Spillimacheen Water Use Plan

Monitoring Programs Annual Report: 2012

Implementation Period: January 2011 to December 2011

- SPNMON-1 Assessment of Rampdown Rates to Minimize River Stage Change during Plant Outages
- SPNMON-2 Monitoring of Habitat Maintenance Flow within Spillimacheen Canyon
- SPNMON-3 Assessment of Gravel Recruitment

For Water Licences FWL 120903 and FWL 120904

January 31, 2012
1.0 Introduction

This document represents a summary of the status and the results of the Spillimacheen Water Use Plan (WUP) monitoring programs to 31 December 2011, as per the Spillimacheen Order under the Water Act, dated 21 July 2005. There are three monitoring programs:

- Assessment of Rampdown Rates to Minimize River Stage Change during Plant Outages
- Monitoring of Habitat Maintenance Flow within Spillimacheen Canyon
- Assessment of Gravel Recruitment*


2.0 Background

The water use planning process for BC Hydro’s Spillimacheen project was initiated in May 2002 and completed in April 2003. The conditions proposed in the WUP for the operation of the project reflect the 2003 recommendations of the Spillimacheen WUP Consultative Committee (WUP CC).

In July 2005, the Spillimacheen WUP was submitted to the Comptroller of Water Rights (Comptroller).

On 21 July 2005, BC Hydro was ordered to implement the conditions proposed in the Spillimacheen WUP and prepare the monitoring program terms of reference (ToR).

The following table outlines the dates that the Spillimacheen WUP TOR were submitted to, and approved by the CWR:

<table>
<thead>
<tr>
<th>Monitoring Program TOR</th>
<th>Order Clause</th>
<th>Date Submitted</th>
<th>Date Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPNMON-1 Assessment of Rampdown Rates to Minimize River Stage Change during Plant Outages</td>
<td>Clause 3 (a)</td>
<td>7 December 2005</td>
<td>10 January 2006</td>
</tr>
<tr>
<td>SPNMON-2 Monitoring of Habitat Maintenance Flow within Spillimacheen Canyon</td>
<td>Clause 3 (b)</td>
<td>7 December 2005</td>
<td>10 January 2006</td>
</tr>
<tr>
<td>SPNMON-3* Assessment of Gravel Recruitment</td>
<td>Clause 3 (c)</td>
<td>7 December 2005</td>
<td>10 January 2006</td>
</tr>
</tbody>
</table>

* On 7 November 2008, the Comptroller of Water Rights issued a letter stating that the Spillimacheen WUP Implementation Order had been amended by removing the requirement to carry out the gravel recruitment monitoring study.

As outlined in the Spillimacheen WUP, the Spillimacheen WUP CC recommended a review of the WUP within 10 years of its implementation with a possible review at Year 5 if significant new risks are identified that could result in a change to operations.
3.0 Status

The following table outlines the status and schedule for the Spillimacheen WUP monitoring programs:

Table 3-1: Status and Schedule of Spillimacheen WUP Monitoring Programs

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Assessment of Rampdown Rates</td>
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<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
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<tr>
<td>Monitoring of Habitat Maintenance Flow</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessment of Gravel Recruitment</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

Legend: ▶ = Program to be initiated in identified year
☐ = Program initiation delayed
■ = Program to be undertaken in identified year
✔ = Program complete for the year

4.0 Spillimacheen WUP Monitoring Programs

This section outlines the status of the Spillimacheen WUP monitoring program as per the Order under the Water Act, dated 21 July 2005.

4.1 SPNMON-1 Assessment of Rampdown Rates to Minimize River Stage Change during Plant Outages

4.1.1 Management Questions

The key management questions addressed by this monitoring program were:

1) How does rampdown duration during planned/unplanned outages at the Spillimacheen Generating Station influence downstream river stage during the periods of low river flow?

2) Does this rampdown duration negatively impact on fish habitat or fish populations? (i.e., dewater habitat suitable for fish spawning or produce stage changes that are expected to strand fish or deposited eggs.)

4.1.2 Overview

The objective of this monitoring program was to provide information to establish a rampdown procedure for planned generation station shutdowns.

The Spillimacheen WUP CC acknowledged that abrupt stage changes in the Spillimacheen River immediately downstream of the powerhouse as a result of plant outages at the generating station potentially have negative environmental impacts during low flows, when generation discharge is >20% of total river discharge. The primary concerns are impacts of river stage change on mountain whitefish spawning, burbot spawning, and stranding of overwintering fish downstream of the powerhouse. To minimize the potential for fish/egg stranding downstream, the WUP CC agreed that there is a need to assess the effects of a variety of outage sequences on river stage and develop a suitable procedure for rampdown operations. The WUP CC
established a two hour ramping rate for initial monitoring, followed by review of four or six hour ramping rates, if necessary.

Monitoring Indicators  
   a) Absolute stage and discharge changes downstream of powerhouse;  
   b) Observed fish and ova stranding during planned outages;  
   c) Duration (in hours) of habitat dewatered during planned outages.

This monitoring program involved the installation of staff gauges with data loggers, visual field observations of habitat conditions during opportunistic or planned unit shutdowns during the low flow period, and observations of fish/ova stranding.

4.1.3 Status

Ice formation in the forebay and within the plant infrastructure during a winter shutdown prohibit initiating a test during that time period. Therefore, the test was planned for late in the fall to coincide with whitefish spawning but prior to freezing conditions and ice formation.

On 22 October 2009 a two-hour rampdown study was initiated and the monitoring was completed internally with the assistance of a First Nation contract crew.

The final report was completed in May 2010 and the study is now complete.

4.1.4 Interpretation of Data

The main objective of the study was to provide information to establish if the two hours rampdown protocol (duration and rate) for planned generation station shutdowns was acceptable to minimize impacts to fishes downstream of the Spillimacheen Generating Station. Target fish species were burbot (*Lota lota*) and mountain whitefish (*Prosopium williamsoni*), although none were observed during sampling.

The observed ramping rates had no adverse effect on fishes or fish habitat. The study showed that the two hour rampdown was effective in mitigating the effects of a planned power outage to Spillimacheen River fish habitat. There were no indications of dewatering of redds, eggs or alevins in the wetted channel habitat that became temporarily unavailable for fish use during the rampdown; the risk to early fish stages is thus considered minimal. The main stem margins appeared deep enough (> 30 cm of residual depth) and no signs of egg deposition nor of suitable spawning ground were observed in either of the two side channels. No stranded fishes were observed during the project. The residual depth of the side channels remained greater than 25 cm during the rampdown period and barriers to access from mountain whitefish or burbot were deemed unlikely. Therefore, the recommendation is to implement a 2-hour rampdown rate.

The rate and magnitude of changes were however greatest in all measured parameters in the hour following the end of the rampdown period (rampup) although there were no fish stranding observed during the reinstatement of flows.

To stay within Department of Fisheries and Oceans recommended ramping rate of 0.025 m/hr, it is recommended that a rampup rate (rate at which the generating units are restarted into operation after a power outage) of at least 90 min be enforced. No such provision exists at the moment.
4.2 SPNMON-2 Monitoring of Habitat Maintenance Flow within Spillimacheen Canyon

4.2.1 Management Questions

The key management questions addressed by this monitoring program are:

1) Does the 0.85 m$^3$s$^{-1}$ minimum flow prevent the formation of anchor ice in riffle habitats of the Spillimacheen canyon?

2) If anchor ice forms, does the formation of ice reduce pool habitat connectivity in the Spillimacheen Canyon?

3) Are changes in overwinter habitat conditions likely to negatively impact productivity or survival of resident fish populations?

4.2.2 Overview

The objective of this monitoring program is to confirm the effectiveness of the current minimum flow release of 0.85 m$^3$s$^{-1}$ from the gated undersluice for prevention of freeze-up of pool refuge habitat and for maintaining habitat connectivity for fish overwintering in Spillimacheen Canyon.

Low winter flow downstream of Spillimacheen Dam was a key issue addressed by the Spillimacheen WUP. During fall and winter, when inflows to the headpond are less than plant capacity, flows in the river channel canyon between Spillimacheen Dam and the powerhouse tailrace outlet are restricted to releases through the undersluice gate and to dam leakage and minimal groundwater input. The WUP CC recommended that the current minimum acceptable release from the undersluice of 0.85 m$^3$s$^{-1}$ be maintained to ensure adequate overwinter and spawning habitat for resident and entrained fish in the canyon. A key uncertainty associated with this operation is the extent to which lower winter flows affect the suitability and availability of fish habitat and overwinter fish survival within the canyon immediately downstream of the dam. To assess the effectiveness of the minimum flow for preventing the development of anchor ice, it was recommended that additional opportunistic field observations be initiated to confirm habitat maintenance during sustained periods of cold weather during winter. The WUP CC established a monitoring study trigger described as low flow cold weather winter conditions of five days with air temperature less than -10°C and no continuous spilling from Spillimacheen Dam.

Monitoring Indicators: a) Observed formation of anchor ice within Spillimacheen canyon.

b) Maintenance of habitat connectivity (expert opinion based on field observations).

This monitoring program involves continuous water temperature and discharge monitoring, assessment of anchor ice development and photographic documentation of habitat conditions during periods of cold weather and ice formation. The study will collect data associated with the 0.85m$^3$s$^{-1}$ minimum flow to monitor its effectiveness.

4.2.3 Status

BC Hydro issued a request for proposals for this study in August 2006 and held an on-site inspection with prospective contractors on 5 September 2006 to identify monitoring program objectives, expectations, and previously identified safety
concerns associated with winter monitoring. The reviewers assessed the two proposals received, both of which were found to be unsatisfactory as indicated in the 2008 annual report.

The reviewers re-evaluated the ability to conduct the on-ice work safely and were more prescriptive on the methods to achieve the objective of working safely. A local consultant was asked to provide a proposal to address the biological and safety requirements. The consultant had experience working in the Spillimacheen River canyon in support of the consultative process. A modified proposal was accepted and the study was initiated in the fall of 2007. The proposal addressed safety requirements, incorporated innovative methods to address the biological objectives, and included direct First Nation participation.

The consultant established all field monitoring sites and monitoring equipment. In late 2007 a start-up site visit was conducted with the consultant who reviewed methods, sites, and safety practices. Safety issues were recognised to be a significant concern to BC Hydro.

Significant safety hazards were identified during the 2007-08 (first) field season and subsequently mentioned in data reports and in follow-up discussions. Accessing the study sites in winter (steep slopes covered in snow and/or ice) and working at the sites (on river ice) proved to be extremely hazardous. In addition, the consultant questioned whether data relevant to answering the management questions could ever be collected under such conditions.

As a result, BC Hydro notified the Comptroller of Water Rights on 26 July 2008 that the study would be suspended for one year pending a comprehensive review of study methods. The internal review resulted in BC Hydro concluding that access to the canyon sites during winter conditions could not be reasonably accomplished in a safe manner and that alternate methodology employing passive in-stream tracers is required.

On 5 June 2009, BC Hydro notified the Comptroller of Water Rights that the study would be further suspended by one year. This delay was requested to install instrumentation at the dam that could measure actual flows, as it was determined that flows were far exceeding the minimum requirements as a result of leakage through the flashboards; therefore, it was impossible to test the minimum flow condition specified in the Terms of Reference. Furthermore, alternate methodology for winter flow canyon monitoring was being implemented at Aberfeldie during the winter of 2009/2010 that, if successful, could be employed at Spillimacheen to alleviate safety concerns.

A letter was sent to the CWR office on 29 September 2010 to advise that the ToR would not be resubmitted as the methodology at Aberfeldie had proved inconclusive and would not be used at Spillimacheen. The letter also stated that the study would resume the winter of 2010/2011 according to the original ToR temperature trigger and would involve opportunistic observations from outside of the actual canyon. The study was implemented from October 2010 to March 2011 and a report was produced.

The approach involved monitoring a minimum threshold “trigger” as five consecutive (or 120 hrs) non-spill days with a daytime high of -10°C or colder as defined by the Fisheries Technical Committee. Air temperature was monitored in real time using temperature loggers and constant monitoring of local weather stations. An estimate
of whether or not a temperature trigger had been met at the canyon was made based on all available information; subsequent field observations were planned accordingly. In the field, three photo point monitoring locations were set up to optimize information collected while ensuring that worker safety was not compromised.

4.2.4 Interpretation of Data

During the study, there were several periods of sustained cold with only one lasting long enough to meet the trigger. Field observations recorded shortly after this trigger showed that although large portions of the Spillimacheen Canyon were frozen over, there was also evidence that many sections remained free-flowing, both on the surface and in the stream bed. Considering that the study did not encompass the entire canyon, there is some uncertainty that this result remained true throughout the entire canyon; however, there was no evidence that extensive ice damming or anchor ice development was occurring during the sustained period of cold weather. In addition, there is strong evidence that additional flows are diverted over the dam due to a frozen intake during sustained periods of cold weather. The overall discharge (estimated at 4.75 m$^3$/s) flowing down the canyon during the field observation was much higher than the minimum flow level (0.85 m$^3$/s$^{-1}$). It is unlikely that anchor ice would form or a canyon channel with continuous frozen-solid pools and riffle sections would result from the higher than minimum discharges observed in the study.

The results of the study neither confirm nor refute the hypotheses that the 0.85 m$^3$/s$^{-1}$ minimum flow prevents the formation of anchor ice in riffle habitats. The minimum flow conditions were not observed during the study and these conditions are not considered possible under winter operating conditions at the dam. Although portions of the canyon remained ice free, the entire canyon was not observed and thus it is inconclusive whether the formation of anchor ice reduces pool habitat connectivity. As neither fish movements nor presence could be safely assessed in the canyon, the study remains inconclusive about whether any changes in overwinter habitat conditions impact productivity or survival of resident fish populations.

A study design more closely linked to fish and fish populations that utilize the Spillimacheen Canyon for overwintering purposes and to habitat importance and quality may provide more information toward answering the management questions. However, the effort required to safely access the study area is considerable and may continue to result in uncertainty. Fish use of the available habitat is likely limited: there is an unpassable 9 m high falls approximately 300 m upstream of the powerhouse and fish use of the remaining of the canyon is from entrainment.

Further studies are not recommended.

4.3 SPNMON-3 Assessment of Gravel Recruitment

4.3.1 Management Questions

The key management questions addressed by this monitoring program are:

1) How does operation of the undersluice gate influence sediment transport past Spillimacheen Dam?

2) Will changing operation of the undersluice increase downstream gravel recruitment?
4.3.2 Overview

The objective of this monitoring program is to assess whether operation of the headpond influences the transport of gravel through the Spillimacheen River canyon. The Spillimacheen WUP CC identified gravel recruitment past Spillimacheen Dam as an important issue, based on historical observation of sediment accumulation in the headpond and a lack of “biologically significant” sized sediment fractions in the reach between the falls and the powerhouse. This absence of suitable gravels in the canyon was believed to impact fish habitat and habitat quality in the diversion reach below the dam. The WUP CC agreed that further study is required to determine current sediment transport through the headpond and to establish whether changing operation of the undersluice could encourage further recruitment of gravel downstream of the dam.

Revised monitoring indicators and a study design are under development, as it was determined that the study design developed by the Fisheries Technical Subcommittee was not operationally feasible in the Spillimacheen Canyon.

4.3.3 Status

Subsequent to the Water Act Section 88 Order (21 July 2005), BC Hydro modified operation of the facility to maximise gravel recruitment during all periods of high inflow. During freshet operations (approximately May through September), when discharges are in excess of 8.25 m$^3$/s, the undersluice gate is now kept fully open. Thus, gravel recruitment is maximised during all periods of high inflow (including the 4-6 week period recommended for review by the Consultative Committee). Thus, it is now redundant to implement a study to assess how gate operations affect gravel recruitment and whether opening the undersluice until early September will increase downstream gravel recruitment. As facility operations have been changed such that the inflows are now being utilized to maximize gravel recruitment under the scenarios presented in the Consultative Committee (CC) Report, the study also no longer meets the WUP Eligibility Criteria for a monitoring program (cf. CC Report, p. 8-1); i.e., no further operational changes can be implemented.

The Comptroller issued a letter (File: 76975-35/Spillimacheen) on 27 November 2008 stating that the Spillimacheen WUP implementation order is amended by deleting the requirement to carry out the gravel recruitment monitoring study.

4.3.4 Interpretation of Data

There are no data to interpret for this monitoring program.

5.0 Spillimacheen WUP Monitoring Programs Costs

The following table summarizes the Spillimacheen WUP monitoring programs costs approved by the Comptroller on 23 January 2006 and the Actual Costs to 31 December 2011.
**Table 5-1: Spillimacheen WUP Monitoring Programs Costs**

<table>
<thead>
<tr>
<th>Monitoring Programs</th>
<th>Activity</th>
<th>Costs approved by CWR</th>
<th>Total Forecast (Life to Date Actuals and Forecast)</th>
<th>Variance Total to Approved</th>
<th>Explanation</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPILLIMACHEEN ANNUAL REPORT</td>
<td>OR</td>
<td>$3,913</td>
<td>$3,668</td>
<td>$245</td>
<td>Study could not be completed as planned due to significant safety hazards.</td>
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<tr>
<td>SPNMON#1 ASSESSMENT OF RAMPDOWN DURATION TO MINIMIZE RIVER STAGE CHANGES</td>
<td>OR</td>
<td>$52,170</td>
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<td>$17,803</td>
<td>Project completed</td>
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<tr>
<td>SPNMON#1 Direct Management 001</td>
<td>OR</td>
<td>$16,370</td>
<td>$15,362</td>
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<tr>
<td>SPNMON#1 Implementation 002</td>
<td>OR</td>
<td>$35,800</td>
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<td>$16,815</td>
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<tr>
<td>SPNMON#2 HABITAT MAINTENANCE FLOWS WITHIN CANYON CHANNEL</td>
<td>OR</td>
<td>$30,715</td>
<td>$26,652</td>
<td>$4,063</td>
<td>Efficiencies found during project implementation.</td>
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<td>SPNMON#2 Direct Management 001</td>
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<td>$10,815</td>
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<td>$21,400</td>
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* Red values in parentheses denote overage.