Peace River Water Use Plan

Monitoring Program Terms of Reference

- **GMSMON-5 Peace River Productivity**

July 30, 2008

Terms of Reference for the Peace River Water Use Plan Monitoring Program: Peace River Productivity

1.0 MONITORING RATIONALE

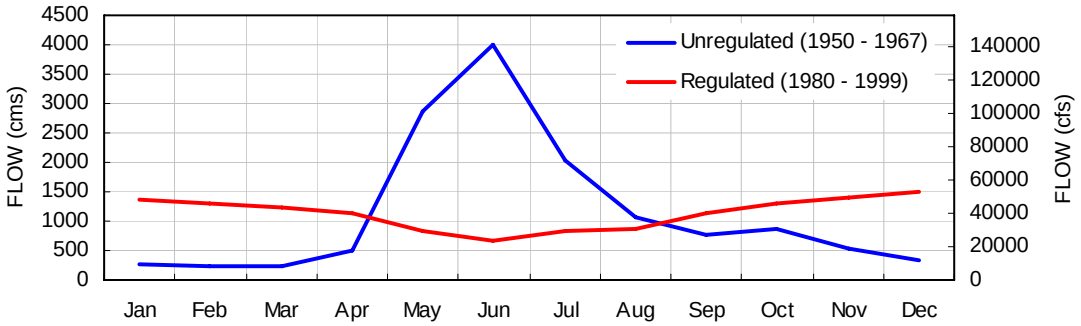
1.1 Background

Monitoring primary productivity and invertebrate productivity can provide an indication of ecosystem change that may impact fish (BC Hydro 2003). Interaction between the physical-chemical environment and the biological environment occurs via primary producers (Lowe and LaLiberte 2006). Primary producers are incorporated into the food chain by consumers such as benthic invertebrates. The role of benthic invertebrates in the aquatic ecosystem is significant as research suggests that food web complexity is largely affected by this group of organisms (Schmid-Araya *et al*. 2002 *in* Palmer *et al*. 2006). Physical conditions within the aquatic ecosystem will control the composition and biomass of the benthic invertebrate community as the organisms are sensitive to abiotic factors such as dissolved oxygen, organic matter content, and water flow (Palmer *et al*. 2006).

The Peace River Productivity monitoring program was recommended by the Peace River Water Use Plan (WUP) Committee (hereafter known as the Committee) as a means of assessing the effectiveness of the Peace River (PCR) Side Channels Plan and the PCR Ramping Plan. The purpose of the PCR Side Channels Plan is to improve fisheries habitat downstream of the Peace Canyon Dam by improving flow into side channels at low flows. An interim review in Year 5 of the PCR Side Channels Plan will determine if enhancement through physical works was a sufficient means of improving habitat, or if an alternative minimum base flow regime is required. The PCR Ramping Plan includes quantifying risk of fish stranding from flow ramping, exploring flow regime options, and assessing potential flow change programs. Improvements to fish habitat and productivity are expected in enhanced side channels due to greater flows. Monitoring of primary producers and benthic invertebrates will provide an indirect measure of fish productivity as they are indicators of change in chemical and physical properties of the water (Perrin *et al*. 2004). A direct response of the fish populations is being tracked through separate monitoring studies (i.e., PCR Fish Index and PCR Side Channel Fisheries).

To date, primary productivity or invertebrate productivity in the Peace River side channels have not been studied. This monitoring program will, therefore, address a data gap in our ecological knowledge of periphyton and invertebrate communities in Peace River side channel habitat and will track them over time to detect temporal patterns of change. Primary productivity and invertebrate productivity are expected to respond to habitat manipulation of side channels, in particular, during the months of low flows (Figure 5-1) when hydraulic conditions created by the habitat manipulation will change most dramatically. Increases in the diversity and biomass of primary producers and benthic invertebrates are an expected outcome of PCR Side Channels Plan and the PCR Ramping Plan and *in vivo* confirmation of such an outcome would be considered an indicator of success.

Figure 5-1: Mean monthly flow pre (1950–1967) and post (1980–1995, 1998–1999) regulation of Peace River at Hudson's Hope. Data from 1996 and 1997 are excluded because of sinkhole investigation spills (BC Hydro 2003).



1.2 Management Questions

The key management question(s) are:

1) What is the composition of the invertebrate and periphyton community in the side channels of the Peace River?

2) Does increased water flow to side channels as a result of side channel enhancement or change in the minimum base flow regime alter the biomass/composition of the periphyton and invertebrate community?

3) After side channel enhancement or implementation of an alternative minimum base flow regime, does the resulting periphyton and invertebrate community increase the food availability (i.e., increased abundance of invertebrate prey) to fish populations?

1.3 Detailed Hypotheses about the Ecological Impacts

The primary hypotheses[1] to be tested are related to the abundance, accrual, and composition periphyton and invertebrate communities. The following hypotheses will be tested:

H_1: There is a difference in the accrual rate of periphyton sampled from the trial side channel habitats of the Peace River between pre and post enhancement states;

H_2: There is a difference in biomass and diversity of invertebrates between pre and post enhancement states of trial side channels habitats in the Peace River;

$H_{3:}$ There is a difference in biomass and diversity of periphyton between pre and post enhancement states of trial side channels habitats in the Peace River.

These hypotheses will be tested on data collected during pre- and post-side channel enhancement. If a minimum base flow is implemented after the interim review of the

[1] For clarity, the hypotheses are stated as the alternate hypotheses. Analyses will test the null hypotheses of no effect or difference.

Peace River Side Channel Plan in Year 5, the data will be used collectively (if no difference is detected) as baseline data to measure the impact of the operational change in flow.

1.4 Key Water Use Decision Affected

The key water use decision affected by the results of the monitoring program is a potential change in the current minimum discharge regime to a novel experimental regime set between 7500 and 20,000 cfs. This may occur after Year 5 of the PCR Side Channels Plan if the results of this study, in combination with other effectiveness monitoring studies, indicate that physical works are ineffective at improving fish habitat. Ramping regimes may also be affected if this monitoring program, in combination with other studies, indicates the physical projects within the Peace River Ramping Plan did not improve fish productivity.

2.0 MONITORING PROGRAM PROPOSAL

2.1 Objective and Scope

The objectives of the monitoring program is to address the management questions identified in Section 1.2 by collecting the data necessary to draw inferences and to test the hypothesis outlined in Section 1.3. Habitat enhancement at selected side channels is expected to improve productivity of the periphyton and invertebrate community and in turn potentially benefit the fish community by increasing food availability. This monitoring program is designed to assess the response of both the periphyton and invertebrate communities over a10-year study period.

Annual monitoring will occur during the growing season when monthly flows from Peace Canyon Dam are near or at their minimum (May–July). At a minimum, one year of pre-enhancement data will be collected; this will serve as the reference condition for statistical comparison to the channels following the enhancement. Year 1 of monitoring will begin once the site selection procedure is complete and prior to any side channel habitat manipulation to obtain at least one year of baseline data. Habitat manipulation in the trial side channels is scheduled in Years 2–3 (completed as part of the PCR Trial Side Channels implementation project) of the monitoring program.

The study area will include the section of the Peace River that extends from the Peace Canyon Dam to the confluence of the Pine River. Within the study area, study sites will include two trial side channels (selected via the Trial Side Channels implementation project) as well as a minimum of two control side channels. If possible, the control side channels will be the same as those selected under the PCR Side Channel Fisheries.

Data collection, data analyses, and reporting will also be done annually over the study period and a final study report will be produced in Year 10 that summarizes the results of the entire monitoring program and the conclusions that can be drawn pertaining to the management questions and hypotheses.

2.2 Approach

Periphyton and invertebrate productivity will be monitored over the 10-year period by collecting biological samples and analyzing content in the laboratory. Statistical analyses will determine if changes in the primary productivity and invertebrate community is related to enhancement of side channels. An annual report will be prepared that describes the outcome of the field program, including trends in primary and benthic production over time. A final report will be prepared at the end of the monitoring program that summarizes the results of the entire program.

2.3 Methods

2.3.1 Task 1: Project Coordination

Project coordination will involve the general administrative and technical oversight of the monitoring program. This task will include but not be limited to: 1) budget management, 2) study team management, 3) logistic coordination, 4) technical oversight of field and analysis components, and 5) facilitation of data transfer among other investigators associated with the Peace River Side Channels Plan and the Peace River Ramping Plan.

In particular, coordination is necessary between this monitoring program, PCR Side Channel Fisheries, and PCR Trial Side Channels. The coordinators of these projects will communicate study details such as site locations, timing of physical works, and data for analysis.

2.3.2 Task 2: Field Sampling

Monitoring will occur within the trial side channels and a minimum of two experimental control side channels of the Peace River. Habitat and geographical features should be similar between control and trial areas (Reynoldson 2006). Ideally, control side channels will be the same as those used in PCR Side Channel Fisheries monitoring program.

Methodology and sampling equipment will remain consistent over the course of the monitoring program. In the selection of sampling equipment, it will be necessary to consider the changing physical conditions (i.e., river stage) in the side channels due to variation in discharge from Peace Canyon Dam. In particular, river stage in side channels is expected to increase following habitat enhancement. Sampling sites within each side channel will also be consistent among years.

Sampling Protocol Information

A site survey data sheet will include but is not limited to the following data fields:

- Crew, date, and time
- Side channel ID, site ID, geo-referenced location, an photo-reference
- Equipment description and specifications
- Discharge rate from Peace Canyon Dam

Physical Measurements of the Environment

Parameters of physical conditions to be measured in triplicate at each site during sampling sessions include but are not limited to:

- Depth
- Temperature
- Current velocity
- Dissolved oxygen

Temperature logging equipment will also be installed within each side channel. The equipment will have to be installed such that it remains in place and submerged throughout the study with the understanding that daily discharge from the dam can range from 10,000 to 70,000 cfs. In case of loss or damage to equipment, two data loggers will be installed within each side channel. Downloading of temperature data will occur at each site visit. Loggers will be removed at the end of the field season if arrangements cannot be made with another monitoring program to maintain and download equipment.

Additional physical measurements characterizing the side channel (e.g., substrate, river stage) will be available by contacting the project coordinator of the PCR Side Channel Fisheries monitoring program. Data from the PCR Side Channel Fisheries monitoring program may assist in trip planning and data analysis.

Periphyton Collection

Field sampling methods will be employed to collect periphyton data relating but not be limited to:

- Algal biomass
- Algal diversity

Sampling sessions should be timed to quantify useful measures or end points such peak algal biomass and a species count. Peak biomass is the highest average concentration of chlorophyll-a. In the collection of algal biomass data, an abbreviated time course of measurements (algal accrual) may be necessary relative to similar studies (Perrin *et al*. 2004). In the collection of algal samples, artificial substrate is recommended as it can reduce confounding in time/space comparisons that may result from using natural substrates which vary in particle size.

Invertebrate Collection

Field sampling methods will be employed to collect invertebrate data relating but not limited to:

- Invertebrate biomass
- Invertebrate diversity

Large river methods similar to those used by Perrin *et al*. (2004) for collecting data should be considered. Methods such as kick samples may not be possible due to fluctuating river stage where as artificial invertebrate samplers enable sampling at water depths that are inaccessible by wading. Artificial substrates also reduce confounding in time/space comparisons that may result from using natural substrates.

2.3.3 Task 3: Data Entry and Analyses

Laboratory

Invertebrate analysis should be identified to the family level or to higher resolution where deemed necessary. Guidelines for laboratory processing is described Reynoldson (2006).

Statistical

The proponent will develop a Microsoft Access database to enter, check and store all data collected during the field season. Suggested metrics for the data are peak algal biomass, species richness, and benthic invertebrate biomass.

Data analyses should follow the quantitative techniques describe in Reynoldson (2006). Statistical analyses (i.e., ANOVA) will determine the effect of location on the data. Analyses will assess if changes in the enhanced side channel trial sites is significantly greater than changes in the control study sites. The type of statistical analysis used to test time trends will depend largely on the nature of the data, and can include simple non-parametric correlation tests as well as more complex time series analyses (e.g., regression). However, the strength of the inference may be limited to some degree as the monitoring program may have only one year of pre-enhancement data for the analysis.

2.3.4 Task 4: Reporting

Project reporting will consist of a series of annual data reports and a single final report at the conclusion of the monitor. The annual report will document the methods, maps and photos of study sites, findings of the year, and will include a discussion on how the year's data compare with that collected in previous years. Included in this discussion will be the results of all pertinent hypothesis testing and recommendations for improving the monitoring program. In Year 10, a final report will be prepared that will include:

a) an executive summary of the annual report;
b) field methods, including maps that indicate survey locations, and photos;
c) the entire environmental and biological dataset, presented in tabular and graphical form;
d) description of statistical analyses;
e) an assessment of the findings as they relate to management question and hypotheses;
f) summary of data gaps and recommendations for improving the program as a monitoring tool.

A report will be provided in hard-copy and as Microsoft Word and Adobe Acrobat (*.pdf) format. The required maps and figures will be included as embedded objects in the report. All maps and figures will also be provided in their native format as separate files. Raw data will be submitted in a Microsoft Access database. All photos will be submitted electronically.

2.4 Interpretation of Monitoring Program Results

The monitoring program will assess the changes in the periphyton and invertebrate communities following side channel enhancement (or potentially implementation of a novel base flow regime). If no change is detected in either of these communities, then this may suggest that the physical and chemical properties of the side channels did not change sufficiently to invoke an observable response in the periphyton or invertebrate communities. Quantifying a change in benthic productivity will act as a useful gauge in assessing the response of fish populations and will assist in the interpretation of other monitoring program results including Peace River Fish Index and Peace River Side Channels Fisheries. Both the Peace River Fish Index and Peace River Side Channels Fisheries monitoring program include surveys of fish populations throughout the 10-year study period. Overall the information gathered from this Peace River Productivity monitoring program and others will be interpreted to determine the effectiveness of the Peace River Side Channels Plan and Peace River Ramping Plan to improve fisheries habitat and fisheries productivity, respectively.

2.5 Schedule

Monitoring is scheduled to occur annually over 10 years during the growing season when monthly flows from Peace Canyon Dam are near or at their minimum (May-July). Monitoring will commence once side channels have been selected via the Trial Side Channels implementation project.

2.6 Budget

The estimated overall cost for the monitoring program is $984,709. Table 5-1 summarizes the budget estimated in 2007 dollars.

Table 5-1 Estimated costs for the Peace River Productivity monitoring program.

Sub-total		$824,450
Inflation	2%	$113,368
Contingency	5%	$46,891
Total		$984,709

2.7 References

BC Hydro. 2003. Consultative committee report: Peace River water use plan. Prepared by the Peace River Water Use Plan Committee.

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Perrin, C.J., J. Korman, and D. Schmidt. 2004. A monitoring protocol for benthic invertebrates and periphyton in the middle and lower Columbia River. Report prepared by Limnotek Research and Development Inc., Ecometric Research Ltd. and Golder Associates Ltd. for BC Hydro. 59p.

Reynoldson, T. B., C. Logan, T. Pascoe, and S .P. Thompson. 2006. CABIN (Canadian Aquatic Biomonitoring Network) Invertebrate Biomonitoring Field and Laboratory Manual. Report prepared by National Water Research Institute and Environment Canada. Website updated Aug 1, 2006. http://cabin.cciw.ca/Application/Downloads/cabin_protocol.doc