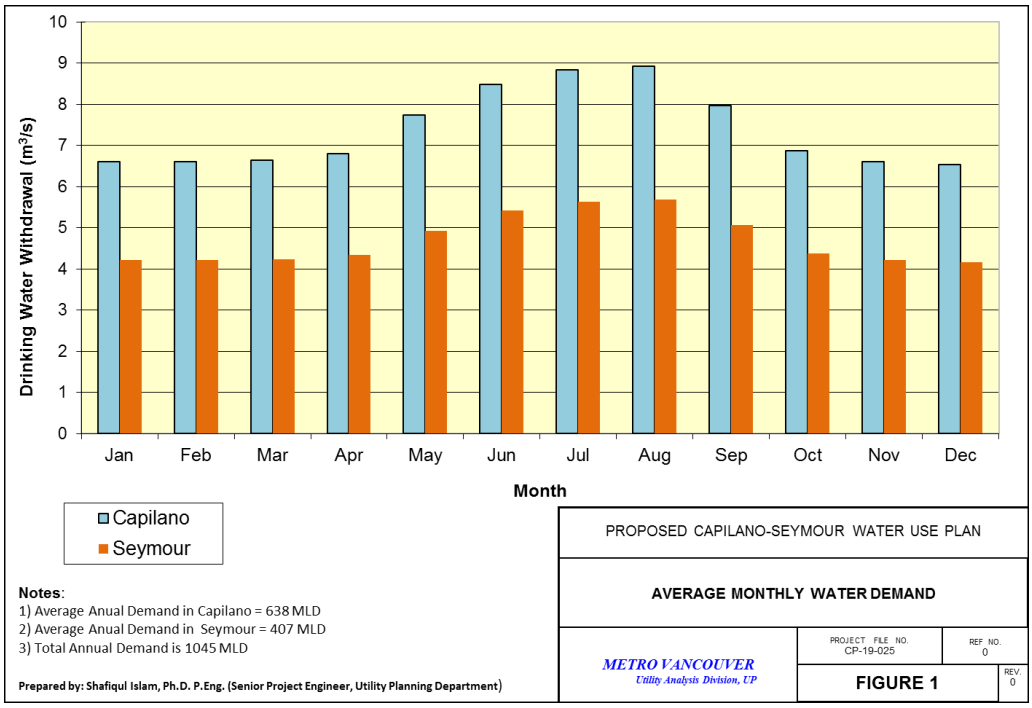
- Reservoir levels (m geodetic);
- Spillway discharges (m^3/s);
- Fish valve discharges (m^3/s);
- Total outflows from the dam to the downstream river (m^3/s);
- Alpine lake storage used in a hydraulic year ($M \cdot m^3$);
- Wetted width and velocity at different locations along the river (m);
- Turbine discharge (m^3/s), average daily and monthly energy production (MW);
- Total annual energy production (GW·h); and
- Number of days favourable for kayaking/canoeing (days).

6.2.3 Modeling Assumptions

The model used historical inflow records for the amount of water that flowed into the main reservoirs for the years 1985 to 2005. In addition, three additional stress years (1915, 1930, 1940) were included within the modeled dataset to better capture summer and fall drought periods, which was seen as the critical period to assess operating alternatives. These three stress years were considered some of the lowest summer / fall inflow conditions (aside from 1987, which was already within the modeled dataset) since the flow gauges and reporting was initiated back in 1915.

The model set monthly water withdrawal rates for Metro Vancouver's domestic water system (see Figure 6-1). The drinking water demand forecasts were based on Metro Vancouver's Drinking Water Management Plan. At Seymour, the monthly water withdrawal rates did not change as a result of projected increased future demand, as Seymour has the highest quality water and is the most cost effective given its higher elevation. At Capilano, monthly water withdrawal rates are set based on the region's projected water demand in the year 2024.

Figure 6-1 Monthly Water Withdrawals Rates used for Modeling Operating Alternatives



The model incorporated the additional storage capacity of the alpine reservoirs in the upper watersheds. Palisade Alpine Reservoir was modelled with a useable storage[9] capacity of 8 million m^3 that could be counted on (note. total storage was 18 million m^3). Burwell was modeled with a useable storage of 12 million m^3 (out of 15.5 total), and Loch Lomond had 6 million m^3 (out of 6.5 total).

In general, releases from these alpine systems would be triggered when the storage in the main reservoirs went below 30% (el. 130.0m for Capilano; and el. 204.5m for Burwell and el. 204m for Loch Lomond in the upper Seymour). Flow releases from the alpine dams would vary depending on how full they were, but generally if they were near full the maximum releases would be approximately 4.5cms at Palisade, 3.3cms at Burwell, and 2.3cms at Loch Lomond.

The model did not take into account additional flows from the hatcheries (from for example groundwater pumps at Capilano or from seepage flows under Seymour Falls dam), as these flows were not considered significant and would have been difficult to model in an accurate manner given their unpredictability.

Tributary inflows below the dams in the lower rivers were modeled as follows:

[9] Useable storage was based on the amount of inflow that could be relied on to refill the reservoir each year.

- No tributary inflows were included along the main length of the lower Capilano River, as there were no significant rivers with the exception of Brothers Creek which was in close proximity to the mouth of the river to the ocean.
- For the tributaries along the length of the lower Seymour, daily inflows were estimated between 1989 and 2005 for each river. All other years (i.e. 1915, 1930, 1940, and 1985 to 1988) the model used estimated flows for the year 1987, which was considered one of the lowest summer / fall flow periods on record. This was seen as a conservative assumption as it would likely under-estimate the actual flows that could be expected.

6.2.4 Operating Alternatives – Lower Capilano River

5 types of operating alternatives were considered for the lower Capilano River during the JWUP process, as follows:

1. Current operations (or status quo) (Alternative 1) – which was meant as a reference point to compare and explore how conditions may change. This alternative did not incorporate changes from the hydropower development.
2. Hydropower (Alternative 2) – which was meant to change operations solely for the benefit of hydropower purposes without having any adverse impacts to drinking water supply[10].
3. Mixed interests (Alternatives 3A – 3F, 4, and 7) – these alternatives were developed to balance the competing interests with more emphasis on meeting environmental values and/or improving conditions for water based recreation in the lower rivers. These alternatives were generally predicated on three water conditions (abundant, average, and drought) to set flow releases to the lower river (the basic principle was when more water is available, more water should be released into the lower river).
4. Fisheries (Alternative 6) – this alternative was based on optimizing flow releases to the lower river for the benefit of aquatic resources.
5. Summertime Pulse Flows – this alternative was meant to facilitate upstream passage of adult salmon from the ocean up the lower Capilano River during extended low flow periods in the summer and fall. This flow option was not developed into an operating alternative, but a preliminary assessment was carried out to assess whether it made sense to pursue these flows.

[10] Note that Metro Vancouver undertook an assessment and determined that reliable drinking water supply would not be adversely affected by allowing water levels in Capilano Reservoir to be lowered by as much as 4m between November 1 and April 30 each year.

A summary of the general operating parameters for these alternatives is summarized in Table 6-1.

Table 6-1 Summary of Operating Alternatives for the lower Capilano River

#	Description	Basic Parameters
1	**Status Quo (Base Case)**	• Current reservoir rules • Current min fish flow 0.57cms (20cfs)
2	**Base Case + Hydro Power**	• Allow 4m drawdown below full pool from Nov 1 to April 30 • Current min fish flow 0.57cms (20cfs)

3A	**Base Case + Hydro + Summer Fish**	• Allow 4m drawdown below full pool from Nov 1 to April 30
		• Current minimum fish flow of 0.57cms except:
		  ○ July 1 to Oct 30 where minimum flow releases vary from 1.2cms to 4.6cms depending on inflows and available storage in the reservoir
		  ○ Flow releases are set on a monthly basis

3B	**Base Case + Hydro Power + Lower Summer Fish**	• Allow 4m drawdown below full pool from Nov 1 to April 30
		• Current minimum fish flow of 0.57cms except:
		  ○ July 1 to Oct 30 where minimum flow releases vary from 0.57cms to 2.3cms depending on inflows and available storage in the reservoir
		  ○ Flow releases are set on a bi-weekly basis

3C	**Base Case + Hydro + Lower Summer Fish + Winter Fish**	• Allow 4m drawdown below full pool from Nov 1 to April 30 • Minimum fish flow releases vary from 0.57cms and 2.3cms between July 1 to Oct 30 depending on inflows and available storage in the reservoir • Minimum fish flow release of 1.2cms between November 1 to June 30 • Flow releases are set on a bi-weekly basis
3D	**Base Case + Hydro + Lwr Summer Fish + Winter Fish**	• Allow 4m drawdown below full pool from Nov 1 to April 30 • Minimum fish flow releases vary from 0.57cms to 2.3cms between June 1 to November 31 depending on inflows and available storage in the reservoir • Minimum fish flow release of 1.2cms between December 1 to May 31
3E	**Base Case + Hydro Power + Lwr Summer Fish + Winter Fish**	• Same as Altern 3D, except for some slightly different criteria for defining the minimum flow targets and for when abundant conditions are triggered on August 30 and September 1
3F	**Base Case + Hydro Power + Lwr Summer Fish + Winter Fish**	• Same as Alternative 3E, except the trigger point for releasing alpine storage water into the main reservoir is earlier. Alpine storage (from Palisade) is released when water levels in the main reservoir drop below 132m (rather than 130m).
4	**Base Case + Hydro Power + Reservoir Fish**	• Same as Alternative 2, except allow only a 2m hydropower drawdown from November 1 to April 30

5A	**Base Case + Hydro + Recreation**	• Allow 4m drawdown below full pool from Nov 1 to April 30
		• Current minimum fish flow 0.57cms, except:
		  ○ Total dam releases of 25cms on the following weekends:
		  ▪ March 2nd and 4th weekends
		  ▪ April 2nd and 4th weekends
		  ▪ May 1st and 3rd weekends
		  ▪ October 2nd and 4th weekends
		  ▪ November 2nd and 4th weekends

#	Description	Basic Parameters
5B	**Base Case + Hydro + Recreation**	• Allow 4m drawdown below full pool from Nov 1 to April 30 • Same minimum flows as Altern 5A except with conditional triggers added based on reservoir elevations. *(Note this alternative was not modeled, as it turned out to be identical to Altern 2).*
6	**Ward Fish Flows**	• Allow 4m drawdown below full pool from Nov 1 to April 30 • Minimum fish flow releases as follows: ○ 6cms between January 1 to March 31 ○ 10cms between April 1 to July 31 ○ Varies between 2cms and 6cms depending on inflows and available storage in the reservoirs from August 1 to November 30 ○ 10cms between December 1 to 31
7	**Base Case + Hydro + lower spring time drawdown**	• Allow 4m drawdown below full pool from Nov 1 to March 14 • Allow 1m drawdown below full pool from March 15 to April 30 • Current min fish flow 0.57cms (20cfs)
-	**Summertime Pulse Flows**	A summer time pulse flow was defined for Cleveland Dam as follows: • 13.1cms dam release • Minimum duration of 8hrs (preferably in the evenings) • Ramp up and down rates as per Metro Vancouver's existing ramping protocol

6.2.5 Operating Alternatives – Palisade Alpine Reservoir

A preliminary aquatic habitat assessment was carried out in the upper watershed and part of this investigation reviewed alternative flow regimes for Palisade Reservoir. Rather than the current maximum summertime flow release of up to about 4.5cms when water is released for drinking water supply purposes to the main reservoir, alternative flow releases of approximately 1cms and 2.3cms were reviewed by the consultants. The FTWG reviewed this preliminary work in relation to area of fish habitat and possible temperature effects.

- **Habitat:** Summer flows in the Eastcap Creek are quite high and given the habitat conditions revealed during the habitat assessment, using Palisade water to increase flows was not expected to provide significant benefits.
- **Temperature**: There was conjecture as to whether higher colder releases from Palisade would adversely affect Coho and Steelhead below the confluence of the Eastcap Creek with the main stem or whether this would be a benefit given the high temperatures which can occur typically in August. Colder temperatures in the Eastcap Creek were not thought to be an issue for the mostly Dolly Varden and Char in this reach. The FTWG agreed to review this through a WUP monitoring study that would assess the optimum flow volume temperature releases.

6.2.6 Operating Alternatives – Lower Seymour River

4 types of operating alternatives were considered for the lower Seymour River during the JWUP process, as follows:

- Current operations (or status quo) (Alternative 1) – which was meant as a reference point to compare and explore how conditions may change. This alternative did not incorporate changes from the hydropower development.
- Hydropower (Alternatives 2) – which was meant to change operations solely for the benefit of hydropower purposes without having any adverse impacts to drinking water supply[11].
- Mixed interests (Alternatives 3, 4A – 4F and Alternative 5) – these alternatives were developed to better balance the competing interests with more emphasis on meeting environmental values and/or improving conditions for water based recreation in the lower rivers. These alternatives were generally predicated on four water conditions[12] (abundant, average, impending drought, and drought) to set flow releases to the lower river (the basic principle was when more water is available, more water should be released into the lower river).
- Fisheries (Alternative 6) – this alternative was based on optimizing flow releases to the lower river for the benefit of aquatic resources.

A summary of the general operating parameters for these alternatives is summarized in Table 6-2.

Table 6-2 Summary of Operating Alternatives for the lower Seymour River

#	Description	Basic Parameters
1	**Status Quo (Base Case)**	• Current reservoir rules • Current rule curve for min fish flows (0.57cms to 1.36cms)
2	**Base Case + Hydro Power**	• Allow 1m drawdown below FP from Nov 1 to April 30 • Current rule curve for min fish flows
3	**Base Case + Hydro Power + Oct Fish**	• Allow 1m drawdown below FP from Nov 1 to April 30 • Current rule curve for min fish flows, except: ○ Minimum fish flow release of 1.36cms from Oct 16 to Nov 15, if reservoir levels are above 207m

4B	**Base Case + Hydro + Summer Fish**	• Allow 1m drawdown below FP from Nov 1 to April 30
		• Current rule curve for min fish flows except:
		  ○ July 1 to Oct 30 where minimum flow releases vary from 0.7cms to 2.8cms depending on inflows and available storage in the reservoir
		  ○ Flow releases are set on a monthly basin

[11] Note that Metro Vancouver undertook an assessment and determined that reliable drinking water supply would not be adversely affected by allowing water levels in Seymour Reservoir to be lowered by as much as 1m between November 1 and April 30 each year.
[12] Rather than the 3 water conditions used for defining the alternatives in Capilano.

#	Description	Basic Parameters

4C	**Base Case + Hydro + Summer Fish**	• Allow 1m drawdown below FP from Nov 1 to April 30
		• Current rule curve for min fish flows except:
		  ○ Minimum fish flow releases vary from 0.7cms to 2.8cms between July 1 to Oct 30 depending on inflows and available storage in the reservoir
		  ○ Flow releases are set on a bi-weekly basis

4D	**Base + Hydro + Lwr Summer Fish + Winter Fish**	• Allow 1m drawdown below FP from Nov 1 to April 30 • Minimum fish flow releases vary from 0.7cms to 2.8cms between June 1 to Nov 30 depending on inflows and available storage in the reservoir • Minimum fish flow release of 1.36cms from Dec 1 to May 31 • *Note. An additional water condition level of "impending drought" was added and targeted a minimum fish flow of 1.1cms prior to dropping down to minimum drought flows of 0.7cms*
4E	**Base + Hydro + Lwr Summer Fish + Winter Fish**	• Same as Alternative 4D, except for some slightly different criteria for defining the minimum flow targets
4F	**Base + Hydro + Lwr Summer Fish + Winter Fish**	• Same as Alternative 4E, except some criteria for defining the minimum flow targets were slightly revised

5	**Base Case + Hydro + Recreation**	• Allow 1m drawdown below FP from Nov 1 to April 30
		• Current rule curve to for minimum fish flow releases, except:
		  ○ Total dam releases of 20cms on the following weekends:
		  ▪ March 2nd and 4th weekends
		  ▪ April 2nd and 4th weekends
		  ▪ May 1st and 3rd weekends
		  ▪ October 2nd and 4th weekends
		  ▪ November 2nd and 4th weekends

6	**Carter Fish Flows**	• Allow 1m drawdown below full pool from Nov 1 to April 30
		• Minimum fish flow releases as follows:
		  ○ 2.8cms from January 1 to February 14
		  ○ 7cms from Feb 15 to May 30
		  ○ Varies between 1.4cms and 2.8cms depending on inflows and available storage in the reservoirs from June 1 to September 30
		  ○ 7cms from October 1 to December 31

7	**Base Case + Winter Fish Flows**	• Current reservoir rules (i.e. no hydropower development) • Current rule curve for min fish flows (0.57cms to 1.36cms), except minimum fish flow release = 1.36cms from Nov 1 to June 30.

6.2.7 Operating Alternatives – Burwell Alpine Reservoir

A preliminary aquatic habitat assessment was carried out in the upper watershed. Given the location and quality of the habitat, flow releases below Burwell Dam were not associated with providing significant fishery benefits. Accordingly, no flow alternatives were proposed for the Burwell facilities.

6.2.8 Operating Alternatives – Loch Lomond Alpine Reservoir

A preliminary aquatic habitat assessment was carried out in the upper watershed and part of this investigation reviewed a flow alternative with a longer sustained flow release of 1.0cms rather than the current maximum release of up to 2.4cms on those years when water is released for drinking water purposes into the main reservoir. The habitat assessment showed that a sustained 1cms release through the summer and early fall provided habitat benefits to juvenile fish.

The FTWG reviewed these benefits in light of the migration barrier below the confluence of Orchid Creek and the fact that Steelhead are currently not transported into the main reservoir and felt that more regular controlled releases do not make sense at this point. A FTWG recommendation was developed for consideration by the CC in relation to Metro Vancouver targeting a lower release from Loch Lomond when releases are made for drinking water purposes (see *Non-Flow Option S2*).

6.2.9 Joint Operating Alternatives – Lower Capilano and Seymour Rivers

At CC meeting #7, the committee reviewed a new concept for an operating alternative which consisted of conceptually allocating water from Capilano to the Seymour system where flows to the lower Seymour River would be augmented by a corresponding reduction in the flows to the lower Capilano River during non-drought periods. This could be achieved through pumping more drinking water from Capilano to the filtration plant at Seymour with the completion of the new tunnel. To avoid significant impacts to the reliable supply of drinking water, it was agreed to only undertake this procedure during non-drought periods (during droughts both systems would be at their minimum flow levels as nobody wanted to reduce flows further in the lower Capilano). It was highlighted that there would be additional pumping costs associated with this alternative and additional greenhouse gas emissions associated with the pumping. This section provides a brief overview of this alternative.

Operating Parameters for Joint Alternative J1

Capilano Alternative 3D and Seymour Alternative 4E were selected as the base conditions for this joint alternative. During non-drought conditions, dam releases from Cleveland are reduced by 0.3cms to augment flows by the same amount below Seymour Falls dam from June 1 to November 30 each year and this would result in the following minimum flow releases:

Water Conditions	Capilano Altern J1 (3D) Min Flows from Dam	Seymour Altern J1 (4E) Min Flows from Dam
Abundant (June 1 to July 31)	**2.0cms** (2.3 – 0.3)	**1.7cms** (1.4 + 0.3)
Abundant (Aug 1 to Nov 30)	**2.0cms** (2.3 – 0.3)	**3.1cms** (2.8 + 0.3)
Average	**0.9cms** (1.2 – 0.3)	**1.7cms** (1.4 + 0.3)

Impending Drought	**0.9cms** (1.2 – 0.3)	**1.4cms** (1.1 + 0.3)
Drought	**0.57cms** (same)	**0.7cms** (same)

Operating Parameters for Joint Alternative J2

The base conditions for this joint alternative consisted of Capilano Alternative 3E and Seymour Alternative 4D. During non-drought conditions, dam releases from Cleveland are reduced by 0.3cms to augment flows by the same amount below Seymour Falls dam from June 1 to November 30 each year and this would result in the following minimum flow releases:

Water Conditions	Capilano Altern J2 (3E) Min Flows from Dam	Seymour Altern J2 (4D) Min Flows from Dam
Abundant (June 1 to July 31)	**2.0cms** (2.3 – 0.3)	**1.7cms** (1.4 + 0.3)
Abundant (Aug 1 to Nov 30)	**2.0cms** (2.3 – 0.3)	**3.1cms** (2.8 + 0.3)
Average	**0.9cms** (1.2 – 0.3)	**1.7cms** (1.4 + 0.3)
Impending Drought	**n/a**	**1.4cms** (1.1 + 0.3)
Drought	**0.57cms** (same)	**0.7cms** (same)

6.3 WUP Non-Flow Options

The following non-flow options were identified and considered during the JWUP process. These non-flow options were grouped into either WUP non-flow options or "other" non-flow options. WUP non-flow options were primarily related to the implementation of any operational changes or alternatively specific recommendations (e.g. enhancement projects) in lieu of any agreed to operational changes, as they may be more effective. The "other" non-flow options summarized below in Section 6.4 were considered more aligned to historical impacts associated with the construction of the original facilities or in relation to the proposed hydropower facilities. Table 6-3 summarizes the WUP non-flow options identified and considered during the planning process (refer to Sections 7.8 and 7.9 for more context).

Table 6-3 WUP Non-Flow Options Considered during the JWUP Process

#	Name	Start Date	Expected Duration	Estimated Costs / yr	Comments
Capilano					
C1	In-Season Management Committee – *after Capilano JWUP flows implemented*	Post Hydro (~2024)	Life of Project	$2,000	After approval of the JWUP, this option would establish a flow committee who would meet on an as needs basis to provide guidance and direction during the implementation of the JWUP. It is expected this would entail seasonal updates and communications including dealing with implementation challenges such as unusual circumstances.
C2	Improved	2013	Life of	n/c	This was specific to improved

#	Name	Start Date	Expected Duration	Estimated Costs / yr	Comments
	Coordination with Capilano Hatchery Smolt Release		Project		coordination and communication between Metro Vancouver and hatchery staff to better ensure that the timing of smolts released at the Capilano hatchery will not occur during a planned reduction in flows from Cleveland Dam.
C3	JWUP Monitoring Committee	Post WUP (~2014)	WUP Review Period		This committee would provide technical input on monitoring studies, provide technical advice on the implementation of JWUP monitoring as needed, and provide a forum for Metro Vancouver to report out on study updates and findings on an annual basis. This committee could be amalgamated with the In-Season Management Committee (item C1)
C4	Preliminary Ramping Rate Protocol	Post WUP (~2014)	Life of Project		Establish interim ramping rates based on the preliminary assessment undertaken by Instream Fisheries. This work was guided by agency guidelines for allowable stage level rate changes. The interim ramping rates are to be updated and adapted through new information collected with monitoring study *C1E – Flow Monitoring of IFR / Stranding Assessment (see Appendix F).*
Seymour					
S1	In-Season Management Committee – *after Seymour JWUP flows implemented*	Post WUP (~2014)	Life of Project	$2,000	After approval of the JWUP, this option would establish a flow committee who would meet on an as needs basis to provide guidance and direction during the implementation of the JWUP. It is expected this would entail seasonal updates and communications including dealing with implementation challenges such as unusual circumstances.
S2	Loch Lomond Alpine Reservoir Recommendation	Post WUP (~2014)	Life of Project		This recommendation was as follows: *"after approval of the WUP, when Metro Vancouver makes releases for drinking water supply purposes, that they target 1cms from Loch Lomond alpine reservoir".*
S3	JWUP Monitoring Committee	Post WUP (~2014)	WUP Review Period		This committee would provide technical input on monitoring studies, provide technical advice on the implementation of JWUP monitoring as needed, and provide a forum for Metro Vancouver to report out on study updates and findings on an annual basis. This committee could be amalgamated with the In-Season Management Committee (item S1).
S4	Preliminary Ramping Rate Protocol	Post WUP (~2014)	Life of Project		Establish interim ramping rates based on the preliminary assessment undertaken by Instream Fisheries. This work was guided by agency guidelines for allowable stage level rate changes. The interim

#	Name	Start Date	Expected Duration	Estimated Costs / yr	Comments
					ramping rates are to be updated and adapted through new information collected with monitoring study *S1F – Flow Monitoring of IFR / Stranding Assessment (see Appendix F).*

6.4 Other Non-Flow Options

"Other" non-flow options were considered more specific to addressing historical impacts associated with the construction of the original water control facilities or anticipated with the development of hydropower at Cleveland Dam and Seymour Falls Dam. Table 6-4 summarizes the "other" non-flow options identified and considered during the planning process (refer to Sections 7.8and 7.9 for more context).

Table 6-4 "Other" Non-Flow Options Considered during the JWUP Process

#	Name	Start Date	Expected Duration	Estimated Cost / yr	Comments
Capilano					
OC1	Upstream and Downstream Fish Passage at Cleveland Dam	Ongoing	Life of project		There were no new specific options developed for the ongoing trap and truck operations with the exception of design criteria for the proposed new hydropower facilities (Item # C-d below) and a number of monitoring studies *C6A and C6B Upstream and Downstream Fish Passage*.
OC2	Real Time Flow Gauges – *Lower Capilano River*	Pre-WUP (i.e. pre ~2014)*	Life of Project	$1,000/yr +$5K upfront	This option includes a real time flow gauge to be permanently installed in the lower river and for this information to be made accessible to the public through the internet. Costs for this option are specific to making the information available to the public (a website), as costs for the equipment were included within monitoring study *C1C and C1D Flow Monitoring of Instream Flow Requirements.* {* Note. initially this option had an expected start date after JWUP approval, but the CC agreed to expedite this option pre-WUP (~2014) during their final meeting.}
OC3	Lower River Forecasting Information – *Lower Capilano River*	Pre-WUP (i.e. pre ~2014)*	Life of Project	$1,000/yr +$5K upfront	This option consisted of providing information to the public on anticipated operational plans and flows in the lower river in the upcoming week. This would therefore provide short term forecasts for how dam releases may vary over time. This information would be shared through an internet website.

#	Name	Start Date	Expected Duration	Estimated Cost / yr	Comments
					The purpose of this option was to better enable paddlers to plan and take advantage of preferred water conditions. {* Note. initially this option had an expected start date after JWUP approval, but the CC agreed to expedite this option pre-WUP (~2014) during their final meeting.}
OC4	Hydropower Design Criteria and Objectives for new hydropower facilities at Cleveland Dam	Preliminary and Detailed Design Phase (2013)	5 years		The FTWG recommended a series of design criteria and objectives in relation to the proposed hydropower facilities at Cleveland Dam. These criteria and objectives were in relation to: 1. Preventing fish entrainment at the hydropower intake 2. Smolt collection system associated with the new facilities 3. Safe downstream passage for smolts 4. Avoidance of operating the spillway during the outmigration period 5. Suitable ramping rates and flows over the widest range of reservoir elevations to avoid fish stranding downstream 6. Exploring a smaller turbine design to generate power year round associated with min fish flows 7. Intake channel designed to improve water temperatures downstream For more information refer to *Appendix H – FTWG Design Criteria & Objectives for Proposed Capilano Power Project*.
OC5	Gravel Recruitment – *Lower Capilano*	Post WUP (~2014)	1 year		During the JWUP, gravel recruitment was suggested as a possible enhancement project below Cleveland Dam. This was in response to the poor spawning habitat and lack of substrate recruitment since the dam was first built. No further work was undertaken to characterize this option.
Seymour					
OS1	Upstream and Downstream Fish Passage at Seymour Falls Dam				Fish passage above Seymour Falls Dam was mentioned during the JWUP process. It was recognized that fish passage fell within the jurisdiction of provincial and federal authorities and until such time as there was clear direction from these fisheries agencies there was no point to

#	Name	Start Date	Expected Duration	Estimated Cost / yr	Comments
					discussing the issue more.
OS2	Real Time Flow Gauges – *Lower Seymour River*	Pre-WUP (i.e. pre ~2014)*	Life of Project	$1,000/yr +$5K upfont	This option includes a real time flow gauge to be permanently installed in the lower river and for this information to be made accessible to the public through the internet. Costs for this option are specific to making the information available to the public (a website), as costs for the equipment were included within monitoring study *S1C, S1D and S1E Flow Monitoring of Instream Flow Requirements.* {* Note. initially this option had an expected start date after JWUP approval, but the CC agreed to expedite this option pre-WUP (~2014) during their final meeting.}
OS3	Lower River Forecasting Information – *Lower Seymour River*	Pre-WUP (i.e. pre ~2014)*	Life of Project	$1,000/yr +$5K upfont	This option consisted of providing information to the public on anticipated operational plans and flows in the lower river in the upcoming week. This would therefore provide short term forecasts for how dam releases may vary over time. This information would be shared through an internet website. The purpose of this option was to better enable paddlers to plan and take advantage of preferred water conditions. {* Note. initially this option had an expected start date after JWUP approval, but the CC agreed to expedite this option pre-WUP (~2014) during their final meeting.}
Joint for both Seymour and Capilano					
OJ1	Assess possible new alpine storage options	Post WUP (~2014)	< 1yr		During the final CC meeting, Metro Vancouver agreed to assess the possibility of additional alpine storage options.
OJ2	Review of Water Shortage Response Levels and Minimum Flow Rule Curves	Post WUP (~2014)	1 year		During the final CC meeting, Metro Vancouver agreed to assess whether triggers could be linked between their Water Shortage Response Levels and the levels in the proposed variable minimum flow rule curves associated with the new alternatives.
OJ3	Regular WUP Progress Updates	2012	Till Hydro facilities are built	n/c	During the final CC meeting, Metro Vancouver agreed to keep CC members informed as to the progress of WUP at key milestone events. For example, • Metro Vancouver internal approval (board) to submit the JWUP • Metro Vancouver submission of JWUP to province

#	Name	Start Date	Expected Duration	Estimated Cost / yr	Comments
					• Province decision on JWUP and direction to Metro Vancouver • Metro Vancouver key design and construction updates • Etc.

7 Assessing the Options

7.1 Introduction

The CC reviewed both operating alternatives and non-flow options during their planning process. The majority of their deliberations and effort were focused on assessing operating alternatives in the lower rivers and these discussions took place during their last four meetings (Meetings 5, 6, 7, and 8). The options assessment was an interactive process that began with the evaluation of modeled alternatives followed by a discussion towards new and improved alternatives to be modeled for the next meeting. Four rounds of options assessment were carried out during the JWUP process. Figure 7-1 and Figure 7-2 summarize the operating alternatives assessed at each CC meeting and identifies those alternatives (if any) that were preferred or selected as the basis for new alternatives. A couple of the alternatives were not modeled based on CC agreement (e.g. Capilano Alternative 7).

Figure 7-1 Capilano Operating Alternatives Reviewed at each CC Meeting

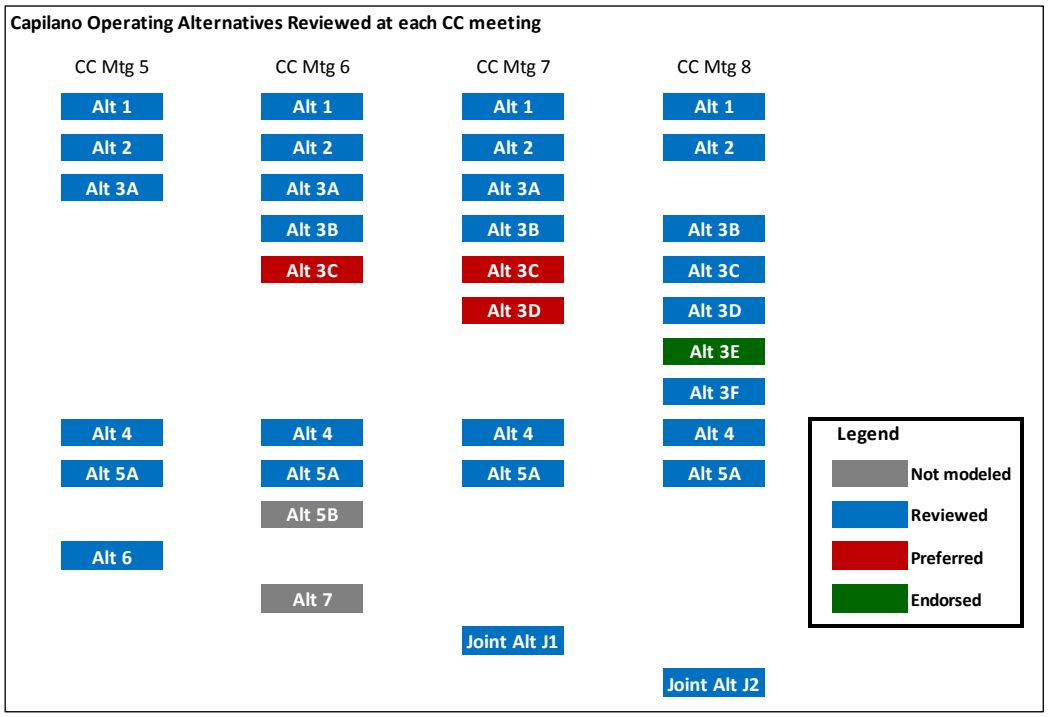
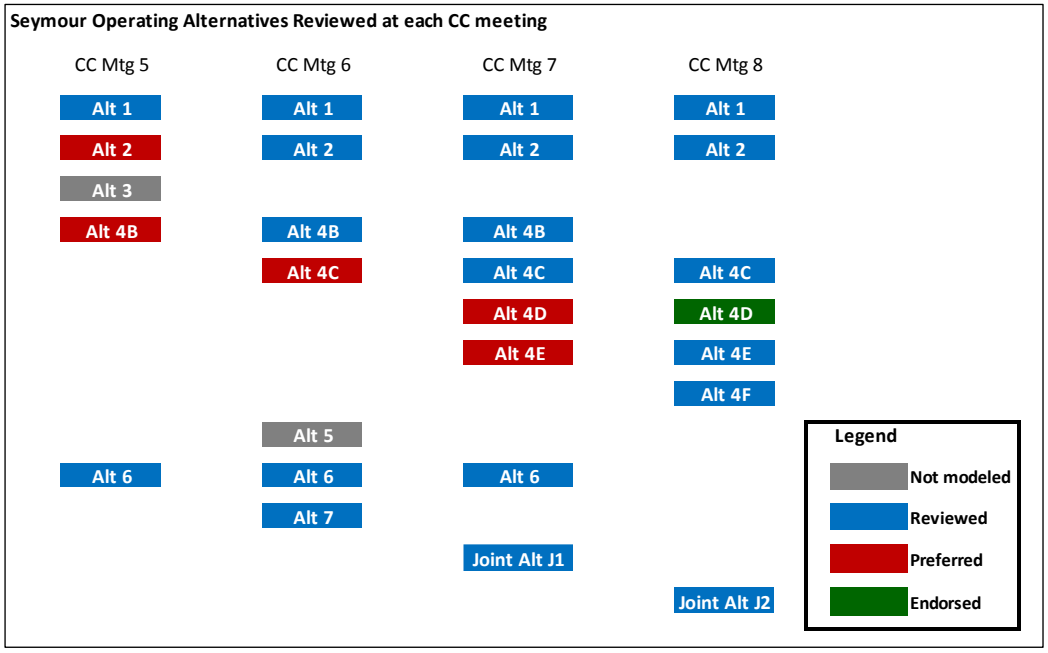


Figure 7-2 Seymour Operating Alternatives Reviewed at each CC Meeting



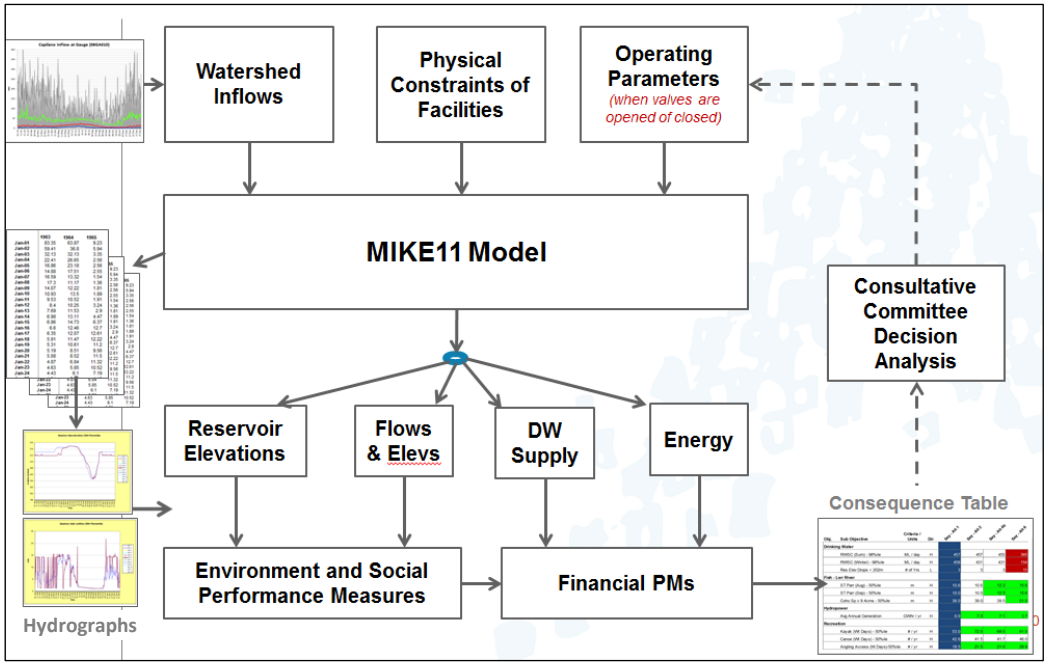
The non-flow options were assessed during the TWG meetings and at CC's final meeting.

7.2 Operating Alternatives

7.2.1 Methods of Assessment

A number of assessment methods were employed during the evaluation of the operating alternatives such as scenario analyses, pair wise comparisons, dominance and sensitivity analyses. The resulting information was summarized through a variety of forms including the use of hydrographs, consequence tables, detailed performance measure graphs, and professional judgements. In general, the assessment of operating alternatives during each meeting consisted of a review of the modeled hydrographs for the rivers and reservoirs, then a review of the calculated performance measures summarized through consequence tables and PM graphs, and lastly through structured discussions by the CC. Figure 7-3 provides a conceptual framework for the iterative options assessment process.

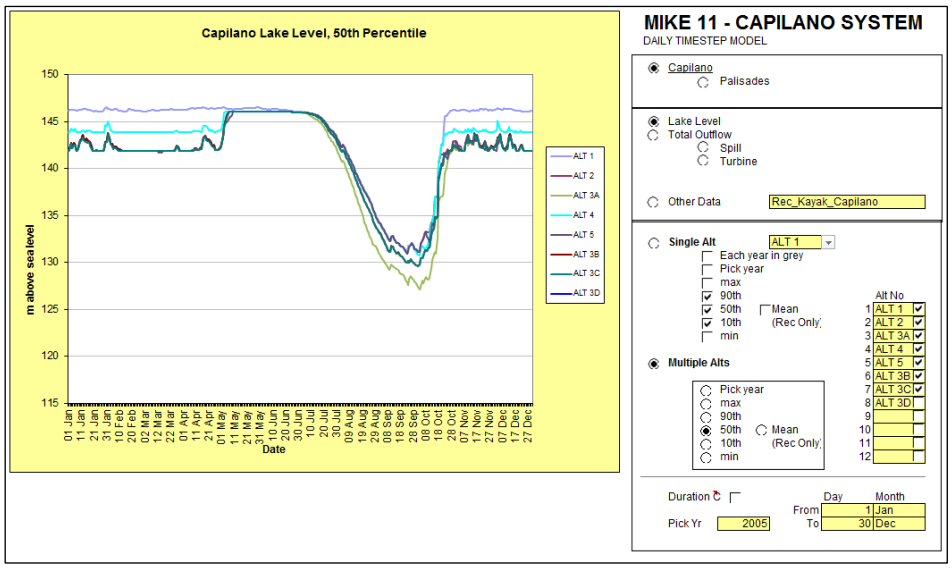
Figure 7-3 Conceptual Framework for the Options Assessment Process



7.2.1.1 Hydrographs

Hydrographs were heavily relied upon for characterizing predicted water conditions – flows and levels – and understanding the consequences of the modeled operating alternatives. These hydrographs summarized the daily conditions in the main reservoirs, the alpine rivers below the alpine reservoirs, and the lower watershed rivers and tributaries based on the output from the MIKE11 model. An excel based compiler was developed to easily and interactively summarize daily flows and water levels on an daily, monthly, yearly, or statistical basis such as 50th percentile (average inflows), 10th percentile (low near drought like conditions) or 90th percentile (wet or abundant conditions), or based on a frequency / duration basis (percentage of time that flows or levels are at, above or below a threshold amount for a given period). Figure 7-4 shows the interface of the compiler that was used to generate the hydrographs from the MIKE11 model outputs.

Figure 7-4 Screenshot of the Compiler Interface used to Generate Hydrographs



7.2.1.2 Consequence Tables

Consequence tables were used to summarize and compare the expected performance of each operating alternatives according to the affected interest areas (as estimated through the calculated performance measures). To better highlight significant and relative differences across the alternatives an interactive colour coded consequence table was used. Figure 7-5 provides an illustration of the consequence table used for the Capilano operating alternatives.

Figure 7-5 Interactive Colour Coded Consequence Table used for Capilano

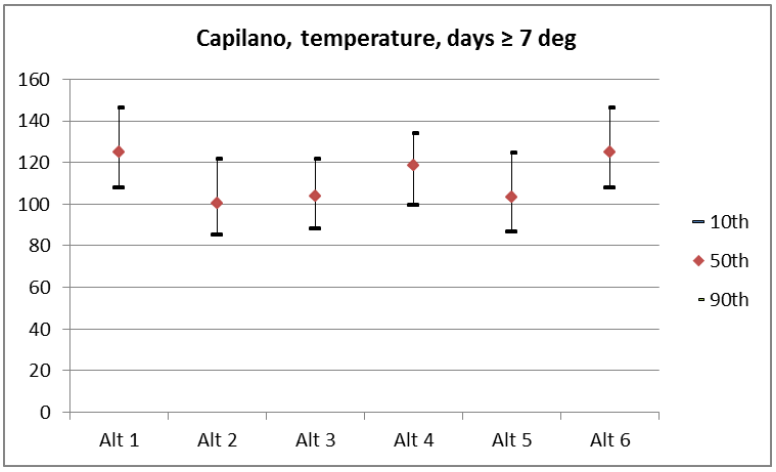
Obj.	Sub Objective	Criteria / Units	Dir	Cap - Alt 1	Cap - Alt 2	Cap - Alt 3	Cap - Alt 4	Cap - Alt 5	Cap - Alt 6
Drinking Water									
	Rel WS Cap (Sum) - 98%	ML / day	H	632	632				
	Res Elev Drops < 121m	# of Yrs	L	2	2	9	2	3	22
Fish - Lwr River									
	Temp ≥ 7°c	Days	H	125.0	100.5	104.0	118.5	103.5	125.0
	ST Parr (Aug) - 50%ile	m	H	6.2	6.2	17.5	6.2	6.2	29.5
	ST Parr (Sep) - 50%ile	m	H	6.2	6.2	17.5	6.2	6.2	16.4
	ST Sp ≥ 11cms - 50%ile	Days	H	33.5	50.0	52.5	47.5	53.5	40.0
Hydropower									
	Avg Annual Generation	GWhr / yr	H	0.0	48.0	46.6	43.7	45.3	35.9
Recreation									
	Kayak (Wt Days) - 50%ile	# / yr	H	0.0	16.3	14.9	15.0	18.3	23.0
	Canoe (Wt Days) - 50%ile	# / yr	H	0.0	15.8	14.4	15.7	18.5	18.7
	Angling Access (W.Days)-50%ile	# / yr	H	0.0	39.8	43.1	22.7	40.3	54.8

Legend
Better than selected
Worse than selected
Selected

7.2.1.1 Detailed PM Graphs

The consequence tables, for the most part, only showed the median values of the performance measures averaged over the 24 year modeled data record and this can hide important information associated with the natural variability between years. It was therefore helpful for some of the performance measures to also summarize the 10th percentile (9 out of 10 years will be better than this value) and 90th percentile (1 out of 10 years will be better than this value) and Median or 50th percentile values (half the years will be better). These statistical summaries were shown through the use of detailed PM graphs.

Figure 7-6 Illustrative Temperature PM Graph Showing 10th, 50th, and 90th Values



7.2.1.2 Pre-Reading Packages

Prior to each consultative committee meeting a pre-reading package was prepared and distributed to CC members. The package included meeting details, updates from the technical working groups, an overview of any new issues or analyses, a review of the current status of the performance measures, and a preliminary assessment of the operating alternatives that included hydrographs, calculated performance measures summarised in a consequence table or detailed PM graphs, and sometimes a commentary to help interpret the implications of the analysis.

7.3 Key Outcomes – Options Assessment at CC Meeting #5

Capilano Operating Alternatives

The CC reviewed and commented on the following operating alternatives 1, 2, 3A, 4, 5A and 6 for the Capilano system. The main outcomes from this review are summarized below.

Topic Area	Comments
Hydropower (without a new near surface intake structure)	It was mentioned that if the existing facilities (i.e. the low-level Howell Bunger valve) were used for hydropower development that the resulting colder water temperatures in the lower river through the spring and fall would adversely affect the health of juvenile steelhead. This was relevant for all the alternatives except the base case Alternative 1.
Productive Fish Habitat	It was emphasized that the majority of the aquatic productive capacity in the Capilano watershed was above the dam (almost opposite to the Seymour watershed). It was noted that the area below Cleveland Dam was the historic habitat for winter steelhead, which was also used by chum and pink salmons.
Recreation	From a canoeing perspective Alternative 5 was best, Alternative 2 was the next most preferred and Alternative 3 appeared the worst. More important than preferred flows was the need for better communication to know when there will be high or low flow days.
Drinking Water	Alternatives 3, 5A, and 6 all had significant impacts on the summer reliable water supply capacity of the system. Moving from Alternative 2 to Alternative 3 resulted in a drop of approximately 150 million litres per day (equivalent to the average water demand of 450,000 people). Some CC members felt that these impacts were too great for the anticipated fisheries benefits and expected improvements in preferred paddling and angling flow levels.
Altern 6	This alternative was removed from further consideration, given the impacts to the reliable drinking water supply capacity and to a lesser extent the loss in hydroelectric generation.
New Alternatives	The CC agreed to explore and develop new options (similar to Alternative 3) that would lessen the impact on reliable drinking water supply capacity while still making improvements to fisheries interests during the summer and the fall.

Seymour Operating Alternatives

The CC reviewed and commented on the following operating alternatives 1, 2, 4B, 5 for the Seymour system. The main outcomes from this review are summarized below.

Topic Area	Comments
Recreation	All the alternatives with hydropower provided significant benefits to water based recreation (i.e. paddling and angling), as the lower river flows were more consistent and nearer preferred levels.
Altern 4B	During some low flow periods in the summer and fall, dam releases to the lower river were below the existing minimum fish flow rule curve. This was unacceptable to a number of CC members.
Altern 6	This alternative was unacceptable to Metro Vancouver. Currently the Seymour system provides water in the winter for almost 1 million people and the proposed alternative would reduce the water supply to about 600,000 people.
New Alternatives	The CC agreed to explore and develop new options with lower river flows between Alternatives 2 and 4B. The goal was to better balance higher flows during low flow summer time periods while lessening the impacts to reliable drinking water supply capacity.

7.4 Key Outcomes – Options Assessment at CC Meeting #6

Capilano Operating Alternatives

The CC reviewed and commented on the following operating alternatives 1, 2, 3A, 3B, 3C, 4, 5A, and 5B for the Capilano system. The main outcomes from this review are summarized below.

Topic Area	Comments
Proposed Hydropower Design	Since the last CC meeting, Metro Vancouver had assessed and now identified a preferred conceptual design option for the proposed hydropower facilities at Cleveland Dam. This new design includes a near surface intake structure for diverting flows through to the proposed hydropower turbines. Aside from offering improved smolt capturing opportunities for the trap and truck program, this option largely addressed the temperature concerns expressed by CC members at the last meeting.
Summer Pulse Flows	The periodic pulse flows from Cleveland Dam to facilitate adult migration up the lower river during prolonged low flow periods in the summer and fall was reviewed by the CC. Given the uncertainty with how successful this operation may be as a result of very cold water temperatures of the pulse flows (as they would rely on releases from the low level outlets on most years), the FTWG recommended an experimental research study to be carried out during the implementation of the WUP prior to recommending this as an add on to the operating alternatives. The CC supported this approach.
Altern 1, 2 (and 5A)	These alternatives were unacceptable to one member and less acceptable to a number of members because of concerns that minimum flows were still too low for fish.
Altern 3A	This alternative was unacceptable to Metro Vancouver as a result of the impacts to the reliable drinking water supply capacity.
Altern 3C	This alternative was agreed to as the most preferred option by CC members. Some members expressed some residual concerns in relation to potential temperature issues, loss in hydropower generation, uncertainty with littoral area versus coho fry production, spring and fall droughts and their effects on drinking water, and a concern that flows to the lower river were still too low from a fisheries perspective.
Altern 5B	The intent of this alternative was to lessen the impact of weekend recreation / paddling flow releases on drinking water. After modeling this alternative with more flexibility, it was observed to be identical to Alternative 2, as the reservoir criteria to trigger higher river flows was consistent with the rules developed for when hydropower generation would occur. As a result, no further improvements were proposed for this alternative.
Altern 7	The intent of this alternative was to explore the implications of a restricted 1m hydropower drawdown in the reservoir from March 15 to April 30 and offset reductions in the amount of littoral area in the event that this was having an adverse impact on juvenile coho. A preliminary assessment revealed that even a 1m drop in water levels had a significant impact on the littoral area. As a result, this alternative was not modeled or considered further.

Topic Area	Comments
New Alternatives	The CC agreed to develop new alternatives based on Alternative 3C with specific attention to extending the minimum flow rule curve into June and November and further refining fishery flows.

Seymour Operating Alternatives

The CC reviewed and commented on the following operating alternatives 1, 2, 4B, 4C, 5, 6, and 7 for the Seymour system. The main outcomes from this review are summarized below.

Topic Area	Comments
Altern 4C	This alternative was the most preferred option by the CC. This alternative effectively dominated the other alternatives based on the calculated performance measure values. However, CC members expressed concerns for how minimum flow releases to the lower river fell below the existing rule curve in the summer in some years.
Altern 5	It was agreed to not model this alternative based on the observations with Capilano Alternative 5 (reservoir criteria to benefit recreation / paddling flows without significantly impacting drinking water turned out to be identical to the criteria used for hydropower generation as in Alternative 2).
New Alternatives	The CC agreed to further refine Alternative 4C with the objectives of a) minimizing flow drops below the existing rule curve, b) avoiding impacts to drinking water supply, c) providing more flexibility to respond to spring and late fall droughts, and d) minimizing winter drought flows associated with the proposed hydropower operations.

7.5 Key Outcomes – Options Assessment at CC Meeting #7

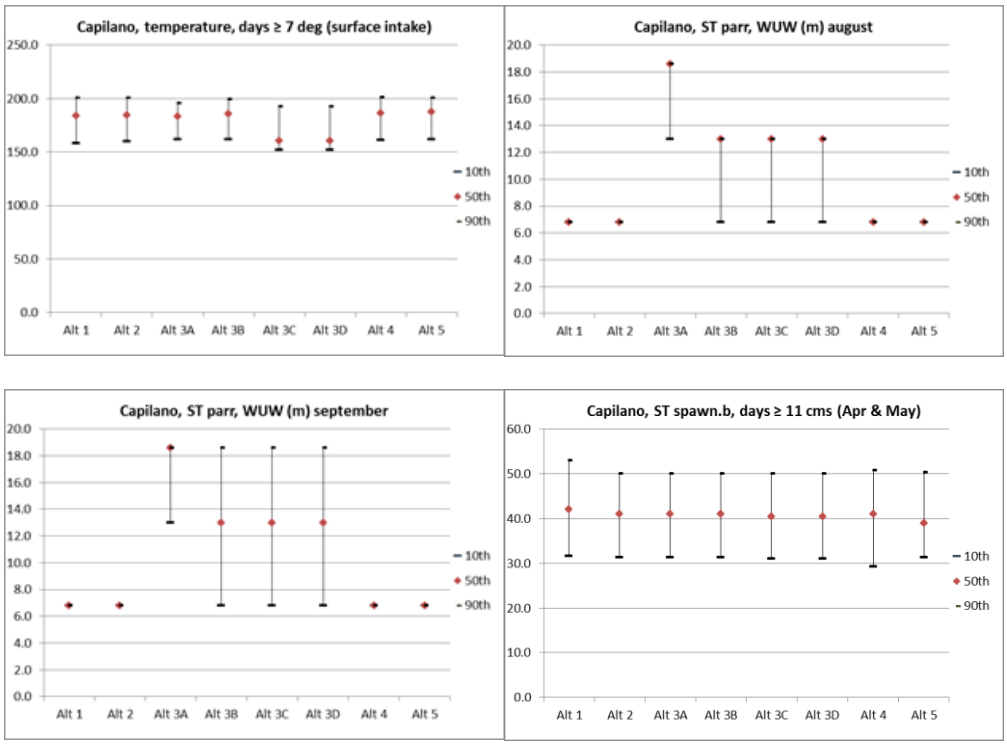
Capilano Operating Alternatives

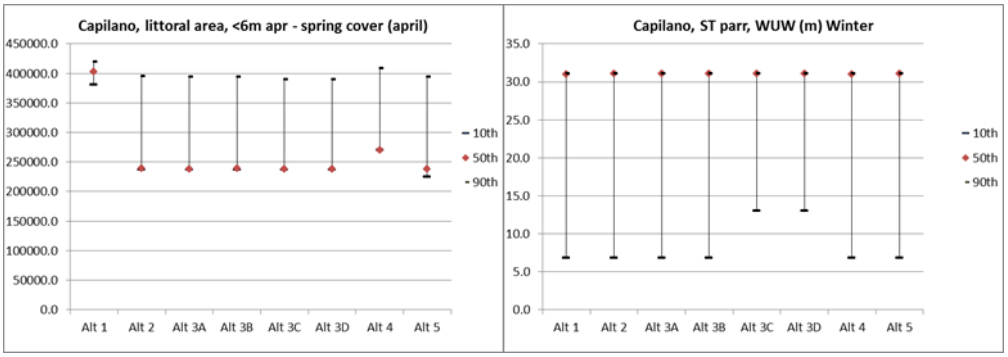
The CC reviewed and commented on the following operating alternatives 1, 2, 3A, 3B, 3C, 3D, 4, 5A, and joint alternative J1 for the Capilano system. The assessment of the alternatives was informed through the consequence table and PM Graphs below.

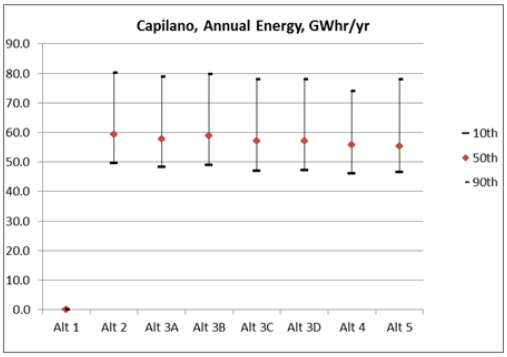
Table 7-1 Consequence Table for Capilano used at CC Meeting #7

Obj.	Sub Objective	Criteria / Units	Dir	Cap - Alt 1	Cap - Alt 2	Cap - Alt 3A	Cap - Alt 3B	Cap - Alt 3C	Cap - Alt 3D	Cap - Alt 4	Cap - Alt 5
Drinking Water											
	Rel WS Cap (Sum) - 98%	ML / day	H	710	710	560	710	710	710	710	642
	RWSC (Winter) - 98%	ML / day	H	1029	892	892	892	875	875	960	825
	Res Elev Drops < 121m	# of Yrs	L	2	2	9	3	3	3	2	3
Fish - Lwr River											
	ST Parr (Aug) - 50%ile	m	H	6.8	6.8	18.6	13.0	13.0	13.0	6.8	6.8
	ST Parr (Sep) - 50%ile	m	H	6.8	6.8	18.6	13.0	13.0	13.0	6.8	6.8
	ST Sp ≥ 11cms - 50%ile	Days	H	42.0	41.0	41.0	41.0	40.5	40.5	41.0	39.0
	ST Parr (Winter) - 10%ile	m	H	6.8	6.8	6.8	6.8	13.0	13.0	6.8	6.8
Fish - Reservoir											
	Littoral Area (April AVG)	1000 m2	H	403	239	238	239	238	238	271	238
Hydropower											
	Avg Annual Generation	GWhr / yr	H	0.0	59.2	57.7	58.9	57.1	57.1	55.9	55.3
Recreation											
	Kayak (Avg % Days ≥ PR 70)	% Days	H	17%	35%	34%	34%	34%	34%	36%	40%
	Canoe (Avg % Days ≥ PR 70)	% Days	H	19%	35%	35%	35%	34%	34%	37%	40%
	Angling (Wt.Days)-AVG	# / yr	H	36.3	40.8	43.8	42.0	42.6	42.7	35.3	40.8

Figure 7-7 PM Graphs for Capilano used at CC Meeting #7







CC members were asked to express their support for the new Alternative 3D according to endorse, accept, accept with reservations, or block. The main comments and rankings from members are summarized below.

Topic Area	Comments
Altern 3C	Two CC members[12] who had previously supported this alternative rescinded their support because of concerns that minimum fish flows in the lower river were too low.
Altern 3D	3 CC members accepted, 9 members accepted with conditions, and 2 members blocked this alternative. The two members[13] who blocked felt that minimum fishery flows were too low. Some conditions or reservations expressed by other members were in relation to the frequency and duration of the 0.57cms minimum fishery flow in the lower river, reliable water supply capacity, improved communications and public access to real time flow monitoring, what flows are accepted in the lower Seymour River, monitoring studies, and the overall package of recommendations that may be included within the WUP.
Alterns 1, 2 (5), 3A, 3B, 4	All other alternatives were unacceptable by one or more CC members primarily as a result of either inadequate fishery flows or impacts to reliable water supply capacity.
New Alternatives	The CC agreed to develop new alternatives based on Alternative 3D with specific attention to avoid the drop to 0.57cms minimum flows on average between October 1 and October 15.

[13] Representatives the Steelhead Society of BC and BC Federation of Drift Fishers.

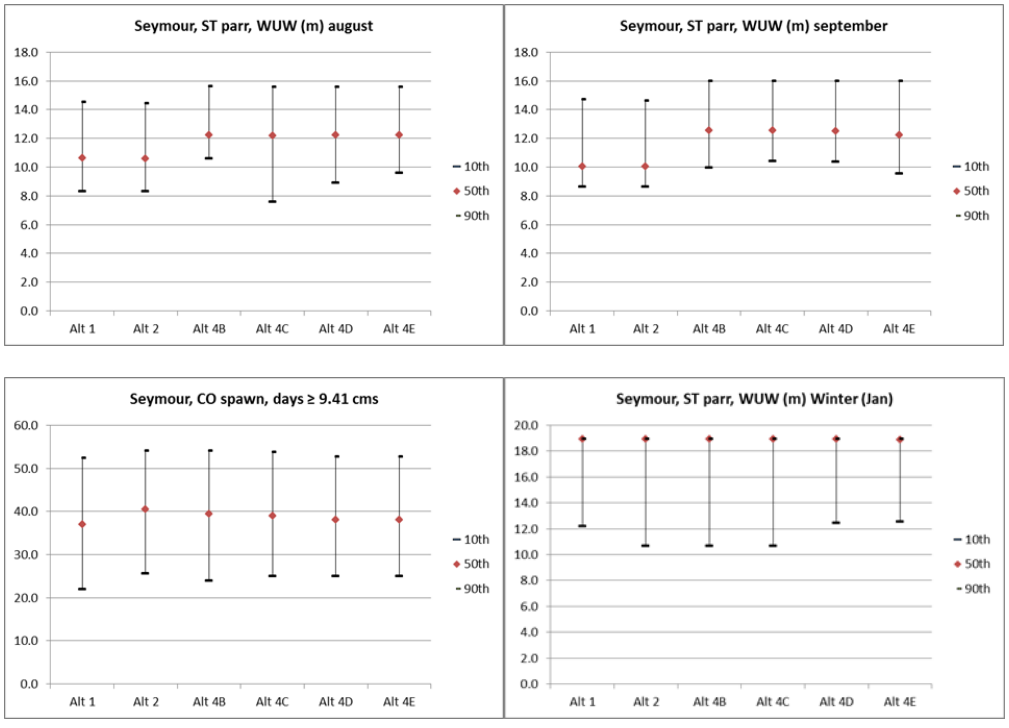
Seymour Operating Alternatives

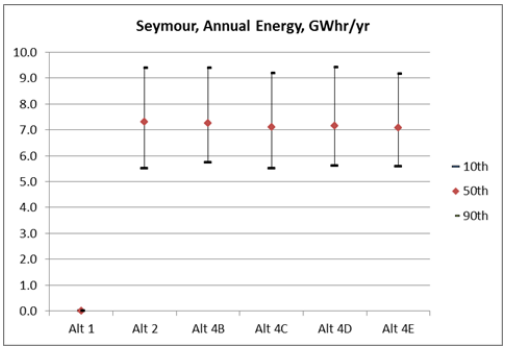
The CC reviewed and commented on the following operating alternatives 1, 2, 4B, 4C, 4D, 4E, 6, and joint alternative J1 for the Seymour system. The assessment of the alternatives was informed through the consequence table and PM Graphs below.

Table 7-2 Consequence Table for Seymour used at CC Meeting #7

Obj.	Sub Objective	Criteria / Units	Dir	Sey - Alt 1	Sey - Alt 2	Sey - Alt 4b	Sey - Alt 4C	Sey - Alt 4D	Sey - Alt 4E	Sey - Alt 6
Drinking Water										
	RWSC (Sum) - 98%ile	ML / day	H	457	457	455	457	457	452	365
	RWSC (Winter) - 98%ile	ML / day	H	458	431	431	431	0	0	154
	Res Elev Drops < 202m	# of Yrs	L	2	3	3	2	3	2	15
Fish - Lwr River										
	ST Parr (Aug) - 50%ile	m	H	10.6	10.6	12.3	12.2	12.3	12.3	15.6
	ST Parr (Sep) - 50%ile	m	H	10.0	10.1	12.6	12.6	12.5	12.3	15.6
	Coho Sp ≥ 9.4cms - 50%ile	m	H	36.0	40.5	39.5	39.0	38.0	38.0	51.0
	ST Parr (Winter) - 10%ile	m	H	12.0	10.7	10.7	10.7	12.4	12.5	14.8
Hydropower										
	Avg Annual Generation	GWhr / yr	H	0.0	7.3	7.2	7.3	7.2	7.1	3.7
Recreation										
	Kayak (Avg % Days ≥ PR 70)	% Days	H	24%	30%	30%	30%	29%	29%	0%
	Canoe (Avg % Days ≥ PR 70)	% Days	H	43%	44%	44%	44%	43%	43%	0%
	Angling (Wt.Days)-AVG	# / yr	H	29.6	31.8	31.7	31.7	31.5	31.5	0.0

Figure 7-8 PM Graphs for Seymour used at CC Meeting #7





CC members were asked to express their support for the new Alternatives 4D and 4E according to endorse, accept, accept with reservations, or block. The main comments and rankings from members are summarized below.

Topic Area	Comments
Altern 4D	Alternative 4D was blocked by 2 CC members[14] because of concerns with low fish flows and as a result of fish flows dropping below the existing minimum flow rule curve during low flow summer periods (in 4 out of 24 years). Other CC members accepted this alternative with reservations related to the timing for hydropower development, a fuller investigation and review of joint alternative J1, drinking water supply, monitoring, improved communications, and accessible real time flow monitoring. A number of CC members expressed concern for delaying the implementation of WUP flows until after hydropower is developed at Seymour, given that the existing infrastructure is capable of delivering these flows.
Altern 4E	Alternative 4E was blocked by 3 CC members[15] because of either concerns that fish flows are still too low or as a result of the expected impacts to drinking water supply. For the Metro Vancouver representatives, the impact to the summer RWSC PM of losing 5 million litres per day moving from Alternative 4D to 4E was unacceptable in light of the similarities in the fish performance measure values. It was also mentioned that the water from the Seymour is the preferred supply choice over Capilano as a result of its quality and high elevation (which reduces pumping costs). Other CC members either abstained[16], accepted this alternative or accepted with reservations related to drinking water impacts, monitoring, improved communications, and accessible real time flow monitoring.
New Alternatives	The CC agreed to further refine Alternative 4E with an aim to lessen the impacts to the reliable drinking water supply capacity.

Joint Operating Alternative

The CC reviewed joint alternative J1 at the meeting. It was highlighted during the meeting that the modeling for the joint alternative was not consistent with the

[14] Representatives from Living Rivers and BC Federation of Drift Fishers.
[15] Representatives from Metro Vancouver and BC Federation of Drift Fishers.
[16] The representative from the District of West Vancouver abstained as a result of the Seymour system being outside the jurisdiction of West Vancouver.

intended parameters and as a result the alternative resulted in more significant impacts to reliable water supply capacity than what was expected. An assessment was provided in the pre-reading package that was distributed to members and this included the comparative consequence tables highlighting the impacts with the base operating alternatives (Capilano Alternative 3D and Seymour Alternative 4E) that were used to develop the Joint Alternative J1.

Table 7-3 Consequence Table for Joint Alternative J1 used at CC Meeting #7

Capilano – Comparison between Altern 3D and Altern J1

Obj.	Sub Objective	Criteria / Units	Dir	Cap - Alt 3D	Cap - Alt J1
Drinking Water					
	Rel WS Cap (Sum) - 98%	ML / day	H	710	710
	Res Elev Drops < 121m	# of Yrs	L	3	4
Fish - Lwr River					
	ST Parr (Aug) - 50%ile	m	H	13.0	10.5
	ST Parr (Sep) - 50%ile	m	H	13.0	10.5
	ST Sp ≥ 11cms - 50%ile	Days	H	40.5	40.5
Hydropower					
	Avg Annual Generation	GWhr / yr	H	57.1	56.8
Financial					
	Increase in Pumping Costs	$ / yr	L	$0	$33,000
Recreation					
	Kayak (Avg % Days ≥ PR 70)	% Days	H	34%	34%
	Canoe (Avg % Days ≥ PR 70)	% Days	H	34%	34%
	Angling (Wt.Days)-AVG	# / yr	H	42.7	41.1
Climate Change					
	Addn Tons of CO2 equiv.	t /yr	L	0	17

Seymour – Comparison between Altern 4E and Altern J1

Obj.	Sub Objective	Criteria / Units	Dir	Sey - Alt 4E	Sey - Alt J1
Drinking Water					
	RWSC (Sum) - 98%ile	ML / day	H	452	428
	Res Elev Drops < 202m	# of Yrs	L	2	2
Fish - Lwr River					
	ST Parr (Aug) - 50%ile	m	H	12.3	13.0
	ST Parr (Sep) - 50%ile	m	H	12.3	13.3
	Coho Sp ≥ 9.4cms - 50%ile	m	H	38.0	40.0
Hydropower					
	Avg Annual Generation	GWhr / yr	H	7.1	7.0
Recreation					
	Kayak (Avg % Days ≥ PR 70)	% Days	H	29%	29%
	Canoe (Avg % Days ≥ PR 70)	% Days	H	43%	43%
	Angling (Wt.Days)-AVG	# / yr	H	31.5	31.5

The main outcomes from the CC's review are summarized below.

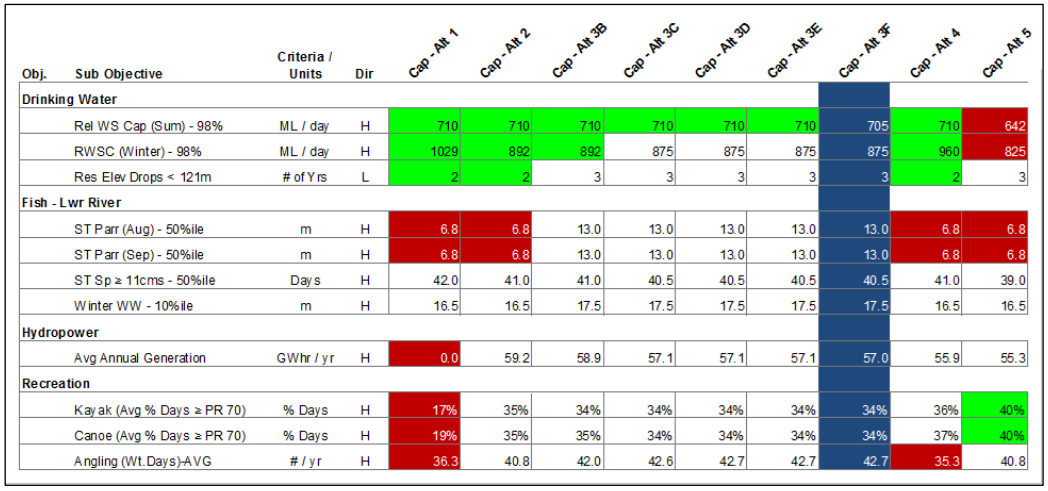
Topic Area	Comments
Joint Altern J1	While many CC members saw benefits of a joint alternative, concerns were raised that the way in which the fisheries benefits were being characterized may not be accurate. A provincial representative (MFLNRO) also mentioned that the province does not promote taking from one watershed at the expense of another one. Aside from the impacts to drinking water, other concerns raised by CC members were related to pumping costs and greenhouse gas impacts.
New Alternatives	The CC requested that the FTWG review how fisheries effects were being characterized and collectively represented. The CC also agreed to refine the joint alternative to lessen the negative impacts.

7.6 Key Outcomes – Options Assessment at CC Final Meeting #8

Capilano Operating Alternatives

The CC reviewed and commented on the following operating alternatives 1, 2, 3B, 3C, 3D, 3E, 3F, 4, 5A, and joint alternative J2 at their final meeting. The assessment of the alternatives was informed through the consequence table below (Figure 7-9), PM graphs, and a review of a number of detailed hydrographs.

Figure 7-9 Consequence Table for Capilano used at CC Meeting #8



Obj.	Sub Objective	Criteria / Units	Dir	Cap - Alt 1	Cap - Alt 2	Cap - Alt 3B	Cap - Alt 3C	Cap - Alt 3D	Cap - Alt 3E	Cap - Alt 3F	Cap - Alt 4	Cap - Alt 5
Drinking Water												
	Rel WS Cap (Sum) - 98%	ML / day	H	710	710	710	710	710	710	705	710	642
	RWSC (Winter) - 98%	ML / day	H	1029	892	892	875	875	875	875	960	825
	Res Elev Drops < 121m	# of Yrs	L	2	2	3	3	3	3	3	2	3
Fish - Lwr River												
	ST Parr (Aug) - 50%ile	m	H	6.8	6.8	13.0	13.0	13.0	13.0	13.0	6.8	6.8
	ST Parr (Sep) - 50%ile	m	H	6.8	6.8	13.0	13.0	13.0	13.0	13.0	6.8	6.8
	ST Sp ≥ 11cms - 50%ile	Days	H	42.0	41.0	41.0	40.5	40.5	40.5	40.5	41.0	39.0
	Winter WW - 10%ile	m	H	16.5	16.5	17.5	17.5	17.5	17.5	17.5	16.5	16.5
Hydropower												
	Avg Annual Generation	GWhr / yr	H	0.0	59.2	58.9	57.1	57.1	57.1	57.0	55.9	55.3
Recreation												
	Kayak (Avg % Days ≥ PR 70)	% Days	H	17%	35%	34%	34%	34%	34%	34%	36%	40%
	Canoe (Avg % Days ≥ PR 70)	% Days	H	19%	35%	35%	34%	34%	34%	34%	37%	40%
	Angling (Wt.Days)-AVG	# / yr	H	36.3	40.8	42.0	42.6	42.7	42.7	42.7	35.3	40.8

As well, a commentary on the new alternatives was provided in the pre-reading package and during the meeting with the following points being highlighted:

- There is very little difference across Alternatives 3D, 3E and 3F according to the hydrographs and performance measures. In general, they all provide significant improvements to fish habitat and recreation in the lower Capilano River over current conditions, as follows:

  <u>Fish Habitat</u>
  - An increase by as much as 2.7 times in the summer when water is considered abundant (an increase from 6.8m to 18.6m in WUW);
  - Approximately a doubling in the summer under average water conditions (from 6.8m to 13m WUW); and
  - During dryer summer and fall periods, no fish habitat benefits are expected over current operations (6.8m WUW).

  <u>Recreation</u>
  - Preferred paddling flows almost double for kayaking and canoeing over current conditions; and
  - Preferred angling days also increase by about +17%.

- Alternative 4F was successful at avoiding the drop to 0.57cms min flows on average in early Oct (through an earlier release of alpine storage), but this resulted in an impact to DW (loss of 5ML/day – RWSC 98%ile(Summer))
- Given the new design constraint of 130m associated with the new proposed hydropower facilities and intake, aside from exploring more creative solutions with how Alpine storage is released, there are limited means available to mitigate the minimum fish flow drop to 0.57cms on most years in the early

fall. This is based on Metro Vancouver's projected water demand in 2024 and it was noted that the frequency of dropping down below 130m in the interim period will be less than what is being represented in the MIKE11 model and hydrographs.

CC members were asked to express their support for the new Alternative 3E and 3F according to endorse, accept, accept with reservations, or block.

Topic Area	Comments
Altern 3E	Alternative 3E was accepted by 4 CC members, and 9 others accepted it with reservations or conditions related to the selection and timing of a preferred flow alternative at Seymour, monitoring studies, non-flow options, design criteria for the proposed hydropower facilities, additional analyses being carried out, and other components of a package for the JWUP.
Altern 3F	Alternative 3F was blocked by the 2 Metro Vancouver CC members because of the impacts to reliable water supply capacity. One CC member accepted the alternative and 9 others accepted with reservations or conditions related to drinking water impacts and/or other needed components within a package such as monitoring, timing, non-flow options, etc.
Conclusion	The facilitator noted that Alternative 3E appeared as the best option for consideration within a JWUP package to take into account and address the CC's residual conditions and reservations. Refer to Section 7.9 for more details on how the CC used Alternative 3E in reaching an agreement for a JWUP package.

Seymour Operating Alternatives

The CC reviewed and commented on the following operating alternatives 1, 2, 4C, 4D, 4E, 4F, and joint alternative J2 for the Seymour system. The assessment of the alternatives was informed through a consequence table (Table 7-4), PM graphs, and a review of a number of detailed hydrographs.

Table 7-4 Consequence Table for Seymour used at CC Meeting #8

Obj.	Sub Objective	Criteria / Units	Dir	Sey - Alt 1	Sey - Alt 2	Sey - Alt 4C	Sey - Alt 4D	Sey - Alt 4E
Drinking Water								
	RWSC (Sum) - 98%ile	ML / day	H	457	457	457	457	452
	RWSC (Winter) - 98%ile	ML / day	H	458	431	431	419	419
	Res Elev Drops < 202m	# of Yrs	L	2	3	2	3	2
Fish - Lwr River								
	ST Parr (Aug) - 50%ile	m	H	10.6	10.6	12.2	12.3	12.3
	ST Parr (Sep) - 50%ile	m	H	10.0	10.1	12.6	12.5	12.3
	Coho Sp ≥ 9.4cms - 50%ile	m	H	36.0	40.5	39.0	38.0	38.0
	Wetted Width (Winter) - 10%ile	m	H	14.7	14.5	14.6	16.2	16.1
Hydropower								
	Avg Annual Generation	GWhr / yr	H	0.0	7.3	7.3	7.2	7.1
Recreation								
	Kayak (Avg % Days ≥ PR 70)	% Days	H	24%	30%	30%	29%	29%
	Canoe (Avg % Days ≥ PR 70)	% Days	H	43%	44%	44%	43%	43%
	Angling (Wt.Days)-AVG	# / yr	H	29.6	31.8	31.7	31.5	31.5

As well, a commentary on the new alternatives was provided in the pre-reading package and during the meeting with the following points being highlighted:

- For the most part, Alternatives 4D and 4E are very similar according to the hydrographs and performance measures. In general, both alternatives provide improvements to fish habitat and kayaking flows in the lower Seymour River over current conditions: on average an increase in weighted useable width of 1m (~+13%) in dryer years (10thile); 1.8m (~+18%) on average (50thile); and 1.2m (~+9%) during wetter summers (90thile).
- It was also noted that the absolute minimum flows were increased for Alternatives 4D and 4E by about 22% (from 0.57cms to 0.7cms) in the summer and fall time period; and minimum flows in the winter were increased to 1.36cms where the current rule curve can be as low as 0.57cms at times. Minimum flows for Alternative 4D dropped below the existing rule curve more regularly than Alternative 4E for the absolute lowest summer flow days across the 24 year modeled dataset.
- In very dry summers and falls there are some differences between the alternatives. This results in a loss of 5ML/day from a reliable water supply capacity (98%ile) for Alternative 4E. Alternative 4E was more effective at avoiding periods when minimum flows would drop below the existing rule curve (only 1 two week period over the 24 modeled years rather than Alternative 4D where 4 out of 24 years dropped below the existing rule curve).

CC members were asked to express their support for the new Alternative 4D and 4E according to endorse, accept, accept with reservations, or block.

Topic Area	Comments
Altern 4D	Alternative 4D was endorsed by 2 CC members, accepted by 5 CC members, accepted with reservations or conditions by 4 CC members related to other needed components within a package such as monitoring, timing, non-flow options, and concerns about drinking water impacts. 1 CC member abstained given the Seymour was outside their area of interest[17].
Altern 4E	Alternative 4E was endorsed by 1 CC member, accepted by 5 CC members, accepted with reservations or conditions by 2 CC members and blocked by 3 CC members[18] because of drinking water impacts. 1 CC member abstained given the Seymour was outside their area of interest[19].
Conclusion	The facilitator noted that Alternative 4D appeared as the best option for consideration within a JWUP package to take into account and address the CC's residual conditions and reservations. Refer to Section 7.9 for more details on how the CC used Alternative 4D in reaching an agreement for a JWUP package.

Joint Operating Alternatives

The CC reviewed a recommendation from the FTWG specific to the joint alternatives (J1 and J2) that was included in the Pre-Reading Package for CC Meeting #8, which read:

> *The FTWG recommended that the Joint Alternatives be dropped from further consideration at this point based on the overall anticipated fishery benefits, and given:*
>
> *i. the current vulnerable status of the winter Steelhead population in the Capilano system (and as compared to the health and abundance of the steelhead in the Seymour system),*
>
> *ii. the desire to not drop flows more regularly below the average conditions in Alternative 3D of 1.2cms (i.e. to 0.9cms), which is already viewed as sub-standard from a fishery perspective,*
>
> *iii. the potential adverse temperature effects at Capilano given the lower amount of warmer water being released from the new near surface intake in the summer (0.3cms less), and*
>
> *iv. the higher mortality of wild Seymour steelhead migrating through Coal Harbour.*

[17] Representative from District of West Vancouver.
[18] Representatives from Metro Vancouver and North Shore Community Association.
[19] Representative from District of West Vancouver.

The CC agreed with the FTWG's recommendation and the joint alternatives were dropped from further consideration.

For more details and information about the CC's final meeting refer to *Appendix G – Meeting Notes from Final CC Meeting #8.*

7.7 Monitoring Studies – Assessment

The Consultative Committee reviewed and discussed candidate studies during their last two meetings. At their final meeting, the CC reviewed the recommended FTWG Monitoring Program (summarized in *Appendix F – FTWG Monitoring Program Presented to CC*) and was asked to consider each study according to the following two questions:

1. What is the likelihood that a study result will lead to a change in a future water management decisions?
2. What is the relative importance of the study given the uncertainty, study cost, value of information?

CC members were asked to rank each study according to priority, as follows:

High this study must be undertaken in order to make responsible future water management decisions

Medium this study is recommended as it will likely affect future water management decisions

Low this study is not likely going to serve as a basis to make future water management decisions

"NC" If CC members do not feel they are able or knowledgeable enough to rate a particular study, they can also respond "NC" – No Comment

Table 7-5 and Table 7-6 provide a summary of the CC rankings for each study and any associated relevant comments or amendments that were agreed to at their final July 19, 2012 meeting. It is noted that the Capilano system included biological response monitoring given the expected improvements to fish and fish habitat, whereas in the Seymour system the response monitoring was not expected to provide meaningful results within a reasonable timeframe given the smaller change in flows. For more specific details on the individual studies, please refer to *Appendix F*.

Table 7-5 CC Recommended Monitoring Studies for Capilano

Study		CC Priority	Approx Start Date	Expected Duration	Estimated Costs / yr	CC Comments
C1A	Monitoring of fish flow releases and drinking water withdrawals	High	Ongoing	life of project	$5,000	Supported based on FTWG recommendation
C1B	Monitoring of hydropower water withdrawals	High	Post Hydro (~2021)	life of project	$1,000	Supported based on FTWG recommendation
C1C	Flow monitoring of instream flow requirements (IFRs)-*prior to JWUP impl.*	High	Present	JWUP approval (~2014)	$30,000	Supported based on FTWG recommendation
C1D	Flow monitoring of instream flow requirements (IFRs) - after JWUP	High	JWUP approval (~2014)	life of project	$20,000	Supported based on FTWG recommendation
C1E	Flow monitoring of IFR / stranding assessment (ramping)	High	Post Hydro (~2021)	life of project	$5,000 +$50k study	Supported based on FTWG recommendation
C1F	Water level monitoring in Capilano Reservoir	High	JWUP approval (~2014)	Life of project	$5,000	Supported based on FTWG recommendation
C1G	Inflow monitoring to Capilano Reservoir	High	JWUP approval (~2014)	Life of project	$25,000	Supported based on FTWG recommendation. It was also noted that reservoir inflows are also built into the variable level rule curve for setting minimum flows in Alternative 3E.
C1H	Temperature monitoring 1 – Lower River	High	Post JWUP Approval / 2 yrs before Hydro (~2019)	3-5 years	$10,000	Supported based on FTWG recommendation. The timing would begin 1 or 2 years before commissioning of the hydropower project and continue for 2 to 3 years afterwards to assess temperature effects with the new flow regime (Alt 3E) in the lower river.
C2	Temperature monitoring 2 – Palisade alpine reservoir flow releases	Med	JWUP approval (~2014)	3-5 years	$7,500	The FTWG ranked this study as a lower priority, based on differences of opinion on the importance and significance of temperature effects in the upper watershed. CC members deferred to the province on this study, given the species and the issues. The province supported the study, but considered it a Medium priority. It was further noted that the costs for this study would be less if the study was shortened from the original 3 to 5 years identified by the FTWG. CC members supported better understanding the relationship between different flow releases from Palisade reservoir and possible effects (either positive or negative) on fishery values in the Eastcap Creek and Upper Capilano Rivers.
C3	Upstream migration enhancement using pulse flows	Med	Post Hydro (~2021)	3-5 years	$120,000 per yr	The FTWG ranked this study as a lower priority, based on differences of opinion. The study was associated with potentially significant stranding risks and uncertain outcomes, if delivered through the low level Howel-Bunger valve which has limiting ramping abilities and would be associated with very cold (~4c) temperature releases. Accordingly, the CC felt that this would be a high risk study with uncertain results. It was

Study		CC Priority	Approx Start Date	Expected Duration	Estimated Costs / yr	CC Comments
						therefore agreed to wait to carry out this study until the new near surface intake structure was built. The new hydropower facilities would address the potential stranding issues and cold water temperature issues, although the opportunities to carry out pulse flows would be reduced to only periods when reservoir levels were above 130m. It was also recognized that new information collected between now and 2021 will better inform whether this study should be carried out or not. The CC ranked this deferred study as a Medium priority.
C4	Status and trends of key fish species	High	2 yrs prior to Hydro (~2019)	2 yrs baseline 5 yrs post-hydr	$100,000	Supported based on FTWG recommendation
C5	Reservoir littoral area	Med	JWUP approval (~2014)	1-2 yrs	$20,000	The FTWG ranked this study as a lower priority, based on the challenges of understanding all the competing factors (impact hypotheses) that may be influencing coho fry production and the relevance and importance of changed reservoir operations as a result of hydropower drawdowns in the spring time. The CC considered the research question as very important, but recognized the complexity of trying to meaningfully answer it. To this degree the CC agreed to the following approach: • Undertake a literature review on similar systems in the Pacific Northwest • Scope out and characterise what an appropriate research program would look like to adequately address this research question. The CC ranked this revised study as a Medium priority. *(It was also suggested that this may provide an opportunity for a graduate researcher as a thesis.)*
C6A	Upstream and downstream fish passage at Cleveland Dam / efficacy of new intake screens	High	Post Hydro (~2021)	life of project	$5,000	Supported based on FTWG recommendation
C6B	Upstream and downstream fish passage at Cleveland Dam	High	Ongoing / Post Hydro (~2021)	Scaling down intensity over time	$100,000	Both the FTWG and CC considered the ongoing work to enumerate outmigrating smolts being transferred as a part of the ongoing trap and truck program as a high priority. After the operation of the new smolt capture facilities (using the new hydropower intake channel) are refined and optimized, the intensity of effort involved with the smolt monitoring program would be expected to decrease.
C7	Gravel Recruitment and Nutrient Enrichment Scoping Assessment	High	Post WUP	1 yr	-	This scoping study was added by the CC during the development of a JWUP package. The study would explore and scope out opportunities for enhancement projects in the lower Capilano River.

Study		CC Priority	Approx Start Date	Expected Duration	Estimated Costs / yr	CC Comments
Assessment Related Studies *(in relation to new hydropower facilities)*						
C9	Distribution and abundance of SARA-listed species	n/a	As discussed with regulators	1 year	$24,000	*CC did not evaluate or rank these studies, as they were considered to be a part of Metro Vancouver's environmental assessment that will be defined in discussions with the appropriate regulatory agencies*
C10	Stranding within the drawdown zone			1 year	$15,000	
C11	Level 1 and Level 2 Fish Habitat Assessments (FHAP)			1 year	$25,000	
C12	Habitat compensation plan			1 year	$25,000	

Table 7-6 CC Recommended Monitoring Studies for Seymour

Study		CC Priority	Approx Start Date	Expected Duration	Estimated Costs / yr	Additional CC Comments
SEY 1A	Monitoring of fish flow releases and drinking water withdrawals	High	Ongoing	Life of project	$ 5,000	Supported based on FTWG recommendation
SEY 1B	Monitoring of hydropower water withdrawals	High	Post Hydro (~2024)	Life of project	$ 1,000	Supported based on FTWG recommendation
SEY 1C	Flow monitoring of instream flow requirements (IFRs) - prior to JWUP	High	Present	JWUP approval (~2014)	$30,000	Supported based on FTWG recommendation
SEY 1D	Flow monitoring of instream flow requirements (IFRs) - after JWUP impl	High	JWUP approval (~2014)	Life of project	$20,000 +$16K for equip	Supported based on FTWG recommendation
SEY 1E	Flow monitoring of instream flow requirements (IFRs) at WSC gauge at Twin Bridges	High	TBD	Life of project	WSC Funds	Supported based on FTWG recommendation. (Note. This is an allowance should WSC funds not be available in the future and the importance of this gauge from a fisheries perspective).
SEY 1F	Flow monitoring of IFR / stranding assessment (ramping rates)	High	JWUP approval (~2014) Field study post hydro (~2024)	Life of project	$5,000 +$50k study	The collection and review of real time flow data would begin after JWUP approval to assess ramping rates in relation to the preliminary ramping protocol developed by Instream Fisheries, where the rate of change in stage levels is defined by agency guidelines. Field study ($50K) to assess ramping rates in sensitive stranding areas to be deferred until after commissioning of hydropower at Seymour Falls dam (not expected until 2024) or earlier based on a decision by Metro Vancouver to expedite this study given the potential changes that may be needed to their existing ramping rates as compared to Instream's assessed rates.
SEY 1G	Water level monitoring in	High	JWUP approval	Life of project	$ 5,000 +$10K for	Supported based on FTWG recommendation

Study		CC Priority	Approx Start Date	Expected Duration	Estimated Costs / yr	Additional CC Comments
	Seymour Reservoir		(~2014)		equip	
~~SEY 1H~~	~~Inflow monitoring to Seymour Reservoir~~	~~High~~	~~JWUP approval (~2014)~~	~~Life of project~~	~~$25,000~~	While the CC believed that this study was important information, most felt that this study should not be tied to a WUP. The provincial representative on the CC believed this will be a compliance issue for the WUP and it was agreed to let Metro Vancouver discuss this study further with the province.
~~SEY 1I~~	~~Temperature monitoring 1~~	~~High~~	~~JWUP approval (~2014)~~	~~Life of project~~	~~$5,000~~	The FTWG ranked this study as a lower priority, based on differences of opinion. The CC agreed to delete this study based on their current understanding of the issues and given the expected flow changes being recommended and as a result of the expected hydropower operations in the future. It was noted that temperature issues are not currently considered a significant issue; the proposed operational changes associated with Alternative 4D are not significantly different from current operations; the proposed intake structure for the proposed hydropower facility will be at a similar depth as the existing low-level outlet; hydropower operations will likely not be operated through the summer and early fall time period; the reservoir is not stratified through most of the winter; the most important fish habitat is quite far downstream and temperature effects would be moderated by both travel time and tributary inflows.
SEY 2	Status and trends of key fish species	High	Pre-WUP	Till 2014	$50,000	Supported based on FTWG recommendation and the recognition of the importance of continuing to collect this information up till the point that the JWUP is approved. Once the JWUP is approved, this study would not be expected to continue.
SEY 3	Entrainment at Seymour Dam	High	Post Hydro (~2024)	Life of the project	$ 5,000	Supported based on FTWG recommendation
SEY 4	Gravel Recruitment and Nutrient Enrichment Scoping Assessment	High	Post WUP	1 yr	-	This scoping study was added by the CC during the development of a JWUP package. The study would explore and scope out opportunities for enhancement projects in the lower Seymour River
Assessment Related Studies *(in relation to new hydropower facilities)*						
SEY 5	Distribution and abundance of SARA-listed species	n/a	As discussed with regulators	1 year	$ 24,000	*CC did not evaluate or rank these studies, as they were considered to be a part of Metro Vancouver's environmental assessment that will be defined in discussions with the appropriate regulatory agencies*
SEY 6	Level 1 and Level 2 Fish Habitat Assessments (FHAP)			1 year	$ 60,000	
SEY 7	Habitat compensation plan			1 year	$ 25,000	

7.8 Non-Flow Options – Assessment

A number of non-flow related options were raised during the consultative process and these were generally sorted into categories of either within the anticipated terms and conditions of a water license under the *Water Act* (i.e. considered within a WUP) or outside it. The CC reviewed eligibility criteria that have been applied to other WUPs when considering non-flow options, as follows:

- A correlation between operations and the proposed benefits of a non-flow option
- The magnitude of the benefits (in relation to the operational impacts it is attempting to replace)
- The costs (upfront / ongoing) for the non-flow option over time
- The uncertainty or risks of achieving the anticipated benefits
- Potential costs for any studies or assessments associated with the non-flow option
- The overall level of support by the CC for the option

Also, given the unique nature of Metro Vancouver's JWUP, the CC identified 4 reasons that may justify the inclusion of a non-flow option, as follows:

1. In lieu of an operational flow change under the WUP (based on agreement of a preferred flow alternative by the CC) and the premise that the non-flow option is more effective at providing the expected and commensurate benefits
2. As a means to mitigate or compensate for impacts associated with the proposed hydropower facilities
3. As a means to better facilitate long term fish passage at Capilano as this was agreed to at the beginning of the process as an in-scope consideration
4. As a voluntary measure by Metro Vancouver to better meet their sustainability goals, objectives, and/or policies

At the final CC meeting held on July 19, 2012, the CC assessed and agreed to a number of non-flow options for inclusion within a JWUP Package towards building a consensus agreement. While some non-flow options were agreed to at the meeting, others were not. The next section describes which non-flow options were supported and included within the endorsed JWUP package. For a complete summary of all the non-flow options considered during the JWUP refer to Section 6.4.

7.9 Reaching Agreement on a JWUP Package

During the final meeting, CC members were first asked to individually rank and assess the flow options and monitoring studies separately as building blocks towards the development of a JWUP Package of recommendations that would consider other

elements such as non-flow options or timing issues with implementing some of the activities. The concept of bundling various components together also allowed for better considering possible effects of the proposed hydropower facilities as well as making improvements to some historical impacts associated with construction of the original facilities. The components or building blocks for the packages included operating alternatives, monitoring studies, non-flow options, scheduling and implementation items, and a number of voluntary actions not necessarily linked to requirements of a water license (under the *Water Act*).

A preliminary JWUP Package was discussed by the CC at the meeting and this was subsequently amended to address residual concerns and issues expressed by some CC members (for more context about the residual concerns and specific comments made by CC members refer to *Appendix G – Meeting Notes from Final CC Meeting #8*). The amended package was referred to as "JWUP Package A". CC members were asked to express their support for "JWUP Package A" according to the following criteria:

Endorse	I fully support this package of recommendations
Accept	I support this package of recommendations
Accept with reservations	I accept this package with the following reservations / conditions
Block	I cannot live with this package (provide reasons)

The Consultative Committee unanimously **endorsed** "JWUP Package A" without any additional conditions[20].

The remainder of this section provides a summary of the main components of the agreed to "JWUP Package A" endorsed by the Consultative Committee.

"JWUP Package A" - Recommended Operating Alternatives

- **Capilano Alternative 3E** – to be implemented after JWUP approval and the commissioning of the hydropower facilities at Capilano Dam, which is currently scheduled for 2021.
- **Seymour Alternative 4D** – to be implemented after JWUP approval, which is expected in 2014.

[20] It needs to be emphasized that while "JWUP Package A" was a consensus-based recommendation, many CC members still expressed concerns that the anticipated fishery benefits for the Capilano system would not be realised for up to about 10 years based on the current schedule to construct the hydropower facilities at Cleveland Dam. CC members understood that this delay was a result of the need to have new water control facilities built in order to effectively augment and increase minimum fish flows in the lower Capilano River.

"JWUP Package A" – Recommended Review Periods

The CC reviewed an appropriate review period to assess the implemented JWUP at Capilano and Seymour. When recommending a review period the CC considered the timeframe for assessing anticipated benefits and addressing key uncertainties, the timing for when new hydropower facilities could be commissioned, the costs associated with a public review process, and the possible triggers that would warrant and earlier review. While a concurrent review of both Seymour and Capilano is ideal, given the long delay before the Capilano JWUP flows may be implemented, the CC agreed to the following:

- **Review Period for Seymour** – 15 years after JWUP approval (currently estimated at ~2029)
- **Review Period for Capilano** – 10 years after the hydropower facilities at Cleveland Dam are commissioned (currently estimated at ~2032)

The CC also discussed triggers that may warrant an earlier review including events associated with biologically significant events, or if external factors affect the ability to deliver the preferred flow alternatives, or if the CC agrees to pre-defined criteria. Metro Vancouver agreed to develop triggers for consideration prior to the scheduled review period.

"JWUP Package A" - Recommended Monitoring Studies

As agreed to by the CC and summarized in Section 7.7.

"JWUP Package A" – WUP Non-Flow Options

The following non-flow options were agreed to and while these options were not considered in lieu of operational changes associated with the eligibility criteria defined for WUPs (mentioned in Section 7.8), they are considered operationally related and/or associated with common communication activities in WUPs that have been adopted in other locations. Accordingly these non-flow options were expected to be included within the licensing requirements found within a WUP (for more details on these refer to Section 6.3).

#	Name	Start Date	Expected Duration	Estimated Cost / yr	Additional CC Comment
Capilano					
C1	In-Season Management Committee – *after Capilano JWUP flows implemented*	Post Hydro (~2024)	Life of Project	$2,000	No additional comments
C2	Improved Coordination with Capilano Hatchery	2013	Life of Project		This recommendation was for improved coordination and communication between Metro Vancouver and hatchery

#	Name	Start Date	Expected Duration	Estimated Cost / yr	Additional CC Comment
	Smolt Release				staff to better ensure that the timing of smolts released at the Capilano hatchery will not occur during the planned decrease in flows at Cleveland Dam
C3	JWUP Monitoring Committee	Post WUP (~2014)	WUP Review Period		This committee would be expected to provide technical input on monitoring studies, provide technical advice on the implementation of JWUP monitoring studies as needed, and provide a forum for Metro Vancouver to report out on study updates and findings on an annual basis.
C4	Preliminary Ramping Rate Protocol	Post WUP (~2014)	WUP Review Period		Establish interim ramping rates based on the preliminary assessment carried out by Instream Fisheries or until such time as more detailed habitat analysis (Study C1E) suggests different rates.
Seymour					
S1	In-Season Management Committee – *after Seymour JWUP flows implemented*	Post WUP (~2014)	Life of Project	$2,000	No additional comments
S2	Loch Lomond Alpine Reservoir Recommendation	Post WUP (~2014)	Life of Project		This recommendation was as follows: *"after approval of the WUP, when Metro Vancouver makes releases for drinking water supply purposes, that they target 1cms from Loch Lomond alpine reservoir".*
S3	JWUP Monitoring Committee	Post WUP (~2014)	WUP Review Period		This committee would be expected to provide technical input on monitoring studies, provide technical advice on the implementation of JWUP monitoring studies as needed, and provide a forum for Metro Vancouver to report out on study updates and findings on an annual basis.
S4	Preliminary Ramping Rate Protocol	Post WUP (~2014)	WUP Review Period		Establish interim ramping rates based on the preliminary assessment carried out by Instream Fisheries or until such time as more detailed habitat analysis (Study S1F) suggests different rates.

"JWUP Package A" – Other Non-Flow Options (Voluntary Measures)

A number of other non-flow options related to the proposed hydropower facilities or related to historical impacts associated with the construction of the original water control facilities were agreed to as a component of the overall endorsed "JWUP Package A". These options were not in lieu of operational changes under a WUP, but were nevertheless agreed to by Metro Vancouver and would be considered more voluntary measures or possibly regulatory requirements associated with an

environmental assessment during an application for the proposed hydropower facilities (for more details on these non-flow options refer to Section 6.4).

#	Name	Start Date	Expected Duration	Estimated Cost / yr	Additional CC Comment
Capilano					
OC1	Upstream and Downstream Fish Passage	Ongoing	Life of Project		CC supported the continuation of the trap and truck program, proposed design criteria to facilitate the trap and truck operations at the proposed hydropower facilities (see item OC4 below), and two new monitoring studies in the future (see *C6A and C6B Upstream and Downstream Fish Passage*).
OC2	Real Time Flow Gauges – *Lower Capilano*	Pre-WUP (i.e. pre ~2014)	Life of Project	$1,000/yr +$5K upfont	Given the importance of making real time flow data accessible to the public, the CC agreed to expedite this option pre-WUP (~2014).
OC3	Lower River Forecasting Information – *Lower Capilano*	Pre-WUP (i.e. pre ~2014)	Life of Project	$1,000/yr +$5K upfront	Similar to the real time flow gauges, the CC agreed to expedite making this forecasting information accessible to the public pre-WUP (~2014).
OC4	Hydropower Design Criteria and Objectives for new hydropower facilities at Cleveland Dam	Detailed Design Phase (2013)	5 years	n/a	No further comments (see Appendix H for more details on this).
~~OC5~~ Studies C7 & S4	Gravel recruitment and Nutrient Enrichment Studies – *Lower Capilano and Seymour Rivers*	Post WUP (~2014)	1 year	?	Initially, gravel recruitment and nutrient enrichment projects were discussed as possible non-flow options. But given a lack of information and detail for the scope and location of these projects, the CC agreed that studies were required to scope out and characterize possible opportunities. It was emphasized that if the studies identified viable opportunities that they would not commit any party to construct and maintain any recommended enhancement works. It is hoped however, that parties would come together to look for ways to fund and implement them. It was further noted that the recreation paddling community would need to be consulted on any proposed gravel recruitment project that may offer improved access for other paddlers, as there was some disagreement by some kayakers that this would be a positive benefit.
OC6	Fisheries Issues Initiative *(if Cleveland*				In the event that Metro Vancouver decided to not proceed with hydropower at Cleveland Dam, Metro Vancouver

#	Name	Start Date	Expected Duration	Estimated Cost / yr	Additional CC Comment
	Hydropower does not proceed)				agreed to convene an initiative to revisit the ongoing fisheries issues in the lower Capilano River.
Seymour					
OS2	Real Time Flow Gauges – *Lower Seymour*	Pre-WUP (i.e. pre ~2014)	Life of Project	$1,000/yr +$5K upfont	Given the importance of making real time flow data accessible to the public, the CC agreed to expedite this option pre-WUP (~2014).
OS3	Lower River Forecasting Information – *Lower Seymour*	Pre-WUP (i.e. pre ~2014)	Life of Project	$1,000/yr +$5K upfont	Similar to the real time flow gauges, the CC agreed to expedite making this forecasting information accessible to the public pre-WUP (~2014).
Joint for both Seymour and Capilano					
OJ1	Assess possible new alpine storage options	Post WUP (~2014)	< 1yr		No further comments.
OJ2	Review of Water Shortage Response Levels and Minimum Flow Rule Curves	Post WUP (~2014)	1 year		Metro Vancouver agreed to assess whether triggers could be linked between their Water Shortage Response Levels and the levels in the proposed variable minimum flow rule curves associated with the new alternatives.
OJ3	Regular WUP Progress Updates	2012	Till Hydro Construction	n/c	Metro Vancouver agreed to keep CC members informed as to the progress of WUP at key milestone events. For example, • Metro Vancouver internal approval (board) to submit the JWUP • Metro Vancouver submission of JWUP to province • Province decision on JWUP and direction to Metro Vancouver • Metro Vancouver key design and construction updates • Etc.

8 Summary of Endorsed JWUP Package

8.1 Introduction

This section provides a summary of the package of recommendations (JWUP Package A) agreed to at the CC's final meeting held on July 19, 2012. It has been loosely organized according to those items more aligned to (1) operational aspects that would be typically associated with a WUP (i.e. associated with licensing requirements under the Water Act), (2) the proposed new hydropower facilities, or (3) historical effects from the construction of the original water control facilities. This categorization is imperfect and should be considered as more of a guide to facilitate subsequent regulatory discussions and approvals.

8.2 WUP Recommendations

8.2.1 Capilano Operating Alternative 3E

Operating Alternative 3E was recommended for the lower Capilano River. The basic parameters for Alternative 3E included:

- Allow 4m drawdown (below full pool) in Capilano Reservoir from November 1 to April 30 (for hydropower purposes)
- Minimum fish flows of 1.2cms from December 1 to May 30
- Minimum fish flows vary between 0.57cms and 2.3cms from June 1 to November 30 depending on inflows and available storage in the reservoir (see Table 8-1 below)

Table 8-1 Alternative 3E Minimum Fish Flow Releases for Cleveland Dam

Capilano Alternative #3E - Minimum Dam Releases during the period				
	June 1	**June 15**	**July 1**	**July 15**
Abundant Water Conditions	Q_{min} = 2.3cms	Q_{min} = 2.3cms	Q_{min} = 2.3cms	Q_{min} = 2.3cms
Criteria / Threshold	If by June 1st: • Lake level is @ or > full pool (145.89m) **and** Spilling >10cms	If by June 15th: • Lake level is @ or > FP (145.89m) **and** Spilling >10cms	If by July 1st: • Lake level is @ or > FP (145.89m) **and** Spilling >10cms	If by July 15th: • Lake level is @ or > FP (145.89m) **and** Spilling >2cms
Average Water Conditions	Q_{min} = 1.2cms	Q_{min} = 1.2cms	Q_{min} = 1.2cms	Q_{min} = 1.2cms
Drought Conditions	Q_{min} = 0.57cms	Q_{min} = 0.57cms	Q_{min} = 0.57cms	Q_{min} = 0.57cms
Criteria / Threshold	If by June 1st: • Lake level is less than 145.0m	If by June 15th: • Lake level is less than 145.0m	If by July 1st: • Lake level is less than 145.0m	If by July 15th: • Lake level is less than 143.0m
	Aug 1	**Aug 15**	**Sept 1**	**Sept 15**
Abundant Water Conditions	Q_{min} = 2.3cms	Q_{min} = 2.3cms	Q_{min} = 2.3cms	Q_{min} = 2.3cms
Criteria / Threshold	If by Aug 1st: • Lake level is >143.5m **and** Inflows to lake >12cms (excluding Alpine releases)	If by Aug 15th: • Lake level is >142.0m	If by Sep 1st: • Lake level is >140m	If by Sept 15th: • Lake level is >138m
Average Water Conditions	Q_{min} = 1.2cms	Q_{min} = 1.2cms	Q_{min} = 1.2cms	Q_{min} = 1.2cms
Drought Conditions	Q_{min} = 0.57cms	Q_{min} = 0.57cms	Q_{min} = 0.57cms	Q_{min} = 0.57cms
Criteria / Threshold	If by Aug 1st: • Lake level is <139.0m	If by Aug 15th: • Lake level is <135.0m	If by Sep 1st: • Lake level is <130m	If by Sep 15th: • Lake level is <130m and Alpine storage has been released
	Oct 1	**Oct 15**	**Nov 1**	**Nov 15**
Abundant Water Conditions	Q_{min} = 2.3cms	Q_{min} = 2.3cms	Q_{min} = 2.3cms	Q_{min} = 2.3cms
Criteria / Threshold	If by Oct 1st: • Lake level is >136m	If by Oct 15th: • Lake level is >134m	If by Nov 1st: • Lake level is >136m	If by Nov 15th: • Lake level is >138m
Average Water Conditions	Q_{min} = 1.2cms	Q_{min} = 1.2cms	Q_{min} = 1.2cms	Q_{min} = 1.2cms
Drought Conditions	Q_{min} = 0.57cms	Q_{min} = 0.57cms	Q_{min} = 0.57cms	Q_{min} = 0.57cms
Criteria / Threshold	If by Oct 1st: • Lake level is <130m and Alpine storage has been released	If by Oct 15th: • Lake level is <130m and Alpine storage has been released	If by Nov 1st: • Lake level is <130m and Alpine storage has been released	If by Nov 15th: • Lake level is <130m and Alpine storage has been released

No operational requirements were identified for Palisade Alpine Reservoir in the upper watershed above Capilano Reservoir.

8.2.2 Seymour Operating Alternative 4D

Operating Alternative 4D was recommended for the lower Seymour River. The basic parameters for Alternative 4D included:

- Allow 1m drawdown (below full pool) in Seymour Reservoir from November 1 to April 30 (for hydropower purposes)
- Minimum fish flows of 1.36cms from December 1 to May 30
- Minimum fish flows vary between 0.7cms and 2.8cms from June 1 to November 30 depending on inflows and available storage in the reservoir (see Table 8-2 below).

Table 8-2 Alternative 4D Minimum Fish Flow Releases for Seymour Falls Dam

Seymour Alternative #4D - Minimum Monthly Dam Releases				
	June 1	**June 15**	**July 1**	**July 15**
Abundant Water Conditions	Q_{min} = 1.36cms	Q_{min} = 1.36cms	Q_{min} = 1.4cms	Q_{min} = 1.4cms
Average Water Conditions	Q_{min} = 1.36cms	Q_{min} = 1.36cms	Q_{min} = 1.4cms	Q_{min} = 1.4cms
Impending Drought Conditions	Q_{min} = 1.1cms	Q_{min} = 1.1cms	Q_{min} = 1.1cms	Q_{min} = 1.1cms
Criteria / Threshold	If by June 1st: Lake level <213m	If by June 15th: Lake level is <214m	If by July 1st: Lake level is < 213m	If by July 15th: Lake level is <211m
Drought Conditions	Q_{min} = 0.7cms If by June 1st: Lake level < 212m	Q_{min} = 0.7cms If by June 15th: Lake level is <213m	Q_{min} = 0.7cms If by July 1st: Lake level <212m	Q_{min} = 0.7cms If by July 15th: Lake level is <210m
	Aug 1	**Aug 15**	**Sept 1**	**Sept 15**
Abundant Water Conditions	Q_{min} = 2.8cms	Q_{min} = 2.8cms	Q_{min} = 2.8cms	Q_{min} = 2.8cms
Criteria / Threshold	If by Aug 1st: Lake level is >213.8m	If by Aug 15th: Lake level is >213.4m	If by Sep 1st: Lake level is >213m	If by Sept 15th: Lake level is >212m
Average Water Conditions	Q_{min} = 1.4cms	Q_{min} = 1.4cms	Q_{min} = 1.4cms	Q_{min} = 1.4cms
Impending Drought Conditions	Q_{min} = 1.1cms	Q_{min} = 1.1cms	Q_{min} = 1.1cms	Q_{min} = 1.1cms
Criteria / Threshold	If by Aug 1st: Lake level is <208m	If by Aug 15th: Lake level is <206m	If by Sep 1st: Lake level is <204 and Alpine storage released	If by Sep 15th: Lake level is <204 and Alpine storage released
Drought Conditions	Q_{min} = 0.7cms If by Aug 1st: Lake level is <207m	Q_{min} = 0.7cms If by Aug 15th: Lake level is <205m	Q_{min} = 0.7cms If by Sep 1st: Lake level is <203 and Alpine storage released	Q_{min} = 0.7cms If by Sep 15th: Lake level is <203 and Alpine storage released
	Oct 1	**Oct 15**	**Nov 1**	**Nov 15**
Abundant Water Conditions	Q_{min} = 2.8cms	Q_{min} = 2.8cms	Q_{min} = 2.8cms	Q_{min} = 2.8cms
Criteria / Threshold	If by Oct 1st: Lake level is >211m	If by Oct 15th: Lake level is >210m	If by Nov 1st: Lake level is >210m	If by Nov 15th: Lake level is >212m
Average Water Conditions	Q_{min} = 1.4cms	Q_{min} = 1.4cms	Q_{min} = 1.36cms	Q_{min} = 1.36cms
Impending Drought Conditions	Q_{min} = 1.1cms	Q_{min} = 1.1cms	Q_{min} = 1.1cms	Q_{min} = 1.1cms
Criteria / Threshold	If by Oct 1st: Lake level is <204 and Alpine storage has been released	If by Oct 15th: Lake level is <204 and Alpine storage has been released	If by Nov 1st: Lake level is <204 and Alpine storage has been released	If by Nov 15th: Lake level is <206 and Alpine storage has been released
Drought Conditions	Q_{min} = 0.7cms If by Oct 1st: Lake level is <203 and Alpine storage has been released	Q_{min} = 0.7cms If by Oct 15th: Lake level is <203 and Alpine storage has been released	Q_{min} = 0.7cms If by Nov 1st: Lake level is <203 and Alpine storage has been released	Q_{min} = 0.7cms If by Nov 15th: Lake level is <205 and Alpine storage has been released

For the operations of Loch Lomond Alpine Reservoir above Seymour Reservoir, the CC agreed to the following recommendation (Option S2), *"after approval of the WUP,*

when Metro Vancouver makes releases for drinking water supply purposes, that they target 1cms from Loch Lomond alpine reservoir". The purpose of this recommendation was to improve habitat conditions for aquatic resources below Orchid Creek and the main reservoir (see Section 6.2.8).

No operational requirements were identified for Burwell Alpine Reservoir in the upper watershed above Seymour Reservoir.

8.2.3 WUP Monitoring

The following studies were recommended as a **high priority** by the CC. A number of these studies served dual purposes of a WUP and for satisfying anticipated requirements for new hydropower facilities according to federal and provincial guidelines for IPPs (these dual purpose WUP/IPP studies are identified in the column below). For more details on the studies, see Section 7.7 and refer to *Appendix F – FTWG Monitoring Program Presented to the CC.*

Capilano		**Relevance**
C1A	Monitoring of fish flow releases and drinking water withdrawals	WUP
C1B	Monitoring of hydropower water withdrawals	WUP / IPP
C1C	Flow monitoring of instream flow requirements (IFRs) – *prior to JWUP implementation*	WUP
C1D	Flow monitoring of instream flow requirements (IFRs) - *after JWUP*	WUP
C1E	Flow monitoring of IFR / stranding assessment (ramping)	WUP / IPP
C1F	Water level monitoring in Capilano Reservoir	WUP
C1G	Inflow monitoring to Capilano Reservoir	WUP
C1H	Temperature monitoring 1 – Lower River - *duration 3 – 5 years*	WUP / IPP
C4	Status and trends of key fish species – *prior to JWUP approval*	WUP
C6A	Upstream and downstream fish passage at Cleveland Dam - *post hydro*	WUP
Seymour		
S1A	Monitoring of fish flow releases and drinking water withdrawals	WUP
S1B	Monitoring of hydropower water withdrawals	WUP / IPP
S1C	Flow monitoring of instream flow requirements (IFRs) - *prior to JWUP*	WUP
S1D	Flow monitoring of instream flow requirements (IFRs) - *after JWUP implementation*	WUP
S1E	Flow monitoring of instream flow requirements (IFRs) at WSC gauge at Twin Bridges	WUP
S1F	Flow monitoring of IFR / stranding assessment (ramping rates)	WUP / IPP
S1G	Water level monitoring in Seymour Reservoir	WUP / IPP

S2	Status and trends of key fish species – *prior to JWUP Approval*	Existing Program
S3	Entrainment at Seymour Dam	High

A few studies were ranked as **medium priority** by the CC, as follows:

Capilano		**Relevance**
C2	Temperature monitoring 2 – Palisade alpine reservoir flow releases	WUP
C3	Upstream migration enhancement using pulse flows	WUP
C5	Reservoir littoral area	WUP / IPP

8.2.4 Review Period

The CC agreed to:

- **Review Period for Seymour** – 15 years after JWUP approval (currently estimated at ~2029)
- **Review Period for Capilano** – 10 years after the hydropower facilities at Cleveland Dam are commissioned (currently estimated at ~2032)

The CC also recognized that a concurrent review would be preferred, but not at the expense of the current schedule for Capilano.

The CC also discussed triggers that may warrant an earlier review including events associated with biologically significant events, or if external factors affect the ability to deliver the preferred flow alternatives, or if the CC agrees to pre-defined criteria. Metro Vancouver agreed to develop triggers for consideration prior to the scheduled review period.

8.2.5 WUP Non-Flow Options

The CC recommended the following non-flow options typically associated with WUPs (see Section 6.3 and 7.8 for more details).

Capilano	
C1	In-Season Management Committee – *after Capilano JWUP flows implemented*
C2	Improved Coordination with Capilano Hatchery Smolt Release
Seymour	
S1	In-Season Management Committee – *after Seymour JWUP flows implemented*
S2	Loch Lomond Alpine Reservoir Recommendation

Capilano and Seymour	
C3 & S3	JWUP Monitoring Committee

8.3 Recommendations Specific to Proposed New Hydropower Facilities

The CC recommended the following provisions specific to the new hydropower facilities (for more details see Section 6.3 and 7.7 for more details).

Capilano	
OC4	Hydropower design criteria and objectives for new hydropower facilities at Cleveland Dam related to: • Preventing fish entrainment at the hydropower intake • Smolt collection system associated with the new facilities • Safe downstream passage for smolts • Avoidance of operating the spillway during the outmigration period • Suitable ramping rates and flows over the widest range of reservoir elevations to avoid fish stranding downstream • Exploring a smaller turbine design to generate power year round associated with minimum fish flows • Intake channel designed to improve water temperatures downstream For more information on these criteria and objectives refer to *Appendix H – FTWG Design Criteria & Objectives for Proposed Capilano Power Project*.

As well, the CC identified a number of studies aligned with the proposed hydropower projects (beyond those mentioned above in Section 8.2.3) and which may ultimately be included as components to an environmental assessment or subsequent regulatory requirement for any new facilities. They are summarized below for information purposes only and to facilitate future discussions with regulators (also note additional information can be found in *Appendix F - FTWG Monitoring Program Presented to the CC*).

Capilano	
C9	Distribution and abundance of SARA-listed species
C10	Stranding within the drawdown zone
C11	Level 1 and Level 2 Fish Habitat Assessments (FHAP)
C12	Habitat compensation plan
Seymour	
S1H	Inflow monitoring to Seymour Reservoir
S5	Distribution and abundance of SARA-listed species
S6	Level 1 and Level 2 Fish Habitat Assessments (FHAP)

S7	Habitat compensation plan

8.5 Illustrative Implementation Schedule

An illustrative implementation schedule for when the various components of the agreed to JWUP Package is provided below. The actual timing will be dependent on a number of variables such as the approval date for the JWUP. Accordingly, Table 8-3 and Table 8-4 below should be considered as illustrative and are provided to give a general sense of the sequencing of the studies and activities associated with the JWUP.

Table 8-3 Illustrative JWUP Implementation Schedule for Capilano

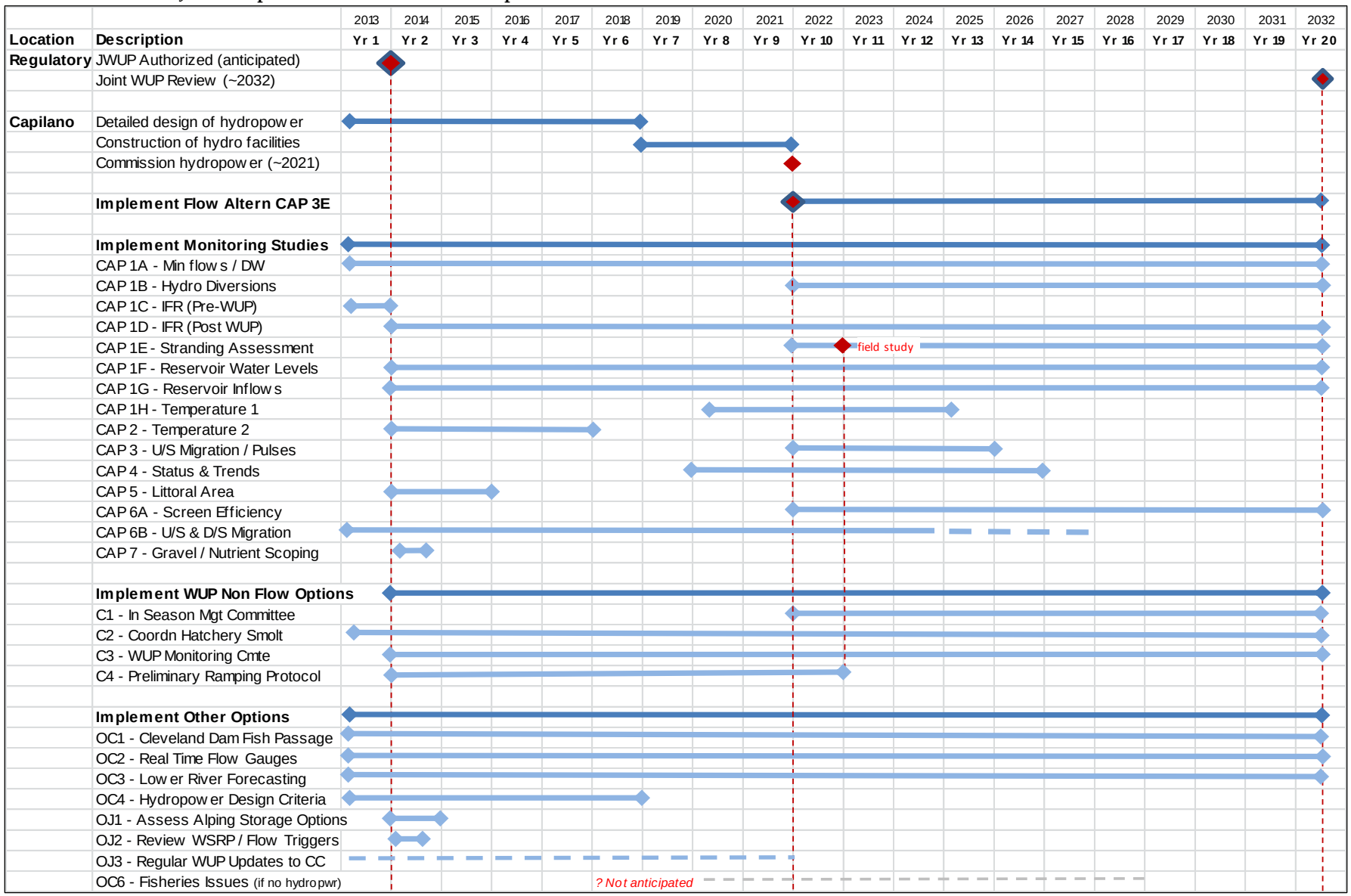


Table 8-4 Illustrative JWUP Implementation Schedule for Seymour

Location	Description	2013 Yr 1	2014 Yr 2	2015 Yr 3	2016 Yr 4	2017 Yr 5	2018 Yr 6	2019 Yr 7	2020 Yr 8	2021 Yr 9	2022 Yr 10	2023 Yr 11	2024 Yr 12	2025 Yr 13	2026 Yr 14	2027 Yr 15	2028 Yr 16	2029 Yr 17	2030 Yr 18	2031 Yr 19	2032 Yr 20
Regulatory	JWUP Authorized (anticipated)	◆																			
	Interim Seymour WUP Review (2029)																	◆			
	Joint WUP Review (proposed 2032)																				◆
Seymour	Detailed design of hydropower							◆		◆											
	Construction of hydro facilities										◆		◆								
	Commission hydropower (~2024)												◆								
	Implement Flow Altern SEY 4D	◆																			◆
	Implement Monitoring Studies	◆																			◆
	SEY 1A - Min flows / DW	◆																			◆
	SEY 1B - Hydro Diversions												◆								◆
	SEY 1C - IFR (Pre-WUP)	◆	◆																		
	SEY 1D - IFR (Post WUP)	◆																			◆
	SEY 1E - IFR - WSC Gauge (20??)				?																◆
	SEY 1F - Stranding Assessment	◆												◆ field study							◆
	SEY 1G - Reservoir Water Levels	◆																			◆
	SEY 2 - Status & Trends	◆	◆																		
	SEY 3 - Entrainment												◆								◆
	SEY 4 - Gravel / Nutrient Scoping		◆	◆																	
	Implement Non Flow Options (WUP)	◆																			◆
	S1 - In Season Mgt Committee	◆																			◆
	S2 - Loch Lomond (1cms target)	◆																			◆
	S3 - WUP Monitoring Cmte	◆																			◆
	S4 - Preliminary Ramping Protocol	◆												◆							
	Other Non Flow Options	◆																			◆
	OS2 - Real Time Flow Gauges	◆																			◆
	OS3 - Lower River Forecasting	◆																			◆
	OJ1 - Assess Alping Storage Options	◆	◆	◆																	
	OJ2 - Review WSRP / Flow Triggers	◆	◆																		
	OJ3 - Regular WUP Updates to CC												◆					◆			◆

Appendix B – Schedule of JWUP Public Meetings

Appendix B provides a summary of the meetings held for each of the committees during the planning process.

Consultative Committee Meetings		Fish Technical WG Meetings		Recreation Technical WG Meetings	
Mtg 1	January 19, 2011	Mtg 1	February 14, 2011	Mtg 1	March 22, 2011
Mtg 2	February 24, 2011	Mtg 2	March 8, 2011	Mtg 2	May 19, 2011
Mtg 3	March 31, 2011	Mtg 3	April 13, 2011	Mtg 3	June 29, 2011
Mtg 4	July 14, 2011	Mtg 4	May 12, 2011	Mtg 4	January 30, 2012
Mtg 5	February 2, 2012	Mtg 5	July 7, 2011	Mtg 5	March 9, 2012
Mtg 6	March 15, 2012	Mtg 6	September 15, 2011		
Mtg 7	May 31, 2012	Mtg 7	November 15, 2011		
Mtg 8	July 19, 2012	Mtg 8	December 9, 2011		
		Mtg 9	January 18, 2012		
		Mtg 10	February 22, 2012		
		Mtg 11	March 28, 2012		
		Mtg 12	April 30, 2012		
		Mtg 13	June 21, 2012		
		Mtg 14	July 5, 2012		

In addition, a number of interagency Steering Committee meetings were held throughout the consultative process.

In addition, two community meetings were held and open to the general public in relation to the JWUP planning process. These meetings were held on October 12, 2010 and October 10, 2012 (for more details refer to Section 3.1.1).

Appendix C – CC Terms of Reference

Appendix C includes the Terms of References agreed to by the Consultative Committee at their second meeting held on February 24, 2011.

Joint Water Use Plan for the Capilano and Seymour Watersheds
Consultative Committee Terms of Reference
March 10, 2011

1.0 Introduction

1.1 Overview

Metro Vancouver is developing a Joint Water Use Plan (JWUP) for the Capilano and Seymour Watersheds to determine how water collected and stored in the watershed reservoirs will be used. The scope of the JWUP includes the reservoirs and lower rivers of both systems below the dams.

The final water use plan will define operating parameters that will be used in the day-to-day operations of water control facilities, which may include any potential hydroelectric facilities.

The planning process to develop the water use plan will follow a structured approach to decision-making, guided by the province's 1998 Water Use Plan Guidelines and aligned with Metro Vancouver's Sustainable Region Initiative.

To ensure public values will be integrated appropriately into water management decision-making, Metro Vancouver is forming a Consultative Committee.

These terms of reference outline the roles and responsibilities of the Consultative Committee (CC) members to ensure participants are aware of their mandate, expectations, how the CC will function, and the advisory role of the CC.

2.0 Joint Water Use Plan Consultative Committee

2.1 Mandate and Purpose

The mandate of the JWUP for the Capilano and Seymour Watersheds CC is to identify and explore water use options and alternatives to current operating practices, and collaboratively develop recommendations for consideration by Metro Vancouver when preparing the JWUP for operation of the Capilano and Seymour water control facilities. The facilities include the Cleveland Dam on the Capilano River and the Seymour Dam on the Seymour River.

To develop recommendations, the CC will:

a. consider the needs and interests of all different water uses, including drinking water supply, fisheries, wildlife, the environment, recreation, heritage conservation, flood control, the net cost of water supply, energy self-sufficiency, and other uses identified during the planning process

b. take into account the best available information about the consequences of proposed alternatives to current operating practices

c. identify a preferred operating system and other considerations seen to be within the scope of the JWUP

d. outline criteria for an ongoing monitoring and assessment program, where required and appropriate

e. establish timing for periodic review of the JWUP for the Capilano and Seymour Watersheds.

2.2 Role

The role of the CC is advisory in nature. The CC reports to Metro Vancouver on the content of the JWUP.

The provincial Comptroller of Water Rights reviews water use plans under the provisions of British Columbia's *Water Act*, and involves Fisheries and Oceans Canada, other provincial agencies, First Nations, and holders of water licences who might be affected by the plans.

The CC may form Technical Working Groups as described in Section 2.6 to study particular topics of interest.

2.3 Structure and Membership

Members of the CC represent a broad spectrum of interests affected by the operations of the Capilano and Seymour water control facilities. Metro Vancouver's interests will be represented by two CC members. The work of the CC will be managed by a Process Coordinator. The role of the Process Coordinator is described in Section 6.0.

Members of the CC do not receive remuneration.

Membership of the CC has been established in accordance with steps two and three of the Provincial Water Use Plan Guidelines. CC members have been invited to participate based on:

a. their constituency, agency, organization or group being considered a key interest group by the JWUP Steering Committee which includes regulatory agencies

b. their ability to represent their constituency, agency, organization or group

c. their knowledge and experience on these systems

d. their commitment to participate in an open, inclusive and engaged manner with the goal of working collaboratively toward mutually acceptable solutions

e. their commitment to attend all CC meetings, and read all pre-meeting materials, understanding that the process is likely to involve approximately 10 meetings over the course of 12-18 months

f. having no direct conflict of interest

g. acceptance of the organizational structure of the CC and areas of interest selected.

2.4 Alternate Members

It is expected that CC members will attend all meetings. In the event that a designated CC member is unable to attend a meeting, it is their responsibility to arrange for an alternate to attend on their behalf. Each organization will designate an alternate, and the designation must be communicated to the Process Coordinator (see Section 6.1) in advance of the meeting in question.

It is the CC member's responsibility to ensure that the alternate is familiar with these Terms of Reference, the Provincial Water Use Plan Guidelines, and is briefed on the issues and deliberations of the CC.

2.5 New Members

Following adoption of these Terms of Reference, only under rare conditions will any individual or organization be considered to apply for membership on the CC. New members may however, be added as follows:

a. applicants must submit a request for CC membership to Metro Vancouver via the Process Coordinator. The Process Coordinator will inform the CC prior to the next meeting

b. applicants must attend the meeting at which their application is being considered and be prepared to detail the interests they represent and why they believe their interests are not adequately represented in the current process

c. members of the CC will consider new applications based on the principle of an equitable, open and inclusive process, and the merits and drawbacks of expanding membership to the CC.

Any new CC members will be required to:

a. abide by the Terms of Reference

b. inform themselves with the past deliberations and work of the CC

c. accept previous decisions of the CC.

2.6 Technical Working Groups

The CC may recommend establishing Technical Working Groups to undertake specified work between CC meetings. Technical Working Groups will:

a. be open to all CC members

b. include non-CC members, such as technical or scientific experts, as appropriate

c. include a Working Group Coordinator whose actions would be guided as outlined in Section 6.1 as required

d. abide by the Terms of Reference established by the CC (see Section 4.2), and

e. prepare options and/or recommendations for consideration by the CC as specified.

2.7 Observers and Guests

Observers may attend meetings but may not participate in CC discussions.

Guests may be invited by the CC or Metro Vancouver to attend meetings to provide a technical presentation or respond to questions on a subject relevant to the JWUP. Presentations will be an agenda item and must be pre-arranged through the CC Process Coordinator.

3.0 Consultative Committee Scope

3.1 Deliberations

Deliberations by the CC will include those issues within Metro Vancouver's control that relate to the Capilano and Seymour water control facilities. The CC will consider:

a. alternatives to current water control operations including changes to water flows, rate of change in flows, the timing of flows, and water levels in the Seymour and Capilano reservoirs and rivers

b. using physical works and programs in lieu of flow alterations, such as habitat enhancement, fertilization programs, etc.

c. design considerations associated with any new water control structures, such as new intakes or turbines for potential hydroelectric power generation

d. Metro Vancouver: fish passage issues on the Capilano River

e. monitoring and assessment requirements to support physical works and/or operational recommendations.

The CC will also be asked to provide advice on the preferred methods of communication between members and Metro Vancouver, including meeting dates/times, and agenda topics.

If new scope issues arise during the consultative process, the CC may provide advice to Metro Vancouver or the JWUP Steering Committee (see Section 2.3), as appropriate.

Issues determined to be outside the scope of the process will be documented and, where applicable, referred to the appropriate agency.

3.2 Deliverable

The CC will produce and sign-off on a report that documents its deliberations. The report will both summarize the process followed and outline the final recommendations of the CC, noting areas of agreement and disagreement. The report will also document water use interests, objectives and performance measures considered, information collected, operating alternatives reviewed, and the trade-offs identified and considered.

Recommendations in the final CC report will be fully considered by Metro Vancouver in their preparation of the draft JWUP for the Capilano and Seymour facilities. A copy of the draft JWUP will be available to the CC members in a timely fashion.

The draft JWUP and final CC report will be submitted to the BC Comptroller of Water Rights. The BC Comptroller of Water Rights will coordinate a final regulatory review and approval as outlined in the Provincial Water Use Plan Guidelines.

4.0 Consultative Committee Responsibilities

4.1 Member Responsibilities

Members of the CC are responsible for:

a. attending each meeting of the CC and any meetings of subcommittees or working groups to which they belong, or assigning an alternate to do so. Members of the CC who are absent, or do not assign an alternate, for two consecutive meetings may be moved to observer status

b. providing comments in advance or appropriate information to the Process Coordinator in the event of an expected absence

c. preparing for each meeting by reading meeting minutes, studies, subcommittee reports and other material distributed as part of this consultative process. Every effort will be made to distribute pre-reading materials at least seven days prior to CC meetings

d. regularly updating members of their constituency, agency, organization or group regarding the deliberations, progress and decisions of the CC

e. being accountable to other CC members and the general public

f. abiding by the code of conduct during the process (as outlined in Section 4.3).

4.2 Consultative Committee Operating Guidelines

Members of the CC have the task of listening to and understanding the various interests around the table. The CC will collaboratively develop recommendations for a JWUP that best meets the needs of all those interests. Specifically, CC members will:

a. follow the planning steps as described by the Process Coordinator (see Section 6.1)

b. express the concerns and interests of their constituency, agency, organization or group

c. establish and develop Terms of Reference for any Technical Working Groups (see Section 2.6) deemed necessary to provide material to assist with the deliberations and decision-making of the CC

d. engage in deliberations in an equitable, open and transparent manner with a view to developing a consensus recommendation

e. communicate and engage with their constituents, including distribution of the CC minutes and materials after they have been approved by the CC (see Section 4.1(d))

f. sign-off on the final CC report, provided it is an accurate representation of the JWUP CC process, documenting all decisions, and areas of agreement and disagreement (see Section 3.2).

The CC will be disbanded following the Metro Vancouver staff final submission of the draft JWUP to the Metro Vancouver Board for approval.

4.3 Code of Conduct

All CC members will endeavour to:

a. work constructively and collaboratively to address areas of mutual concern
b. support an open and inclusive process
c. treat others with courtesy and respect
d. listen attentively with an aim to understand
e. be concise in making a point
f. speak in terms of interests instead of positions
g. be open to a range of outcomes (as opposed to being attached to certain outcomes in advance of the process)
h. let opposing views co-exist
i. avoid disruption of meetings (eg. cell phones, caucusing at the table, etc.)
j. allow issues that fall outside the meeting agenda to be addressed at a later time
k. deliberate with a view to arriving at consensus.

5.0 Consensus Decision-Making

5.1 Consensus

The CC provides advice to Metro Vancouver. No votes will be held to determine the group's position on issues or recommendations to Metro Vancouver. However, the CC may choose to seek consensus on matters of discussion.

Consensus is a goal but not a requirement of the JWUP process. The Provincial Water Use Guidelines define consensus as a decision that participants can accept, without having to agree on all the details of the recommendations put forward. Meeting documentation will identify areas of agreement, areas of discord, and underlying trade-offs between alternative water uses.

Throughout the planning process, the CC may decide to re-visit areas of agreement if:

a. significant new information becomes available that is relevant to a past decision
b. by consensus, the CC decides it needs to review specific agreements that are part of a larger, final package of agreements.

When the CC cannot identify a preferred final recommendation (non-consensus), the final CC report will record and indicate differences of opinion and reasons for non-consensus. Members in disagreement with the 'preferred option(s)' will be responsible for describing what part(s) of the agreement do not meet their needs and possible alternative and acceptable solutions.

5.2 Addressing Dissatisfaction

If left unaddressed, dissatisfaction can become destructive and undermine the effectiveness of the CC. Members agree to raise criticisms of the process or the emerging results as agenda items for resolution by the CC rather than taking them to the media or into a 'political' process. CC members will bring issues of dissatisfaction arising between meetings to the attention of the Process Coordinator as soon as possible.

6.0 Consultative Committee Support

6.1 Process Coordinator

The Process Coordinator serves the CC in achieving its tasks by assisting deliberations and decision-making through:

a. coordinating the consultative process with the Metro Vancouver JWUP Project Team (see Section 6.2)

b. structuring the meetings to encourage free and open discussion of relevant issues

c. remaining impartial and objective throughout the process

d. ensuring that the Code of Conduct (see Section 4.3) is followed

e. ensuring that all parties are heard and that differences are adequately addressed

f. creating a collaborative problem-solving environment for the CC, and promoting creative thinking to overcome road blocks and obstacles

g. being respectful of participants' time and making the best use of CC meeting time

h. working with the Metro Vancouver JWUP Project Team to provide the CC with draft meeting summaries within one week of the meeting

i. working with the Metro Vancouver JWUP Project Team to deliver all meeting materials in advance of meetings

j. providing a final CC report, with sign-off by the process participants, that is an accurate representation of the JWUP CC process, documenting all decisions, and areas of agreement and disagreement.

6.2 Metro Vancouver JWUP Project Team

Metro Vancouver has established a JWUP Project Team to implement the work program and to assist with the deliberations of the CC, including providing logistical and technical support. This support includes:

a. providing technical advice and support on resource valuation, power studies, operations, and the environment, among other topics

b. compiling and providing existing data and information within the scope of this JWUP

c. establishing the scope, limits and boundaries for proposed studies

d. arranging and managing studies for collection of new data and information

e. assisting to determine the best dates, times and locations of the CC meetings for the majority of its members

f. arranging facilities and notice for public meetings, open houses, and other venues to complete the JWUP process

g. providing a Chair, venue, notetaker, and refreshments for CC meetings

h. arranging for an independent Process Coordinator to support the CC in its work (Note the Process Coordinator may also act as the Chair of the CC)

i. maintaining communication with interested parties and observers, including producing communication materials

j. working with the Process Coordinator to prepare and distribute meeting summaries

k. preparing and distributing relevant meeting materials to support deliberations to members of the CC and other interested parties in advance of meetings

l. assisting with preparation of the CC report

m. distributing the draft JWUP for the Capilano and Seymour Watersheds to the CC.

7.0 Public Communication

7.1 Communications Process

The consultative process is intended to be an open, transparent process. As such:

a. meetings of the CC are open to any interested member of the public who wishes to observe the discussions

b. Metro Vancouver will appoint a Media Relations and Communications Task Manager as part of the Metro Vancouver JWUP Project Team

c. members of the CC making statements to the media or the public should be respectful of other CC members and the process. Unless authorized by the CC to be a spokesperson, individual members will not represent themselves as spokespersons for the CC

d. Metro Vancouver will provide periodic updates, describing the CC process and its progress, to the public.

7.2 Media Relations

Metro Vancouver, as the licensee or applicant, will be the official spokesperson for information on Metro Vancouver operations, facilities, and the JWUP process.

Only designated Metro Vancouver spokespeople may speak to the media:

- the lead spokesperson for Metro Vancouver is the Board Chair
- the Water Committee Chair is the lead spokesperson for Water Committee business, particularly policy matters such as the JWUP

- on specific issues, the Water Committee Chair may delegate this spokesperson role to the Chief Administrative Office (CAO) or department managers
- department managers and their delegates will provide technical information on relevant projects and issues.

All media enquiries must be referred to the Metro Vancouver Media Relations and Issues Management Division:

8.0 Revisions

These Terms of Reference may be revised by consensus of the Consultative Committee members, in discussion with the JWUP Steering Committee and Metro Vancouver.

Appendix E – Assessing Fish Impacts

The following summary on the assessment of fish impacts and the work of the Fish Technical Working Group was provided by Todd Hatfield (of Ecofish Research Ltd.) who served as an independent technical resource and co-facilitator during the FTWG meetings.

1. The Fisheries Technical Working Group

The FTWG's primary mandate during the JWUP process was to help coordinate scientific investigations relevant to water management effects on riverine and reservoir aquatic resources, and to develop tools for evaluating alternative water management scenarios. Their role was to provide technical support for the CC during the JWUP decision-making process.

The FTWG decided which studies were required, how the studies should be completed and who should undertake them. The great majority of studies were completed by technical experts within the environmental consulting industry, though some studies included participation by FTWG members. The FTWG was involved with oversight of study design and quality control, but details of study design and execution were the responsibility of individual contractors. The suite of studies completed included both biological investigations (e.g., fish use, habitat conditions) and physical investigations (e.g., hydrology and hydraulics). These studies, along with data collected by Metro Vancouver, formed the primary basis for all evaluation tools developed by the FTWG.

For the JWUP process, the FTWG was tasked with providing a technical assessment of the effects of flow alterations on biota and their habitats in the Capilano and Seymour watersheds. This required making use of the information collected during the detailed biological and physical investigations. The FTWG's assessments focussed entirely on biological effects of water management, but much of the assessment is founded on detailed physical studies of the watersheds, such as hydrology, hydraulics and water quality.

2. Study Area

The areas of interest for the FTWG were the riverine and reservoir habitats in the Capilano and Seymour watersheds. Each watershed was primarily assessed in three portions, the upper watershed, the reservoir, and the lower river, although for some issues there was a smaller scope within each area.

3. Methods

The FTWG used a highly iterative assessment process, progressing from exploration of a wide array of possible impacts to detailed assessment of specific impacts. The

overall process used techniques that are common within the field of environmental impact assessment, starting with conceptual diagrams of impact pathways and progressing to detailed quantitative modeling of impacts. A conceptual "means-ends" diagram is presented in Figure E-1, and shows how water management can affect fish abundance and diversity in the Capilano and Seymour watersheds. The effect of water withdrawals on flow in the river depends critically on the timing, magnitude, frequency, duration and extent of water storage, withdrawals and releases. For example, a withdrawal of 10 $m^3 \cdot s^{-1}$ in the summer may reduce water availability for release to the river substantially more than a withdrawal in the winter. Likewise, the effect of withdrawal during a "dry" year may be considerably different than the same withdrawal during a "wet" year. The effects of storage, withdrawal and release can alter the availability of habitat, abundance of food, and interactions with competitors and predators, which in turn can influence growth and survival and ultimately the abundance and diversity of fish and wildlife in the watersheds.

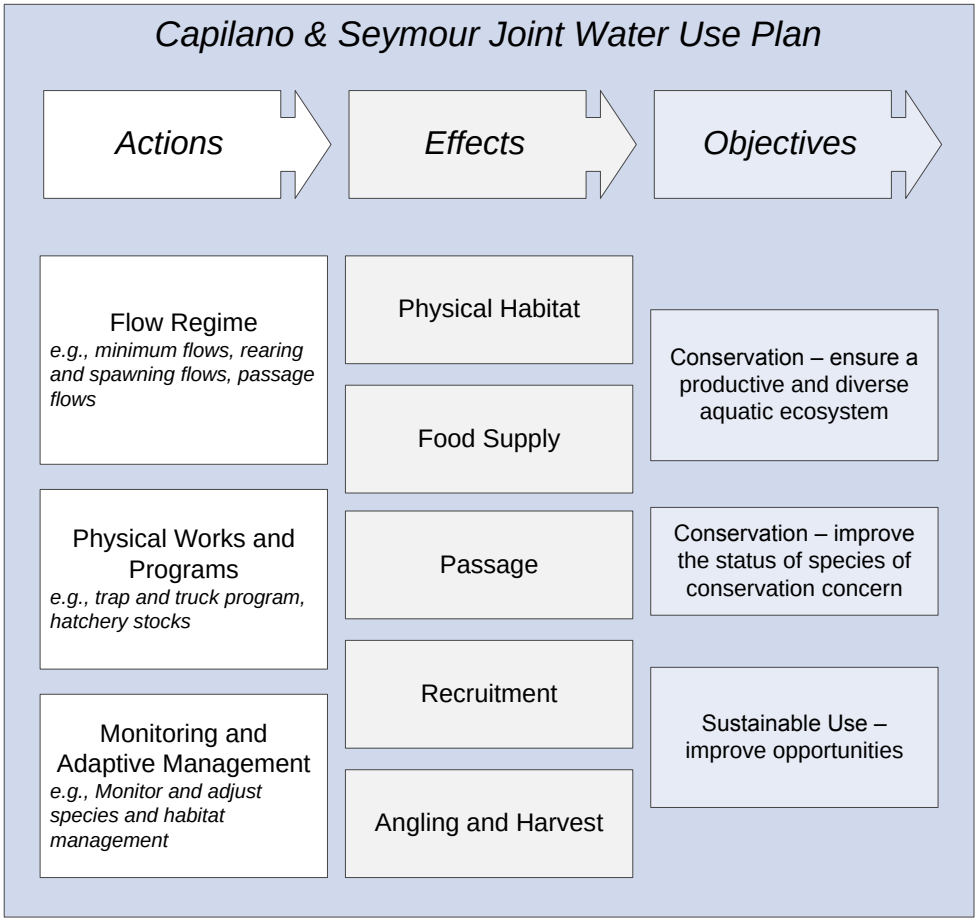


Figure E-1. A means-ends diagram that identifies conceptually how water management actions can influence fish abundance and diversity in the Capilano and Seymour watersheds.

4. Data Sources

Development of Performance Measures and analysis of water management alternatives relied on several data sources.

Metro Vancouver collects data on hydrology and water quality as part of its regular monitoring activities, and has extensive historic records, which in some cases extend back many decades. Metro Vancouver also commissions occasional specific studies in support of specific initiatives or to support specific data needs. The FTWG used the following key data sources from Metro Vancouver:

9. NHC transects. In support of the JWUP, Metro Vancouver contracted Northwest Hydraulic Consultants (NHC) to install and maintain hydrometric gauges at four transects on the lower Capilano River and five transects on the lower Seymour River (Figure E-2). The FTWG made extensive use of the hydraulic measurements taken at these transects, and used these sites as geographic reference points for assessing the alternatives.

10. InStream transects. In support of the JWUP, Metro Vancouver contracted Instream Fisheries Research (InStream) to undertake several studies in the Capilano and Seymour watersheds. The key results used by the FTWG were hydraulic measurements taken at a range of flows at transects near the NHC transects. The InStream transects were established at representative fish habitat for each section of river, and were combined with habitat suitability criteria (HSC) to produce functions of weighted useable width (WUW) versus flow. These functions were used to model habitat availability at these sites in response to different alternatives; these functions were provided for several species and life stages of fish, and for macroinvertebrates.

11. Other InStream studies. In addition to transect work on the lower Capilano and Seymour rivers, InStream also undertook Fish Habitat Assessment Procedure (FHAP) studies in the upper Capilano and the upper Seymour rivers, and completed initial temperature and fish habitat investigations in the upper Capilano related to water releases from alpine storage.

12. Reservoir temperature profiles. Metro Vancouver collected daily temperature profiles in Capilano Reservoir in 2008 through 2009.

13. Reservoir bathymetry. Metro Vancouver has bathymetry data for Capilano and Seymour reservoirs, and surface area vs. water elevation relationships.

14. Reservoir water levels. Metro Vancouver collects information on water elevation at Capilano and Seymour reservoirs, and has historic information extending back decades.

15. Hydrometric gauging on Capilano and Seymour rivers. There are a variety of hydrometric stations in both watersheds and limnology stations in both reservoirs.

    a. Hydrometric stations contracted to Water Survey Canada include:

        i. 08GA077 Seymour River below Orchid Creek (stage, flow, temp, ambient weather)

        ii. 08GA010 Capilano River above intake (stage, flow, temp, turbidity, ambient weather)

        iii. Palisade Lake (stage)

        iv. Burwell Lake (stage)

        v. Capilano River below Cleveland Dam (stage, low flow)

    b. Hydrometric stations operated and maintained by Metro Vancouver

        i. 08GA079 Seymour River above Seymour Reservoir (stage, temp, turbidity)

        ii. 08GA026 Capilano River above Eastcap Creek (stage, temp, turbidity, ambient weather)

        iii. 08GA027 Eastcap Creek near the mouth (stage, temp, turbidity)

    c. Hydrometric stations operated by Water Survey Canada

        i. 08GA030 Seymour River Twin Bridges (stage, flow, temp)

        ii. Snow course stations operated by Metro Vancouver

        iii. Orchid Lake

        iv. Palisade Lake Reservoir

    d. Discharge measurements and water withdrawals from gates and valves at the Seymour Falls Dam and the Cleveland Dam

    e. Limnology for Capilano and Seymour Reservoirs

        i. Monthly profiles (temp, pH, specific conductance, dissolved oxygen, turbidity, chlorophyll a)

        ii. Monthly chemical and biological samples (bacteria, phytoplankton, zooplankton)

iii. Continuous (ambient weather, temp profile, turbidity, stage, water)

16. Fish production estimates. Metro Vancouver undertakes annual smolt enumeration from the upper Capilano Watershed and from the lower Seymour Watershed (from Seymour Falls Dam to Twin Bridges).

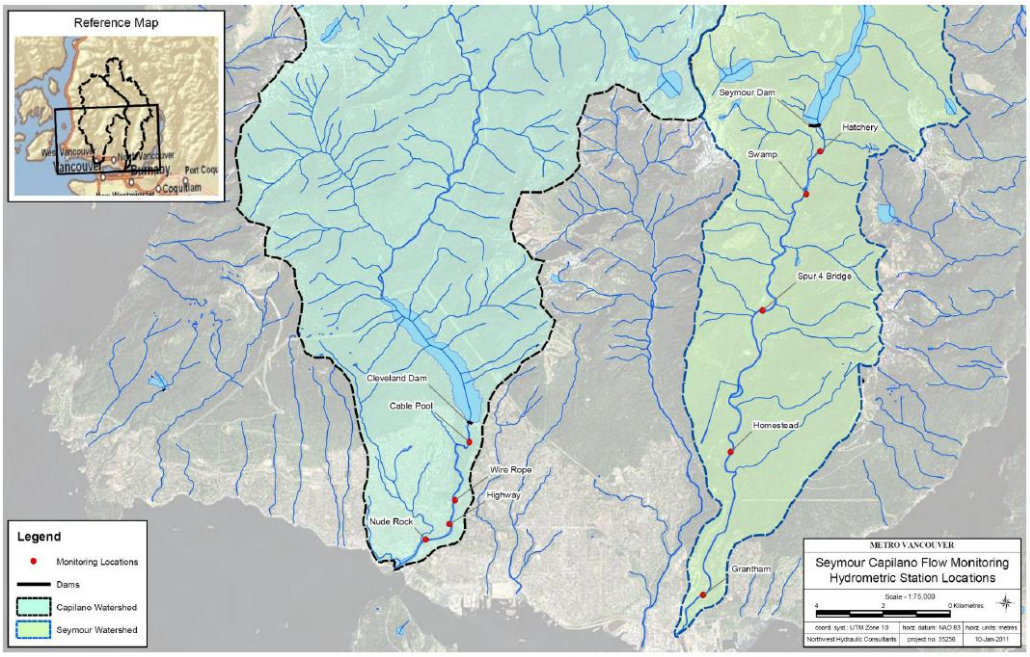


Figure E-2. Locations of hydrometric stations installed by NHC for Metro Vancouver.

Species Periodicity.— Life history timing for salmonids in the Capilano and Seymour rivers was summarized by the FTWG (Table E-5 and Table E-6). To the extent possible this information was based on observations within each river, but information was supplemented with other sources such as information from nearby river systems. The timing windows in these tables indicate times during which approximately 90% of the total activity occurs, so that undue emphasis is not placed on very early or late events or inter-annual extremes.

Table E-5. Salmonid life history timing for salmonids in the Capilano River.

Capilano River		Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			
Species	**Life Stage**	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Chinook	Adult migration																																	x	x			x	x	x	x	x							
	Spawning																																					x	x	x	x	x	x	x	x				
	Incubation	x	x	x	x	x	x	x	x	x	x	x	x																									x	x	x	x	x	x	x	x	x	x	x	x
	Rearing											x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																			
	Juvenile migration																																																
Chum	Adult migration																																		x	x	x	x	x	x	x	x							
	Spawning																																					x	x	x	x	x	x	x	x				
	Incubation	x	x	x	x	x	x	x	x	x	x	x	x																											x	x	x	x	x	x	x	x	x	x	x	x
	Fry outmigration											x	x	x	x	x	x																															
Coho	Adult migration																	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Spawning																																							x	x	x	x	x	x	x	x	x	x	x	x
	Incubation	x	x	x	x	x	x	x	x	x	x	x	x																											x	x	x	x	x	x	x	x	x	x	x	x
	Rearing													x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
	Juvenile migration													x	x	x	x	x	x	x	x	x	x																										
Cutthroat (resident)	Adult migration																					*Indian River*	x	x	x	x	x	x	x	x	*y*	*y*	*y*	*y*	*y* - *Chilliwack*														
	Spawning																																																
	Incubation																																																
	Rearing																																															
	Juvenile migration																																															
Pink	Adult migration																													x	x	x	x	x	x	x	x	x	x	x	x								
	Spawning																																	x	x	x	x	x	x	x	x	x							
	Incubation	x	x	x	x	x	x	x	x	x	x	x	x																					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Fry outmigration											x	x	x	x	x	x																															
Rainbow	Adult migration																																																
	Spawning																																															
	Incubation																																															
	Rearing																																															
	Juvenile migration																																															
Steelhead	Adult migration	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																			x
	Spawning									x	x	x	x	x	x	x	x	x	x	x	x																											
	Incubation					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	?	?	?	?																		
	Rearing													x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x								
	Juvenile migration												?	x	x	x	x	x	x	x	x	x	x										?	?	?	?	?											
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
		Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			

Table E-6. Salmonid life history timing for salmonids in the Seymour River.

Seymour River		Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			
Species	**Life Stage**	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Chinook	Adult migration																													x	x	x	x	x	x	x	x										
	Spawning																																					x	x	x	x	x	x	x	x				
	Incubation	x	x	x	x	x	x	x	x	x	x	x	x																											x	x	x	x	x	x	x	x	x	x	x	x
	Rearing											x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																			
	Juvenile migration																																																
Chum	Adult migration																																			x	x	x	x	x	x	x	x							
	Spawning																																							x	x	x	x	x	x	x	x				
	Incubation	x	x	x	x	x	x	x	x	x	x	x	x																													x	x	x	x	x	x	x	x	x	x	x	x
	Fry outmigration									x	x	x	x	x	x	x	x																															
Coho	Adult migration																	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Spawning																																							x	x	x	x	x	x	x	x	x	x	x	x
	Incubation	x	x	x	x	x	x	x	x	x	x	x	x																											x	x	x	x	x	x	x	x	x	x	x	x
	Rearing													x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x								
	Juvenile migration													x	x	x	x	x	x	x	x	x	x																										
Cutthroat (resident)	Adult migration																					*Indian River*	x	x	x	x	x	x	x	x	*y*	*y*	*y*	*y*	*y* - *Chilliwack*														
	Spawning																																																
	Incubation																																																
	Rearing																																															
	Juvenile migration																																															
Pink	Adult migration																													x	x	x	x	x	x	x	x	x	x	x	x								
	Spawning																																	x	x	x	x	x	x	x	x	x							
	Incubation	x	x	x	x	x	x	x	x	x	x	x	x																											x	x	x	x	x	x	x	x	x	x	x	x
	Fry outmigration									x	x	x	x	x	x	x	x																															
Rainbow	Adult migration																																																
	Spawning																																																
	Incubation																																																
	Rearing																																															
	Juvenile migration																																															
Steelhead	Adult migration	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	?	?	?	?	?	?	?	?	?	?	?	?	?	?	x	x	x	x
	Spawning					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	*x indicates winter run*																						
	Incubation									x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																				
	Rearing													x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x								
	Juvenile migration												?	?	?	x	x	x	x	x	x	x	x										?	?	?	?	?											
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
		Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec			

MOE models and data.— Where appropriate the FTWG used criteria and data from the BC Ministry of Environment. For example, target flows for spawning and migration were not directly assessed by JWUP data collection efforts, so we relied on predictions based on MOE's modified Tennant approach (Ptolemy and Lewis 2002).

Literature.— Much of the analysis and data collection effort was informed by the primary science literature, and experience garnered from other Water Use Plans in western Canada.

5. Alternatives

An "alternative" is a hypothetical rule or set of rules determining water storage, withdrawals and releases. The rules determine how much water is released below Capilano and Seymour dams and how much is diverted to supply drinking water. The rules also specify different assumptions regarding hydropower, such as timing and infrastructure. The purpose of alternatives is to allow an exploration of effects of withdrawals. All alternatives were specified as a 24-year time series of daily flows, which were used as the inputs to performance measure models (see below). Alternatives are discussed greater detail in Section 6.2.

6. Impact Hypotheses

One of the first stages of the FTWG's technical assessment was a scoping exercise in which "impact hypotheses" were developed and evaluated. Impact hypotheses describe how a particular ecological component is affected by water management alternatives. Most of the impact hypotheses were developed at FTWG meetings in spring 2011, with additions and revisions completed at further meetings. The primary questions addressed were, what resources are present in the study area, and what impacts might occur to these resources associated with the alternatives? Much of the original exploration was informed by work completed on other Water Use Plans.

In total, 17 impact hypotheses were developed. Each impact hypothesis was screened using existing information, and rejected, accepted or categorized as not applicable or data deficient, for different locations in each watershed. 10 impact hypotheses were rejected or deemed not applicable, based on available information. Seven impact hypotheses were accepted with sufficient certainty to recommend developing performance measures. An initial overview assessment of all 17 impact hypotheses is presented and discussed in Hatfield (2011). (It is important to understand that during this scoping exercise "acceptance" of an hypothesis implies only that this issue required further investigation and analysis. It did not imply that all water withdrawal scenarios would result in a significant impact. Measures of the effect of withdrawal are discussed below, under Performance Measures.)

Table E-7. Summary of Impact Hypotheses for Capilano and Seymour watersheds (from Hatfield 2011). Impact hypotheses are listed for each of the main areas. The first symbol identifies whether the hypothesis is accepted (✓), rejected (x) or untested (?) as an operational impact; the second symbol identifies whether a performance measure was developed. Note that the document also briefly assesses links to footprint and the proposed hydropower project.

Impact Hypothesis	Lower Capilano	Upper Capilano	Capilano Reservoir	Lower Seymour	Upper Seymour	Seymour Reservoir
Rearing Habitat	✓✓	✓x	xx	✓✓	✓x	xx
Spawning Habitat	✓✓	✓x	xx	✓✓	✓x	xx
Invertebrate Production	✓✓	✓x	xx	✓✓	✓x	xx
Passage Flows	✓✓	xx	xx	✓✓	xx	xx
Blockage of Upstream and Downstream Passage	xx	xx	xx	xx	xx	xx
Access to Side Channels and Tributaries	xx	xx	xx	xx	xx	xx
Geomorphic and Channel-Forming Flows	xx	xx	xx	xx	xx	xx
Gravel Condition	xx	xx	xx	xx	xx	xx
Gravel Recruitment	xx	xx	xx	xx	xx	xx
Stranding	xx	xx	✓x	xx	xx	✓x
Effective Littoral Zone	xx	xx	✓✓	xx	xx	✓✓
Marine-Derived Nutrients	✓x	xx	xx	✓x	xx	xx
Entrainment	xx	xx	✓✓	xx	xx	✓✓
Spills	xx	xx	xx	xx	xx	xx
TGP	? ?	xx	xx	? ?	xx	xx
Temperature	✓✓	✓x	xx	✓✓	✓x	xx

7. Performance Measures

The FTWG developed detailed models for 6 impact hypotheses. These models are referred to as Performance Measures or PMs, and are measures of performance associated with a specific water management alternative. The PMs were used to assess a number of alternatives and provide guidance on development of new alternatives. The FTWG developed detailed PMs for the following topics:

1. Stream temperature
2. Chinook fry habitat
3. Steelhead parr habitat
4. Invertebrate habitat
5. Steelhead spawning habitat

6. Chinook spawning habitat
7. Chum spawning habitat
8. Coho spawning habitat
9. Pink spawning habitat
10. Wetted width
11. Reservoir littoral area

A summary of the PMs is provided in the following sections.

Stream Temperature

Cold temperatures due to hypolimnetic releases have been a long-standing concern in the lower Capilano River, and there were concerns that this effect may be exacerbated with the addition of hydropower. A PM was developed based on reservoir thermal stratification, and a simple mixing model that used water releases from three locations at Cleveland Dam: surface (i.e., spills), mid-level outlet, and deep-water outlet (i.e., Howell Bunger valve). The PM tracked the number of days each year ≥7° C, which is MOE's criterion for defining the growth period for salmonids. For each alternative the PM was reported as the 10th, 50th and 90th percentile among the 24 years simulated for each alternative. Two hydropower scenarios were modeled: a surface intake and a deep-water intake. The stream temperature PM was calculated for the lower Capilano River only.

Metro Vancouver operations of alpine storage systems affect stream temperature in the upper watersheds, but the magnitude of effect requires additional assessment. The effect of greatest concern was the lower Capilano River, so a performance measure focused on this area.

Riverine Fish Habitat

By altering discharge Metro Vancouver has the capacity to influence abundance, distribution, and quality of rearing habitat for fish in the Capilano and Seymour watersheds. Wetted area, water depth, and water velocity are important determinants of habitat quantity and quality. They are also directly related to discharge. By inference, habitat quality and quantity are directly related to discharge, and reductions in rearing habitat are assumed to result in lower fish production. There is sufficient evidence from other rivers to accept this hypothesis and to build a performance measure to explore the relationship between operations and severity of impact.

Habitat in the upper watersheds is related in part to releases from Metro Vancouver's alpine storage; however, low nutrient levels and the inability to provide fine control of water releases suggested that a PM should focus on the lower rivers.

Species-specific fish habitat PMs were developed for Chinook fry, Steelhead fry, Coho fry, and Steelhead parr. Habitat suitability criteria (HSC) used for the PM were from the Province's HSC database developed during BC Hydro Water Use Planning. WUW vs. flow curves for Steelhead fry and parr and Coho fry were developed by InStream; the WUW vs. flow curve for CH fry was developed by NHC. The analysis was based on the Nude Rock and Highway transects on the lower Capilano River, and the Grantham, Homestead and Spur 4 Bridge transects on the lower Seymour River. The WUW vs. flow curves were used to transform the flow time series of each alternative into daily measures of WUW at each transect, and the average value was calculated for each river. Average WUW was then summarized for April through October (the approximate growing season for fish) as the 10^{th}, 50^{th} and 90^{th} percentile among the 24 years.

Results for fry life stages indicated optimum flows that would be considered detrimental to other life stages, and this coupled with professional opinion that fish production in Capilano and Seymour rivers is not limited by the fry life stage led to FTWG consensus that evaluation of alternatives should focus on results for Steelhead parr.

Spawning

Spawning habitat is ecologically important in the upper and lower watersheds of the Capilano and Seymour systems. The quality and quantity of this habitat type are assumed to be directly related to fish production. There is sufficient evidence from other rivers to accept this hypothesis and to build a performance measure to explore the relationship between operations and severity of impact. Habitat in the upper watersheds is related in part to releases from Metro Vancouver's high alpine systems; however, the inability to provide fine control of these water releases and limited data for these areas suggested that a PM should focus on the lower rivers where the resource values are high and the data availability is good.

Several species-specific spawning PMs were developed based on two key inputs: spawning times identified in the species periodicity tables (Table E-5 and Table E-6) and MOE's modified-Tennant approach to specifying appropriate spawning flows for salmonids (Ptolemy and Lewis 2002). The critical thresholds used in the spawning PM were 11 $m^3 \cdot s^{-1}$ and 9.41 $m^3 \cdot s^{-1}$ for the Capilano and Seymour rivers respectively, which was calculated from the equation: 148*MAD^-0.36, where MAD is the natural long-term mean annual discharge.

The spawning PM produced two complimentary descriptors. The first was a count of the number of days in the spawning window that met or exceeded the threshold flow, and the second was the maximum duration (number of days in a row) that met or exceeded the threshold flow. The PMs were made species-specific by calculating them separately for the spawning windows noted in the periodicity tables.

The spawning PMs were calculated and presented for the lower Capilano and Seymour rivers, for Steelhead, Coho, Chinook, Chum, and Pink. For each alternative the PM was reported as the 10th, 50th and 90th percentile among the 24 years modeled. The results for some species closely mirrored those for other species, so evaluation of alternatives focussed on results for Steelhead and Coho.

Invertebrate Habitat

Productivity of invertebrates in river systems is related in part to patterns of stream flow (magnitude, frequency, timing, duration), which is influenced by Metro Vancouver operations. This issue is similar to the habitat-based impact hypotheses for fish, but the target is invertebrate production. Invertebrates are a vital part of the drift food base for riverine fishes, so reductions or enhancements of invertebrates are assumed to translate into changes in fish production. The PM focussed on two riffle transects in the lower Capilano River and three riffle transects in the lower Seymour River.

Two approaches to the PM were developed. The first calculated WUW based on HSC for benthic invertebrates; the second calculated mean velocity in riffle transects. A WUW vs. flow curve, and a mean velocity vs. flow curve were produced by InStream. The curves were used to transform the flow time series of each alternative into daily measures of WUW and mean velocity at each transect, and the average value calculated for Capilano and Seymour. The analysis was based on the Nude Rock and Highway transects on the lower Capilano River, and the Grantham, Homestead and Spur 4 Bridge transects on the lower Seymour River. Average WUW and mean velocity were then summarized for April through October, which represents the approximate growing season for fish, as the 10th, 50th and 90th percentile among the 24 years.

Results for the invertebrate habitat PM closely mirrored those for Steelhead parr, so evaluation of alternatives focussed on PM results for Steelhead.

Wetted Width

The purpose of the wetted width PM was to provide an assessment of winter flow releases and to identify whether winter releases decline to abnormally low levels. This issue was not identified by the FTWG during the original impact hypothesis review. It

was noted as a concern during a later review when occasional low winter flow releases were identified in some of the alternatives. Since most of the fish habitat PMs are calculated for the warmer parts of the year and use HSCs based on those warmer temperatures, the river PMs described above were deemed inappropriate to address this concern.

A wetted width PM was developed separately for each month of November through March. Daily wetted width was based on the Nude Rock and Highway transects on the lower Capilano River, and the Grantham, Homestead and Spur 4 Bridge transects on the lower Seymour River. The wetted width PM was calculated and presented for the lower Capilano and Seymour rivers. For each alternative the PM was reported as the 10th, 50th and 90th percentile among the 24 years.

Reservoir Littoral Area

Coho fry and parr use the shallow areas of Capilano Reservoir for rearing and cover from fish predators during the early spring period. During the JWUP members of the FTWG expressed the concern that a smaller area available to Coho juveniles may affect potential fish production in the reservoir.

A simple bathymetry-based PM was developed to describe differences among alternatives in availability of littoral areas. The PM defined littoral area as those portions of the lake ≤ 6m depth, based on MOE's working definition of littoral. Metro Vancouver provided a lake area vs. water elevation curve for Capilano Reservoir; the most sensitive part of the curve was at the highest water levels. These inputs were used to transform the reservoir water elevation time series from each alternative into daily measures of littoral area in the reservoir. The littoral area PM was calculated and presented for the month of April, as an indicator of spring conditions in the reservoir. For each alternative the PM was reported as the 10th, 50th and 90th percentile among the 24 years.

8. Use of the Aquatic PMs in the JWUP Process

Reducing the Suite of PMs

During the JWUP process the outputs from PMs were compiled in a consequence table to allow a comparison of the effects of different alternatives. Initial consequence tables included outputs from a wide array of aquatic ecosystem PMs, and as a result the tables were lengthy and complex. The FTWG attempted to minimize the number of PMs to focus attention at the CC meetings on the critical fisheries-related differences among alternatives.

The FTWG used two primary methods to reduce the suite of environmental PMs: insensitivity and redundancy. Across a suite of multiple alternatives, several PMs

were found to be insensitive. That is, they showed little variation in response to the modeled water management alternatives. It was agreed that these PMs could be de-emphasized since they did not respond to the modeled alternatives, and in a general sense offered little or no insight into the performance of different alternatives. (As a matter of process, it was agreed that all PMs would be calculated and made available, but that some would be de-emphasized during discussions at the CC.) Many of the fish habitat PMs did not detect differences among alternatives during the late fall through spring.

Additional effort went into formally examining redundancy among PMs. During earlier winnowing of the impact hypotheses, the hypotheses were examined for conceptual redundancy, and the FTWG was satisfied with the reduced set of hypotheses that were used as the basis for PM development (Hatfield 2011). To examine statistical redundancy, PMs were calculated for a variety of alternatives and plotted as scatterplot matrices, or sploms, to assess correlations among PMs. Example sploms are shown in Figure E-3 and Figure E-4 and show pairwise comparisons of PM scores across the alternatives. When the PM scores form a line in one of the pairwise plots, the two PMs can be said to be correlated; where the line is tightly confined, as opposed to a loose cloud of points, the two PMs are highly correlated. Where correlations are high, the two PMs provide the same information because the form of the response to water withdrawal is similar, although the response scale may differ.

Several PMs were highly correlated. Where high correlations exist between a pair of PMs, there is redundancy in the PMs because both respond in a similar manner to alternatives. In other words, a reduced set of PMs will capture most of the concerns expressed by a larger set of PMs. This redundancy makes decision-making easier because multiple concerns can be expressed in a single PM.

The FTWG discussed the redundancy issue in detail and recommended that the following PMs be used to evaluate alternatives for the Capilano and Seymour:

Table E-8. Final list of aquatic ecosystem PMs recommended by the FTWG.

Watershed	PM	Species	Notes
Capilano	temperature	all	lower river
Capilano	salmonid rearing	ST parr	lower river (highway, nude rock - Instream transects)
Capilano	salmonid spawning	ST	threshold flow at cable transect
Capilano	salmonid spawning	CO	threshold flow at cable transect
Capilano	littoral area	CO	reservoir
Capilano	wetted width	all	lower river (highway, nude rock - Instream transects)
Seymour	salmonid rearing	ST parr	lower river (spur4, homestead, grantham - Instream transects)
Seymour	salmonid spawning	ST	threshold flow at homestead transect
Seymour	salmonid spawning	CO	threshold flow at homestead transect
Seymour	wetted width	all	lower river (spur4, homestead, grantham - Instream transects)

This reduced set of PMs is believed to capture, either through direct measurement or correlation, the ecosystem components that are of greatest concern to fisheries managers for these rivers. As noted earlier, all PMs were made available, but this reduced set formed the primary basis for decision-making at the CC.

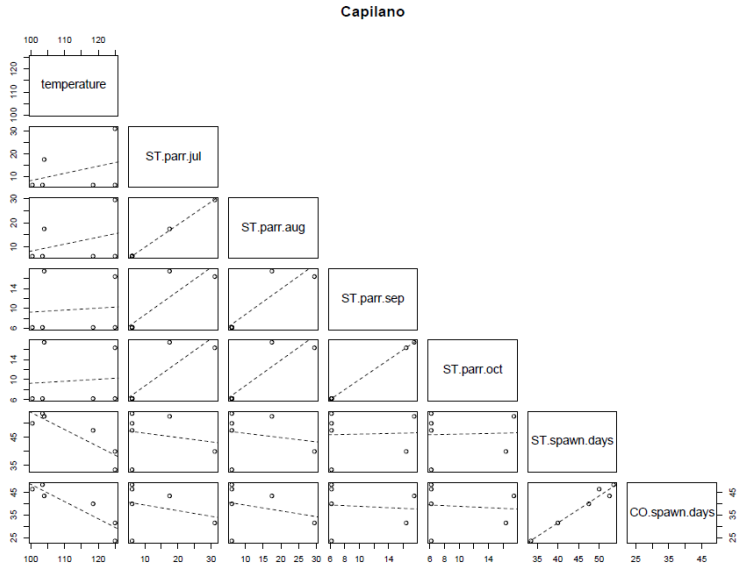


Figure E-3. Scatterplot matrix of seven aquatic ecosystem PMs for the Capilano River calculated for six divergent alternatives.

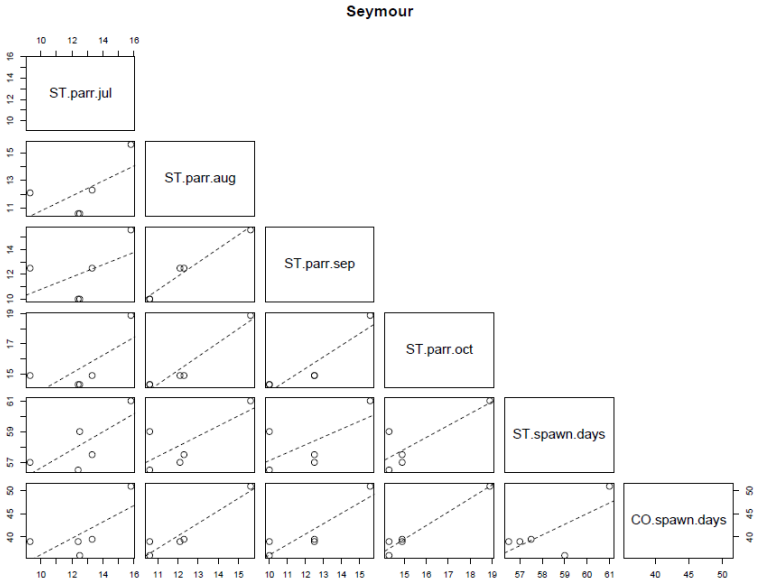


Figure E-4. Scatterplot matrix of seven aquatic ecosystem PMs for the Seymour River calculated for six divergent alternatives.

Limitations of the PMs

The FTWG recognized that there were limitations to the use of the PMs in developing recommendations for the JWUP, particularly during the latter stages of the decision-making process. In recognition of these limitations, the following guidance was provided for use of the fish PMs in assessing alternatives.

1. There is uncertainty around any of the PMs calculated. Conceptually, this is described in Figure E-5 as a grey area around a PM result for an alternative.

2. Despite some uncertainty, the aquatic PMs perform well in distinguishing between divergent alternatives. For example, the PMs allow one to distinguish between alternatives A and B, in Figure E-5.

3. The aquatic PMs work less well when we are trying to distinguish between similar alternatives. For example, when uncertainty bounds are overlapping, as they are for alternatives X and Y in Figure E-5, the alternatives likely have similar PM responses.

4. The PMs also work less well for assessing effects during extreme events, such as rare low flow events or events that are not within the existing 24 year flow record. One of the main reasons for this is that the PM calculations place no special weight on rare events such as extreme low flows. (This can be contrasted to the drinking water PM.)

5. To assess differences among similar alternatives, one must use professional judgement. This judgement should be informed by the behaviour of the PMs during comparison of more divergent alternatives, coupled with other sources of information.

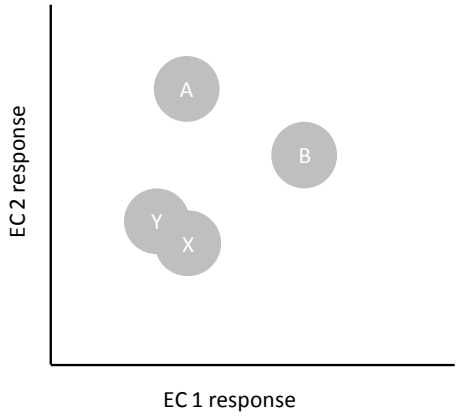


Figure E-5. Conceptual diagram indicating uncertainty in environmental responses and the ability to distinguish among water management alternatives. Divergent alternatives (A and B) can be distinguished with the FTWG's set of PMs, but there is greater difficulty in distinguishing alternatives that are similar (X and Y).

9. Protocols

During the JWUP process several concerns were raised that could not readily be incorporated into PMs or addressed within the alternatives, either due to lack of sufficient data or to insufficient sensitivity in the modeling procedures. The FTWG decided to develop protocols to provide guidance to Metro Vancouver operations.

Ramping.— Fish select habitats that minimize predation risk while maximizing net energy intake. For young fish in rivers, such habitats are often near margins or in side channels. If flows decrease rapidly such habitats may become cut off from mainstem areas or dewater entirely, with the consequence that individuals become stranded in isolated pools or exposed on the dewatered river bed. The extent of stranding depends on several factors, including channel morphology and pattern of water level fluctuations (frequency, magnitude, duration, and timing). Stranding risk in rivers is greatest at lowest flows, when small changes in river stage may result in dewatering of large areas of habitat, particularly in riffle areas. Small, slow changes in water elevation typically have much lower risk than fast, large changes in stage.

Hydropower development on the Capilano and Seymour rivers has the potential to increase the frequency of flow changes on the lower river, and thereby the potential to strand fish when flow changes are rapid. Preliminary studies by InStream identified locations that are likely sensitive to flow ramping and approximate thresholds below which ramping restrictions should be implemented, but detailed studies have not been completed. Studies are required that would quantify the risks associated with ramping, by undertaking measurements at one or more transects in the sensitive zones during a variety of flows, establishing a relation between flow and stage changes at these sites, and then calibrating the flow-stage relations with empirical assessments of stranding. Once a benchmark/protocol is established and agreed on with agencies, there is an expectation of continuous flow monitoring to assess and report on compliance with the ramping protocols. Thus, there are three distinct components: pre-commissioning assessments that focus on hydrology and stage changes, commissioning assessments that focus on confirming hydrologic and biotic predictions, and long-term monitoring that assesses compliance and makes adjustments based on information collected.

Data collection and analysis can be combined with other monitoring components, as appropriate.

Release of alpine storage.— Existing information indicates that flow releases from Palisade have a fairly neutral effect on habitat availability, but there are concerns regarding temperature effects since the released water is typically much colder than surface waters in Eastcap Creek during the summer and fall. A single trial conducted in 2010 indicated a 10° C drop associated with the Palisade release. The release may

last for several weeks, and there is a concern that the lower temperatures may have a detrimental effect on fish growth and production.

Additional studies will be undertaken during JWUP monitoring as part of an experimental temperature study of alpine storage releases, with an aim to assess different options for releases from Palisade Lake. These data will be analysed to understand effects of flow released on temperature, and to inform discussions on how best to implement releases from Palisade Lake.

Entrainment.— There are no upstream or downstream fish passage facilities at Cleveland Dam. Currently, to take advantage of substantial rearing and spawning habitats that occur in the upper watershed, adult fish are caught below the dam, then transported and released above the dam. Hatchery-produced juvenile fish are also released above the dam. Out-migrating fish suffer high mortality when they travel over the spillway or through the various gates and valves, so there are ongoing attempts to intercept smolts via trapping (RST, lake trapping, etc.) as they leave the upper watershed, transport them around the dam and release them into the lower Capilano River. These various mitigation attempts are labour intensive and intercept only a portion of the out-migrating fish. There has been an ongoing attempt to improve the efficiency of the trap and truck operations.

The addition of hydropower to the existing infrastructure presents additional risk of entrainment, but also an opportunity to incorporate a fish collection system to improve capture of out-migrants to increase the proportion of fish that are given safe passage downstream of the dam. Monitoring studies are proposed to assess the efficacy of the fish collection system. The data will allow assessment of the infrastructure and provide information that may lead to possible improvements of the structures and protocols.

As part of the JWUP process, the FTWG developed specific design objectives for the hydropower facility, which are aimed primarily at improving downstream passage of fish at Cleveland Dam.

10. References

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Appendix F – FTWG Monitoring Program Presented to CC

Monitoring Table 1 below summarizes the studies initially recommended by the Fish Technical Working Group and presented to the CC at their final meeting held on July 19, 2012 (note. This table was included in the Pre-Reading Package distributed prior to the meeting). At their final meeting, the CC weighed and considered these studies towards their final recommended monitoring program (summarized in Section 7.7). While the CC mostly agreed with the FTWG's recommended program, there were some differences for the inclusion and timing of some of the studies.

Background

During development and application of aquatic ecosystem PMs the FTWG identified a number of key environmental uncertainties, and made preliminary recommendations for a long-term monitoring program. During discussions on JWUP monitoring, the FTWG identified two primary types of monitoring studies, response monitoring and compliance monitoring, and two other types of study that could be incorporated into the monitoring program, filling of knowledge gaps and studies associated with project regulatory approvals.

> **Response Monitoring and Compliance Monitoring.—** Monitoring is a cornerstone of good resource management. Monitoring allows post-implementation assessment of management decisions and programs and provides direction on adjustments that may be necessary. There are essentially two types of monitoring, compliance monitoring and response monitoring. Compliance monitoring measures water use to ensure a user is complying with the conditions of a water license, or it may include monitoring of water quality, channel morphology, or other physical states where conditions have been articulated in regulations and permits. Compliance monitoring may also apply to habitat compensation works to ensure that they are physically stable and performing adequately.
>
> Response monitoring is often more difficult to design and implement. It involves a test of whether flow management decisions result in the expected ecological outcomes (e.g., fish populations, fish habitat, invertebrate production). Developing a biotic response monitoring program is like developing an experiment, and requires detailed consideration of experimental design and analysis to measure response relative to a reference or baseline condition. Since biological responses are difficult to measure and variable in space and time, an effective monitoring program must be designed to address the complexity of relationships between biological responses and flow, and to account for external factors (i.e., non-flow related) and natural temporal

variations. The overriding argument for implementing a biotic response monitoring program is recognition of the current uncertainty in predictions of biological response (e.g., fish abundance) to changes in environmental conditions (Ludwig et al. 1993, Castleberry et al. 1996 (see references in Appendix E)). Results from a well-designed monitoring program can highlight needs for changes to management strategies, or they may demonstrate that a decision led to acceptable outcomes. In the latter case, data may support adjustments that reduce restrictions on water use. For this reason, response monitoring is of keen interest to all stakeholders.

Knowledge Gaps.— The JWUP recommendation was made while acknowledging several information gaps that could not be addressed within the time frame of the JWUP process. For example, during development of aquatic ecosystem PMs the FTWG identified several key data gaps, and made recommendations that a monitoring program attempt to fill these. The JWUP monitoring recommendations address key knowledge gaps encountered during the JWUP process, and do not represent new issues raised after the process.

Approvals and Permitting.— Developing hydropower on Capilano or Seymour rivers will likely require studies additional to those completed to date for the JWUP process or those indicated for the monitoring program. For example, there may be a need for surveys of SARA-listed species or development of habitat compensation requirements. Such studies are outside the purview of the JWUP monitoring program.

The selection of JWUP monitoring studies proceeded from populating a broad list of potential studies to an iterative screening process that focussed the program on key uncertainties and regulatory requirements. The process was somewhat unique for WUPs in BC because it included consideration of assessment and monitoring guidelines for new Independent Power Producers (IPPs), in addition to the more typical consideration of establishing reference points or baselines for assessing future changes.

In an effort to standardize approaches to information collection and analysis, provincial and federal regulatory agencies developed guidelines and information documents to provide direction on specific elements of assessment and monitoring of small hydropower projects. These guidelines documents include:

Hatfield, T., A. Lewis, D. Ohlson, and M. Bradford. 2003. Development of instream flow thresholds as guidelines for reviewing proposed water uses. prepared for: B.C. Ministry of Sustainable Resource Management and B.C. Ministry of Water, Land and Air Protection. Victoria, BC.

Lewis, A., T. Hatfield, B. Chilibeck, and C. Roberts. 2004. Assessment methods for aquatic habitat and instream flow characteristics in support of applications to dam, divert, or extract water from streams in British Columbia. Prepared for: British Columbia Ministry of Water, Land and Air Protection and British Columbia Ministry of Sustainable Resource Management, Victoria, BC.

Hatfield, T., A. Lewis, and S. Babakaiff. 2007. Guidelines for the collection and analysis of fish and fish habitat data for the purpose of assessing impacts from small hydropower projects in British Columbia.

Lewis, F.J.A., A.J. Harwood, C. Zyla, K.D. Ganshorn, and T. Hatfield. 2012. Long-term aquatic monitoring protocols for new and upgraded hydroelectric projects. Consultant's report prepared for DFO. [in press]

Detailed recommendations for effects monitoring are provided in Hatfield et al. (2007) and Lewis et al. (2012) and describe experimental design and information collection methods for fish abundance and distribution, water quality, hydrology, geomorphology, aquatic macroinvertebrates, wildlife and species-at-risk. The guidelines documents helped direct the FTWG's selection and emphasis of monitoring studies. In addition to recommended studies from the guidelines, the FTWG considered key uncertainties encountered during the JWUP process and long-standing data needs in the watersheds.

All potential studies were collated, annotated with brief descriptions and assigned approximate costs and study durations. The full list of potential monitoring studies was then reviewed by the FTWG to develop a priority ranking based on the research questions, relevance of the study findings to future water management decisions, expected quality of information from the study, relation of the study to water use versus a regulatory requirement for new hydropower facilities, and projected cost. During discussions, the FTWG noted:

- some forms of compliance monitoring (e.g., construction monitoring, compensation effectiveness monitoring) are best left to the environmental assessment and permitting process,
- the monitoring recommendations do not limit the authority/responsibility of agencies to ask for additional works during the EA approval process (e.g., inventories for SARA-listed species in the reservoir areas)
- other forms of compliance monitoring (e.g., flow and temperature monitoring) are clearly within the purview of the FTWG's mandate,
- response monitoring is challenging at the best of times, but is especially challenging in these systems where the expected response (treatment effect) is small and the outside influences are many.

The FTWG's detailed monitoring recommendations were presented to the CC at their final meeting on 19 July 2012, where they were discussed and revised. The final list of proposed monitoring studies is presented separately below for Capilano and Seymour watersheds.

The table below differentiates those studies based on being a likely WUP requirement versus a likely IPP regulatory requirement (described as an assessment related study). Accordingly a study identified as an IPP requirement would not be initiated unless the proposed hydropower facilities were built.

Also note that the column which includes the FTWG's rating in terms of "High" or "Lower". The "Lower" refers to studies where there were differences of opinion by FTWG members as to whether the study would be able to provide meaningful results given the uncertainties and the available methods to address them.

Monitoring Table 1 Summary of Original FTWG Recommended Monitoring Studies for Seymour System

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs	FTWG Priority
SEY 1A	**Monitoring of fish flow releases and drinking water withdrawals**	all	ALL	WUP Compliance	This monitoring study will collect continuous data on fish flow releases and drinking water withdrawals from Seymour Reservoir, and assess and report on compliance. The data shall be collected to appropriate standards (e.g., rating curve error, etc.) and there will need to be agreement on defining compliance (e.g., consideration of error bounds on estimates).	life of project	pre-JWUP post-JWUP pre-hydro post-hydro		$ 5,000	High
SEY 1B	**Monitoring of hydropower water withdrawals**	all	ALL	WUP Compliance / IPP Compliance	This monitoring study will collect continuous data on hydropower water withdrawals from Seymour Reservoir, and assess and report on compliance. The data shall be collected to appropriate standards (e.g., rating curve error, etc.) and there will need to be agreement on defining compliance (e.g., consideration of error bounds on estimates). The data will be collected continuously after commissioning of the hydropower project.	life of project	post-JWUP post-hydro		$ 1,000	High
SEY 1C	**Flow monitoring of instream flow requirements (IFRs) - prior to JWUP implementation**	lower river	ALL	WUP Compliance	This monitoring study will collect continuous data on water flows in the lower Seymour River (i.e., below Seymour Dam), and assess and report on IFR compliance. There have been requests to make the flow data available in real time. There will need to be a decision on whether Metro release data are sufficient, or whether one or more full time gauges are required in the river below the dam. The data shall be collected to appropriate standards (e.g., rating curve error, etc.) and there will need to be agreement on defining compliance (e.g., consideration of error bounds on estimates, definition of ramping excursions). There are two distinct monitoring periods: A. up until JWUP is approved and implemented, and B. post-implementation of the JWUP. During the pre-implementation period, Metro will continue to collect data at 5 cross-sections on the lower Seymour River operated by Metro Vancouver/NHC	life of project	pre-JWUP		$30,000	High

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs	FTWG Priority
SEY 1D	**Flow monitoring of instream flow requirements (IFRs) - after JWUP implementation**	lower river	ALL	WUP Compliance	This monitoring study will collect continuous data on water flows in the lower Seymour River (i.e., below Seymour Dam), and assess and report on IFR compliance. There have been requests to make the flow data available in real time. This assumes the NHC gauge site at Spur 4 is continued as a real time gauge. The data shall be collected to appropriate standards (e.g., rating curve error, etc.) and there will need to be agreement on defining compliance (e.g., consideration of error bounds on estimates, definition of ramping excursions).	life of project	post-JWUP/pre-hydro post-JWUP/post-hydro	$10,000 ($16K for real time)	$20,000	High
SEY 1E	**Flow monitoring of instream flow requirements (IFRs)**	lower river	ALL	WUP Compliance	This monitoring study will support ongoing collection of continuous data (stage, flow, temperature) at the hydrometric station currently operated and funded by Water Survey Canada at Twin Bridges (08GA030).	life of project	TBD		WSC Funds	High
SEY 1F	**Flow monitoring of instream flow requirements / stranding assessment (ramping rates)**	lower river	ALL	WUP Compliance / IPP Compliance	Hydropower development on the Seymour River has the potential to increase the frequency of flow changes on the lower river, and thereby the potential to strand fish when flow changes are rapid. This monitoring study will establish/confirm ramping protocols, and collect continuous data on water flows in the lower Seymour River (i.e., below Seymour Dam), and assess and report on compliance with the ramping protocols. More detailed studies are required to quantify the risks associated with ramping, by undertaking measurements at one or more transects in the sensitive zones during a variety of flows, establishing a relation between flow and stage changes at these sites, and then calibrating the flow-stage relations with empirical assessments of stranding. Data collection and analysis can be combined with other monitoring components, as appropriate.	life of project	post-JWUP/pre-hydro post-JWUP/post-hydro	$50,000	$5,000	High
SEY 1G	**Water level monitoring in Seymour Reservoir**	reservoir	ALL	WUP Compliance / IPP Compliance	This monitoring study will collect continuous data on water levels in Seymour Reservoir, and assess and report on compliance with the water license requirements. There will need to be a decision on whether Metro's current data collection program is sufficient, or whether another gauge is required. The data shall be collected to appropriate standards (e.g., rating curve error, etc.) and there will need to be agreement on defining compliance (e.g., consideration	life of project	post-JWUP/post-hydro	$10,000	$ 5,000	High

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs	FTWG Priority
					of error bounds on estimates).					
SEY 1H	**Inflow monitoring to Seymour Reservoir**	upper watershed	ALL	WUP Compliance / IPP Compliance	This monitoring study will install and maintain a gauge to measure continuous data (stage, flow, temp) to assess inflows to Seymour Reservoir, and ensure that the data are reported. The data shall be collected to appropriate standards (e.g., rating curve error, etc.).	life of project	post-JWUP/post-hydro		$25,000	High
SEY 1I	**Temperature monitoring 1**	lower river	ALL	WUP Compliance / IPP Compliance	These data and analyses will provide an assessment of the significance of water temperature changes and their effect on fish habitat. They will also provide an indirect assessment of fish response to temperature changes associated with hydropower development on Seymour, and provide a better understanding of factors limiting fish production.	3-5 years	post-JWUP/post-hydro		$5,000	Lower
SEY 2	**Status and trends of key fish species**	all	ST, CO, other fish	Ongoing	Response monitoring is challenging at the best of times, but is especially challenging in the Seymour system where the expected response (treatment effect) is small and the outside influences are many. During the WUP, the FTWG suggested that designing and implementing a full-blown response monitoring program would not be recommended. On the other hand, there was widespread agreement that current programs (e.g., smolt enumeration, etc.) provide useful information on the status of some stocks and can be used to understand trends. Over time these data may also provide better understanding of cause and effect relationships. Continue until approval of the JWUP, and preferably after. Enumeration of smolts produced from the lower Seymour Watershed (from Seymour Falls Dam to Twin Bridges)	pre-JWUP	pre-JWUP		$50,000	High

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs	FTWG Priority
SEY 3	**Entrainment at Seymour Dam**	all	ALL	WUP Compliance / IPP Compliance	There are no upstream or downstream fish passage facilities at Seymour Dam. Entrainment at this facility was not deemed to be a significant issue during the JWUP, but the issue has been flagged as a potential issue if the fisheries agencies decide to move fish into the upper watershed. A monitoring program for that case has not been designed. However, even in the absence of such a program there would be a requirement to assess the efficacy of the fish screens at a hydropower intake.	life of project	post-JWUP/post-hydro		$ 5,000	High

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs
SEY 5	**Distribution and abundance of SARA-listed species (e.g., Pacific water shrew, red-legged frog)**	all	SARA-listed species	IPP Compliance	At present, little is known about the distribution and abundance of SARA-listed wildlife in the watershed, and whether these species may be affected by changes in operations. The first step in this assessment is to undertake a basic inventory of these species, especially in the reservoir. It is possible that such work would be required as baseline information for the project development plan.	1 year	post-JWUP/ pre-hydro		$ 24,000
SEY 6	**Level 1 and Level 2 Fish Habitat Assessments (FHAP)**	lower river	all	Ongoing	This study will undertake an FHAP assessment of fish habitat in the Seymour River. Costing assumes that the study will assess only a portion of the river.	1 year	post-JWUP /pre-hydro		$ 60,000
SEY 7	**Habitat compensation plan**	all	all	IPP Compliance	This study will be completed prior to construction of the Seymour Dam hydropower project, and will identify the habitats that are expected to be impacted by construction. As part of the study a habitat compensation plan will be developed based on existing information of habitats and habitat use in the watershed.	1 year	post-JWUP /pre-hydro		$ 25,000

Table 8-9 Summary of Original FTWG Recommended Monitoring Studies for Capilano System

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs	FTWG Priority
CAP 1A	**Monitoring of fish flow releases and drinking water withdrawals**	all	ALL	WUP Compliance	This monitoring study will collect continuous data on fish flow releases and drinking water withdrawals from Capilano Reservoir, and assess and report on compliance.	life of project	pre-JWUP post-JWUP/pre-hydro post-JWUP/post-hydro		$5,000	high
CAP 1B	**Monitoring of hydropower water withdrawals**	all	ALL	WUP Compliance / IPP Compliance	This monitoring study will collect continuous data on hydropower water withdrawals from Capilano Reservoir, and assess and report on compliance. The data will be collected continuously after commissioning of the hydropower project.	life of project	post-hydro		$1,000	high
CAP 1C	**Flow monitoring of instream flow requirements (IFRs) - prior to JWUP implementation**	lower river	ALL	WUP Compliance	This monitoring study will collect continuous data on water flows in the lower Capilano River (i.e., below Cleveland Dam),and assess and report on IFR compliance. There have been requests to make the flow data available in real time. There are two distinct monitoring periods: A. up until JWUP is approved and implemented, and B. post-implementation of the JWUP. During the pre-implementation period, Metro will continue to collect data at 4 cross-sections on the lower Capilano River operated by Metro Vancouver/NHC	life of project	pre-JWUP		$30,000	high
CAP 1D	**Flow monitoring of instream flow requirements (IFRs) - after JWUP implementation**	lower river	ALL	WUP Compliance	This monitoring study will collect continuous data on water flows in the lower Capilano River (i.e., below Cleveland Dam), and assess and report on IFR compliance. There have been requests to make the flow data available in real time. This assumes the NHC gauge site at cable pool is continued as a real time gauge. note: need to determine needs for real time (e.g., kayakers may only need web cam)	life of project	post-JWUP/pre-hydro post-JWUP/post-hydro		$20,000	high

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs	FTWG Priority
CAP 1E	**Flow monitoring of instream flow requirements / stranding assessment (ramping)**	lower river	ALL	WUP Compliance / IPP Compliance	Hydropower development on the Capilano River has the potential to increase the frequency of flow changes on the lower river, and thereby the potential to strand fish when flow changes are rapid. This monitoring study will establish/confirm ramping protocols, and collect continuous data on water flows in the lower Capilano River (i.e., below Cleveland Dam), and assess and report on compliance with the ramping protocols. More detailed studies are required to quantify the risks associated with ramping, by undertaking measurements at one or more transects in the sensitive zones during a variety of flows, establishing a relation between flow and stage changes at these sites, and then calibrating the flow-stage relations with empirical assessments of stranding. Data collection and analysis can be combined with other monitoring components, as appropriate.	life of project	post-JWUP/post-hydro	$50,000	$5,000	high
CAP 1F	**Water level monitoring in Capilano Reservoir**	reservoir	ALL	WUP Compliance	This monitoring study will collect continuous data on water levels in Capilano Reservoir, and assess and report on compliance with the water license requirements.	life of project	post-JWUP/pre-hydro post-JWUP/post-hydro		$5,000	high
CAP 1G	**Inflow monitoring to Capilano Reservoir**	upper watershed	ALL	WUP Compliance	This monitoring study will support ongoing collection of continuous data (stage, flow, temperature) at the hydrometric stations currently operated by Water Survey Canada above and below Cleveland Dam. It is possible that one or more of these gauges will adequately fill the information needs described in other monitoring components, in which case duplication of effort is unnecessary. Details of the flow monitoring program require further planning. There have been requests to make the river flow data available in real time, and it may be possible to modify existing programs.	life of project	post-JWUP/pre-hydro post-JWUP/post-hydro		$25,000	high

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs	FTWG Priority
CAP 1H	**Temperature monitoring 1**	lower river / reservoir	ALL	WUP Compliance / IPP Compliance	The effects of temperature on fish production in the Capilano River were a key consideration in the WUP and simple temperature models were used to assess the effects of different alternatives. This monitoring study will collect continuous data on water temperatures in the lower Capilano River (i.e., below Cleveland Dam) and in the Capilano Reservoir to assess the effect of operational changes in river water temperatures. Monthly temperature profiles will be taken at one or more locations in the reservoir to understand thermal stratification patterns. There have been requests within the FTWG to collect temperature data at more than one point in the river to assess changes in water temperature (i.e., heating, cooling, effect of inflows). Note that there is some relevant historical information on this as part of NHC's gauging.	3-5 years	post-JWUP/pre-hydro post-JWUP/post-hydro		$10,000	high
CAP 2	**Temperature monitoring 2**	upper watershed	ALL	WUP Compliance	Existing information indicates that flow releases from Palisade have a fairly neutral effect on habitat availability, but there are concerns regarding temperature effects since the released water is typically considerably colder than surface waters in Eastcap Creek during the summer and fall. A single trial conducted in 2010 indicated a 10 C drop in temperature associated with the Palisade release. The release may last for several weeks, and there is a concern that the lower temperatures may have a detrimental effect on fish growth and production. This monitoring study will undertake an experimental temperature study of alpine storage releases to assess different options for Palisade releases. Continuous temperature and flow data will be collected before, during and after the releases on Palisade Creek and Eastcap Creek. These data will be analysed to understand effects of flow released on temperature, and to inform discussions on how best to implement Palisade releases.	3-5 years	post-JWUP/pre-hydro post-JWUP/post-hydro		$7,500	lower

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs	FTWG Priority
CAP 3	**Upstream migration enhancement using pulse flows**	lower river	ST, CO, PK, CM, CH	WUP Compliance	During the WUP, concerns were expressed regarding the effects of delayed migration during the migration and spawning window. The hypothesized effect is greater interception by fisheries near the mouth of the river and greater predation (e.g., by otters) when the delay occurs further upstream. At present there is no direct information of critical migration flows, though anecdotal information on the Capilano River and elsewhere indicates that fish migration can be triggered by flow pulses, both natural and operational. This monitoring study will undertake an experimental pulse flow release to assess the effect of different options for pulsed releases during the low flow period. Currently, the infrastructure would likely not allow fine control of the release, and would therefore not likely meet ramping requirements. It is also likely that releases would be made up entirely or substantially of cold, hypolimnetic water. Any decision to undertake this study using current infrastructure would therefore need to assess these risks and obtain prior approval from regulators. Fish would be monitored before, during and after the pulse releases to determine fish migration responses to the pulse flows. Fish movements could be studied using a combination of telemetry and snorkel assessments. Several pulse flow trials may be needed to understand the benefits of pulse releases and to optimize the design of pulse flows (i.e., timing, duration, frequency).	3-5 years	post-JWUP/pre-hydro post-JWUP/post-hydro	$20,000	$100,000	lower

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs	FTWG Priority
CAP 4	**Status and trends of key fish species**	all	ST, CO, other fish	WUP Compliance	Response monitoring is challenging at the best of times, but is especially challenging in the Capilano system where the outside influences are many (e.g., hatchery, trap and truck program, marine survival, etc.). During the WUP, the FTWG discussed these issues but nevertheless recommended designing and implementing a response monitoring program. There was widespread agreement that current programs (e.g., smolt enumeration, etc.) provide useful information on the status of some stocks and can also be used to understand trends. Details of the response monitoring program will need to be developed further, but are loosely budgeted here as a program of annual enumeration of juvenile fish in the lower Capilano each fall using snorkel swims and electrofishing. Minimum duration of the program is based on the provincial and federal monitoring guidelines of 2 years baseline and 5 years post-construction monitoring.	2 years baseline / 5 yrs post hydro	pre-JWUP/pre-hydro post-JWUP/post-hydro		$100,000	high
CAP 5	**Reservoir littoral area**	reservoir	ST, CO, inverts	WUP Compliance / IPP Compliance	Coho fry and parr use the shallow areas of Capilano Reservoir for rearing and cover from fish predators during the early spring period. During the WUP, simple bathymetric models indicated that less shallow water habitat would be available under most hydropower alternatives. There is a concern that the smaller area available to coho juveniles may affect potential fish production in the reservoir. This monitoring study will collect habitat use data of coho fry and parr in the Capilano Reservoir, to better define limiting habitats in the reservoir. The study will allow for example a better understanding of whether these fish use all shallow habitat equally or whether they are concentrated in some locations like the north end of the reservoir. Habitat use data will permit more accurate modeling of drawdown effects and therefore better assessment of potential effects associated with hydropower development. Additional study requirements may be apparent after completing the initial habitat use study. This may be a good topic for a Masters student.	1-2 years	post-JWUP/pre-hydro post-JWUP/post-hydro		$20,000	lower

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs	FTWG Priority
CAP 6A	**Upstream and downstream fish passage at Cleveland Dam / efficacy of new intake screens**	all	ST, CO	WUP Compliance / IPP Compliance	There are no upstream or downstream fish passage facilities at Cleveland Dam. Currently, to take advantage of substantial rearing and spawning habitats that occur in the upper watershed, adult fish are caught below the dam, then transported and released above the dam. Juvenile fish are also released above the dam. Outmigrating fish suffer high mortality when they travel over the spillway or through the various gates and valves, so there are ongoing attempts to intercept smolts via trapping (RST, lake trapping, etc.) as they leave the upper watershed, truck them around the dam and release them into the lower Capilano River. These various mitigation attempts are labour intensive and capture only a portion of the outmigrating fish. There has been an ongoing attempt to improve the efficiency of the trap and truck operations. The addition of hydropower to the existing infrastructure presents additional risk of entrainment, but also an opportunity to incorporate a fish collection system to improve capture of outmigrants to increase the proportion of fish that are given safe passage downstream of the dam. The hydropower intakes will be screened to prevent entrainment of fish into the hydropower intake. This monitoring study has two components: it will assess the efficacy of the fish screens at the hydropower intake and it will monitor the fish collection system. The data will allow assessment of the infrastructure and provide information that may lead to possible improvements of the structures and protocols. This component will assess the efficacy of the fish screens.	life of project	post-hydro		$5,000	high
CAP 6B	**Upstream and downstream fish passage at Cleveland Dam**	all	ST, CO	WUP Compliance	There are no upstream or downstream fish passage facilities at Cleveland Dam. Currently, to take advantage of substantial rearing and spawning habitats that occur in the upper watershed, adult fish are caught below the dam, then transported and released above the dam. Juvenile fish are also released above the dam. Outmigrating fish suffer high mortality when they travel over the spillway or through the various gates and valves, so there are ongoing attempts to intercept smolts via trapping (RST, lake trapping, etc.) as they leave the upper watershed, truck them around the dam	life of project	pre-JWUP post-JWUP/pre-hydro post-JWUP/post-hydro		100,000	high

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs	FTWG Priority
					and release them into the lower Capilano River. These various mitigation attempts are labour intensive and capture only a portion of the outmigrating fish. There has been an ongoing attempt to improve the efficiency of the trap and truck operations. The addition of hydropower to the existing infrastructure presents additional risk of entrainment, but also an opportunity to incorporate a fish collection system to improve capture of outmigrants to increase the proportion of fish that are given safe passage downstream of the dam. The hydropower intakes will be screened to prevent entrainment of fish into the hydropower intake. This monitoring study has two components: it will assess the efficacy of the fish screens at the hydropower intake and it will monitor the fish collection system. The data will allow assessment of the infrastructure and provide information that may lead to possible improvements of the structures and protocols. This component will assess the efficacy of the fish trap and truck program. It does not include the cost of trapping and trucking, rather it monitors the program with the intent of evaluating its success and the relative success of any changes over time.					

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs
CAP 9	**Distribution and abundance of SARA-listed species (e.g., Pacific water shrew, red-legged frog)**	all	SARA-listed species	IPP Compliance	At present, little is known about the distribution and abundance of SARA-listed wildlife in the watershed, and whether these species may be affected by changes in operations. The first step in this assessment is to undertake a basic inventory of these species, especially in the reservoir. It is possible that such work would be required as baseline information for the project development plan.	1 year	post-JWUP/pre-hydro		24,000

Study		Location	Species	Relevance	Purpose / Description	Duration	When	Capital Costs	Annual Costs
CAP 10	**Stranding within the drawdown zone**	reservoir	ST, CO	IPP Compliance	Stranding of fish may occur in isolated pools as the reservoir is drawn down during operations, and there may be additional risks under a hydropower water level regime relative to the non-hydropower alternative. The magnitude and extent of this potential impact is not known at this time and could not be explored adequately during the WUP process. It is believed that the greatest risk is inlet area at the north end of the reservoir. This monitoring study will undertake an initial assessment of stranding risk to assess whether this is a problem that requires further assessment.	1 year	post-JWUP/pre-hydro		15,000
CAP 11	**Level 1 and Level 2 Fish Habitat Assessments (FHAP)**	lower river	all	IPP Compliance	This study will undertake an FHAP assessment of fish habitat in the Capilano River. Costing assumes that the study will assess only a portion of the river.	1 year	post-JWUP/pre-hydro		25,000
CAP 12	**Habitat compensation plan**	all	all	IPP Compliance	This study will be completed prior to construction of the Cleveland Dam hydropower project, and will identify the habitats that are expected to be impacted by construction. As part of the study a habitat compensation plan will be developed based on existing information of habitats and habitat use in the watershed.	1 year	post-JWUP/pre-hydro		25,000

Appendix G – Meeting Notes from Final CC Meeting #8

Meeting Highlights:

- The Consultative Committee (CC) was provided with an update of recent activities and work undertaken by the Fish Technical Working Group.
- The CC reviewed and assessed a number of options for the Joint Capilano-Seymour Water Use Plan (JWUP).
- **The CC unanimously endorsed a consensus package of recommendations for the JWUP, which included:**
  - Operating Alternatives for the lower Capilano and Seymour Rivers
  - Capilano and Seymour Monitoring Programs
  - WUP Non-flow options associated with both Capilano and Seymour
  - Voluntary measures associated with both Capilano and Seymour
  - Timing recommendations for when flow and non-flow options should be implemented
  - Review periods for both Seymour and Capilano

Summary of Meeting Action Items:

Item	Who	When
• CC Meeting #8 notes to be completed and distributed	Facilitator	Wk of July 31
• Metro Vancouver and Province to discuss and decide on whether Seymour Study 1H – Inflow Monitoring – needs to be included within the WUP monitoring program or not	MV / MFLNRO	tbd
• Facilitator to consult with Ellen Hong and Poul Bech on their support for the CC's endorsed JWUP Package	Facilitator	WK of July 31

Attendance:

Consultative Committee Members:	Project Support:
Bill Cafferata, Living Rivers Georgia Basin and Vancouver Island (LRGBVI) Eric Carlisle, BC Federation of Drift Fishers (BCFDF) Norman Daniel, North Shore Community Association (NSCA) Tom Hoskin, Vancouver Kayak Club (VKC) Duane Jesson, Ministry of Forests, Lands, Natural Resources Operations (MFLNRO) John McMahon, District of West Vancouver Albert van Roodselaar, Metro Vancouver Corino Salomi, DFO (arrived 1:20 p.m.) Brian Smith, Seymour Salmonid Society (SSS) (departed 6:10 p.m.) Michelle Weston, District of North Vancouver (DNV) (arrived 11:50 a.m.) Stan Woods, Metro Vancouver (MV) **Regrets:** Bill Williams, Squamish Nation Randall Lewis, Squamish Nation Poul Bech, Steelhead Society of BC (SSBC) Ellen Hong, BC Recreational Canoeing Association (BCRCA) Evan Stewart, Tsleil-Waututh Nation	Michael Harstone, Compass Resource Management (Facilitator) Vivian Guthrie, Raincoast Ventures Ltd. (Recording Secretary) **Observers and Invited Guests:** Derek Bonin, Metro Vancouver (arrived 11:37 a.m.) Kenzi Miyazaki, Ministry of Forests, Lands, Natural Resources Operations (MFLNRO) Mark Wellman, Metro Vancouver Agnes Rosicki, Metro Vancouver (departed 1:20 p.m.)

Meeting Agenda

11:00am	Update & Overview
11:45am	Operating Alternatives – Capilano & Seymour
12:30pm	Lunch (provided)
1:00pm	Monitoring Program & Review Period
2:00pm	Residual Mitigation Options and Other WUP Recommendations
3:30pm	Review and Assessment of Package(s) of WUP Recommendations
5:00pm	Dinner (provided)
5:30pm	Recommending a WUP Package
6:45pm	Wrap Up and Next Steps
7:00pm	Meeting Adjourn

Meeting Objectives

- To provide an update on the Joint WUP
- To reach agreement on a package of recommended options and measures for the JWUP, consisting of:
  - operating alternatives
  - monitoring program
  - non-flow options / residual mitigation measures
  - a review period for when the JWUP should be reviewed in the future
  - other recommendations (e.g. timing for WUP)
- To confirm the next steps of the JWUP process.

Meeting Handouts

- Pre-Reading Package for CC Meeting #8 distributed to CC members on July 13 (copies available at the meeting)
- CC Ranking Form – Capilano Monitoring Studies

- CC Ranking Form – Seymour Monitoring Studies
- CC Ranking Form – Non-Flow / Mitigation Options – for both Capilano and Seymour

#	Key Points/Discussions	Action Items
	Meeting Convened/Agenda Reviewed • Michael Harstone, Facilitator, reviewed the meeting agenda and conducted a round table introduction.	
1.	**Update & Overview** • The purpose, scope, and steps of the Joint Water Use Plan (JWUP) planning process were reviewed. The Facilitator referred to the provincial Water Use Plan Guidelines and the steps following the consultative steps, which included discussing what occurs in the event of a non-consensus JWUP. **Goals / Deliverables** • The Facilitator discussed deliverables following a WUP should Metro Vancouver decide to submit a WUP: CC Summary Report and the technical Water Use Plan document. • Further goals for the day were to provide an update on the JWUP, assess Flow Options for Seymour and Capilano and to assess the recommended Monitoring Program. • The meeting would aim for consensus; however it was not required as every component making up a package may not be agreeable to each committee member. Regardless areas of agreement and disagreement would be recorded. The Facilitator mentioned that he had received feedback from both Ellen Hong and Poul Bech, based on the pre-reading package materials, and would include their rankings and stated responses within the meeting notes. After the meeting he will consult with them to seek their feedback on the preferred package of recommendations identified during this meeting. Albert van Roodselaar, Metro Vancouver (MV), responded to a query regarding the overall time frame informing the meeting it was the intent of MV to get the JWUP draft to the MV Board by end of the year for consideration. Once it was approved it would then go to the Comptroller for approval, for a possible start as early as June 2013. The Facilitator provided further information: • Materials distributed since the last meeting were reviewed – pre-reading package #8. • FTWG meetings of June 21 & July 5 • The status of action items from the prior meeting was reviewed and all had been completed. • Steering Committee (SC) meeting was held July 10, 2012. • Issues and Objectives have been updated to include recent comments received from Squamish First Nations.	
2.	**Cleveland Dam Hydro Facilities Update** Stan Woods, MV, provided an update on their current preferred design option for hydropower development at Cleveland Dam and the timing for when it could be built. The envisioned construction schedule for the new facilities would not have them operational until approximately 2021. MV has now selected a preferred design option (referred to as Option 1A) which consists of New Intake, High Level Tunnel and Underground Powerhouse. **Discussion** • It was queried how adjustable the fish flows would be, and	

#	Key Points/Discussions	Action Items

determined that part of what was decided today would feed into that, but the hydro can build in a range of fish flows that we have been considering especially because the turbines can be controlled to ramp down to allow variable flows. The proposed new intake structure will have an invert elevation of 130 m and will not provide opportunities to augment fish flows below this level (note full pool 146 m).

- The Facilitator commented that the 130m invert elevation is a new design constraint that has been added since the last meeting and affects the operating alternatives at Capilano.
- It was reiterated that assuming regulatory approvals go well, the current long-range plan is to commission the new facilities in 2021/22; this is a big facility and will take a number of years.
- It was mentioned that the new intake structure will allow improved temperature conditions downstream as it is a near surface intake. Albert van Roodselaar added that this was designed with Fisheries criteria in mind.
- It was queried if this design had any significant cost concerns, to which the response was the new intake design and location was more expensive than the original proposal for using the deep water Howell-Bunger valve as the intake for the new hydropower facilities.

3. Fish Technical Working Group Update - Capilano and Seymour

The Facilitator reviewed the recent FTWG meetings and their recommendations, specifically:

- New Joint Alternatives (J1 & J2) were not recommended by the FTWG given the anticipated overall fisheries benefits and associated risks.
- A recommended monitoring program for both Capilano and Seymour
- An assessment of the identified non-flow and residual mitigation options (summarized below)

Capilano

- Ramping rate protocol – covered under monitoring
- Palisade Alpine (experimental) temperature study
- Experimental summer pulse flow study
- Fish passage improvements (HDR design parameter)
- Real time flow gauges and reporting
- Dam release forecasting information (web-based)
- In-season management committee
- Hydropower Design Criteria and Objectives
- Outside WUP are gravel recruitment and improved access

Seymour

- Real time flow gauges
- Dam relay forecasting information
- In season management committee
- Lock Lomond Release Recommendation

4. Performance Measures

- The Facilitator reviewed the current working set of PMs and the addition of a revised PM to characterize fishery benefits in the winter period (Wetted Width)

5. Operating Alternatives – Capilano

- The Facilitator reviewed the assessment of the operating Alternatives –

#	Key Points/Discussions	Action Items

Capilano as summarized in the pre-reading package with an emphasis on Alternatives 3D, 3E, and 3F. This included a review of the hydrographs and calculated PMs.

- Metro Vancouver expressed concerns about the risks to the water supply system associated with Alternative 3F and how this affects alpine storage.

Ranking Alternative 3E and 3F

- The Facilitator provided a summary of the main differences between these alternatives as follows:
  - Alternatives 3D, 3E and 3F are very similar according to the hydrographs and performance measures. They all provide significant improvements to fish habitat and preferred paddling and angling flows in the lower Capilano River over current conditions:
    - In dryer years (10th%ile), there is no increase in WUW (=6.8m)
    - In average years (50th%ile), an increase in WUW of 5.2m (~2X)
    - In wetter years (90th%ile), an increase in WUW of 11.8m (~2.7X)
    - Preferred paddling flows almost double for kayaking and canoeing over current conditions
    - Preferred angling days also increase by about +17%
    - Altern 4F was successful at avoiding the drop to 0.57cms min flows on average in early Oct (through an earlier release of alpine storage), but this resulted in an impact to DW (loss of 5ML/day – RWSC 98%ile(Summer))
- The Facilitator asked each CC member to rank Alternative 3E and 3F according to endorse (fully support); accept (support); accept with reservations (specific reservations/conditions); block (cannot live with it). A summary follows:

Michelle Weston	• Accept 3F with reservations as stated by others. • Support 3E.
John McMahon	• 3E is okay. • 3F with reservations unless conditions attached. Caveat for worst years to suspend alpine water to uses similar to current water restrictions. Need a mechanism to allow constraint during drier years.
Brian Smith	• Accept 3E or 3F with the reservations stated by Eric.
Norm Daniel	• Accept 3E • Accept 3F with reservations in relation to possible impacts to water supply system
Duane Jesson	• Accept 3E as a minimum and with reservations to be addressed through other components in a package • Accept 3F • The adjustment of temperature and intake structure is essential to any benefits to steelhead stocks.
Eric Carlisle	• Accepts both 3E and 3F with the provided improvement actions (handout provided) related to: o adjustable fish valve at Cleveland Dam o triggers to reduce water consumption o increase water supply system (e.g. alpine lakes) o efficient smolt collection system o temperature adjustment capability with new intake o gravel recruitment below Cleveland dam o nutrient enrichment below Cleveland dam o real time flow gauges

#	Key Points/Discussions	Action Items

	○ implementation of Seymour flow regime regardless of hydropower development
Bill Cafferata	• Accept 3E and 3F with reservations in relation to the new hydropower facilities being able to improve temperature issues
Tom Hoskin	• Reserves opinion for time being
Stan Woods	• Block 3F because of the impacts to reliable water supply capacity and as it goes against operational experience (there are directives for using the emergency water supply, one is not to open Alpine Lakes too early) • Accept 3E with reservations that these flows cannot be delivered until after approvals and construction of new hydropower facilities
Albert van Roodselaar	• Block 3F as per reasons mentioned by Stan. • Accept 3E with reservations. • Already included in the modeling and alternative is lawn sprinkling bans. This model reflects Level 3, which occurs about every 15 years. The proposed rule curve in Alternative 3E will result in the curtailing of drinking water supply as the only mechanism to respond to lower reservoir levels. With 3E we can meet fish flows without significantly impacting drinking water (Stage 3).
Ellen Hong (via email)	• Accept any alternatives except Alt 1 with condition that the real time flow data and forecasting information be provided as a non-flow option.
Poul Bech (via email)	• Endorses Capilano flow alternatives 3D, 3E or 3F with qualifying statements provided and on the condition that Seymour flow alternatives 4D or 4E are also implemented.
Corino Salomi	• From the DFO perspective there is no significant difference of 3E or 3F both are acceptable.

Summary

- The Facilitator summarized the results of the ranking exercise on Alternatives 3E and 3F as follows: 3E appears to be the only viable option towards reaching a consensus WUP pending the consideration of a JWUP Package.

6. Operating Alternatives – Seymour

- The Facilitator reviewed the results of the assessment provided in the pre-reading package for Alternatives 4C, 4D, 4E and 4F.
- The Facilitator provided a summary of the main differences between these alternatives as follows
  - Alternative 4F turned out to be the same as 4E
  - Alternatives 4D and 4E are very similar according to the hydrographs and performance measures. Both alternatives provide improvements to fish habitat and kayaking flows in the lower Seymour River over current conditions:
    - In dryer years (10th%ile), an increase in WUW of 1m (+13%)
    - In average years (50th%ile), an increase in WUW of 1.8m (+18%)
    - In wetter years (90th%ile), an increase in WUW of 1.2m (+9%)
    - Absolute min flows during summer / fall droughts increased by 22% (from 0.57 to 0.7cms), however Altern 4D was below the existing rule curve 64% of time on the lowest flow days (Jul 1 to Oct 30 which occurred in 4 out of the 24 years)
    - Absolute min flows during winter droughts increased to 1.36cms from existing rule curve which can be 0.57cms
  - Altern 4E was associated with an impact to drinking water supply (loss of 5ML/day – RWSC 98%ile(Summer))

The Facilitator asked CC members to rank Alternatives 4D and 4E according to: **endorse** (fully support); **accept** (support); **accept with reservations** (specific reservations/conditions); or **block**

#	Key Points/Discussions	Action Items

(cannot live with it). A summary follows:

Albert van Roodselaar	• Endorse 4D • Block 4E as a result of impacts to drinking water supply and similarity in fisheries benefits
Stan Woods	• Endorse 4D • Block 4E • Further, Metro stated that they would implement the flow changes at Seymour once the JWUP is approved by the comptroller and after the necessary 60-day appeal period. • Existing facilities would allow changes to Seymour as soon as they are approved (anticipated for the beginning 2014 or sooner).
Tom Hoskin	• Support both 4D and 4E.
Bill Cafferata	• 4D with reservations for when it gets implemented, the associated monitoring, and the non-flow options
Eric Carlisle	• Accept 4D and 4E with reservations as previously noted. • Would like to implement as soon as possible.
Duane Jesson	• Accept 4D or 4E. • Acknowledged timing issue clarification.
Norman Daniel	• Accept 4D with reservations • Block 4E. Seymour is the emergency system given the gravity feed system and less willing to tamper with water supply system at Seymour.
Brian Smith	• Accept either 4D or 4E. • Timing issue was a reservation as well as those Eric Carlisle had pointed out .
John McMahon	• Abstain as this is outside West Van's jurisdiction
Michelle Weston	• Support both 4D and 4E
Corino Salomi	• Accept both 4D and 4E
Ellen Hong by email	• Accept any of the WUP alternatives with the condition that the real time flow data and forecasting information be provided as a non-flow option.
Poul Bech by email	• Endorses Seymour alternatives 4D or 4E.

7. Monitoring Program & WUPs

The Facilitator discussed monitoring in relation to the adaptive nature of WUPs (as outlined in the provincial guidelines) and the screening process undertaken by the FTWG in their recommended monitoring program summarized in the pre-reading package. The acid test for considering whether or not a particular study should be included or not should be in relation to compliance issues and/or the importance that a study leads to changes in future water management. In other words, there needs to be a strong link between study results and future water management decisions. The CC was asked to consider the following questions during the review of the proposed studies:

- Would the study outcome result in a change to operations?
- Can the study provide meaningful results?
- Is the study the most cost effective way?
- Do the benefits of the information exceed the costs for the study?

The Facilitator reviewed the different categories of potential studies as follows:

- Compliance monitoring – is Metro Vancouver meeting terms and conditions?
- Effects or Response Monitoring - are flow decisions resulting in their expected outcomes (e.g. benefits for fish)?

#	Key Points/Discussions	Action Items

- Knowledge Gaps – were some issues deferred due to lack of data, for example ecological baseline data (coho production versus reservoir elevations)?
- Assessment related studies associated with the proposed new hydropower facilities – these studies were included for "information only" and ultimately will be decided upon through discussions with regulators in concert with Metro Vancouver's project development plans.

The Facilitator reviewed each study included within the FTWG recommended monitoring program and noted that biological response monitoring was only being considered for the Capilano system as the expected changes at Seymour were considered too difficult to measure a biological response within a reasonable timeframe and given the potential costs.

CC members were asked to consider the following questions when basing their recommendations for a particular study:

1. Likelihood that a study result will lead to a change in a future water management decision.
2. Relative importance of the study given the uncertainty, study cost, value of information.

CC members were asked to use the following priority rankings:

- **High -** this study must be undertaken in order to make responsible future water management decisions.
- **Medium -** this study is recommended as it will likely affect future water management decisions.
- **Low -** this study is not likely going to serve as a basis to make future water management decisions.
- **"NC" -** If CC members do not feel they are able or knowledgeable enough to rate a particular study, they can also respond "NC" – No Comment.

8. Monitoring Studies for WUP at Seymour

The table below summarizes the outcome and main comments in relation to the reviewed monitoring studies.

Study		CC Priority	Additional CC Comments
SEY 1A	Monitoring of fish flow releases and drinking water withdrawals	**High**	Supported based on FTWG recommendation
SEY 1B	Monitoring of hydropower water withdrawals	**High**	Supported based on FTWG recommendation
SEY 1C	Flow monitoring of instream flow requirements (IFRs) - prior to JWUP	**High**	Supported based on FTWG recommendation
SEY 1D	Flow monitoring of instream flow requirements (IFRs) - after JWUP implementation	**High**	Supported based on FTWG recommendation
SEY 1E	Flow monitoring of instream flow requirements (IFRs) at WSC gauge at Twin Bridges	**High**	Supported based on FTWG recommendation. (Note. This is an allowance should WSC funds not be available in the future and the importance of this gauge from a fisheries perspective).
SEY 1F	Flow monitoring of IFR / stranding assessment (ramping rates)	**High**	The collection and review of real time flow data would begin after JWUP approval to assess ramping rates in relation to the preliminary ramping protocol developed by Instream Fisheries, where the rate of change in stage levels is defined by agency guidelines. Field study ($50K) to assess ramping rates in sensitive stranding areas to be deferred until after

#	Key Points/Discussions		Action Items
			commissioning of hydropower at Seymour Falls dam (not expected until 2024) **or** earlier based on a decision by Metro Vancouver to expedite this study given the potential changes that may be needed to their existing ramping rates as compared to Instream's assessed rates.
SEY 1G	Water level monitoring in Seymour Reservoir	**High**	Supported based on FTWG recommendation
~~**SEY 1H**~~	~~Inflow monitoring to Seymour Reservoir~~	~~**High**~~	While the CC believed that this study was important information, most felt that this study should not be tied to a WUP. The provincial representative on the CC believed this will be a compliance issue for the WUP and it was agreed to let Metro Vancouver discuss this study further with the province.
~~**SEY 1I**~~	~~Temperature monitoring 1~~	~~**High**~~	The FTWG ranked this study as a lower priority, based on differences of opinion. The CC agreed to delete this study based on their current understanding of the issues and given the expected flow changes being recommended and as a result of the expected hydropower operations in the future. It was noted that temperature issues are not currently considered a significant issue; the proposed operational changes associated with Alternative 4D are not significantly different from current operations; the proposed intake structure for the proposed hydropower facility will be at a similar depth as the existing low-level outlet; hydropower operations will likely not be operated through the summer and early fall time period; the reservoir is not stratified through most of the winter; the most important fish habitat is quite far downstream and temperature effects would be moderated by both travel time and tributary inflows.
SEY 2	Status and trends of key fish species	**High**	Supported based on FTWG recommendation and the recognition of the importance of continuing to collect this information up till the point that the JWUP is approved. Once the JWUP is approved, this study would not be expected to continue.
SEY 3	Entrainment at Seymour Dam	**High**	Supported based on FTWG recommendation
Assessment Related Studies			
SEY 5	Distribution and abundance of SARA-listed species	See comments	*CC did not evaluate or rank these studies, as they were considered to be a part of Metro Vancouver's environmental assessment that will be defined in discussions with the appropriate regulatory agencies*
SEY 6	Level 1 and Level 2 Fish Habitat Assessments (FHAP)		
SEY 7	Habitat compensation plan		

9. Monitoring Program – Capilano

The table below summarizes the outcome and main comments in relation to the reviewed monitoring studies.

Study		CC Priority	Additional CC Comments
C1A	Monitoring of fish flow releases and drinking water withdrawals	**High**	Supported based on FTWG recommendation
C1B	Monitoring of hydropower water withdrawals	**High**	Supported based on FTWG recommendation
C1C	Flow monitoring of instream flow requirements (IFRs)-*prior to JWUP impl.*	**High**	Supported based on FTWG recommendation
C1D	Flow monitoring of instream flow requirements (IFRs) - after JWUP	**High**	Supported based on FTWG recommendation

#	Key Points/Discussions			Action Items
C1E	Flow monitoring of IFR / stranding assessment (ramping)	**High**	Supported based on FTWG recommendation	
C1F	Water level monitoring in Capilano Reservoir	**High**	Supported based on FTWG recommendation	
C1G	Inflow monitoring to Capilano Reservoir	**High**	Supported based on FTWG recommendation. It was also noted that reservoir inflows are also built into the variable level rule curve for setting minimum flows in Alternative 3E.	
C1H	Temperature monitoring 1 – Lower River	**High**	Supported based on FTWG recommendation. The timing would begin 1 or 2 years before commissioning of the hydropower project and continue for 2 to 3 years afterwards to assess temperature effects with the new flow regime (Alt 3E) in the lower river.	
C2	Temperature monitoring 2 – Palisade alpine reservoir flow releases	**Med**	The FTWG ranked this study as a lower priority, based on differences of opinion on the importance and significance of temperature effects in the upper watershed. CC members deferred to the province on this study, given the species and the issues. The province supported the study, but considered it a Medium priority. It was further noted that the costs for this study would be less if the study was shortened from the original 3 to 5 years identified by the FTWG. CC members supported better understanding the relationship between different flow releases from Palisade reservoir and possible effects (either positive or negative) on fishery values in the East Capilano and Upper Capilano Rivers.	
C3	Upstream migration enhancement using pulse flows	**Med**	The FTWG ranked this study as a lower priority, based on differences of opinion. The study was associated with potentially significant stranding risks and uncertain outcomes, if delivered through the low level Howell-Bunger valve which has limiting ramping abilities and would be associated with very cold (~4c) temperature releases. Accordingly, the CC felt that this would be a high risk study with uncertain results. It was therefore agreed to wait to carry out this study until the new near surface intake structure was built. The new hydropower facilities would address the potential stranding issues and cold water temperature issues, although the opportunities to carry out pulse flows would be reduced to only periods when reservoir levels were above 130m. It was also recognized that new information collected between now and 2021 will better inform whether this study should be carried out or not. The CC ranked this deferred study as a Medium priority.	
C4	Status and trends of key fish species	**High**	Supported based on FTWG recommendation	
C5	Reservoir littoral area	**Med**	The FTWG ranked this study as a lower priority, based on the challenges of understanding all the competing factors (impact hypotheses) that may be influencing coho fry production and the relevance and importance of changed reservoir operations as a result of hydropower drawdowns in the spring time. The CC considered the research question as very important, but recognized the complexity of trying to meaningfully answer it. To this degree the CC agreed to the following approach: • Undertake a literature review on similar systems in the Pacific Northwest • Scope out and characterise what an appropriate research program would look like to adequately address this research question. The CC ranked this revised study as a Medium priority. *(It was also suggested that this may provide an opportunity for a graduate researcher as a thesis.)*	
C6A	Upstream and downstream fish passage at Cleveland Dam / efficacy of new intake screens	**High**	Supported based on FTWG recommendation	

#	Key Points/Discussions			Action Items
	C6B	Upstream and downstream fish passage at Cleveland Dam	**High**	Both the FTWG and CC considered the ongoing work to enumerate outmigrating smolts being transferred as a part of the ongoing trap and truck program as a high priority. After the operation of the new smolt capture facilities (using the new hydropower intake channel) are refined and optimized, the intensity of effort involved with the smolt monitoring program would be expected to decrease.	
	Assessment Related Studies				
	C9	Distribution and abundance of SARA-listed species	*See comments*	*CC did not evaluate or rank these studies, as they were considered to be a part of Metro Vancouver's environmental assessment that will be defined in discussions with the appropriate regulatory agencies*	
	C10	Stranding within the drawdown zone			
	C11	Level 1 and Level 2 Fish Habitat Assessments (FHAP)			
	C12	Habitat compensation plan			

10. WUP Timing and Review

The Facilitator described how the review period is typically a component of a WUP and how this is informed by the timing of the studies, construction of new facilities and other factors such as the costs for a review process. The current schedules affecting the timing of a review period were shared as follow:

Capilano:

- 2013 detailed design Cleveland Dam Hydropower
- 2019 construction of Cleveland Dam Hydropower
- 2021 Commission Cleveland Dam Hydropower

Seymour:

- 2019 detailed design Seymour Falls Dam Hydropower
- 2022 construction of Seymour Falls Dam Hydropower
- 2024 commission of Seymour Falls Dam Hydropower

Biological Studies

- 7 years of response monitoring would at Capilano would imply the earliest review date of 2028

Metro Vancouver had proposed the earlier of either the following for the review:

- 20 years after JWUP approval (~2034)
- 10 years after commissioning (~2031 based on Cleveland Dam hydropower dates)

Interim Review Dates

- It was noted that interim reviews are possible within WUPs to share and seek feedback (typically these are related to specific technical aspects or items that were conditional in nature during the public process)

Review periods were discussed further below as a component of an overall recommended package.

11. Residual Mitigation Options Capilano:

The Facilitator reviewed the conditions or criteria that is normally applied for recommending non-flow options within a WUP, as follows:

- the benefit can be obtained through the operational changes that have been agreed to
- the option can be done within Metro Vancouver's jurisdiction and w/i legal and safety agreements
- the option can provide commensurate benefits to the operational changes (or more)
- the option is more effective at achieving the benefits through operational changes (compared to other impacts: e.g. costs, other PM effects, etc.)

#	Key Points/Discussions	Action Items

The Facilitator provided an overview of the mitigation options identified in the process so far and how they would likely be considered according to the WUP criteria or outside WUPs (based on possible mitigation options associated with the new hydropower facilities or as voluntary measures that Metro Vancouver may be supportive of), as follows (see pre-reading package for more details):

Capilano

Within A WUP

A. Real time flow gauges and reporting
C. In-season management committee
Cii. Coordination of smolt releases at Capilano hatchery
New - WUP Monitoring / Water Licensing Review (WLR) Cmte

Outside WUP

B. Dam release forecasting information web-based Stan added after JWUP approval (ref. p 45)
D. Hydro power Design Criteria and Objectives (ref. appendix p 51 in the pre-reading package)
E. Gravel Recruitment Project / Improved access for paddlers
New - Match water shortage response levels to min flow levels
New - Increase supply system new alpine reservoirs
New - Nutrient enrichment program in Capilano

Seymour

Within A WUP

A - real time flow gauges
C - in season management committee
D - Loch Lomond Release Recommendation (ref. p 45)

Outside WUP

B. Dam release forecasting information web-based Stan added after JWUP approval (ref. p 45)

Comments:

The Facilitator discussed the residual mitigation options (those identified as Outside WUP above) for Capilano and Seymour clarifying that these options were more associated with addressing impacts related to the construction of the original water control facilities (i.e. 'footprint impacts') or the proposed new hydropower facilities. These options, if recommended, were considered more aligned to voluntary measures offered by Metro Vancouver or as possible mitigation / compensation associated with the new hydropower facilities (through an environmental assessment for example).

It was during this part of the meeting that the new options suggested by Eric Carlisle were added to the list of possible options 'Outside WUP' (identified as new above).

- It was mentioned that a gravel recruitment project in the Lower Capilano River would cost approximately $50,000 per application and may be designed as to improve access conditions for paddlers (if desired).
- It was highlighted that gravel is a key constraint affecting in particular steelhead populations for both the lower Capilano and Seymour Rivers.
- Some tributaries add gravel to the Seymour but that condition does not exist in the Capilano River.

12. Developing a Consensus Package

At this point in the meeting the Facilitator outlined the building blocks or components towards the development of a consensus package for the JWUP consisting of flow alternatives, monitoring

#	Key Points/Discussions	Action Items

studies, WUP non-flow options, other voluntary measures, and recommendations related to timing and an appropriate review period.

Discussion
In regard to Capilano Options for building a package the CC members commented:

- More information and work is required to scope out and characterize possible opportunities for the newly proposed gravel recruitment and nutrient enrichment projects at Capilano (e.g. completion of the habitat assessment)
- Does the province have a nutrient enrichment program?
- Yes - It ended in BC this year; it was not done in Capilano.
- It was noted that without additional gravel, that eventually there will not be any place for fish to spawn in the lower Capilano River.
- Two possible options for gravel placement were mentioned: 1. gravel could be added near the hatchery and then washed down river, 2. transport gravel into specific locations for late March spawning for steelhead.
- The new option to match water shortage response levels has not been reviewed or assessed by MV to better understand the implications of this
- Bedrock features are nice for kayakers and access for kayakers at the hatchery would be helpful

The CC recommended that the first step in terms of the proposed gravel and enrichment projects was a study to better characterize possible opportunities. If viable projects were identified, it would be up to the parties to work together to fund and construct and maintain the projects.

13. Consideration of JWUP Package A

The Facilitator developed the following package for consideration and feedback from the CC, as follows:

<table>
<tr><th colspan="8">JWUP Package A</th></tr>
<tr><th colspan="4">Capilano</th><th colspan="4">Seymour</th></tr>
<tr><td>Flow Alt.</td><td>Studies</td><td>WUP Options</td><td>Other Options</td><td>Flow Alt.</td><td>Studies</td><td>WUP Options</td><td>Other Options</td></tr>
<tr><td rowspan="3">3E</td><td rowspan="3">As per CC direction and ratings</td><td>C- Mgt Cmte</td><td>A. Real time gauges</td><td rowspan="3">4D</td><td rowspan="3">As per CC direction and ratings</td><td>C- Mgt Cmte.</td><td>A. Real time gauges</td></tr>
<tr><td>Cii</td><td>B. River Forecast</td><td>D- Loch Lomond</td><td>B. River Forecast</td></tr>
<tr><td>WUP Cmte</td><td>C. Design Criteria</td><td>WUP Cmte</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Explore opportunities for Gravel Enrichment;
Assess Water Shortage Response Plan and new alpine storage options</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Timing and Review Period:
Implement Alt 3E after commissioning
CAP WUP Review in Year 2032 (10 yrs. after commissioning
Implement 4D after JWUP approval
Seymour WUP Review in Year 2024 (10 yrs. after JWUP approval)</td><td colspan="4">Implement 4D after JWUP approval
Seymour WUP Review in Year 2024 (10 yrs. after JWUP approval)</td></tr>
</table>

The Facilitator asked each CC member to express their support for the package according to: **endorse** (fully support); **accept** (support); **accept with reservations** (specific reservations/conditions); **block** (cannot live with it). A summary follows:

#	Key Points/Discussions	Action Items

Corino Salomi	• Accept with reservation that throughout this process we were looking at the proposed hydropower project as a means to make improvement to temperature and fish passage and the proposed timeline for building these new facilities will delay these benefits from occurring. • From a WUP perspective, the package is good • Also from a regulatory perspective, the package is consistent with DFO's policy to make historical projects better conform to existing regulatory requirements • Would have to look at fishery management plan waiting for hydro planning. • We have the hatchery in place and could perhaps do more.
Michelle Weston	• Support for Package A.
John McMahon	• Support for Package A.
Brian Smith	• Support with reservations. • Would like to see gravel and nutrient enrichment projects be considered for Seymour as well • Why can't real time gauges go in before JWUP approval?
Norman Daniel	• Accept with reservations • The exception being for the length of time for the review, it would be preferable if it were earlier if possible. • Facilitator comment: it is fairly common to identify triggers to initiate a review earlier than anticipated if a new issue is having a significant effect on an interest area.
Duane Jesson	• Accept with reservations. • Would like to see gravel and nutrient projects considered for the Seymour system. • Provincial concern is with Capilano and having to go through this process and not realize any flow improvements for 10-years. Would like to see this timeline expedited. • Implementation of real time gauges before JWUP would show intention. • What will happen if hydropower does not proceed at Capilano in terms of improving smolt capture and dealing with temperature and flow issues? It would be good to have updates and communication with MV in terms of hydro development. • Would like to see the real time gauges option implemented prior to JWUP approval.
Eric Carlisle	• Accept with a few reservations. • A concern about the 10-year wait. • Implementation of real time gauges. • Gravel and enrichment to be included at Seymour.
Bill Cafferata	• Accept with reservation that should hydro at Capilano not go ahead, fisheries issues be revisited and resolved
Tom Hoskin	• Support with reservations of installing real time gauges and forecasting earlier regardless of Hydro. • A concern is that Coquitlam only releases information on major spills. • Some of my constituents said they did not want improved access at the hatchery (e.g. associated with a possible gravel recruitment project)
Stan Woods	• Support package with reservations mentioned earlier (e.g. dependent on Board approval scheduled for the fall/winter) • It is MV's intent (subject to Board approval) to move forward with Capilano hydropower sooner than later, but there are many factors outside MV's control in terms of the approval and regulatory stages of the project, which lead to uncertainty. Moreover, there are incentives for MV to not delay hydropower development once the necessary approvals have been made (e.g. water license duration and associated licensing fees)

#	Key Points/Discussions	Action Items
	Albert van Roodselaar	• Accept with reservation regarding the review timeline. • The review on the Seymour is ahead of the one for Capilano; would prefer if it was 15-years after JWUP approval.

14. CC Recommended JWUP Package

Based on the CC comments and rankings, the Facilitator modified some of the items in the original proposed JWUP Package A. This included: expediting the real time and forecasting options prior to WUP approval; expanding the gravel and recruitment study to include Seymour; modified review periods; and added some voluntary measures (ongoing communication in relation to Capilano hydropower development, commitment to meet to discuss fishery issues should Cap hydropower not proceed). The revised package is summarized below. *(Note. a more detailed description of the recommended JWUP Package has been written up and will be distributed in a separate document).*

Capilano				**Seymour**			
Flow Alt.	Studies	WUP Options	Other Options	Flow Alt.	Studies	WUP Options	Other Options
3E	As per CC direction and ratings	C- Mgt Cmte	A. Real time gauges pre-WUP	**4D**	As per CC direction and ratings	C- Mgt Cmte.	A. Real time gauges pre-WUP
		Cii	B. River Forecast pre-WUP			D- Loch Lomond	B. River Forecast Pre-WUP
		WUP Cmte	C. Design Criteria			WUP Cmte	
			Explore opportunities for Gravel & Enrichment; Assess Water Shortage Response Plan *WRSP) and new alpine storage				Explore opportunities for Gravel & Enrichment and new alpine storage
Timing and Review Period: Implement Alt 3E after commissioning CAP WUP Review in Year 2032 (10 yrs. after commissioning) Ongoing communication on WUP progress Commit to revisit fisheries issues if no hydro				Implement 4D after JWUP approval Seymour WUP Review in Year 2029 (15 yrs. after JWUP approval)			

The Facilitator asked the CC whether this revised JWUP Package would be supported without reservations or conditions, as it was intended to address them all. An “endorse” package rather than an “accepted” package would also send a strong message to the Comptroller and others for the high degree of support, which may help in expediting the review process.

The CC unanimously “endorsed” the JWUP Package of Recommendations.

The Facilitator would seek agreement from the two absent CC members who had previously emailed their rankings prior to the meeting. {POST MEETING NOTE. Ellen Hong reviewed the agreed to JWUP Package and stated that her constituents would “endorse” the recommendations.}

#	Key Points/Discussions	Action Items

15. Other Points of Consideration

Triggers

The Facilitator clarified that WUPs can be re-opened at any time (pending an order from the Comptroller) and that these events are usually associated with events related to:

1. Biologically significant triggers
2. If external factors affecting the ability to deliver the preferred flow alternative
3. Agreed to triggers defined by the CC

MV will develop triggers for consideration for re-opening a WUP prior to the scheduled review period. MV also mentioned that they would keep the CC informed as to the progress of the JWUP at milestone points (e.g. submission to Comptroller, water license approval, etc.).

Operationalizing WUP Flows

The Facilitator mentioned that there are a lot of details still unresolved for how the recommended operating alternatives get operationalized such as:

- How often are adjustments made
- What tolerance levels before making changes
- How is compliance defined in relation to meeting minimum flow targets (instantaneously, hourly, daily weekly)
- Tolerance levels with delivering below min targeted flows
- And other factors

MV stated that these details will be defined consistent with the spirit of the package that has been endorsed.

16. Next Steps

The Facilitator outlined the next steps and target dates:

- Draft meeting notes to be circulated July 31, 2012
- Draft consultative committee report September 30, 2012
- Deadline for CC to submit comments October 15, 2012
- Final Consultative Committee Report October 31, 2012 and possible sign off
- Metro Vancouver submits JWUP to Comptroller of Water Rights (CWR) Winter 2012/13
- CWR refers JWUP to federal government and consults with First Nations
- CWR makes determination on JWUP (approx. summer 2013)

Discussion:

- CC members agreed, a “sign off” celebration would be beneficial.
- If MV were planning a news release, it would be good to know.
- Metro Vancouver will be communicating with senior management and their Board as soon as possible.

17. Meeting Adjournment

- MV thanked CC members for their participation and input during the consultative process.
- The Joint Capilano & Seymour Water Use Plan Consultative Committee Meeting #8 held July 19, 2012 concluded at 8:00 p.m.

Appendix H – FTWG Design Criteria & Objectives for Proposed Capilano Power Project

Appendix H provides the fish design objectives and criteria recommended by the FTWG for the proposed Capilano power project. These objectives and criteria were endorsed by the CC at their last meeting.

Fish Design Objectives and Criteria (extracted from a memo dated on July 10, 2012)

Introduction

Metro Vancouver has launched a Capilano-Seymour Joint Water Use Planning (JWUP) process. This plan currently calls for a new power project on the Capilano River which has the potential to partially restore natural Coho and Steelhead productivity from the watershed above and below the Cleveland Dam. It is proposed that this facility will have a screened surface intake and underground powerhouse on the west bank of the Capilano River. It has the potential to overcome some of the inherent fish issues arising from the 1954 Cleveland Dam, namely:

a) Provision of safe and unimpeded downstream passage of Coho and Steelhead smolts from April 15th to June 15th each year avoiding as much as practicable mortalities associated with fish passing over the spillway (these being field study estimated at over 70%);
b) Provision for enhanced minimum flow capacity and fine control of ramping rates particularly below 4 CMS at all times of the year with a "fish valve"; and
c) Provision for near surface withdrawal of water from Capilano Lake into the Capilano River to offset very cold water temperatures from the existing mechanical pump tailrace which provides a base flow of 0.57cms.

Design Objectives and Criteria

The design of the intake and fish facilities for the new power project is an important consideration in obtaining regulatory approval for the project and has received limited attention to date by the Fisheries Technical Working Group (FTWG) in support of the Consultative Committee (CC) of the JWUP. The following provides tentative design objectives and criteria for consideration by the CC:

1. The new facility must prevent all fish from entering the intake for the power project at all times of the year through easily cleaned screens that do not impinge fish on the screens. (Standard specifications for travelling screens would apply.)
2. There needs to be an effective smolt collection system with attraction water provided by gravity flow through the power project and/or fish valve bypass that will be operational under all reservoir levels from approximately April 15th to June 15th each year. This system should employ sufficient surface currents and guide

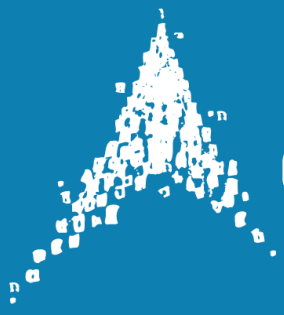
nets (leads) to help direct migrating Steelhead and Coho smolts to the collection facility and discourage them from backing out or going over the spillway if it is operating. The design and orientation of the intake, leads and collection facility should be optimized in this regard. (The current lake traps and rotary screw traps operated by MVRD for collecting Coho and Steelhead smolts have improved the situation, but are not effective enough to rebuild natural populations particularly of Steelhead where trapping efficiency has been approximately 10%.)

3. Once captured, smolts can be reintroduced to the Capilano River below Cleveland Dam either by a direct safe downstream passage facility that discourages subsequent predation and provides for enumeration and sampling capability or they need to be safely held in flow-through collection box (es), enumerated, sampled/tagged as required and transported below the dam to one or more release points on at least a daily basis and preferably more frequently during peak migration periods.
4. The spillway should not be operated during the smolt collection period unless necessary to pass flows beyond the capacity of the new power project and fish valve under peak flow conditions.
5. The power project must have a bypass "fish valve" that can provide for appropriate ramping rates and fish flow releases to the river whether or not the power project is operating through the widest possible range of lake elevations.
6. It is suggested that at least one small turbine (or equivalent facilities) be explored to generate power from the fish flow releases on a year round basis. It could potentially replace the energy requirements of the existing water to water hydraulic pumping system to high elevation reservoirs on the north shore. (The tailrace from this system currently provides the base fish flows of 0.57 CMS and has colder water for extended periods than could be provided by the new surface intake.)
7. The power project intake channel and the intake itself should be designed to provide improved water temperatures downstream, relative to historic operation, when lake conditions permit. (The optimal water temperatures for salmonids during the growing season are in the range of 10 to 15 degrees C.)

Capilano Hatchery Considerations

The original adult diversion structure, fishway, collection facility and trucking operations were a requirement of Cleveland dam construction in 1954. They were integrated with the Capilano Hatchery facility when it was completed in the early 1970s. The facility also relies on flows from the existing MVRD water supply intake in the dam. Should the Capilano Hatchery operations be altered in any way or closed by the federal government in future for any reason, trucking adults above the dam would still need to be maintained under the original regulatory provisions.

Serious consideration should also be given in the design of the plumbing system to connect the hatchery water supply to the new surface intake for the power project in order to give more flexibility for water temperature and flow management and to provide for a safer intake location further removed from the domestic water chlorination facilities.



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