Aberfeldie Project Water Use Plan

Monitoring Program Terms of Reference

- **ABFMON#4 - Monitoring of Winter Habitat Maintenance Flows**

August 25, 2009

Monitoring Program ABFMON-4
Monitoring of Winter Habitat Maintenance Flows

1.0 Overview

This document presents Terms of Reference for the monitoring programs for the revised Aberfeldie Water Use Plan, which was completed as part of the Aberfeldie Redevelopment Project. These programs will monitor outcomes of the recommended operations for the redeveloped facility to ensure that mitigation and compensation targets associated with the Aberfeldie Redevelopment Project have been met, and will provide information on which to base future operating decisions for the redeveloped Aberfeldie facility. This document provides detailed Terms of Reference for the following program:

> ABFMON#4 - Winter Flow Effectiveness Monitoring: A one year monitoring program to assess the effectiveness of the winter flow provisions in the canyon reach of the Bull River located between the dam and the first upstream barrier from the generating station.

Table 1 Aberfeldie Water Use Plan Physical Works and Monitoring Program Terms of Reference Submission Information

Name of Monitoring Program or Physical Works	Order Clause Fulfilled	Previously Submitted To CWR	Previous Submission Date	Leave to Commence	Re-Submission Date
ABFMON-4 Winter Flow Effectiveness Monitoring	Clause 6(d)	Yes	31 March 2008	Yes	15 Sep 2009

Monitoring Program ABFMON-4
Monitoring of Winter Habitat Maintenance Flows

2.0 Monitoring Program Rationale

2.1 Background

Low winter flows downstream of the Aberfeldie Dam[1] were a key issue addressed by the Aberfeldie Water Use Plan. The reconvened Aberfeldie Consultative Committee (CC) identified ecological connectivity and possible freezing of refuge habitat in the canyon and diversion reach between the dam and generating station during the winter months as an issue that could impact overwintering fishes entrained into this section of the Bull River.

Two studies were undertaken as part of the original Water Use Plan (WUP) to better address the uncertainty surrounding the adequacy of winter flows on fish survival in the canyon between the dam and the generating station (Cope 2003, Bisset and Cope 2003). These studies suggested that leakage flows of approximately 0.05 m^3/s, combined with deep pool refuge habitat, were sufficient to support mountain whitefish (*Prosopium williamsoni*) and Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) overwintering between the dam and the first barrier upstream from the generating station (Figure 1). It was felt, however, that there was very little margin for safety given the limited flows, restricted habitat connectivity and general lack of information on fish use and fish habitat within the Aberfeldie canyon and diversion reach. Accordingly, a fish habitat-flow study was commissioned by BC Hydro as part of the planning for the Aberfeldie Redevelopment Project to assess fish habitat and pool connectivity at flows between 0.25 and 5.0 m^3s^{-1} [2](Bisset and Cope 2003). Results suggested that the canyon may function as overwintering habitat for fish entrained over the dam (mountain whitefish, Westslope cutthroat trout, kokanee, *O. nerka*, and torrent sculpins, *Cottus rhotheus*).

The 0.25 and 5.0 cms flows were selected as the possible range of potential instream flow recommendations. Based on the outcome of that study, the reconvened Aberfeldie WUP CC recommended the provision of a minimum flow of 0.25 cms to be delivered to the Bull River between the dam and generating station between December 1 and March 31 of each year to ensure adequate overwinter and spawning habitat for resident and entrained fish.

The WUP CC recognized, however, that a key uncertainty was the extent to which low winter flows affect suitability and availability of overwintering fish habitat and fish survival immediately downstream of the dam. It therefore recommended additional field observations to confirm the effectiveness of these flows as habitat maintenance during sustained periods of cold weather in winter.

[1] Although only the Aberfeldie dam and canyon and Bull River diversion reach are mentioned, the intent of the present study stems from studies to monitor fish winter habitat in Spillimacheen, Elko and Aberfeldie diversion reaches. The winter leakage flows from the Spillimacheen and Elko dams are above 1.0 $m^3 \cdot s^{-1}$ (D. Den Biesen, Natural Resource Specialist, BC Hydro, pers. comm. 2008) and are therefore above the minimum flows requirement.

[2] m^3s^{-1} and cms are used interchangeably throughout.

During the fall and winter when inflows to the headpond are less than plant capacity and not spilling, flows in the river channel between Aberfeldie Dam and the powerhouse tailrace outlet are restricted through the dam and minimal groundwater input. As stated above, the minimum acceptable release through the environmental bypass valve on the dam is currently 0.25 m^3s^{-1} from December 1 to March 31.

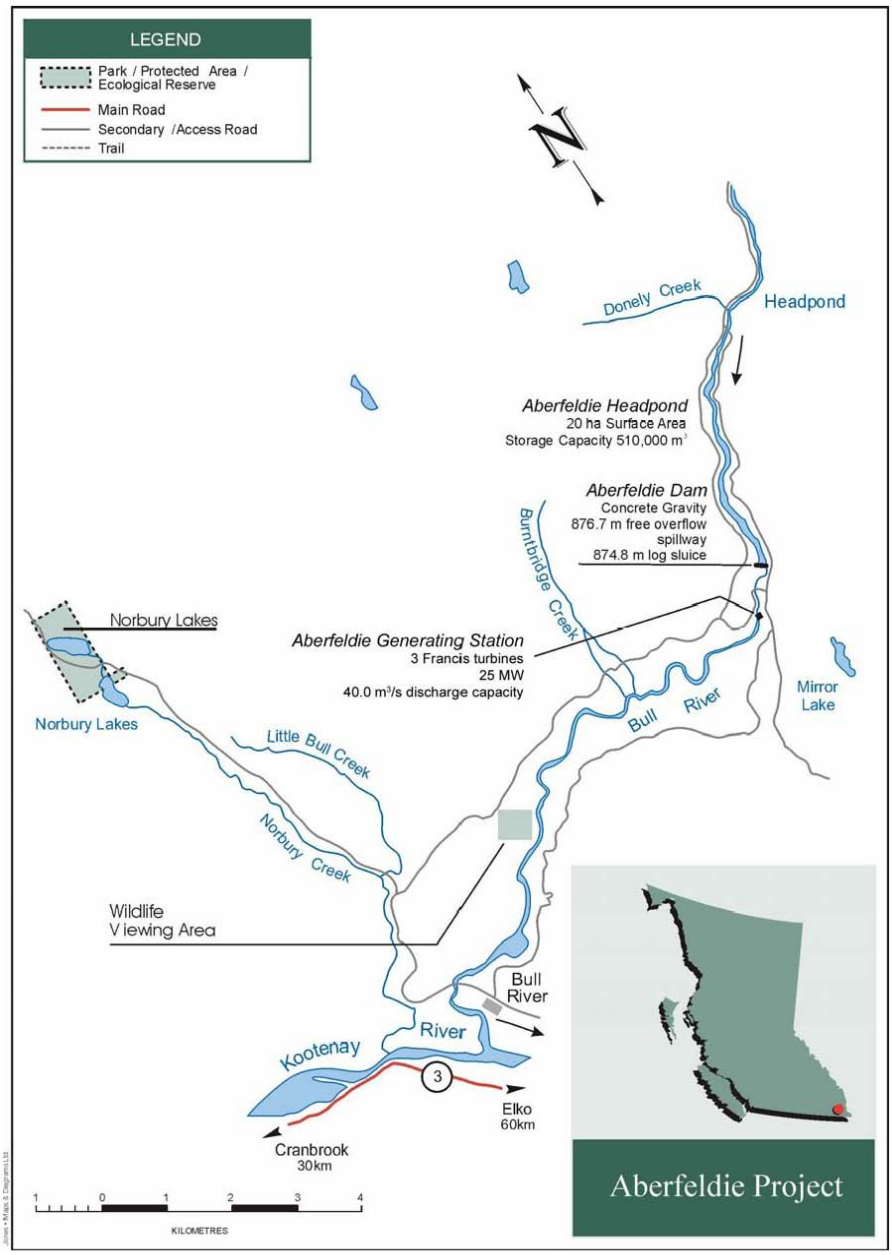

Figure 1: Geographic location of Aberfeldie Hydroelectric Generating Facility.

2.2 Management Questions

The fundamental goal of the monitoring program is to reduce uncertainty related to the adequacy of the 0.25 m^3s^{-1} minimum flow releases as overwinter habitat during sustained cold weather conditions. Such conditions may result in the formation of anchor ice and or obstruction of water movements among habitats. The primary management questions for the monitoring program specific to the overwintering period are:

1) Do the 0.25 m^3s^{-1} minimum flows during the overwintering period prevent the use of riffle habitat by fish in the Bull River diversion reach [1]?
2) Do the 0.25 m^3s^{-1} minimum flows during the overwintering period reduce pool habitat connectivity in the Bull River diversion reach?
3) Are changes in overwinter habitat conditions linked to minimum flows likely to negatively impact survival of overwintering fish populations?

2.3 Management Hypotheses

The hypotheses to be tested by the monitoring program are:

H_{oA}: The 0.25 m^3s^{-1} minimum flow releases are adequate to maintain flow connectivity within the diversion reach during extended periods of low air temperatures and per force, to maintain suitable overwinter fish habitat.

H_{oB}: The 0.25 m^3s^{-1} minimum flow releases are adequate to maintain fish overwintering habitat requirements as defined by temperature and depth within the diversion reach during extended periods of low air temperatures.

The alternate hypotheses are:

H_{1A}: The 0.25 m^3s^{-1} minimum flow releases are not adequate to maintain flow connectivity within the diversion reach during extended periods of low air temperatures.

H_{1B}: The 0.25 m^3s^{-1} minimum flow releases are not adequate to maintain fish overwintering habitat requirements within the diversion reach during extended periods of low air temperatures.

These hypotheses will be tested by monitoring water temperature over the winter period to assess changes in available water depth due to ice relative to known or assumed requirements for fish previously sampled in the Bull River diversion reach.

2.4 Key Water Use Decision Affected

The key water use decision affected by results of the monitoring program is the magnitude of the minimum flow release from the bypass valve at Aberfeldie Dam. This decision has implications for ecological and power generating values. The diversion reach is viewed as providing potential overwintering habitat for mountain whitefish, Westslope cutthroat trout, kokanee and torrent sculpins that are restricted to the channel during the winter low flow period. Alternatively, releasing additional

water from the dam will reduce the amount of water available for power generation. Results of this program will help to select a long-term minimum flow release from Aberfeldie Dam during the next review of the Water Use Plan (WUP).

3.0 Monitoring Program Proposal

3.1 Objective and Scope

The objective of the monitoring program is to confirm the effectiveness of the current minimum flow releases of 0.25 m^3s^{-1} from the environmental bypass valve in maintaining suitable habitat for overwintering fish in the Bull River diversion reach.

The study will be conducted in the Bull River diversion reach. It will consist of measuring habitat values related to habitat connectivity and species-specific suitability.

3.2 Approach

The monitoring program will involve conducting indirect field observations and measurements of fish habitat conditions as a function of water depth as affected by sustained periods of cold weather and ice in winter in the Bull River diversion reach.

Note that the approach originally recommended was to monitor local weather conditions and conduct field inspections when ice formation was likely to occur. The Fisheries Technical Committee had defined a minimum threshold for 'sustained cold weather conditions' as five consecutive non-spill days with a daytime high of -7.5 °C or colder without prolonged spill. It was anticipated that these conditions would be experienced at least once within a three year period. Multiple surveys were then to be conducted to follow the progression of ice development. This temperature trigger has since been judged to be inefficient and has been removed from the present Terms of Reference. Reasons for this deletion include the impossibility to correlate temperatures with ice formation or thickness, the lack of corroboration for such a trigger in the peer–reviewed or grey literatures, logistic problems in adequately monitoring *in situ* air temperature, and general safety considerations (Westslope Fisheries, 2008).

BC Hydro further realizes that winter conditions may be hazardous and emphasizes a safety first approach to field work. Direct methods of measuring fish habitat would involve monitoring ice thickness in selected pools and riffles and monitoring fish condition during that time. However, a study in Aberfeldie canyon stressed the negative aspects of such endeavour[3] and direct observations in the canyon during winter have been ruled out for the time being.

[3] "Subsequent canyon sampling during the Aberfeldie Redevelopment Project in 2004 and 2005 re-enforced our reluctance to work under these conditions and in this winter environment…This caused serious worker discomfort and safety concerns, as sampling requires an individual to establish transects and work within the stream channel. Climbing back out of the canyon under these conditions was extremely difficult and staff expressed "never again" sentiments. Falls and spills resulted in damaged equipment and bruises but no serious injuries. It was recognized that a two-person crew would be incapable of self-rescue if something went wrong." (Westslope Fisheries 2008, p. 2, 3rd paragraph)

Fish overwintering habitat will only be assessed indirectly. Acoustic tags were considered to track fish during winter but their use was deemed problematic under winter conditions commonly encountered in the canyon (Eric Munday and Jim Dawson, BioSonics Inc, pers. comm., June 30, 2009). Habitat connectivity through dye releases was also considered but dye travel time and concentration may be affected by frazil ice (likely to be present in the canyon) and the results would be inconclusive (Gary VanDer Vinne, Northwest Hydraulic Consultants, pers. comm., Nov. 24, 2008).

3.3 Methods

3.3.1 Task 1: Project Coordination

Project coordination involves the general administrative and technical oversight of the program. This will include but not be limited to: 1) budget management, 2) staff selection, 3) logistic coordination, 4) technical oversight in field and analysis components; and 5) liaison with regulatory and other interested parties, as required.

3.3.2 Task 2: Office and field work

At least two tasks are required to implement this monitoring program[4]:

1) Literature review of overwintering requirements of species likely to be present in the Aberfeldie diversion reach, of their passage requirements and of dissolved oxygen concentrations variations in ice-covered pools ;
2) Assessment of overwintering conditions and habitat connectivity

Literature review

A literature review of available peer-reviewed and grey literature will summarize information on the overwintering requirements and passage thresholds of mountain whitefish, Westslope cutthroat trout, kokanee and torrent sculpin. Experts in the field will also be consulted. This will result in a list of abiotic requirements such as minimum water depth (for habitat and passage among habitat units) and temperature for these species. Dissolved oxygen concentration may be a limiting variable for fish overwinter survival; the literature will therefore also be searched for references to variations of dissolved oxygen in ice-covered pools.

Assessment of overwinter fish habitat

Deep pools will be selected within areas potentially accessible to fishes and where installation of monitoring equipment is logistically and safely feasible. Such pools connected by riffles are present and accessible approximately 500 m upstream from the Aberfeldie powerhouse and immediately downstream of the Aberfeldie dam (sites 1 and 3, Bisset and Cope 2003).

Index locations for deployment of long term air and water temperature measuring stations will be representative of the habitat available in the diversion reach based on

[4] Proponents may elect to add to these activities

habitat maps from Bisset and Cope (2003). Where feasible, index locations will be established at sampling sites established during the winter 2002/2003 fish habitat study (Bisset and Cope 2003).

Winter habitat availability and connectivity will be assessed through monitoring of water temperature in deep pools and in connectors before onset of winter conditions and during winter. Water temperature will be measured as a surrogate of ice presence: temperatures below 0 ˚C will be taken to be representative of ice formation (while pure freshwater usually freezes at 0 ˚C, impurities in the water will decrease its freezing point. This is therefore a conservative target; sea water of 30 ppm typically freezes at -2 ˚C – Adkins et al. 2002).

Temperature data loggers will be installed before onset of ice formation in pools at fixed depth intervals from the surface to the bottom and in connectors. Water depth will also be measured and mapped at several points (the exact number of samples being dependent of logistics) in pools and connectors. An inventory of habitat area, water depth and wetted width (measured at 3-5 points along the channel centerline / thalweg) will be conducted at each index location. These measurements will be related to water flows.

Transducers may also be installed, depending on the logistics involved (probability of retrieval, etc.). While transducers will not measure ice thickness, they may provide an independent measure of water levels in pools. The data loggers will be retrieved each year in the spring to determine the range of water temperatures experienced in the diversion reach at various depths.

Local daily weather reports will be monitored and correlated to *in situ* temperature data loggers.

Daily river discharge estimates for the diversion reach will be derived from : 1) Water Survey of Canada Station Bull River (Station 08NG002), and 2) B.C. Hydro Power Records.

Expected results

Temperature data will approximate maximum ice thickness in deep pools and in connectors in function of released flows. Overwinter habitat connectivity will be related to average water temperature in connectors. The difference between connector depth and ice layer depth in pools will be assumed to approximate overwinter connection depths. e.g., water temperatures consistently below 0 ˚C at 0.1 m in pools will be assumed to represent ice formation and lack of connectivity in adjacent connectors of average depth < 0.1 m.

The degree to which average connector depth allows fish passage (based on the literature review for different species requirements) will define the effectiveness of the 0.25 cms winter flow release.

Furthermore the results will indicate whether deep pools can provide suitable conditions for viable overwinter fish habitat based on the literature review and under minimum flow conditions.

3.3.3 Task 3: Data Entry

The proponent will ensure that the databases used for data entry (biophysical variables, GIS measures, etc.) are compatible with BC Hydro's databases. A photographic database will also be provided of the sites with suitably descriptive titles, tags and keywords.

3.3.4 Task 4: Reporting

The report will justify site selection and adoption of the methods. Emphasis will be on how the chosen methods address the management questions. The report will also summarize available information on fish overwintering requirements and habitats in the study area.

As this is a one year study, there are no progress reports necessary. The final report will follow the standard format developed for WUP monitoring programs and will be submitted by June 30, 2010. It will include:

- an executive summary of the project of not more than 300 words;
- description of data collection methods;
- detailed summary of the findings as they relate to the management questions;
- raw data, to be provided in an Excel spreadsheet or other suitable format acceptable to BC Hydro;
- hard copy and digital maps, in an acceptable format, showing the area topography, sampling sites and summarizing stranding risk.

All reports will be provided in hard-copy and as Microsoft Word and Adobe Acrobat (PDF) format, and all maps and figures will be provided as embedded objects in the Word file and as separate GIS files or photographs (JPEG or TIFF). Photographs will be embedded in the final report and also provided separately in a searchable photography database with suitable titles, keywords and tags. Minimum resolution for photographs in the database should be 2816 × 2112 pixels.

3.4 Interpretation of Monitoring Program Results

The results from this study will help answer the management questions identified by the Consultative Committee (see Section 1.2). Habitat availability and connectivity will be assessed in consideration of species specific overwintering requirements to determine if the 0.25 cms flow is adequate. Furthermore, the information will eventually be used in conjunction with other Aberfeldie monitoring programs to make a decision regarding the acceptability of the chosen minimum flow regime. If the minimum winter flows are deemed insufficient to protect overwintering fish habitats, the results of the study may lead to increasing the minimum flows to 0.5 cms and to subsequent monitoring to ensure that the measure is effective in protecting overwintering fish habitat in the diversion reach. If the recommended flow is judged to be sufficient to protect fish habitat, the planned review of the water use plan will occur in fifteen years as recommended by the reconvened Consultative Committee.

3.5 Schedule

The monitoring program is expected to last one year, from onset of winter temperatures to their end. The exact timing of field surveys will depend on logistics (low flows are a requirement for the reconnaissance survey and installation of monitoring devices) and on winter conditions.

3.6 Budget

The total estimated budget for the monitoring program is $30,802. This cost estimate includes a 5% contingency.

Literature Cited

Adkins, J.F., K. McIntyre and D.P. Schrag. 2002. The salinity, temperature, and $\delta^{18}O$ of the glacial deep ocean. Science 298: 1769-1773.

Bisset, J.E. and R.S Cope. 2003. Fish and fish habitat resources in the lower Bull, Elk, and Spillimacheen rivers (between dam and powerhouse) during the non-spill period, 2002. Report prepared for BC Hydro.

Cope, R.S. 2003. Fish and Fish Habitat Resources in the lower Bull and Elk Rivers (between dam and powerhouse) during the non-spill period, 2003. Report prepared for BC Hydro by Westslope Fisheries Ltd., Cranbrook, B.C. 7p.

Westslope Fisheries, 2008. Monitoring of habitat maintenance flow within Spillimacheen canyon. Report prepared for BC Hydro