

Peace Project Water Use Plan

Monitoring Program Terms of Reference

Peace Spill Protocol

- **GMSMON-7 Peace River Side Channel Fisheries**

February 9, 2008

Terms of Reference for the Peace Project Water Use Plan Monitoring Programs Peace Spill Protocol

1.0 OVERVIEW

This document presents Terms of Reference for the effectiveness monitoring programs for the Peace Spill Protocol (Table 1). These programs will monitor and quantify the environmental effects of spills. Information collected through the Peace Spill Protocol will be used, if appropriate, in the revision of future spill strategies. This document provides detailed Terms of Reference for the following programs:

- 1) **GMSMON-3 Peace River Fish Stranding:** A conditional monitoring program to be implemented immediately following a spill event that will assess the magnitude of fish stranding in the Peace River.
- 2) **GMSMON-4 WAC Bennett Dam Entrainment Study:** A conditional monitoring program to be implemented for a spill event that will estimate the number of fish entrained through WAC Bennett Dam and the rate of mortality experienced by entrained fish. Formerly known as the GMS Entrainment Study. The original project title was misleading as the focus of the study is spillway entrainment and not turbine entrainment.
- 3) **GMSMON-6 Peace River Riparian Flooding:** A conditional 2-year monitoring program to be implemented in Years 9 and 10 of the Peace Project Water Use Plan should a spill event occur during the 10-period.
- 4) **GMSMON-7 Peace River Side Channel Fisheries:** A 10-year required program to provide baseline data on flow, fish use, and substrate changes in side channels as well as to assess the response of trial sites (a physical works project).
- 5) **GMSMON-8 Peace River Side Channel Response:** A conditional monitoring program to assess the response of side channels to spill events in terms of flow, fish use, and substrate.
- 6) **GMSMON-9 Peace River Spill Hydrology:** A conditional program to ensure the collection and reporting of hydrological data associated with a spill event.
- 7) **GMSMON-10 Peace River Spill Photos:** A conditional monitoring program that captures the Peace River at five different flows during a spill event.
- 8) **GMSMON-11 Peace River Spill TGP/Temp:** A conditional monitoring program that monitors TGP and temperature levels of the Peace River during a spill and two weeks following.
- 9) **GMSMON-12 Peace River Wildlife Survey:** A conditional monitoring program that assesses the impact of a spill event on ungulates, beavers, riparian birds, and toads.
- 10) **GMSMON-13 Williston Fish Index:** A study that will estimate the abundance of fish in the pelagic area of the Peace Arm of the Williston Reservoir to assist in assessing the impact of entrainment on fish populations during a spill.

Table 1 Peace Spill Protocol Monitoring Program Terms of Reference Submission Information

Name of Monitoring Program	Order Clause Fulfilled	Submitted with this Package	Previously Submitted To CWR	Ordered Submission Date
GMSMON-3 Peace River Fish Stranding	Schedule D 3(a)	Yes	No	February 2008
GMSMON-4 WAC Bennett Dam Entrainment	Schedule D 3(b)	Yes	No	February 2008
GMSMON-6 Peace River Riparian Flooding	Schedule D 3(c)	Yes	No	February 2008
GMSMON-7 Peace River Side Channel Fisheries	Schedule C 4(d)	Yes	No	August 2008
GMSMON-8 Peace River Side Channel Response	Schedule D 3(d)	Yes	No	February 2008
GMSMON-9 Peace River Spill Hydrology	Schedule D 3(e)	Yes	No	February 2008
GMSMON-10 Peace River Spill Photos	Schedule D 3(g)	Yes	No	February 2008
GMSMON-11 Peace River Spill TGP/Temp	Schedule D 3(f)	Yes	No	February 2008
GMSMON-12 Peace River Wildlife Survey	Schedule D 3(h)	Yes	No	February 2008
GMSMON-13 Williston Fish Index	Schedule D 3(i)	Yes	No	February 2008

Monitoring Program No. GMSMON-7 Peace River Side Channel Fisheries

1.0 MONITORING RATIONALE

1.1 Background

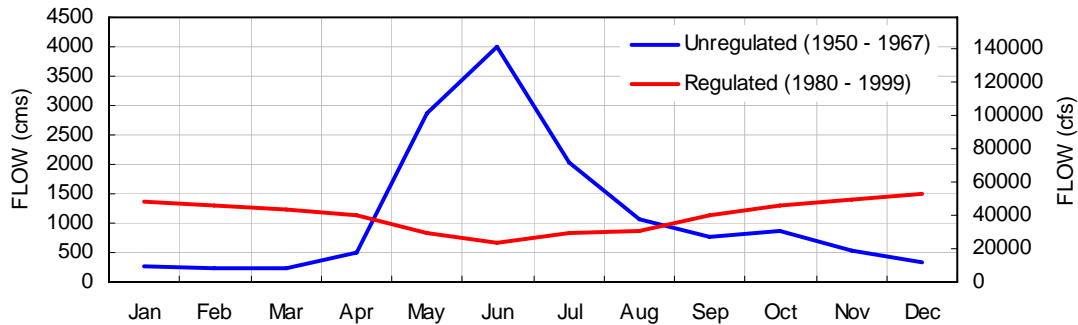
Regulation of the Peace River (PCR) has resulted in changes to flow and sediment transfer (Church 2005). Changes include a reduction in the mean annual flood by a factor of three at the dam, an increase in winter flow, and reduced variability in seasonal flows (30-50%) (Figure 7-1). Normal operational flows lack the competence to move bed material; specifically, upstream of the confluence with the Pine River where no significant movement of material occurs. When investigating the impact of these changes on the morphology of the river, Church (1995) identified a reduction in channel width by abandonment of seasonally inundated channel bar surfaces and secondary channels, as well as sediment accretion. These changes to channel width are encouraged by the establishment of vegetation in active channel areas (Church 1995).

The Peace River Water Use Plan (WUP) Committee (hereafter known as the Committee) recognized that the changes in river morphology due to reduced peak flows are creating loss and continued degradation of fish habitat in side channels. Thus, the Peace River Side Channel Fisheries program will include monitoring of hydrological and physical properties of side channels, as well as fish utilization, during normal operations. The PCR Side Channel Fisheries program was recommended by the Committee as one measure for assessing the effectiveness of the PCR Side Channels Plan and the Peace Spill Protocol.

The purpose of the PCR Side Channels Plan is to improve fisheries habitat in side channels downstream of the Peace Canyon Dam. At low flows, side channels can become isolated from the mainstem or dewatered. Fish within these side channels are vulnerable to stranding and are more susceptible to predation and thermal stress if isolated in pools. This Peace River Side Channel Fisheries program will monitor side channels enhanced through physical works to assess their effectiveness at improving fish habitat. 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 Peace Spill Protocol will attempt to quantify the environmental effects of a spill by collecting information through a variety of monitoring programs. The Peace River Side Channel Fisheries program will provide baseline information on the state of side channels in terms of water flow, channel morphology and fish abundance such that in the event of a spill, the effect of the spill on the side channels may be detected. Side channel response to spills will be assessed as part of Peace River Side Channel Response monitoring program and complements this program. Information gained from these monitoring programs will aid future decision-making related to spill risk strategies.

Figure 7-1. 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 response of side channel stage to fluctuations in discharge?
- 2) What physical processes are occurring in the beds of side channels of the Peace River and is there a trend over time?
- 3) Which fish species and fish life stages are using the side channels of the Peace River and are changes occurring over time?

The monitoring program will provide baseline information on the side channels of Peace River to determine the effects of the habitat manipulation on the side channels. In the event of a spill changes will be documented as part of separate monitoring program (PCR Side Channel Response); however, data relating to spill response will also be critical to understanding observations within this program.

1.3 Detailed Hypotheses about the Ecological Impacts

The primary hypotheses¹ to be tested are:

- H₁: Morphology of side channels is:
- H_{1a}: changing over time;
 - H_{1b}: changing more in trial sites than control study sites
- H₂: Bed-material armouring as measured by the median particle size in side channels is:
- H_{2a}: changing over time;
 - H_{2b}: changing more in trial sites than control study sites
- H₃: The relative abundance of fish species, age/size class structure, fish numbers, and species present in side channels is:
- H_{3a}: changing over time;
 - H_{3b}: changing more in trial sites than control study sites

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

Side channels are expected to change naturally over time and those side channels that undergo physical works as part of the PCR Trial Side Channels are expected to experience greater changes in morphology, bed material, and fish abundance due to changes in water flow. Physical works on side channels should be examined as an explanatory factor for observed changes.

1.4 Key Water Use Decision Affected

The key water use decisions affected by the results of the monitoring program include a potential change in the current minimum discharge regime, as well as a revision of future spill strategies. After Year 5 of the PCR Side Channels Plan, a novel experimental regime may be implemented if this study, in combination with other effectiveness monitoring programs, indicates that physical works are ineffective at improving fish habitat. Decisions regarding future spill strategies will be based on this monitoring program and other studies within the Peace Spill Protocol. Results of the monitoring could affect power generation as well as fish, wildlife, and vegetation downstream of Peace Canyon Dam.

2.0 MONITORING PROGRAM PROPOSAL

2.1 Objective and Scope

The objectives of this monitoring program as the channels respond to changes in the flow regime due to habitat manipulation are to:

- 1) Monitor stage and flow in the side channels;
- 2) Assess degradation/aggradation in the side channels;
- 3) Assess bed-texture changes (infilling/armouring) in the side channels;
- 4) Determine abundance and distribution of small fish within side channels.

The objectives are designed to develop a baseline of information from which spill-induced, and habitat manipulation changes can be measured. This monitoring program will characterize the side channels of the Peace River in terms of flow, physical state, and fish use/presence under normal dam operations (i.e., 10,000–70,000 cfs). The small fish survey will target juveniles and other small fish in the side channels as little is known of their presence and use of this habitat. This fish survey component will also complement the PCR Fish Index monitoring program, which focuses on the mainstem of the Peace River, by providing a more complete picture of the Peace River fish community. Data transfer between the PCR Fish Index program and this program will be a required component of project coordination. As part of the investigation, inferences on the impacts (positive and negative) to fish populations should be made where possible using both the fish survey data and observed changes in the physical state.

The study area is the Peace River from Peace Canyon Dam to the confluence with the Pine River. Study sites will include the trial (habitat manipulation) side channels selected in PCR Trial Side Channels implementation project (part of the PCR Side Channels Plan). At least two trial side channels and two control side channels will be monitored over the 10-year period.

Data will be collected immediately following a spill event as part of the PCR Side Channel Response monitoring program and is the subject of a separate terms of

reference. Data transfer between the PCR Side Channel Response monitoring program and this program will be required as part of project coordination.

2.2 Approach

The monitoring program will begin in Year 1 of the 10-year study period of the PCR Side Channels Plan with the individual survey components staggered throughout this time period (Table 7-1). Cross-section surveys and surveys of substrate texture will begin in Year 1 and continue every other year until Year 10. A stage-discharge relationship will be developed using a discharge rating curve in Year 1. The fish index survey will begin in Year 1 as a pilot study and the standardized survey will begin in Year 2 and continue every other year of the study period. The combination of these individual monitoring components will provide an overall picture of the side channels, the physical processes shaping them and variation within them, as a result of dam discharge and habitat manipulation. Monitoring in Year 1 will be completed prior to any habitat manipulation scheduled for that year to obtain at least one year of baseline data. Habitat manipulation in the trial side channels is scheduled for Years 1–2 (completed as part of the PCR Trial Side Channels implementation project).

2.3 Methods

During all field sampling, georeferencing of monitoring sites will be required, as well as photodocumentation of field activities and the side channel at established and replicated photopoints; all photopoints should include upstream, downstream, and bank shots.

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 Spill Protocol.

In particular, project coordination with PCR Trial Side Channels implementation will be required to determine timing of construction and maintenance. Coordination with PCR Fish Index program will be required to ascertain whether study sites between these programs overlap and if so, to facilitate data transfer. Project coordination will also be required with PCR Side Channel Response to acquire data that was collected following a spill.

2.3.2 Task 2: Site Selection

Trial side channels will be pre-selected by the PCR Trial Side Channels implementation project. In consultation with the BC Hydro Implementation Lead and the PCR Trial Side Channels project coordinator, project coordinator of this monitoring program will select a minimum of two experimental control side channels. The selection process for control side channels will consider similarity of site characteristics to trial side channel sites such as channel size, isolation/dewatering at low flows, habitat quality (e.g., cover, substrate type) and known fish species distribution. By selecting multiple control sites, the assumption is that the variation in

the (before and after) measurements of these sites is the same as the variation among the trial sites, and that the variability over time between the control sites is not correlated.

2.3.3 Task 3: Survey Cross-Section Sites

A series of cross-sections will be established in each study side channel. Cross-sectional surveys are intended to measure bank and channel erosion and channel deposition and therefore will include sufficient detail to measure changes to the cross-section. Methods will follow those described in Ayles (2001) and Church and Ayles (2002). Rebar or a similar marker will be used as semi-permanent benchmarks at each cross-section end point to provide location and orientation, vertical, and horizontal control. Special consideration to vertical control is required if the sections are too deep to wade and boat surveys are required. Benchmark locations will be georeferenced and photographed. At least three benchmarks are required at each cross-section if sections are to be surveyed independently. Discharge measurements will also be taken at the time of cross-sectional surveys.

The number and location of cross-sections is at the discretion of the researcher and subject to the available budget. However, a clear rationale for the determination of the exact number and location of cross sections is expected. Changes in the channels are expected by position (i.e., upstream to downstream) and by habitat type (e.g., well-armoured coarse riffles in stable locations may not change appreciably). Consideration of these factors is expected in the cross-section layout rationale. This rationale will be subject to review by BC Hydro.

Cross-section surveys will begin in Year 1 and continue every other year. Survey timing will be consistent from year to year.

2.3.4 Task 4: Survey of Substrate Texture

Bed-material substrate texture of side channels will be assessed through a series of surface substrate measurements. Surface texture will be assessed using a Wolman pebble count (Wolman 1954) or other equivalent method. Transects for the survey will be placed systematically along the entire length of the side channel. Changes in surface substrate over time will indicate if side channels or given sections of side channels are armouring (winnowing is occurring) or infilling with fines. Preference for substrate sampling locations should be given to, but not limited by, cross-section sites so the two measurements can be analyzed together.

Like the cross-section layout, the number and location of bed texture monitoring sites is at the discretion of the researcher but a clear rationale should be presented on how these sites will be determined.

The assessment of bed-texture change will begin in Year 1 and continue every other year. In the first year only, repeated measurements will be taken at a single, typical site to estimate precision of measurements and hence the resolution of the measurements required to detect change.

2.3.5 Task 5: Installation of Pressure Transducers and Gauges

An integrated stage and pressure/temperature datalogger will be installed at each site, according to standard RIC practices, in Year 1. Installation may require coordination with PCR Trial Side Channels to ensure placement does not interfere with physical works. Equipment will be positioned in a stable location where little

change in the cross-section is expected, such as a mid-channel pool, to avoid the need to re-develop the discharge rating curve (see Task 6: Discharge Rating Curve Development). When selecting the location, consideration should also be given to minimizing occurrences of dislodgement and/or damage by high flows, debris, or ice. Sites will need to be capable of withstanding spill events. A minimum of three local benchmarks are required as vertical control for the station. The benchmarks should be semi-permanent installations that are expected to remain stable over the life of the project. Station description will include, but is not limited to, photo-documentation, and an account of location and local benchmarks.

2.3.6 Task 6: Maintenance and Downloading of Equipment

Equipment maintenance and data downloading are expected to occur approximately twice a year as determined by the storage capacity of the logger system and to ensure data continuity and quality (i.e. battery levels, stability of site, vandalism, etc.). Attempts should be made to schedule this activity with the timing of other components of this monitoring program or other projects, such as PCR Mainstem Stage Discharge Relations, to provide project efficiency and cost effectiveness. Maintenance visits will confirm proper functioning of equipment and/or correct problems with equipment.

2.3.7 Task 7: Discharge Rating Curve Development

A stage-discharge relationship will be quantified for each side channel by developing a discharge rating curve. The curve will be developed as per the guidelines found in Resource Inventory Standards Committee hydrometric survey manual (RIC 1998). The curve will be based on measurements of at least five concurrent stage and discharge observations and ideally will include up to 10 data points. It is expected that the regularly changing discharge from the dam will allow the collection of more than one stage-discharge measurement per trip. The metering section will be located downstream away from the works in a stable section of the channel

Discharge rating curve development is scheduled for Year 1 before the commencement of physical works for the Peace River Trial Side Channels implementation project (expected to occur in Years 1 and 2). Location of the metering section, as mentioned above, should be a stable location.

2.3.8 Task 8: Fish Survey

The fish survey will focus on young-of-the-year and juveniles of large fish species as well as small fish species. Fish that are <200 mm fork length will be targeted. Estimates of the following for each species will be obtained for each study side channel:

- Relative abundance
- Spatial distribution
- Size distribution

The data required to provide these estimates will be collected every second year in a minimum of four side channels (same study sites as other monitoring components of this program). Each sampling session will consist of collecting biological data for all fish species captured. A previous small fish monitoring study (RL&L 2001) on side channels of the Peace River found that the spring sampling session had the greatest abundance of small fish which the authors speculated was either due to (i) stable

water levels enabling fish to establish themselves or (ii) fish entering the river in the spring from tributaries and a net loss of individual occurring as the season progressed. Biological information to be collected from all captured fish includes but is not limited to:

- Species
- Sex (if possible)
- Fork length
- Weight

Capture methods will target small fish species, and young-of-the-year and juveniles of large fish species. Some capture methods have been more successful than others for collecting small fish in the Peace River (RL&L 2001). Collection and handling of fish will follow RIC standards (RIC 1997). Methods will be specific to site conditions but should be consistent for each location. Stratified sampling by habitat type within each side channel should be done as catch rates of fish in the Peace River have been shown to be influenced by habitat in previous studies (Mainstream 2006). However, the sample size and location of sampling within the study sites is at the discretion of the researcher and subject to the available budget; however, a clear rationale of these decisions will be provided. Special note should also be made of captured fish with marks or tags and the information distributed to the project coordinator of the relevant mark-recapture program. Information on the sampling protocol will be analyzed and/or stored for future reference. The following information will be collected to provide an indication of the reliability of the catch data:

- Date and time
- Crew and skill level
- Capture method and equipment specifications
- Effort

During each sampling session, physical measurements of the study area will be taken to determine sampling conditions. Data will be analyzed and stored for future reference. Sampling conditions may provide insight into potential bias and variability in estimates of abundance and distribution. Parameters to be measured include but are not limited to:

- Water clarity
- Water temperature
- Water velocity
- Water depth
- Light intensity
- Habitat characteristics of sampling sites (i.e., % cover, substrate composition, habitat description: glide, pool, riffle)
- Recent flow variation (i.e., is sampling occurring during a falling or rising stage).

A pilot study will be implemented in the spring of Year 1 to develop sampling design and test capture methods. The pilot study will assist in finalizing a protocol for a standard monitoring program that will begin in Year 2 and continue every other year. Survey timing should be consistent from year to year. The project coordinator will ensure data-sharing between this program and the PCR Fish Index program if study areas overlap.

2.3.9 Task 9: Data Entry and Analysis

The proponent will enter, check and store all data collected during the study into a Microsoft Access database. Analyses will be performed in the context of the hypotheses and include but are not limited to:

- a) assess the vertical and lateral stability of the cross-sections (e.g., aggradation, degradation, narrowing, widening);
- b) estimation of bed-texture changes of side channels;
- c) estimation of relative fish (juveniles and small fish species) abundance (catch rate such as fish/m² for each species based on habitat type) in side channels;
- d) estimation of standard life history summaries including length-frequency distribution, length-weight relationship of fish (juveniles and small fish species) in side channels;
- e) comparison of data collected in this program with data collected in the Peace River Fish Index program.

For all components of the monitoring program, through statistical analysis, the likelihood that the habitat manipulation caused the observed difference at the trial sites, given the observed variability in the control sites will be determined. The type of statistical analysis used to determine 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 will have only one year of pre-habitat manipulation data for the analysis.

2.3.10 Task 10: Reporting

Project reporting will consist of a series of annual data reports and a single final report at the conclusion of the monitoring program in Year 10. The data reports will document the 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.

The final report will be compiled following the conclusion of the monitoring program that collates all of the data and includes:

- a) an executive summary of the project;
- b) field methods, including maps that indicate sampling locations, and photos;
- c) analytical methods used in assessing trends of habitat change or fish usage as well as any assumptions made;
- d) description of the results of field program including data in graphical and tabular form where appropriate;
- e) an assessment of the findings as they relate to the management question and hypotheses;
- f) any recommendations towards future monitoring (if any) and/or enhancement projects .

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 key result of the monitoring is to collect a baseline of information on the physical conditions in side channels of the Peace River and infer which changes affect fish populations in terms of habitat. If results of the monitoring program indicate improvements in fish habitat and/or more fish then this will support the ecological merit of channel enhancement (habitat manipulation). The results will also assist in assessing the impact of the spill by providing information on baseline conditions of side channels. If the spill response of side channels indicates a negative impact to fish or fish habitat based on baseline conditions, then a review of spill strategies may be required to mitigate the negative impacts on fish populations in the Peace River.

2.5 Schedule

Monitoring is scheduled to begin in Year 1 and continue annually during the 10-year study period, as described in Table 7-1. Monitoring in Year 1 will be completed prior to any habitat manipulation scheduled for that year to obtain at least one year of baseline data. Habitat manipulation in the trial side channels is scheduled for Years 1–3 (completed as part of the PCR Trial Side Channels implementation project).

Timing of the projects will be scheduled to achieve cost efficiencies where possible. A pilot study for the fish survey will occur when the river is at or near low flow (end of May or June) and unless the pilot study determines otherwise, the standard fish monitoring program will begin at the same time in the following year and continue every other year.

Table 7-1: Schedule of program components over the 10-year monitoring period.

Program Component	Timing	Year of Study
Survey cross-section sites and substrate texture	May-June	1,3,5, 7 and 9
Installation of gauge and transducers	February	1
Stage-discharge relationships	February-July	1
Maintenance of equipment	As required	1-10
Fish survey	May-June	1,2,4,6 8,10

2.6 Budget

The estimated total cost for the monitoring program is \$679,305. Table 7-2 summarizes the budget estimated in 2007 dollars.

Table 7-2: Estimated costs for the Peace River Side Channel Fisheries

Sub-total		\$579,800
Inflation	2%	\$67,157
Contingency	5%	\$32,348
Total		\$679,305

2.7 References

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