Stave River Water Use Plan (Stave Falls and Ruskin Projects)

Revised for Acceptance by the Comptroller of Water Rights

15 December 2003

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BC hydro Generation 15 December 2003

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P.T.B. Adams

Manager, Operations

Preface

The Stave River Water Use Plan, was initiated as a result of Condition 14 of the Stave Falls Powerplant Replacement Energy Project Certificate, which allowed BC Hydro to construct and operate the new power facilities at Stave Falls in Mission, B.C. This condition required BC Hydro to undertake a water use planning process for both their Alouette River and Stave River power facilities, including Alouette, Stave Falls and Ruskin dams and Generating Stations.

Two separate consultation processes were conducted to complete the Alouette and Stave River Water Use Plans. The Alouette Water Use Plan was submitted to the Comptroller of Water Rights in September 1996 and is available in a separate report.

The Stave River Water Use Plan was submitted to the Comptroller of Water Rights in November 1999. This document is a revision to that plan for the acceptance by the Comptroller of Water Rights following advice from the office of the Comptroller of Water Rights. This Water Use Plan contains the elements of the draft plan submitted by BC Hydro, in a form suitable for acceptance by the Comptroller of Water Rights in the licensing of BC Hydro's facilities under the *Water Act*. The proposed conditions for the operation of BC Hydro's facilities will not come into effect until implemented under the *Water Act*.

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1.0 INTRODUCTION

The conditions, proposed in this water use plan, for the operation of BC Hydro's Stave Falls and Ruskin hydroelectric generation facilities reflect the June 1999 consensus recommendations of the Stave River Water Use Plan Consultative Committee. The proposed terms and conditions to be authorized under the *Water Act* for the beneficial use of water at the Stave Falls and Ruskin hydroelectric facilities on the Stave River are set out in this document. The proposed conditions for the operation of the Alouette Hydroelectric Facilities, located on the Stave Reservoir, are covered in a separate document called the Alouette Water Use Plan.

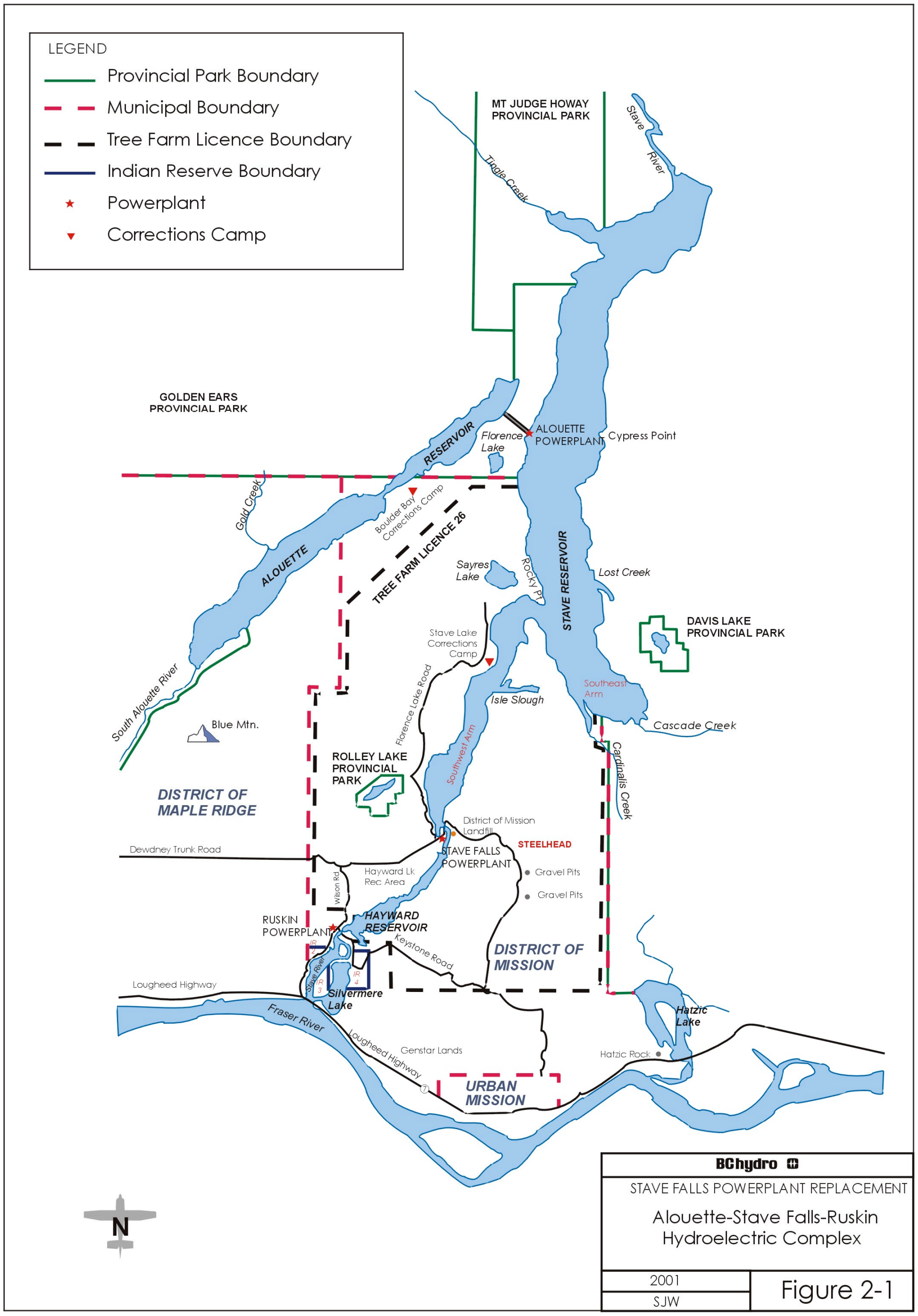
These proposed conditions would change current operations and are expected to result in enhanced habitat for fish in the Stave River watershed, improved water levels in Stave Lake Reservoir for industry and recreation, and enhanced archaeological site protection and investigation opportunities. They also allow for improved peaking flexibility on power operations at Ruskin generating station. A monitoring program and a review period is proposed which will study key uncertainties to enable improved operating decisions in the future. Refer to the Stave River Water Use Plan: Report of the Consultative Committee dated July 1999 for details on the consultation process, interests, objectives, performance measures, values associated with operating alternatives and details of the proposed monitoring program.

2.0 DESCRIPTION OF WORKS

The Alouette-Stave Falls-Ruskin generating complex includes four dams, a 1090 m long diversion tunnel and three powerhouses. Water can be used from Alouette Lake Reservoir three times and from Stave Lake Reservoir twice, to produce up to 203.6 MW of electrical power for BC Hydro's integrated system.

2.1 Location

The Alouette-Stave Falls-Ruskin hydroelectric facilities are located approximately 64 km east of Vancouver, north of the Fraser River between Haney and Mission (Figure 2-1). The Stave Falls Dam and powerplant are located at the south end of Stave Lake Reservoir, 6.4 km north of the Fraser River. Ruskin Dam and powerplant are located at the south end of Hayward Reservoir on the Stave River, 3.0 km upstream of the confluence with the Fraser River. Stave and Ruskin facilities are accessible by public roads. Alouette powerplant on Stave Lake Reservoir can be reached by four-wheel drive along Burma Road, or by boat from the Stave Lake Reservoir Boat Launch just north of Stave Falls Dam.


LEGEND
Provincial Park Boundary
Municipal Boundary
Tree Farm Licence Boundary
Indian Reserve Boundary
Powerplant
Corrections Camp
MT JUDGE HOWAY PROVINCIAL PARK
Stave River
Tingle Creek
GOLDEN EARS PROVINCIAL PARK
RESERVOIR
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ALOUETTE POWERPLANT
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ALOUETTE
Boulder Bay Corrections Camp
TREE FARM LICENCE 26
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DAVIS LAKE PROVINCIAL PARK
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Cascade Creek
Cardinalis Creek
ROLLEY LAKE PROVINCIAL PARK
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DISTRICT OF MAPLE RIDGE
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STEELHEAD
STAVE FALLS POWERPLANT
Dewdney Trunk Road
Hayward Lk Rec Area
Gravel Pits
Gravel Pits
Wilson Rd
RUSKIN POWERPLANT
HAYWARD RESERVOIR
Keystone Road
DISTRICT OF MISSION
Lougheed Highway
Silvermere Lake
Fraser River
Hatzic Lake
Lougheed Highway
Genstar Lands
Hatzic Rock
URBAN MISSION
N
BChydro
STAVE FALLS POWERPLANT REPLACEMENT
Alouette-Stave Falls-Ruskin Hydroelectric Complex
2001
SJW
Figure 2-1

2.2 Alouette Power Facilities

The Alouette power facility consists of a dam on the South Alouette River, at the south end of Alouette Lake Reservoir, a low-level outlet, and a spillway. At the north end of the Alouette Lake Reservoir, there is an intake, diversion tunnel to an 8.0 MW powerplant which discharges into Stave Lake Reservoir. Included as part of the authorized works are the transmission lines from the powerhouse to the connection with the provincial power grid at Stave Falls substation. Also included as authorized works are the auxiliary works required for the operation of the dam, low-level outlet, spillway and Alouette Generating Station.

2.3 Stave Falls Power Facilities

Completed in 1999, the current Stave Falls Generating Station consisting of two 45 MW generators for a total plant capacity of 90 MW replaced the original 85-year old 50 MW generating station. The authorized works at the Stave Falls Generating Station are Stave Falls Dam, Blind Slough Dam, approach channel, intakes, two tunnels, powerhouse, tailrace channel, tailrace protection berm, and connecting underground transmission line from powerhouse to switchyard connecting into the provincial power grid. Auxiliary works for the operation of the Stave Falls Generating Station are also included. The Blind Slough Dam contains the spillway and provides another means of discharging water for flood control and for purposes other than power generation. The original powerhouse was decommissioned and is being used as a Visitor Centre.

2.4 Ruskin Power Facilities

The 105.6 MW powerhouse at Ruskin Dam contains three electrical generation units. The authorized works consist of a dam, intakes, tunnels, powerhouse and switchyard connecting to the provincial power grid. Auxiliary works for the operation of the Ruskin Generating Station are also included.

See Appendix 1 for more details on the physical characteristics of the facilities.

3.0 HYDROLOGY OF THE STAVE RIVER BASIN

The report entitled, "Hydrology of the Stave River basin",[1] highlights the physiography, climate, and hydrology of the Stave River basin. The major source of precipitation in the Stave drainage basin comes during November to June from frontal southwesterly flows of warm moist air aloft. The abrupt rise of the Coast Mountains above the flat or rolling topography of the Lower Fraser Valley has a significant influence on this moist air, causing about two thirds of the annual precipitation to occur during this period. Sources of precipitation in the summer are generally weak frontal or convective storms.

The report also describes daily inflow and seasonal volume inflow forecasting procedures. The supporting network of hydrometeorological stations in the area is described. Summaries of inflow hydrographs for Alouette Lake and Stave Lake reservoirs are provided.

4.0 OPERATING CONDITIONS FOR FACILITY

4.1 Role of Facilities in BC Hydro's System

The Stave Falls and Ruskin generating stations are part of BC Hydro's integrated generation system, which is described in BC Hydro's publication, *Making the Connection* (2000).

The Stave and Ruskin Generating Stations are located close to the major load centre in the Lower Mainland. Their location is important in the provision of consistent voltage in the transmission network, and for system security in the event of transmission or generation problems elsewhere in the system. The Alouette/Stave Falls/Ruskin development contributes about 2% of BC Hydro's hydroelectric generation.

4.2 Use of Water for Power Generation at the Stave Falls and Ruskin Facilities

The Stave Lake Reservoir is classified as a "coastal reservoir" which means that the majority of inflow results from seasonal rainstorms and spring snowmelt. In addition, water is diverted from the Alouette Lake Reservoir into Stave Lake Reservoir. Hayward Lake Reservoir has negligible local inflows. As Hayward Lake Reservoir has limited storage, Ruskin generating station is operated in close hydraulic balance with the Stave Falls generating station.

[1] Hydrology of the Stave River basin, BC Hydro Power Supply Resource Management Hydrology and Technical Services, October 2001.

BC Hydro uses all of the available inflow, within the storage and generation limits of the facilities. Spill occurs when storage is full and inflows exceed generation capacity.

4.3 Emergencies and Dam Safety

Emergencies and dam safety requirements shall take precedence over the operational constraints outlined in this Water Use Plan. Emergencies include actual or potential loss of power to customers. Dam safety requirements for operations are outlined in the following documents, which are issued by BC Hydro's Director of Dam Safety:

- Ruskin Dam: Operation, Maintenance and Surveillance Requirements (OMS) for Dam Safety.
- Stave Falls Dam: Operation, Maintenance and Surveillance Requirements for Dam Safety.

Operational instructions for surcharging the reservoirs and undertaking a special drawdown for dam safety purposes are described in the OMS Manual for Dam Safety. Community notification procedures are documented in the Emergency Planning Guide.

4.4 Operation of Works for Diversion and Use of Water

The following constraints apply to the operation of the diversion works at Stave Falls and Ruskin. It is recognized that BC Hydro may not be able to operate within these constraints during extreme hydrological events.

4.4.1 Tailwater Level

From 15 October to 30 November (the spawning period for chum and coho), BC Hydro will maintain a minimum tailwater level of 1.8 m (Geodetic Survey of Canada datum) at the Ruskin plant. For the remainder of the year, BC Hydro will maintain a minimum tailwater level of 1.7 m (Geodetic Survey of Canada datum) at the Ruskin plant. The minimum tailwater level is to ensure sufficient wetting of the spawning area downstream of Ruskin plant to benefit fish. At times when Fraser River flows or tidal fluctuations influence the tailwater level at the Ruskin tailrace, Ruskin minimum turbine flows may be reduced or eliminated accordingly, provided the minimum tailwater level is maintained.

In the event of a plant outage, BC Hydro will re-establish the minimum tailwater level downstream of Ruskin Dam as soon as possible, by spilling water if necessary.

4.4.2 Fall Block Loading

From 15 October to 30 November (the spawning period for chum and coho), Ruskin output is subject to weekly block loading. Block loading is when a generating plant is operated at a set output for a specific period of time. The intent is to maintain relatively constant water flow from Ruskin during the block load period. When the discharge from Ruskin is 100 m^3/s or less, the discharge must remain constant for a minimum of 7 days after each change in discharge and each new block load on the plant must be greater than the previous block load. In making a plant load change, it is recognized that this may consist of several individual unit changes over a period of 4 hours. When the weekly block load flow exceeds 100 m^3/s, peaking at Ruskin above 100 m^3/s will be permitted (i.e. the block loading constraint is not required) provided a minimum flow of 100 m^3/s is maintained during the 7 day period and the duration of each peaking event is less than 12 hours.

In the event of a forced outage, BC Hydro will re-establish the pre-outage flow as soon as possible, by spilling if necessary, to maintain the block load flow or 100 m^3/s, whichever is lower.

4.4.3 Spring Block Loading

From 15 February to 15 May (the emergence period for salmon fry), Ruskin is subject to limited daily block loading. The intent is to maintain relatively constant water flow from the Ruskin during the block load period. Daily block loading is defined as a maximum of one plant load change each day within the effective dates. In making a plant load change, it is recognized that this may consist of several individual unit changes over a period of 4 hours. When the daily block load flow exceeds the threshold value of 100 m^3/s, peaking at Ruskin above 100 m^3/s will be permitted (i.e., the block loading constraint is not required) provided a minimum flow of 100 m^3/s is maintained for the day.

In the event of a plant outage, BC Hydro will re-establish the pre-outage flow as soon as possible, by spilling water if necessary, to maintain the block load flow or 100 m^3/s, whichever is lower.

4.4.4 Ramping

During the Spring and Fall Block Loading periods, the rate of reduction of total discharge from Ruskin, when discharge is 100 m^3/s or less, will be less than 35 m^3/s at intervals of not less than 10 minutes.

During the Spring and Fall Block loading periods, the rate of reduction of total discharge from Ruskin, when discharge is greater than 100 m^3/s, will be less than 113 m^3/s at intervals of not less than 30 minutes.

There are no other ramping requirements for the Ruskin facilities.

There are no ramping requirements for the Stave Falls facilities.

4.4.5 Incubation Flows

Current practice of providing, during the period between the fall and spring block loading periods, for a minimum of 1 hour each day, a flow equal to or higher than the maximum block loading flow that was provided during the previous fall block loading period, will be discontinued.

4.5 Operation of Storage Works

The following constraints apply to the operation of the storage works at Stave Falls and Ruskin. It is recognized that BC Hydro may not be able to operate within these constraints during extreme hydrological events.

4.5.1 Archaeological Drawdown

In consultation with the Kwantlen First Nation BC Hydro will develop a "Archaeological Management Plan" that includes periodic drawdown of the reservoir to provide access to known and potential archaeological sites. When a drawdown is planned in accordance with the Archaeological Management Plan, BC Hydro shall notify the Comptroller of the planned period of drawdown and minimum elevation. Drawdowns below the licensed minimum reservoir level of 73.0 m require prior approval of the Comptroller of Water Rights. Access to sites will be provided for a minimum of 6 weeks between 1 January and 31 March one out of 3 years on average. The lowest elevation above which access will be provided is 72 m. BC Hydro will inform Kwantlen First Nation of each drawdown attempt at least one month prior to the provision of access. Drafting of Stave Lake Reservoir will only be done with discharge through the Stave Falls powerplant and only when that discharge can be passed through the Ruskin powerplant. Spilling of water at either plant will not be used as the means for achieving a target drawdown. In order to provide some storage space for runoff events during the access period, the reservoir will be drafted below the elevation required for access to sites. In order to maintain minimum flow requirements in Ruskin tailwater, the reservoir may be drafted below the level required for provision of access.

4.5.2 Recreation Season Targets on Stave Lake Reservoir

From 15 May to 7 September, the preferred elevation of Stave Lake Reservoir for recreational activities is between 80.0 and 81.5 m. During this period, the level of Stave Lake Reservoir will be targeted at 76 m or higher, and will be targeted between 80.0 and 81.5 m for a minimum of 53 days. In the case of conflict between recreational targets and flow management requirements for fish downstream of Ruskin, the flow management requirements for fish shall take precedence. In the event of high inflow into Stave Lake Reservoir with the lake level above 81.5 m, the Stave Falls generating plant will be run at maximum possible to draw the reservoir down below 81.5 m. Spilling at the Blind Slough Dam will be initiated when the level of Stave Lake Reservoir reaches 82.1 m.

Recreational interests at Stave Lake Reservoir indicated that the preferred water levels in the reservoir for their needs were above 80 m. The recreational season was defined as occurring between Victoria Day and Labour Day.

4.5.3 Hayward Reservoir Operations

During the spring (15 February to 15 May) and the fall (15 October to 30 November) block load periods, the normal minimum operating level at Hayward Reservoir will be 39.5 m. At other times, the normal minimum operating level at Hayward Lake Reservoir will be 41.08 m. The reservoir may be drafted to elevation 33 m for maintenance of facilities, archaeological access or other unusual circumstances at any time.

5.0 PROGRAMS FOR ADDITIONAL INFORMATION

Development of an optimal operating strategy for the Stave River system was complicated by many uncertainties and information gaps. The consensus agreement of the Consultative Committee was contingent on the implementation of monitoring programs to reduce these uncertainties over time and an ongoing management program to address priority issues related to operational impacts. The monitors are designed to address key questions that affected decision making throughout the consultation process. These questions are summarized in Table 5-1.

Table 5-1 Monitoring Components and Related Questions on the Implications of Operations raised by Consultative Committee

Component	Purpose/Research Questions
Stave/Hayward Reservoir Monitoring Program	What are the productivity improvements at Stave resulting from changes in operations? What further productivity improvements could occur through other operating changes? How does the new operation affect littoral productivity in Hayward?
Limited Block Loading[2] Monitoring Program	Do the benefits of limited block loading outweigh the risks? Does partial peaking succeed in deterring spawning at high elevations? How much adult stranding occurs? How much fry stranding occurs? Is high velocity a deterrent to mid channel spawning? Could partial peaking be optimized given daily patterns of fry out-migration?
Archaeological Monitoring Program	How are archaeological sites affected by erosion? How would sites be affected by other operational strategies? How can they be protected or salvaged? Are there other sites in the area, including lands adjacent to the reservoir? How would these be affected by other operational strategies?
Hayward Water Quality Monitoring Program	Does the change in Hayward minimum normal operating water level increase the frequency or magnitude of turbidity events?

The recommended monitoring program will

- evaluate the effectiveness of the new operating constraints,
- provide improved information on which to base decisions about future operating constraints,
- collect scientifically defensible information about reservoir productivity processes and the impacts of reservoir operations on productivity.

The program design will be flexible in order to provide the basis for recommendations to the Comptroller on mitigative measures required to address operational impacts of implementing the Water Use Plan.

[2] The CWR ordered BC Hydro through an interim Order on 22 December 1998 to block load Ruskin plant during the Spring and Fall periods. The block loading prescribed in the Order permitted one plant loading change during a period of 1 day (for Spring block loading) or during a period of one week (for Fall block loading). The new Spring and Fall Block Loading constraint, defined in Section 4.4, is similar to the December 1998 Order but includes a relaxation of the block loading constraint whenever the plant release exceeds 100 m^3/s. The Stave WUP Consultative Committee referred to this loading as "limited block loading."

The program design will be reviewed annually and adjusted to reflect results. Further recommendations may be made to the Comptroller on mitigative measures to address operational impacts introduced by the Water Use Plan.

During the detailed design of the monitoring programs, Fisheries and Oceans Canada, provincial fisheries agencies, Kwantlen First Nation, the District of Mission and the Alouette Management Committee will be consulted as appropriate. Study terms of reference and study schedules will be approved by the Comptroller of Water Rights prior to commencement. Details and costs of the proposed monitoring program are provided in the "Stave River Water Use Plan: Report of the Consultative Committee." The main elements of the monitoring program are described below.

Fisheries: Stave/Hayward Reservoir Monitoring Program (Phase I and II). The Phase I Reservoir Monitor is an intensive monitoring program designed to improve understanding of reservoir productivity processes and performance of the operation relative to expectations. Once the productivity processes are understood, the Phase II Monitor will begin. This will be a more routine monitor, designed to detect changes over time. Details of the Phase II design will be finalized after Phase I results are analyzed. The results of this monitor will be relevant and beneficial for other coastal reservoirs in BC Hydro's system.

Fisheries: Limited Block Load Monitoring Program. The Limited Block Load Monitoring Program is a resource intensive monitor for the first 2 years after implementation, as it is necessary to ensure that the introduction of peaking above 100 m^3/s does not result in negative impacts on downstream fish productivity.

Heritage: An Archaeological Management Plan will guide the long-term management of archaeological sites within the Stave River watershed. Studies include programs related to monitoring, assessment, mitigation/salvage and inventory work.

Water Quality Monitoring Program. It is possible that there may be some erosion due to the increase in water-level fluctuations as a result of the modified operating regime in Hayward Lake Reservoir. Monitoring of turbidity is proposed because of the concerns of local residents who draw drinking water from Hayward Lake Reservoir.

6.0 IMPLEMENTATION OF RECOMMENDATIONS

The operational changes and monitoring plans, proposed in this Water Use Plan, will be implemented after BC Hydro receives direction from the Comptroller of Water Rights.

7.0 EXPECTED WATER MANAGEMENT IMPLICATIONS

The interests considered during the preparation of this Water Use Plan were:

.1 Avoid disruption to industrial operations:

- maintain access to loading/offloading equipment;
- avoid impacts from downstream flooding.

.2 Support recreational opportunities:

- support Stave Reservoir activities;
- support Hayward Reservoir activities;
- improve safety downstream of Ruskin Dam.

.3 Support viability of wildlife populations:

- maintain reservoir level stability;
- maintain downstream water level stability;
- ensure periodic flooding of riparian areas.

.4 Protect and preserve First Nations archaeological values:

- protect sites from erosion and illegal collection;
- preserve access to sites;
- recover and interpret artifacts.

.5 Support viability of fish populations:

- increase spawning capacity;
- increase rearing capacity;
- reduce stranding;
- reduce risk of exposure to elevated levels of Total Gas Pressure;
- increase reservoir productivity.

.6 Avoid cost increases for electricity production:

- minimize cost of replacement electricity and/or additional program or works.

.7 Maximize flexibility to respond to change:

- maximize resilience to and ability to respond to electricity market volatility, scientific uncertainties, etc.

.8 Gain knowledge about the system and impacts:

- maximize learning about key uncertainties affecting decision-making.

It is expected that the proposed operational changes in this Water Use Plan will have the following consequences for non-power interests. These are expected outcomes based on best available information. After BC Hydro has been directed to implement the operational changes, BC Hydro will be responsible for meeting the operational parameters but not for achieving the expected outcomes.

7.1 Other Licensed Use of Water

The District of Mission has a licence to remove water from Hayward Lake Reservoir to provide drinking water for a small number of residential dwellings in the local community.

The water use plan includes a component that changes the normal minimum level in Hayward Lake Reservoir from 41 m to 39.5 m during periods of block loading. These periods occur from 15 October to 30 November and 15 February to 15 May. The purpose of the change is to provide increased flexibility to produce power at Stave Falls powerhouse while the block loading constraint is in place.

Water quality at the water supply intake is not expected to be affected but a monitoring program is recommended as described in Section 5.0.

7.2 Riparian Rights

The operational changes proposed in this water use plan are not expected to impact riparian rights associated with the reservoirs or along the stream below the facilities.

7.3 Fisheries

The implementation of this water use plan is expected to result in a significant improvement in rearing habitat downstream of Ruskin Dam, largely as a result of the introduction of the spring block loading, which will reduce the stranding of emerging fry. There may be a reduction in the spawning habitat performance measure. This may occur as a result of the introduction of the limited block loading procedure which allows peaking above 100 m^3/s. Some adult stranding may occur as a result of this change. However, the introduction of limited block loading is expected to improve matters and result in a reduction in egg stranding. It is anticipated that the net effect of the limited block loading procedure will be an increase in emerging fry. Monitoring is recommended - refer to Section 6.0 for details.

With respect to the risk of direct mortality from exposure to elevated levels of total gas pressure, neither current operations nor the new operations under this water use plan are expected to result in any risk. This is because the duration of spills is very short and below the estimated duration threshold for direct mortality to occur.

A positive benefit in the Stave Lake Reservoir, is that the effective littoral zone area rises from 30 to 860 hectares, which drives an estimated productivity improvement of 21% in annual reservoir carbon production. The impact of the water use plan on Hayward Lake Reservoir carbon productivity is expected to be negligible.

7.4 Wildlife Habitat

Implementation of the water use plan is expected to have little impact on wildlife. The water use plan is expected to result in slightly more frequent flushing of riparian habitat downstream of Ruskin Dam, which returns nutrients to these areas and should help improve their productivity. It is not expected to increase the magnitude of downstream spills.

7.5 Flood Risk

Flood risk is unchanged by this water use plan.

7.6 Recreation

Primary recreation interests on Stave and Hayward Lakes Reservoirs include family-oriented recreation, camping, boating and fishing. Hiking, bird watching and other activities also occur. Downstream of Ruskin Dam, family-oriented recreation, swimming and fishing are the dominant uses affected by operations.

The new operations may have some consequences for recreation on Hayward Lake Reservoir and downstream of Ruskin Dam. Specifically, the change in the normal minimum operating level on Hayward Reservoir (from 41 to 39.5 m from 15 October to 30 November, and 15 February to 15 May) may have implications in terms of safety and aesthetics:

- Safety - Boaters may have less clearance above standing debris in the reservoir. This is mitigated by the fact that low levels occur only during low use periods.
- Aesthetics - Reservoir shoreline and riprap on the new island will be exposed during drawdowns. This is mitigated by the fact that low levels occur only during low use periods.

The introduction of the limited block loading procedure (which allows peaking above 100 m^3/s) will have implications for fishers downstream of Ruskin Dam. During the peak fishing season (fall spawning), fishers will now experience water level fluctuations. However, the new operating strategy does not increase the maximum rate of change of water releases from current rates.

7.7 Water Quality

No change in water quality is expected. Also see Section 7.1

7.8 Industrial Use of Water

Low reservoir levels can affect industrial operations on Stave Lake Reservoir by limiting access to loading and off-loading equipment. This can have a financial impact on the affected businesses. Large spills can disrupt log transportation on the river downstream of Ruskin Dam and cause damage to equipment. No change in spill frequency is expected.

The water use plan includes the implementation of a spill notification system (see Section 10.0). This addresses the concerns of industrial users downstream of Ruskin Dam. Provided they have adequate notice, downstream industries are able to protect their equipment from damage.

7.9 First Nations Considerations

The Stave River system lies within the traditional territory claimed by the Kwantlen First Nation. Kwantlen First Nation, have an interest in:

- understanding how their ancestors lived,
- protecting archaeological sites from erosion and the illegal collection of artifacts,

- accessing sites (for mitigation and inventory purposes as well as cultural and spiritual activities), and
- recovering and interpreting artifacts.

The operation of the storage works described in Section 4.0 will allow Kwantlen an opportunity to conduct archaeological inventories, recover artifacts, assess the condition of sites and mitigate any damage caused by operations. It will also allow them to conduct on-site cultural or spiritual activities.

The water use plan is expected to improve protection of archaeological sites from public disturbance, illegal artifact collection and damage from the use of recreational vehicles because it targets Stave Lake Reservoir water levels above 80 m during the peak recreation season.

7.10 Transportation

The operational changes proposed in this Water Use Plan are not expected to affect transportation on the Stave River or along the Stave River valley.

8.0 RECORDS AND REPORTS

8.1 Compliance Reporting

BC Hydro will submit data as required by the Comptroller of Water Rights to demonstrate compliance with the conditions conveyed in the Water Licenses. The submission will include records of

- Stave Lake Reservoir elevation
- Hayward Lake Reservoir elevation
- Discharge into Ruskin tailrace
- Ruskin tailwater elevation

8.2 Non-compliance Reporting

Non-compliance with licence conditions, or anticipation thereof, will be reported to the Comptroller of Water Rights in a timely manner.

8.3 Monitoring Program Reporting

Reporting procedures will be determined as part of the detailed terms of reference for each study or undertaking.

9.0 PLAN REVIEW

A review of this water use plan is recommended within ten years of its implementation. A review may be triggered sooner if significant risks are identified that could result in a recommendation to change operations.

10.0 NOTIFICATION PROCEDURES

Notification procedures for floods and other emergency events are outlined in the "Ruskin and Stave Falls Dams Emergency Planning Guide" and the "Power Supply Emergency Plan: Fraser Valley Generation" (PSEP). Both these documents are filed with the Office of the Comptroller of Water Rights.

Appendix 1
Alouette, Stave Falls and Ruskin Data Summary Tables

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STAVE FALLS DATA SUMMARY

STAVE RESERVOIR

Location: North of Stave Falls Dam
Reservoir area at max. normal level: 6200 ha
Drainage area: 1170.0 km^2
Live Storage: $4.70 \times 10^8 m^3$
Max. Normal Level: 82.08 m
Min. Normal operating level: 73 m
Max. Flood elevation: 85.4 m
Freeboard above MNL: 1.7 m
Inflow design flood: 5775 m^3/s

DAM

Stave Falls Dam
Type: Concrete gravity and rockfill
Use: Storage
Crest Length: 122 m
Crest Elevation: 83.75 m
Crest Width: 5.1 m

Blind Slough Dam (spillway)
Type: Concrete gravity
Use: Storage/Spillway
Crest Length: 190 m
Crest Elevation: Deck Sluice Gates: 83.75 m
Sluice Gate Sill: 76.1 m; Taintor Gates Sill: 68.4 m
(10 Stop log Sluice gates – discharge capacity with reservoir at MNL: 1450 m^3/s, at crest elevation: 2100 m^3/s; 4 Taintor/Radial gates – discharge capacity: 1400 m^3/s)
Crest Width: 8.54 m

SWITCHGEAR

Location: Between Main Dam and Blind Slough Dam
Switchgear: 60 kV switchyard

POWERHOUSE

Powerhouse: two vertical shaft Kaplan turbines coupled to umbrella type generators (each with a rated capacity of 45 MW, 0.9 power factor) within a reinforced concrete substructure.

Switchyard: power to switchyard from 69 kV cables in underground ducts and distributed to 69 kV by overhead lines.

Tunnels: 2
Length: (1) 183 m (2) 202 m
Max. Velocity 3.5 m/s
Lining: Fibre reinforced shotcrete constructed in rock

Intakes: left abutment of Main Dam
Invert elevations: 59.4 m
Operating Gates: 2 ; Operating Gate Sill: 58.94 m
Maintenance Gates: 2

RUSKIN DATA SUMMARY

HAYWARD RESERVOIR
Location: 3 km upstream of its confluence with the Fraser River; south of Stave Falls dam and north of Ruskin dam
Length: Hayward Reservoir, a small reservoir of 5.6 km long.
Capacity: total storage 42 000 000 m^3
Reservoir area at max. normal level: 298.0 ha
Drainage area: 953.0 km^3
Live storage: daily pondage (m^3)
Max. normal level: 42.80 m
Normal Operating Range: 41.1 m to 42.80 m
Min. operating level: 33.0 m
Normal Minimum Dam Freeboard:
Over power intakes 2.75 m
Over spillway gates 2.85 m
Max. flood elevation: 46 m
Inflow design flood: 4500 m^3/s

DAM
Type: Concrete gravity
Foundation: Bedrock, hornblende diorite
Use: Storage
Crest Length: 110 m
Maximum Height: 59.4 m
Crest Width: 5.28 m
Crest Elevation: 45.7 m

SPILLWAY
Location: whole dam
Type: gated ogee crest: 7 radial gates
Crest elevation: 35.0 m
Maximum Capacity: 4430 m^3/s
Dimensions (WxxL): 2.1 x 83.2 m

PENSTOCKS
Type: circular in rock
Lining: Partially concrete lined, partially steel lined

POWERHOUSE
Turbines: 3 Francis type units, discharge capacity of 116 m^3/s per penstock
Generators: 3 conventional generators, vertical-axis, umbrella-type air-cooled units.
Rating of 35.2 MVA

SWITCHGEAR
Location: Powerhouse roof
Switchgear: 60 kV switchyard

ALOUETTE DATA SUMMARY

RESERVOIR
Reservoir area at max. normal level: 1665.0 ha
Drainage area: 200.0 km^2
Live storage: 1.94×10^8 m^3
Max. Normal Level: 125.5 m
Min. operating level: 112.6 m
Max. flood elevation: 128.9 m
Freeboard above MNL: 5.0 m
Inflow design flood: 1257 m^3/s

DAM
Type: Earthfill Embankment
Use: Storage
Crest Length: 288 m
Crest Elevation: 130.5 m
Crest Width: 7.0 m

SPILLWAY
Type: Free Overflow
Crest Elevation: 125.5 m
Length: 121 m
Spill Gate: 1 Vertical Lift; Sill elevation: 121.35 m
LLO: Vertical slide, discharge capacity at MNL: 3.0 m^3/s

POWER INTAKES AND PENSTOCKS
Intake operating gates: 1 vertical lift stoney roller gate; 100.5 m sill elevation
Penstocks: 1 concrete lined tunnel and steel type penstock; 1 unit for this penstock

POWERHOUSE
Location: Stave Lake Reservoir
Turbines: 1 Francis turbine; discharge capacity; 24 m^3/s
Generators: 1 surface generator; 8.0 MW
Tunnel: North end of Alouette Lake Reservoir to Stave Lake Reservoir. Unlined rock and steel lined penstock
Length: 106.7 m; Diameter: 4.6 m
Adit Gate: Above Powerhouse; slidegate
Intake: Alouette Lake Reservoir; Stoney roller vertical lift.

SWITCHGEAR
Location: adjacent to Powerhouse
Switchgear: 60 kV switchyard