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FALLS RIVER HYDRO DAM
Fisheries Restoration Feasibility Study

prepared for
BC HYDRO FISH AND WILDLIFE BRIDGE COASTAL RESTORATION PROGRAM

prepared by
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EXECUTIVE SUMMARY

This study involved background research and preliminary field studies in order to assess the need for, and feasibility of, fish habitat restoration prescriptions for the Falls River (or Big Falls Creek) downstream from the dam. Although this study was limited to the collection of a small amount of data over a period of two months, some general conclusions have been made. Data gaps that still exist require additional studies. These include adult spawning assessments during peak spawning, continued water quality monitoring to ensure that there are no issues in this regard and a hydrology study. Historical information and current conditions at the site indicate that the hydroelectric facility has likely impacted fish and fish habitat in the tail water pond. Spawning habitat has potentially been disturbed by high flushing flows, extremely low flows during shut down periods, grading and scarification of gravels, a lack of gravel recruitment and the placement of rock weirs in the tail pond. Rearing habitat for salmonids has likely been altered by a lack of woody debris recruitment and retention, a lack of riparian vegetation on the right bank and rapid changes in flows from low (potentially stranding) flows to high flushing flows.

Several potential restoration projects are proposed to address these issues, including the construction of spawning platforms (gravel placement) and large woody debris placements. Final design for these structures is dependent upon the results of the hydraulic analysis that is still pending. The hydraulic information is important for the design of habitat improvement projects and for the Water Use Planning process.

Detailed prescriptions for habitat improvement projects will be outlined in a proposal submission to BC Hydro BCRP by October 1, 2003.

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1.0 INTRODUCTION

1.1 Background

In 1930, the Northern B.C. Power Company constructed a dam and associated infrastructure at the Falls River site. The site was acquired by B.C. Hydro in 1964 and in 1983 and 1992, the infrastructure at the site was significantly altered (BC Hydro, 2000 – Vol. 2) (Wilson, 1991). The 1992 rehabilitation involved plant automation and remote control from Prince George (Lewis et al, 1996).

Spawning pink salmon (*Oncorhynchus gorbuscha*), chinook salmon (*Oncorhynchus tshawytscha*) and chum salmon (*Oncorhynchus keta*) have been recorded in the tail pond downstream of the larger falls since 1947 (DFO, 1947-2001). Steelhead, rainbow trout, sea-run and resident dolly varden, coho, sculpins and lamprey have also been observed in the mainstem of Falls Creek (FISS, 2000). Estimates of returning salmon have ranged from lows of zero to highs of 2000 pinks, 300 chum and 100 chinook salmon. Optimum escapements have been noted in the Salmon Stream Spawning Reports as 500, 100 and 75 for pink, chum and chinook, respectively. A summary of these reports is in Appendix B. Lack of monitoring and a possible decrease in some stocks have resulted in no recorded observations of spawning salmon in the tail pond since 1987.

Fish and fish habitat in the tail pond have likely been impacted by a number of issues associated with the construction and operation of the Falls River Project. Potential impacts of the facility to fish and fish habitat downstream of the dam are outlined in the Strategic Plan (BC Hydro, 2000 – Vol. 1). Operational issues that likely impact fish and fish habitat include:

- fish stranding due to flow changes; and
- unnatural (controlled) flows that alter quantity and quality of available habitat.

Operational issues are dealt with through BC Hydro's Water Use Planning process. This process is currently underway, and is expected to be complete in spring/summer 2003.

Significant footprint impacts include the following:

- a lack of gravel recruitment and retention which impacts spawning habitat;
- less woody debris recruitment and retention likely affects rearing habitat quality;
- possible changes in water temperature which could negatively or positively affect all life stages of salmonids;
- placement of two rock spoil piles in the tail pond alter flow patterns below the falls ;
- alterations to the right bank of the tail pond such as rock placement and removal of riparian vegetation may affect hydrology and water quality, respectively;
- a garbage incinerator on the right bank of the tail pond may be leaching into the water, negatively affecting water quality; and,
- blasting of the lower falls which may have resulted in increased backwatering of the tail pond at a lower tide levels.

The BC Hydro Fish and Wildlife Bridge Coastal Restoration Program (BCRP) was established to address footprint impacts to fish, wildlife and their habitats at specific hydroelectric facilities, including Falls River (BC Hydro, 2000, Vol. 1). This study was first initiated through the BCRP, but has expanded to include the collection of some data in support of the Water Use Plan, in partnership with BC Hydro.

1.2 Objectives

The general objective of the project was "to improve habitat conditions for fish stocks between the dam and the Ecstall River" (BC Hydro, 2000, Vol. 2). The first step in this process involves identifying and addressing key information gaps. This will enable us to determine critical habitats necessary to sustain present stocks and to identify potential habitat improvement opportunities for future development. A literature review revealed that there are many data gaps pertaining to fish and fish habitat in the Falls River tail pond. Water quality data and information regarding juvenile salmonid usage is sparse. Information on adult salmon usage over the last decade is non-existent (DFO, 1947-2001).

The specific project objective was to develop a practical set of prescriptions for fish habitat conservation and improvement in the Big Falls Creek Watershed that address limiting factors for salmonids. Field studies and site visits focussed on addressing data gaps and identifying potential project opportunities. This included the following tasks:

- familiarising ourselves and our partners with the area and relevant issues with respect to fish and their habitat;
- conducting water quality measurements;
- collecting information on juvenile and adult fish utilisation;
- completing topographic surveys, velocity measurements and substrate data for hydraulic analysis; and,
- devising conceptual ideas for restoration projects.

1.3 Study Area

Falls River is located approximately 56 km southeast of Prince Rupert, illustrated in Figure 1 below. It flows into the Ecstall River approximately 25 km upstream from the Ecstall confluence with the Skeena River (Lewis et al., 1996). It drains an area of 243 km^2 and comprises 22.7% of the total Ecstall River flow from the Falls/Ecstall confluence, downstream (Falls River WUP Project Team, 2002). The most practical access is by float plane or helicopter from Prince Rupert or by boat from Tyee boat launch on the Skeena River ~ 45km east of Prince Rupert off Highway 16.

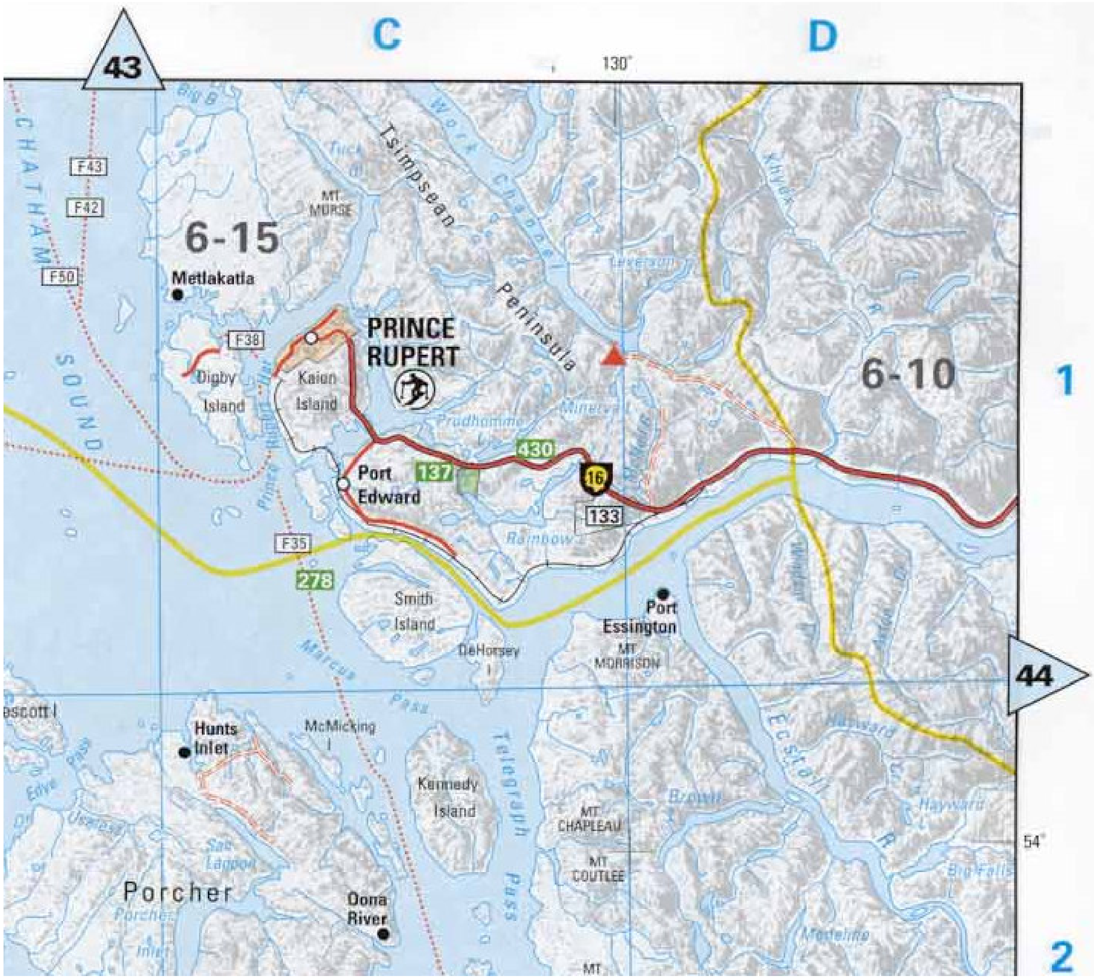

Figure1: Map Location of Falls River with Reference to Prince Rupert (taken from The 4th Edition BC Recreational Atlas, 1997).

The Falls River dam is located on the top of a 20m falls that is impassable to upstream migrating fish. Below the falls, there is a ~180m long by ~100m wide reach of river that is referred to as the tail pond or tail water pond (these terms will be used interchangeably throughout the report). The outlet of the tail pond consists of a smaller falls that is a 4.5m barrier at low tide, but becomes backwatered by the Ecstall River at a tide greater than 4.5m (Lewis et al., 1996). The study area is illustrated in Figure 2 below, and in Appendix C.

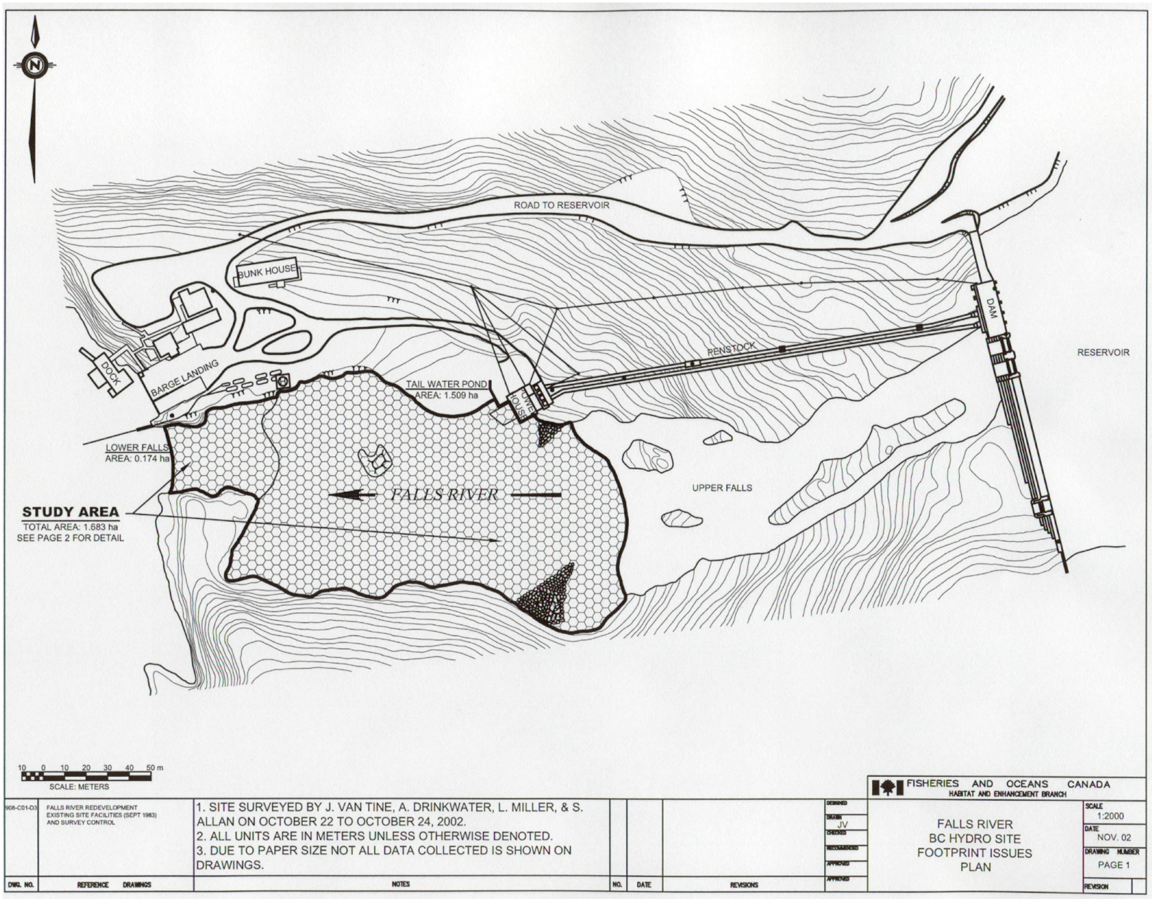

Figure 2: Falls River Study Area
Appendix C contains a larger version of figure 2.

2.0 METHODS

2.1 Water Quality

Two locations were selected for water quality monitoring stations. The upstream site was located just downstream from the penstock outlets on the right bank. This site is adjacent to proposed gravel placement site #1 (see figure 5 on page 18 and Appendix C), and is easily accessible from the bank (ie. no boat required to access this site during low tide). The downstream site was located adjacent to the helicopter pad on the right bank, just upstream from the bedrock outcropping of the lower falls. This site was also easily accessible from the stream bank. At the monitoring stations, temperature loggers were installed and various water quality parameters were measured at high and low tide. Dissolved Oxygen (DO) and temperature were measured using the OxyGuard Handy Gamma. pH was tested using the Oakton 300 Series pH/DO/Meter. A digital thermometer (Hanna instruments Checktemp 1) was also used to confirm temperature. Conductivity and salinity were measured using the Orion Model 1230 pH/mV/ORP/Conductivity/Dissolved Oxygen/Salinity/Temperature Meter. On November 15, 2002, additional salinity/conductivity measurements were taken at water surface and at a depth of 2.0 meters in the tailpond and in the Ecstall side-channel. A Total Dissolved Gas Monitor (Model TBO-F "Gastimator") was used to collect gas pressure data at the penstock outlets. Measurements were only acquired at the water surface before an equipment malfunction prevented additional readings.

Temperature Data Loggers

Two StowAway TidbiT Temperature Loggers, which have a battery life of approximately 5 years were installed at each site on October 24th, 2002. In order to avoid loss of data due to logger malfunction, the loggers were installed in pairs. Each pair of loggers were placed in a small perforated PVC case that was cabled to a fixed object on land and weighted with a 10 lb lead weight to ensure that it remained submerged. The upstream logger was cabled to the sheet pile adjacent to the concrete wall that runs from the tailrace to the Northwest corner of the powerhouse. The downstream logger was cabled to the Southeast support of the helicopter pad.

Loggers were programmed to record the water temperature every hour, which results in a logger lifespan of approximately 4 years before they begin to overwrite previously recorded data. It is our intention to download data and re-launch loggers on each subsequent trip into Falls River.

2.2 Juvenile sampling

Preliminary Presence/Absence Sampling

On October 10, 2002, ten minnow traps (5 small mesh and 5 regular mesh) were set on the left bank and right bank of Big Falls Creek (5 traps per side) between the dam and small falls. Traps were set and retrieved during low tide from ~11:15 to 14:00. Fish were anaesthetised with clove oil, identified by species and sampled for length and weight.

Population/Density Estimate

On October 22, 2002, 25 traps were set in Big Falls Creek between the dam and lower tidal falls. Thirteen traps were set on the right bank (7 - ¼" mesh and 6 - 1/8" mesh) and twelve traps (7 - ¼" mesh and 5 - 1/8" mesh) were set on the left bank. Traps were set and retrieved during low tide (from ~ 12:10 to 14:30). A portion of the fish were anaesthetised with clove oil, identified and sampled for length and weight. The remainder of the fish were anaesthetised (except Dolly Varden), and all fish were identified by species and marked with a small fin clip on the upper fork of the dorsal fin. Fish were then returned to the water, all on the right bank side of the creek.

On October 24, 2002, the traps were re-set in the same locations as the Oct 22 trapping. Traps were set during low tide from ~ 09:45 to 09:15 and retrieved from 13:00 to 14:00. All fish were identified, marks were recorded and fish were returned to the creek.

2.3 Adult sampling

On October 10, 2002, the site was sampled for presence of adults and evidence of spawning. The area was flown by helicopter and the tail pond was snorkelled and angled using roe as bait.

2.4 Predator observations

Visual observations of predators were recorded during each site visit to Falls River.

2.5 Topographic Survey

A detailed topographic survey of the tail water pond and lower falls was completed using a total station, geographic positioning system (GPS), depth sounder and computer correction software (see figure 3 below).

The total station was used to collect topographic data above the water line and some specific points in shallow areas of the tail water pond. Most of the tail water pond was mapped for its topography with the use of the GPS, depth sounder, and computer correction software working together as a single unit.

Control points were established for both surveys so that the two sets of data could be combined.

Figure 3: Jaison Van Tine surveys the Falls River tail water pond

2.6 Hydraulic Analysis

The data collected from the two topographic surveys will be inserted into BC Hydro's River Two Dimensional (R2D) modelling program. The R2D program will produce hydraulic information for the study area such as water depth, water velocity at various depths and total flow. This information is being produced by BC Hydro in support of the BCRP study and the Water Use Planning (WUP) process.

In support of the hydraulic analysis, and as reference points of 'real' data, a limited number of velocity measurements were taken in areas of known historical and potential spawning. These measurements were collected from a boat during high tide on November 15, 2002. The collection of additional velocity measurements at low tide was hampered by the unexpected spill that day of approximately 40-50 cms. The spill was unexpected because flashboards are usually installed on November 15, resulting in a no-spill situation.

3.0 RESULTS

3.1 Water Quality

Various water quality parameters were sampled on three different dates between October 10th and November 15th 2002.
Results of these measurements are summarised in Tables 1 and 2 below.

Table 1. Falls River Water Quality Data – Oct/Nov 2002

Location/site	Date	Tide Ht (feet)	Temp (°C)	DO (mg/l)	% Sat (%)	pH	Conductivity (mS/cm)	Salinity ppm?	Approx flow (cms)
U/S site	Oct 10-02	<15'	8.7	12.3	104				50
U/S site	Oct 24-02	<15'	7.6	11.7	96	6.6	18	0	14
D/S site	Oct 24-02	<15'	7.7	11.9	100	6.7	18	0	14
U/S site	Oct 24-02	>15'	7.2	11.6	94	6.8	18	0	14
D/S site - surface	Oct 24-02	>15'	7.2	11.6	95	6.3	18	0	14
D/S site - 2m deep	Oct 24-02	>15'	7.2	11.6	94	6.3	18	0	14
Ecstall R tidal pool 2m deep	Nov 15-02	>15'	3.8				14	0	
U/S site 2m deep	Nov 15-02	>15'	3.8		103		13	0	40

Table 2. Falls River Water Quality Data – Nov. 2002
TGP RESULTS

Location/site	Date	Tide Ht (feet)	Temp (°C)	BAR (mmHg)	PT (mmHg)	% Sat (%)	Delta P (mmHg)	pO2 (mmHg)	(PT - pO2) (mmHg)
Penstock outlet @ Water Surface	Nov 15-02	>15'	3.8	763	783	103.4	20	129	658

Description	Abbreviation	Units
Barometric Pressure	BAR	mmHg
Total dissolved Gas Pressure (TDGP)	PT	mmHg
% Saturation, TDGP	% Sat	%
Delta P (change in pressure)	Delta P	mmHg
Partial Pressure of Oxygen	pO2	mmHg
Balance of dissolved gases	PT - pO2	mmHg
Dissolved Oxygen	DO	(mg/l or ppm)
Upstream	U/S	
Downstream	D/S	

Dissolved oxygen levels were good (94-104% saturation). Conductivity readings were low (14-18 µS/cm), however none of the *preliminary* water quality variables were outside the 'normal' range of water quality values for the health of aquatic organisms (Sigma, 1979). Wilson (1991) referenced a study conducted in 1983 by Bradley that recorded reservoir pH at 5.8 which is low when compared to the almost neutral levels (6.3-6.8) found in Falls River downstream of the dam in this study. Total Gas Pressure measurements were limited to the water surface at one location due to an equipment malfunction. Salinity and conductivity measurements were taken in both the tail water pond and in the Ecstall River tidal pool (at floatplane dock) at high tide. The length of the conductivity/salinity meter cable limited measurements to a depth of two meters. No saline water was found in any of the sampling.

3.2 Juvenile Sampling

Results from the juvenile sampling are summarised in Table 3 on page 12. Juvenile chinook, coho, dolly varden and sculpins were captured.
It is important to note that the sample area was isolated from the Ecstall River during each sampling period by the lower falls at low tide, but between the first trapping and the second trapping – fish had access in and out of the site during high tide events.

Table 3: Falls River Juvenile Salmonid Sampling Results – Oct. 2002

Falls River Juvenile Salmonid Sampling

Date	**Sampling method**		
10-Oct-02	Presence/absence using 10 gee minnow traps		
Species	**Number**	**Ave length (mm)**	**Ave weight (g)**
Chinook	7	77	5.1
Coho	25	68	3.4

Date		**Sampling Method**					
Oct 22-24, 2002		Mark-Recapture using 25 gee minnow traps					
Species	**# marked**	**# marked recapt'd**	**# unmark recapt'd**	**% unmark/ mark**	**Pop'n estimate**	**Site area (m2)**	**Est density (juv/m2)**
Chinook	73	4	82	0.05	1497	15 000	0.100
Coho	112	16	119	0.13	833	15 000	0.056
Dolly Varden	22	1	3	0.33	66	15 000	0.004
All salmonids	207	21	204	0.10	2011	15 000	0.134

Species	**Ave length (mm)**	**Ave weight (g)**
Chinook	71	4.3
Coho	70	4.1
Dolly Varden	135	(only 1 sampled for length only)

A rough estimate of the population of juvenile salmonids utilising the tail pond indicated that densities are generally low (~0.134 juvenile salmonid per m^2) and fish would likely benefit from habitat complexing such as large woody debris placement (Keeley et al., 1996) (Slaney et al., 1997). It should be noted that the recapture results from Oct 24/02 may be biased (possibly over-estimating the population). This is because all fish captured from both the left bank and the right bank in the first trapping on Oct 22/02 were marked and then released in one location on the right bank. After the initial trapping/marking, fish should have been returned to the same location from which they were obtained for a more even re-distribution and possibly greater recapture rate. Limited time and access to the left bank prevented this release.

In general, Dolly Varden were found in traps placed at the base of the upper falls where water tends to be deep and fast. Coho were found in greater abundance in traps on the rip rapped right bank where the water is relatively shallow. Chinook juveniles were found in greater percentages in traps located in the middle of the tailpond and on the left bank, which is characterised by bedrock banks, deeper water and greater water velocities. See Figure 4 on page 13 illustrates fish captured near the base of the larger falls.

Figure 4: Juvenile Fish Sampling
Dolly Varden, coho and chinook in bucket

3.3 Adult Sampling
Two adult salmon (possibly coho) were observed from the helicopter below the lower falls at low tide on Oct 10, 2002.
Angling, snorkelling and helicopter observations on Oct 10, 2002 did not result in any sightings of adult salmon or evidence of spawning in the tail pond. Snorkelling was hampered by poor visibility 1-1.5 meters, deep water and high velocities.

3.4 Predator Observations
At least two seals were observed downstream of the tail pond, in the Ecstall River on Oct 10, 2002. Two seals were observed in the tail pond at high tide and below the tail pond at low tide on Oct 22, 23 and 24, 2002.

3.5 Topographic Survey

For the purpose of this report, two drawings of the site and study area have been produced from the topographic survey data (see figure 2 on page 8, figure 5 on page 18 and Appendix C). Due to the paper size restriction for this report, it was not possible to show all of the topographic and survey details.
More detailed drawings and designs will be produced from the topographic data collected for the purposes of a restoration proposal to be submitted to BCRP in October 2003.

3.6 Hydraulic Analysis

Results of the hydraulic analysis are still pending. Once completed, the R2D program will provide critical information for the design of restoration works in the tail water pond and for the Water Use Planning process.

4.0 DISCUSSION & CONCLUSION

4.1 Water Quality

None of the *preliminary* water quality variables were outside the 'normal' range of water quality values for the health of aquatic organisms (Sigma, 1979). Additional measurements are recommended in the future due to the limitations of the data collected to date. This study addressed only a few water quality parameters over a period of one month. Total Gas Pressure measurements were limited to the water surface at only one location due to an equipment malfunction. The length of the conductivity/salinity meter cable limited measurements to a depth of two meters. Although no saline water was found in any of the sampling, measurements on the streambed at high tide are necessary to provide more conclusive results regarding salt water intrusion. Hickey (1981) found no evidence of a salt water wedge in the tail pond during his study. Turbidity was not measured, but it was not expected to be an issue in this relatively clear water system (in comparison to the Ecstall River, for example).

The temperature loggers should provide consistent water temperatures over a longer time period, which will help to determine the timing of incubating egg development, and provide data on annual temperature fluctuations. This data can also be correlated with flows.

Potential Impacts to Water Quality and Quantity

Water flow through the gravel is critical to ensure that sufficient dissolved oxygen is delivered to incubating eggs, and waste products are flushed away. Low flow conditions in the winter months may reduce subgravel dissolved oxygen levels for incubating eggs, which could impact survival rates.

Standing water, which occurs during tidal innundation, particularly when there is little spill or a shutdown, would likely reduce the flow of water through the gravel.

Lack of riparian vegetation of the right bank could result in reduced nutrient input to the tail pond and increased water temperatures during the summer months.

An incinerator adjacent to the creek on the right bank may be leaching pollutants into the river. Septic fields on the right bank may have a similar affect, but it is not known if they are currently being used (Wilson, 1991).

4.2 Juvenile Salmonids

As outlined in the results section of the report, juvenile salmonid densities in the tail pond in late October were estimated at approximately 0.134 juveniles per m^2. This value is relatively low compared to biostandards for similar habitat (Keeley et al., 1996), (Slaney et al., 1997) and may be a result of factors such as erratic flow conditions and a lack of habitat complexity. Juvenile salmonids in the tail pond could benefit from large woody debris placements. Although habitat for juvenile salmonids may not be the critical limiting factor in this system, this tributary may provide important rearing in the Ecstall watershed as juveniles likely seek the clear waters of Falls River as a refuge from the highly turbid waters of the lower Ecstall River. The two fall sampling events provide a snapshot of juvenile salmonid usage of the tail pond during this time of year only. Additional sampling is recommended.

Potential Impacts to Juvenile Salmonid Habitat

Erratic flows may cause stranding and flushing out of juveniles in the tail pond. The dam and the removal of riparian vegetation on the right bank likely reduces recruitment of large woody debris (LWD) to the tail pond. Flushing flows and tidal action likely reduce retention of woody debris. LWD is an important habitat feature for several species of juvenile salmonids (Slaney et al., 1997). It provides protection from a variety of predators, including seals which were observed in the tail pond from Oct 22-24/02. Lack of riparian vegetation on the right bank would also reduce cover and nutrients/food input for juveniles.

4.3 Adult Salmon

Status and Timing of Falls River Stocks

In Falls River, spawning pink, chinook and chum salmon have been recorded in the tail pond downstream of the larger falls since 1947 (DFO, 1947-2001). Lack of monitoring and a possible decrease in some stocks have resulted in no recorded observations of spawning salmon in the tail pond since 1987. This year, when Falls River was flown by helicopter, snorkelled and angled on October 10, 2002, no fish were observed in the tail water pond, although two unidentifiable adult fish were observed below the lower falls from the helicopter. These results were not unexpected, since the timing of this sampling was well past recorded estimates of peak spawning for pink, chum or chinook in this system. Returning chinook are documented returning to Falls River in early August, with peak spawning in late August/early September and end of spawning ranging from September to late October. Pink salmon are recorded arriving in August, with peak spawn ranging from mid-August to early September and end of spawning ranging from early September to October. Limited information has been recorded about the timing of chum in Falls River. Start of spawn is estimated at mid-August and peak spawning documented in late August once in 1967. Falls River estimates of returning salmon have ranged from lows of zero to highs of 2000 pinks, 300 chum and 100 chinook salmon. Optimum escapements have been noted in the Salmon Stream Spawning Reports as 500, 100 and 75 for pink, chum and chinook, respectively. A summary of these reports is in Appendix B).

Historical Spawning Distribution in the Tail Water Pond

Historical Salmon Stream Spawning Reports from 1948, 1966 and 1968 illustrate pink spawning on the left bank gravel bar of the tail water pond. Hickey, with D.B. Lister and Associates (1981) mapped actual and potential redds just downstream of the penstock outlets on the right bank, and in the center of the creek, at the tail-out of the lower falls.

Potential Impacts to Spawning Habitat

In 1983, substrates in the tail pond were graded and scarified (Wilson, 1991). The inspection of substrate in areas of historic spawning during this study revealed small gravel (ave size estimated at 50mm) with a high percentage of fines (sand). Although this falls within the range of substrate criteria for spawning chinook salmon (Slaney, et al., 1997), it is small when compared to the average dominant size of gravel generally used successfully for chinook salmon spawning habitat creation, (100-130 mm) (Anderson et al., 2001).

Rock weir spoil piles were placed in various locations in the tail pond. These weirs likely affect water velocities in the tail pond and may have impacted existing spawning habitat. The lower falls appear to have been blasted because drill holes from historic blasting are evident in the bedrock of the falls. The original height of the falls has not been determined; however, if the invert of the lower falls was lowered by blasting, tidal backwatering would now occur at lower tide levels than in the past and for increased duration. This could severely impact survival of incubating eggs which need a relatively constant flow of water through the gravel to provide dissolved oxygen and remove metabolic wastes. This is particularly important for chinook salmon which appear to need strong subsurface flows (Groot & Margolis, 1991). Increased tidal backwatering may also discourage adult salmon, such as chinook, from spawning in an area.

The tail pond has experienced some extreme high flows historically – possibly enough to flush some gravel out of the system. Over 600 cms was recorded in December of 2000 (Molstad, 2002). It was noted during the presentation that the reliability of this data point may be questionable, however it is not implausible given that inflow events can exceed 500cms. During the week of November 12th, 2002, spill exceeded 200 cms according to the maintenance crew that was working on-site. By November 15th, spill had dropped to ~ 40 cms.

Blasting that was conducted in close proximity to the river, or in the river may have impacted incubating eggs if it occurred prior to the eyed stage at approximately 280 accumulated temperature units (ATU's) (DFO, 1994). One blasting incident was documented by Hickey (1981) on September 22, 1981. Eggs were incubating in the gravel at that time, one redd was sampled, but their stage of development was not recorded, so it is not known if they were eyed at the time of blasting.

4.4 Limiting Factors

Although this study was limited to the collection of a small amount of data over a period of two months, some general conclusions can be drawn. Data on current adult salmon returns is necessary, in part, to determine if proposed habitat improvement projects will be naturally colonised by fish, or if a combination of habitat improvements and fish culture will be needed to help re-establish adult fish populations in Falls River. One of the critical limiting factors for fish production in Falls River is believed to be a lack of appropriate spawning habitat for chinook, pink and chum salmon.

Juvenile rearing habitat is generally underutilised. Existing rearing habitat should be preserved and would likely benefit from the addition of LWD.

4.5 Topographic Survey, Hydraulic Analysis and Design

Design engineering and on-site work to date has been limited to the collection of survey data, comparison of conceptual fish habitat restoration alternatives, adoption or elimination of proposed rehabilitation techniques, and an investigation of mobilization of equipment and materials to the site.

Hydraulic modelling of the site is currently being developed, and other data still need to be collected. At the present time, it is our intention to use the hydraulic data, water basin hydrology and collected DFO survey data to locate and design spawning platforms and large woody debris placements. Three potential gravel placement sites have been identified (see figure 5 below and Appendix C). The two most promising locations (sites 1 & 3) are sited at historical chinook spawning sites documented by Hickey (1981). It is recognised, however, that it would be premature to develop final prescriptions for habitat improvements prior to the completion of the hydraulic modelling and the development of an optimal instream flow strategy through the Water Use Plan.

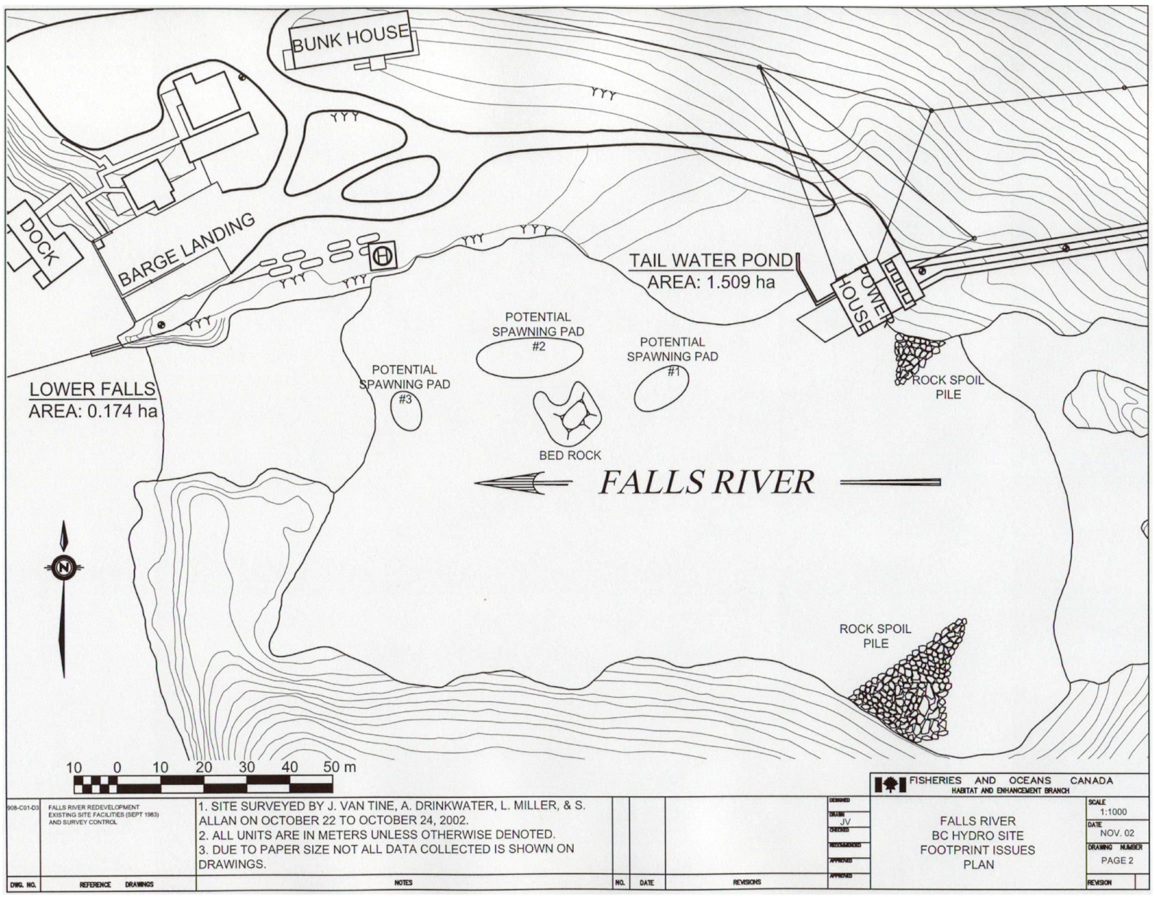

Figure 5: Falls River site plan with proposed spawning platforms

A note about minimum flow

Currently, the minimum fish flow in Falls River is 1.3 cms. It appears that this number may have been derived from historic leakage through the dam structure, which was estimated to be 1.2 cms (Wilson, 1991). In this report, Wilson described that the 1992 site rehabilitation project would eliminate this leakage and that a minimum flow release of 1.2 cms from the sluice gates would be released.

A flow of ~ 1.3 cms was observed at low tide during a complete system shutdown on Oct 24th, 2002. When the units were taken offline, water levels and wetted width began to decrease rapidly in the tail pond and lamprey were stranded on the right bank. DFO staff requested an increase in flows to maintain a ‘reasonable’ wetted width. The gates were opened to 0.1m marker on the gate. This amount of water seemed sufficient to temporarily maintain outflows and stabilise the wetted width.

Detailed prescriptions for habitat improvement projects will be outlined in a proposal submission to BC Hydro BCRP by October 1, 2003.

5.0 RECOMMENDATIONS

5.1 Additional Studies

5.1.1 Water Quality

Water quality monitoring throughout the calendar year over a range flows and tide levels should be conducted. Additional measurements of total gas pressure are recommended. Temperature logging should continue and loggers should be downloaded occasionally to ensure proper functioning. This baseline of temperature information will be useful for determining egg development, and to record changes in temperature that may be correlated with flow and tidal innundation. Subgravel water quality measurements would be helpful in determining the potential for egg survival. It has also been suggested that eyed eggs (source to be determined) be placed in yellow Scotty Jordon boxes and buried in the gravel at sites identified as potential spawning platform locations. These particular boxes would allow eggs to develop to hatch without allowing alevins to escape, which would provide an estimate of potential survival at these locations. The possibility of conducting this study is being investigated.
Potential effects of the incinerator on the right bank of the tail pond should be investigated for possible leachates entering the river. The functioning of septic fields on the right bank should also be examined.

5.1.2 Juvenile Sampling

Juvenile sampling should be repeated for a more accurate density estimate – all within one low tide event. This could be accomplished using a 3-pass removal method with minnow traps. Minnow trapping could be combined with seining to increase capture rate. This will provide greater baseline data that can be used to evaluate future habitat improvements such as large woody debris placements.

5.1.3 Adult Sampling

Lack of monitoring and a possible decrease in some stocks have resulted in no recorded observations of spawning salmon in the tail pond since 1987.
Additional snorkelling and angling in the tail pond throughout the months of August and September are recommended in future years to determine if fish are still returning to this system to spawn. SCUBA may be necessary given the low water clarity and potential depth of spawning activity.

5.1.4 Hydraulic Analysis and Hydrology

Additional velocity measurements may be necessary, if the hydraulic modelling is not considered to be adequate for the design of spawning platforms.
A hydrology study of the watershed should be completed. This study is required to assess the operating parameters and effects of changes to the tail water pond. Water levels are

crucial to the reconstruction of spawning areas and juvenile habitat that may be necessary to help re-build previous fish populations. Calibration of discharge gates is needed so that the relationship between gate openings, flow amounts and tail water levels can be determined. An instream flow strategy must be established with practical minimum and maximum flows to assure success of any proposed fish habitat rehabilitation projects.
It is recommended that accurate water flow/water level monitoring of the tail pond be restarted and continued throughout the life of the facility. This information is a vital adjunct to the determination of wetted width, depths and other variables upon which the success of habitat restoration projects will depend.

The effect of rock spoil piles in the tail pond near the base of the main falls should be examined to determine if the resultant disturbances to the flow patterns have negatively impacted spawning habitat such as the historic left bank pink spawning area.

The blasting of the lower falls should be investigated to determine if the invert of the falls was lowered from its original height, thereby decreasing the height at which tidal events innundate the tail pond and increasing the duration of backwater events.

5.2 Proposed Projects

Pilot spawning platforms are recommended to help re-establish healthy populations of chinook salmon, with possible projects for pink and chum in future years (see Figure 5 on page 18 and Appendix C).
There may be a need to re-start salmon populations in Falls River, if fish do not re-colonise created habitat on their own. This could involve a combination of techniques such as adult transfer and holding or artificial instream incubation methods.

Large woody debris and boulder placements are recommended to improve rearing habitat for juvenile salmonids.

Possible removal or adjustment of the rock spoil piles in the tail pond may be necessary to return flow patterns to their previous state, if they are negatively impacting spawning habitat.

Planting and maintenance of vegetation on the right bank of the tail pond is recommended for the benefit of fish and other aquatic life.

If the invert of the lower falls has been lowered, the feasibility of returning the falls to its original height may be explored.

Any proposed works must incorporate potential effects of future BC Hydro upgrades/changes to the existing generating station. Changes to velocities and/or flow patterns may influence the success of fish habitat rehabilitation projects.

5.3 Evaluation and Monitoring

All fish habitat restoration projects will have monitoring plans to evaluate their success. This highlights the importance of acquiring baseline data in order to effectively measure changes to fish populations and their habitat.

Detailed prescriptions for habitat improvement projects will be outlined in a proposal submission to BC Hydro BCRP by October 1, 2003.

ACKNOWLEDGEMENTS

The North Coast Resource Restoration Unit of Fisheries and Oceans would like to thank the BC Hydro Fish and Wildlife Bridge Coastal Restoration Program for funding this study. Their patience and courtesy in recognizing the difficulties of working in a remote site is appreciated. Local BC Hydro staff, and in particular, the on-site electrician Ron Bullock, were also very helpful in assisting with planning, safety issues, travel to and from the site, equipment loans, lodging and general hospitality. Ron Bullock was also an excellent source of information regarding the operation and history of the Falls River hydroelectric facility. Vancouver-based BC Hydro staff were also of great assistance, helping develop safety plans, First Nations contacts and providing information and equipment when necessary. Alf Leake (BC Hydro) assisted in survey data collection and is producing the hydraulic analysis that is critical for this study and for the Water Use Plan.
Adam Lewis of ECO*fish* provided advice, contacts, references and technical assistance.

Various DFO sectors including Fish Management, Stock Assessment and Conservation and Protection assisted with data gathering, travel to the site and relevant information. DFO Resource Restoration staff on Vancouver Island also provided important reference material and technical advice regarding potential habitat rehabilitation projects on systems impacted by hydroelectric facilities.

Jeff Lough of the BC Ministry of Water Land and Air Protection (MWLAP) provided letters of support and air photo mosaics of the upper watershed.

Barry Drees from the Prince Rupert Salmonid Enhancement Society (PRSES) and Jim Hellman of the Community Fisheries Development Center (CFDC) and PRSES assisted with data collection and provided some historical enhancement information. Scott Allen of CFDC provided a letter of support.

Lax Kw'Alaams will be an important partner in this project, and although many obstacles prevented a site visit during the fall of 2002, we look forward to their involvement in the future.

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APPENDIX A

FINANCIAL STATEMENT

Note: *The entire budget of $5000.00 has been spent and final expenses have been entered into our financial system, however, the system does not yet reflect the final expenses. An updated financial statement will be forwarded to the BC Hydro BCRP Program Manager upon receipt.*

Report: ALYD100E

FY: 2002-2003

Fiscal Period: 8

Date: 20/11/2002
Time: 04:21 PM

Assets and Liabilities
DETAILED TRANSACTIONS
by Responsibility Centre, Project, Allotment and Line Object
Report as of November 20, 2002

REGION: Pacific

RESPONSIBILITY CENTRE: 5G400 Area Chief, Habitat and Enhancement, BC North Coast

PROJECT: 58624

Vendor Name	Invoice Number	Transaction Description	PO Number	Invoice Date (dd-mm-yyy	Bus. Line	Allot Code	Lobj Code	Invoice Amount
		Distribution for receipt 53090274G.	53090274G		440	760	3239	(5,000.00)
		TOTAL LINE OBJECT: 3239 SPA-Miscellaneous Accounts - Credit						(5,000.00)
BETTY MAH	09-OCT-02PC	Betty Mah - 28-Aug-02 - 09-Oct-02PC October 22, 2002 Independent Industrial - Safety Line belts - D. Hjorth		28-08-2002	440	760	3339	30.89
BETTY MAH	04-NOV-02PC	Betty Mah - 22-Oct-02 - 04-Nov-02PC Alisha Drinkwater Expense Claim - Restoration Survey @ Falls River BC Hydro site - Oct. 22-24/02		22-10-2002	440	760	3339	33.31
		INDEPENDENT INDUSTRIAL//HJORTH DONALD//Safety line for survey boat//MASTER CARD			440	760	3339	88.38
		CANADA SAFEWAY #078//VAN TINE JAISON//Camp food - 6 people 3 days//MASTER CARD			440	760	3339	249.40
		VANC ISLAND HELICOPTER//MILLER LANA RENE//Charter Seal Cove/Falls River//MASTER CARD			440	760	3339	1,713.16
		HARBOUR AIR//VAN TINE JAISON//Air Charter Seal Cove/Falls R.//MASTER CARD			440	760	3339	596.00
		SKEENA PROJECT SERVICES L//HJORTH DONALD//Falls Crk maps//MASTER CARD			440	760	3339	20.90
		SKEENA PROJECT SERVICES L//HJORTH DONALD//Falls Crk maps//MASTER CARD			440	760	3339	16.50
		SKEENA PROJECT SERVICES L//HJORTH DONALD//Falls Crk maps//MASTER CARD			440	760	3339	10.26
		HARBOUR AIR//VAN TINE JAISON//Air charter Seal Cove/Falls R.//MASTER CARD			440	760	3339	381.60
		HOME WARES//MILLER LANA RENE//Cable & clamps//MASTER CARD			440	760	3339	12.96
		HARBOUR AIR//VAN TINE JAISON//Air charter Falls River//MASTER CARD			440	760	3339	441.60
		CANSEL//VAN TINE JAISON//Survey gear//MASTER CARD			440	760	3339	472.82
		TOTAL LINE OBJECT: 3339 SPA-Miscellaneous Accounts- Debit						4,067.78
		TOTAL ALLOTMENT: 760 Miscellaneous Project Deposits						(932.22)

This report provides a listing of all year-to-date assets and liabilities by Responsibility Centre, Project, Allotment and Line Object.

Filter used to generate Report: NBX.PRJ_CODE = '58624'

Report: ALYD100E

FY: 2002-2003

Fiscal Period: 8

Assets and Liabilities
DETAILED TRANSACTIONS
by Responsibility Centre, Project, Allotment and Line Object
Report as of November 20, 2002

Vendor Name	Invoice Number	Transaction Description	PO Number	Invoice Date (dd-mm-yyy	Bus. Line	Allot Code	Lobj Code	Invoice Amount
REGION: Pacific								
RESPONSIBILITY CENTRE: 5G400 Area Chief, Habitat and Enhancement, BC North Coast								
TOTAL PROJECT: 58624 BC HYDRO-L.MILLER								(932.22;
TOTAL RESPONSIBILITY CENTRE: 5G400 Area Chief, Habitat and Enhancement, BC North Coast								(932.22)
TOTAL REGION: Pacific								(932.22;
							Grand Total:	(932.22)

This report provides a listing of all year-to-date assets and liabilities by Responsibility Centre, Project, Allotment and Line Object.

Filter used to generate Report: NBX.PRJ_CODE = '58624'

APPENDIX B

SUMMARY OF SALMON STREAM SPAWNING REPORTS

(1947-2001)

Summary of Salmon Stream Spawning Reports (BC 16' s)

STREAM ID		Watershed Code		40-0100-080 (43-1200 up to 1991)				Area 4
		Gazetted name		Big Falls Creek				Subdistrict - Lower Skeena
		First local name		Falls River				
YEAR	**Dates inspected**	**Method**	**Reliability**	**Pink**	**Chum**	**Chinook**	**Predation**	**Observer/recorder**
OPTIMUM ESCAPEMENT PER SPECIES				500	100	75		
1991-2001	No inspections							
1990	12, 25 Sep	heli	4	0	0	0		Dave Einarson
1989	25-Aug, 5, 24 Sep	heli	3	0	0	0		Dave Einarson
1988	5-Sep	heli	2	0			seals	Dave Einarson
1987	9-Sep	walk	2	50	0	0		Barry Rosenberger (BR)
	Spawning in tail end of pool; area inspected thru-out season by locals							
1986	Not inspected by DFO							Barry Rosenberger (BR)
	Escapement info is gathered from BC Hydro staff living on site							
1985	Not inspected by DFO							local residents (BR)
	CN holding below dam to tidal falls before moving up Ecstall. No active spawning observed							
1984	Not inspected by DFO						seals	BC Hydro caretaker
	No signs/indications of spawning salmon by mid-Sep.							(R. Sjolund)
	Low water and freezing Nov/Dec							
1983	Not inspected by DFO			50		0		BC Hydro staff (BR)
	CN obsv' d holding on gravel near entrance in Aug - no spwng obsv' d							
1982	Aug 12-14, 24, 25, Sept 8					21	seals	Fisheries staff under study
	Historically good PK producer, v. little change in CN escapements							by BC Hydro staff on site and
	over the yrs; spawning habitat - erosion effected by opening of							biologist (BR)
	power dam gates							
1981	Periodically all season					27		BC Hydro consultant on site
	Spawning at tailrace, base of falls & gravel bar immed d/s of falls.							
	Comprehensive study & spawning observations were conducted by biological consultants (D.B. Lister and Associates). Water levels vary from very high to very low (BC Hydro).							
1980	Missing stream summary sheet							
1979	11-Sep	heli				25		P.C. Harvey
	13-Sep	river boat						(illegible)
	Limited spawning below dam at base of falls and gravel bar immed d/s falls							
1978				N.O.		N.O.		P.C. Harvey
	Spawn location same as above							
1977				N.O.		N.O.	light predn	T.B. Panko
	Spawn location same as above							
1976	No date given	Once by heli		N.O.		N.O.	light predn	DR Ross
	Spawn location same as above. Extremely limited spawning are below dam; possibility for enhancement almost nil							
1975	No date given	Twice by air		N.O.		N.O.	light predn	P.C. Harvey
	Spawn location same as above. May be possible site for installation of incubation boxes because of hydro facilities							
1974	No date given	Twice by air		N.O.		N.O.	minor predn	P.C. Harvey
	Spawn location same as above. Extremely limited spawning area below dam							
	Recommend including escapement figures in rpt for Ecstall River in future							
YEAR	**Dates inspected**	**Method**	**Reliability**	**Pink**	**Chum**	**Chinook**	**Predation**	**Observer/Recorder**

1973	Twice by aircraft, once by river boat	50		20	N.O.	L.S. Freeman
	Spawn location same as above. Due to limitiation of this stream and available spawning are d/s of falls and dam, potential for improved escapements or enhancement activities are almost nil					
1972	31-Aug	N.O.		50	N.O.	L.S. Freeman
	CN observed immed. below dam/ v. limited spawning area on this stream					
1971	Twice by aircraft, once by river boat	N.O.	N.O.	N.O.		L.S. Freeman
	Extremely limited spawning area immed below falls					
1970	10-Sep	N.O.	N.O.	N.O.	Nil	P.C. Harvey
	Extremely limited spawning area immed below falls					
1969	Aug 23, Sep 12,17,23	N.O.	1-300	1 to 50	Nil	G.W. Lowdon
	Limited spawning area below dam, distribution of spawning salmon is sparse flows normal, high during heavy Aug rains					
1968	Aug 24, Sept 8, 18	300-500		50-100	Nil	G.W. Lowdon
	Limited spawning area below dam, distribution of spawning salmon is sparse					
1967	Aug 23, 30, Sep 11	100-300	1 to 50	N.O.	Nil	Not recorded
	Only one area of spawning gravel below dam, approx. 2500 sq. yds; distribution of spawning salmon is sparse, flows high					
1966	Aug 29, Sept 11	1 to 50	N.O.	1 to 50	Nil	E.T. Kasmer (EK)
	Only one area of spawning gravel below dam, remainder of stream too silty and tidally affected. Very few fish reported from year to year.					
1965	Not inspected by DFO	300-500	100-300	1 to 50	N.R.	Rpt by powerhse staff (EK)
1964	28-Sep	1 to 50		1 to 50	N.O.	V.H.B. Giraud (VG)
	Spawning in big pool below falls, flows high after mid-Sept					
1963	2-Sep-22	500-1000				V.H.B. Giraud
	Spawning below falls, flows normal to high					
1962	12-Sep	1 to 50		1 to 50	N.O.	V.H.B. Giraud
	Spawning in pool below falls, flows normal					
1961	Periodically by patrolman T. Hnilica	50-100		1 to 50	N.O.	T. Hnilica (VG)
	Spawning on bars below falls, flows normal					
1960	Periodically by patrolman T. Hnilica	1 to 50		50-100	N.O.	T. Hnilica (VG)
	Spawning on bars below falls, flows above normal					
1959	Periodically by patrolman T. Hnilica	300-500		1 to 50	N.O.	T. Hnilica (VG)
	Spawning on gravel bars below falls, flows above normal					
1958	12-Sep	100		50	seals	W. Strachan
	Small spawning area on gravel bar below falls at powerhse, flows high,					
1957	Aug, Sep, Oct	50-100			Nil	D.E. MacIntyre
	Approx. 300 yds of avail. spawning gravel in this stream, only minor spawning takes place yearly, 300 yds from mouth of stream to dam, flows normal					
1956	Aug 31, Sep 13	50			seals	W. Strachan
	Spawning on gravel bar below falls at powerhse, flows normal					
1955	9-Sep	1000 to 2000		50-100	seals	W. Strachan
	Spawning on gravel bar below falls at powerhse, flows high					
1954	Aug 27, Sept 7, 18	500			seals	W. Strachan
	Spawning on gravel bar below falls at foot of powerhse, flows high					
1953	Aug 12, Sep 12, Oct 6	300-500			seals	P.J. Sims
	Possible some loss of spawning beds when power dam sluice gates opened, due to turbulence; flows normal - controlled by dam; spawning evenly on available gravel - approx 300 yds at base of falls, spawning beds close to power plant, some fish damaged by seals. No serious ice condition as tide water and power plant overflow covers gravel. Good deep deposit gravel. Water not polluted. Parts of gravel bed					

show dry 2-3 ft during periods of low tides and dry weather when gates closed at the dam.

YEAR	Dates inspected	Method	Reliability	Pink	Chum	Chinook	Predation	Observer/recorder
1952	9-Sep			500-1000			seals	W. Strachan
	Flows normal, additional note in pencil to check pink estimate of 500-1000							
1951	2-Oct			300			seals, trout	W. Strachan
	Flows normal							
1950	25-Sep			200			trout	W. Strachan
	Just below falls on gravel bar, flows normal							
1949	1-Sep-16			1000			seals, trout	W. Strachan
	Pink spawn on gravel bar below the falls, flows normal							
1948	19-Sep			300-500			trout	W. Strachan
	Even distribution of spawners, flows low							
1947	Not recorded			500-1000				W. Strachan
	Spawning about the same as in cycle year 1945							

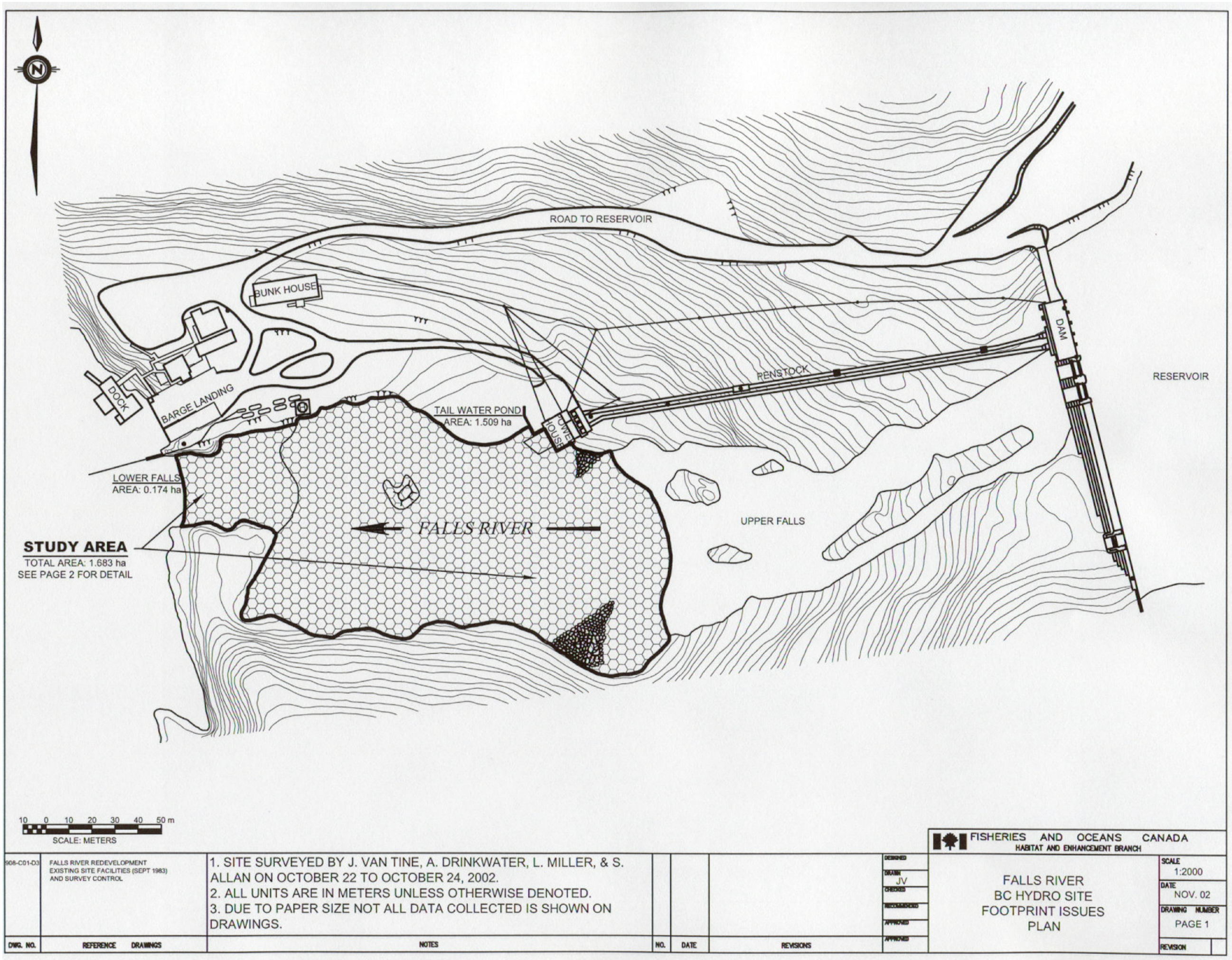
Range of Timing for Chinook, Pink and Chum

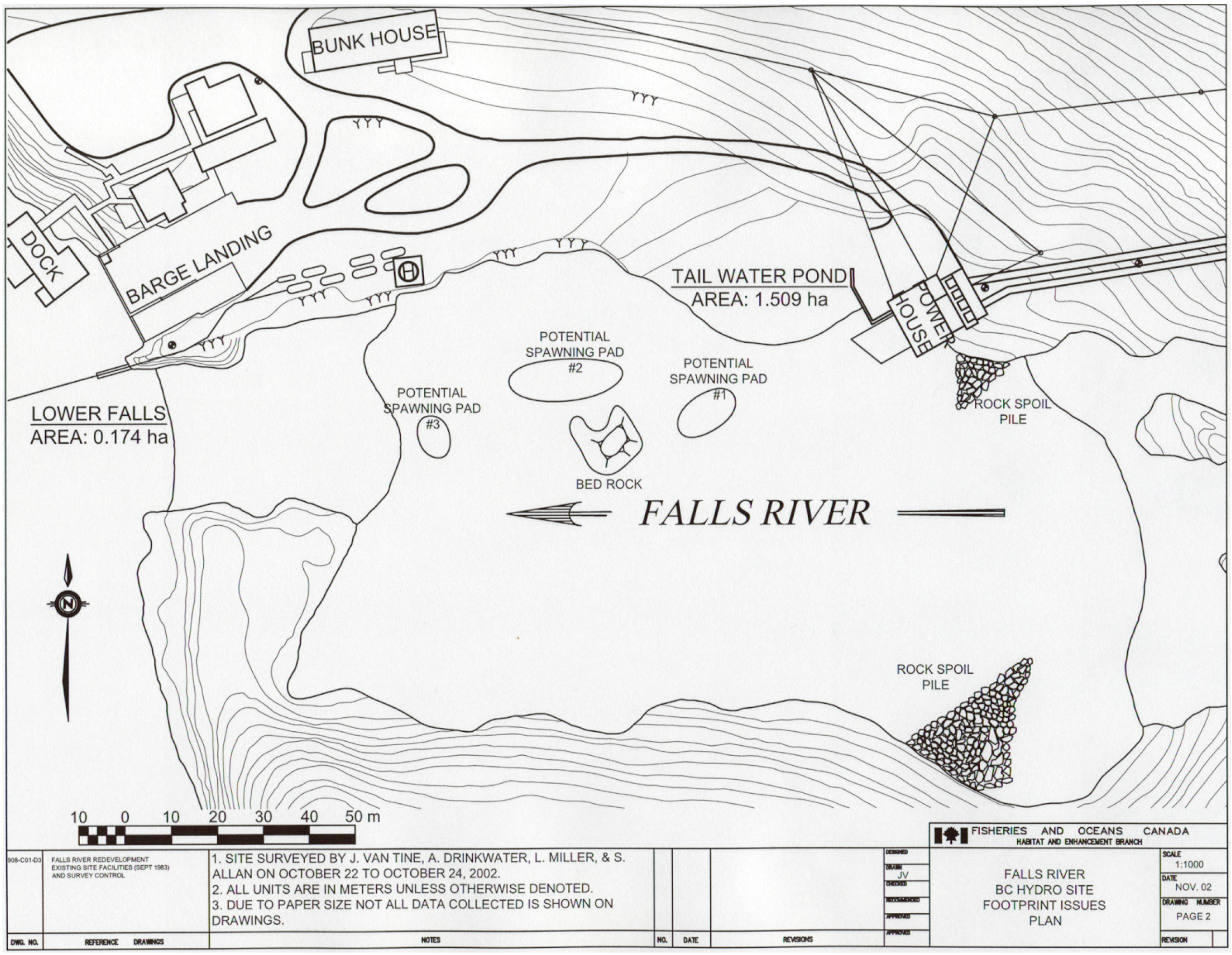
	Chinook	Pink	Chum
Arrival in stream	Early Aug - Aug 15	15-Aug	
Start of spawn	Early Aug - Sep 5	Aug 10 - Sep 5	16-Aug
Peak of spawn	Late Aug - Sep 15	Late Aug - Sep 20	30-Aug
End of spawn	Early Sep - Oct 31	Early Sep - Oct	

Abbreviations
Reliability = low 1 2 3 4 5 high
N.O. = none observed
N.R. = none recorded

APPENDIX C

STUDY AREA AND SITE PLAN DRAWINGS


ROAD TO RESERVOIR
BUNK HOUSE
DOCK
BARGE LANDING
TAIL WATER POND
AREA: 1.509 ha
PENSTOCK
DAM
RESERVOIR
LOWER FALLS
AREA: 0.174 ha
STUDY AREA
TOTAL AREA: 1.683 ha
SEE PAGE 2 FOR DETAIL
FALLS RIVER
UPPER FALLS
10 0 10 20 30 40 50 m
SCALE: METERS
908-C01-D3
FALLS RIVER REDEVELOPMENT
EXISTING SITE FACILITIES (SEPT 1983)
AND SURVEY CONTROL
1. SITE SURVEYED BY J. VAN TINE, A. DRINKWATER, L. MILLER, & S. ALLAN ON OCTOBER 22 TO OCTOBER 24, 2002.
2. ALL UNITS ARE IN METERS UNLESS OTHERWISE DENOTED.
3. DUE TO PAPER SIZE NOT ALL DATA COLLECTED IS SHOWN ON DRAWINGS.
DWG. NO.
REFERENCE DRAWINGS
NOTES
NO.
DATE
REVISIONS
DESIGNED
DRAWN
JV
CHECKED
RECOMMENDED
APPROVED
APPROVED
FISHERIES AND OCEANS CANADA
HABITAT AND ENHANCEMENT BRANCH
FALLS RIVER
BC HYDRO SITE
FOOTPRINT ISSUES
PLAN
SCALE
1:2000
DATE
NOV. 02
DRAWING NUMBER
PAGE 1
REVISION



BUNK HOUSE
DOCK
BARGE LANDING
TAIL WATER POND
AREA: 1.509 ha
POWER HOUSE
POTENTIAL SPAWNING PAD #2
POTENTIAL SPAWNING PAD #1
POTENTIAL SPAWNING PAD #3
ROCK SPOIL PILE
LOWER FALLS
AREA: 0.174 ha
BED ROCK
FALLS RIVER
N
ROCK SPOIL PILE
10 0 10 20 30 40 50 m
FISHERIES AND OCEANS CANADA
HABITAT AND ENHANCEMENT BRANCH
908-C01-D3
FALLS RIVER REDEVELOPMENT EXISTING SITE FACILITIES (SEPT 1983) AND SURVEY CONTROL
1. SITE SURVEYED BY J. VAN TINE, A. DRINKWATER, L. MILLER, & S. ALLAN ON OCTOBER 22 TO OCTOBER 24, 2002.
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3. DUE TO PAPER SIZE NOT ALL DATA COLLECTED IS SHOWN ON DRAWINGS.
DESIGNED
DRAWN JV
CHECKED
RECOMMENDED
APPROVED
APPROVED
FALLS RIVER
BC HYDRO SITE
FOOTPRINT ISSUES
PLAN
SCALE 1:1000
DATE NOV. 02
DRAWING NUMBER PAGE 2
DWG. NO.
REFERENCE DRAWINGS
NOTES
NO.
DATE
REVISIONS
REVISION