

Peace Project Water Use Plan

Monitoring Program Terms of Reference

Peace Spill Protocol

- **GMSMON-11 Peace River Spill TGP/Temp**

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 GSMON-11 Peace River Spill TGP/Temp

1.0 MONITORING RATIONALE

1.1 Background

Spill releases at the Williston Project (GMS) can affect water quality of downstream waters. Specifically, supersaturation of dissolved gases during a spill may occur as water plunges from the dam into the receiving waters and in the process entraining air into the flow. The result is partial pressures of atmospheric gases in solution that are greater than in the atmosphere (BC Hydro 2003). Total gas pressure (TGP) is a measure of dissolved gas supersaturation. At high TGP levels, lethal and sub-lethal effects in fish have been documented (Fidler and Miller 1997, Antcliff et al. 2002). Water quality guidelines for fish populations in BC specify that TGP should not exceed levels of approximately 110% and 103% for water depths greater and less than one metre, respectively (Fidler and Miller 1997). The Peace Water Use Plan Committee (hereafter known as the Committee) notes that prolonged exposure to TGP levels exceeding 115% results in acute physiological effects (Antcliff et al. 2002). Consequently, the Committee recommended monitoring of TGP levels to assess dissolved gas supersaturation downstream of a spill during and immediately after a spill event.

The Peace River Spill TGP/Temp monitoring program addresses two management plans, the Peace Spill Protocol (PSP) and the Peace River Flood Pulse Plan. The PSP attempts to quantify the negative environmental effects of a spill. As part of the PSP, this monitoring program will quantify the effect of a spill on TGP levels and the potential implications for fish populations. Information gained from this study and others within this management plan will aid future decision-making related to spill risk strategies. The Peace River Flood Pulse Plan was developed to improve downstream fisheries productivity and riparian habitat for flora and fauna by investigating the feasibility of periodic flood pulse events (e.g., a spill) to maintain side channel and riparian habitat downstream of Peace Canyon (PCN) Dam. As part of the PCR Flood Pulse Plan, the results from this monitoring program will be assessed in terms of a weighting against the ecological merits of flood pulses. The monitoring programs within both of these management plans will be conducted opportunistically as no planned spill release is proposed. Spill events on the Peace system exceeding generation capacity of 70,000 cfs are rare, occurring only four times since 1968. Four additional spills events have occurred for other reasons during this period (BC Hydro 2003). These eight spills, in total, roughly equate to a spill occurring on average once every five years.

1.2 Management Questions

The key management question is:

- 1) During a spill event at GMS, do dissolved supersaturated gases in the Dinosaur Reservoir and the Peace River reach a level that negatively impacts fish populations?

1.3 Detailed Hypotheses about the Ecological Impacts

The primary hypotheses¹ to be tested are:

H₁: TGP levels downstream at GMS during a spill are at levels that are known to cause mortality or sub-lethal effects to fish

This hypothesis will examine TGP levels as well as the time period over which the levels occur to assess whether fish are expected to suffer lethal or sub-lethal effects from dissolved supersaturated gases based on accepted values within scientific literature.

1.4 Key Water Use Decision Affected

The key water use decisions affected by the results of the monitoring program are the revision of future spill strategies and the necessity of flood pulse events to maintain side channel and riparian habitat. In addition to the information from this monitoring program, other studies within the Peace Spill Protocol and the Peace River Flood Pulse Plan will influence these water use decisions. These decisions have important implications for power generating and ecological values. Results of the monitoring could affect power generation as well as fish, wildlife, and vegetation downstream of the Peace Canyon Dam.

2.0 MONITORING PROGRAM PROPOSAL

2.1 Objective and Scope

The objective of this monitoring program is to:

- 1) Measure total gas pressure for the duration of a spill and immediately after;
- 2) Assess total gas pressure levels in terms of impact on fish populations in the Dinosaur Reservoir and the Peace River downstream of the Peace Canyon Dam.

Impacts to fish will be assessed in terms of acute mortality and chronic responses to TGP levels. The study area includes the forebay of GMS to the Peace River immediately downstream of Pine River. This monitoring is conditional on the occurrence of a spill event where spill discharge (Q_{SDI}) at:

- GMS exceeds a daily average of 7240 cfs (205 cms) for two or more days;
- Peace Canyon Dam exceeds a daily average of 17657 cfs (500 cms) for seven or more days;
- Peace Canyon Dam exceeds a daily average of 52972 cfs (1500 cms) for two or more days.

Monitoring will also occur when total discharge from the Peace Canyon facility exceeds a total discharge of 70,629 cfs (2000 cms) for two or more days.

TGP monitoring will begin immediately prior to a spill and will be measured continuously throughout the spill and two weeks after spill completion. Equipment will be installed one to two weeks, if possible, before the spill to collect data on pre-spill conditions.

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

2.2 Approach

TGP meters will be installed at stations within the forebay of the dams, tailraces, and in the Peace River downstream of the PCN Dam. Temperature and TGP data will be collected for the entire period of the spill as well as one week after the spill. Data will then be analyzed to determine the relationship between dam discharge and TGP, and assess the extent of fish exposure to deleterious levels of gases. A report detailing the findings will be produced following the spill.

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 Spill Protocol Plan and the Peace River Flood Pulse Plan.

In particular, coordination with Peace River Baseline TGP/Temp implementation project is essential as TGP data loggers/meters will be purchased, calibrated, and maintained prior to deployment as part of that project.

2.3.2 Task 2: Installation of TGP meters

TGP data loggers will be installed at six stations prior to the spill (~two weeks) in the following locations:

- GMS forebay
- GMS tailrace
- PCN Dam forebay
- Peace River at Hudson Hope pumphouse station
- Peace River downstream of the Halfway River
- Peace River downstream of the Pine River

In the selection of exact installation location, the TGP monitoring locations used during previous monitoring should be considered (BC Hydro 1999). All sampling locations will be georeferenced. Probe placement in water will follow protocol described in Schmidt et al. (2001). The probe should, if possible, be situated at or below compensation depth. Probes may also require housing to shield them from damage during inflow events and be secured to a fixed object to prevent them from being washed away. TGP meters may also require suitable housing to prevent theft or damage due to vandalism and weather conditions.

2.3.3 Task 3: Data Collection

Data collection will include taking continuous and spot measurements using protocol established by Schmidt et al. (2001). In particular during the measurements, the probe should, if possible, be situated at or below compensation depth and where water exchange is continuous. TGP equipment installed at the study stations (described above) will make continuous measurements (e.g., five-minute intervals)

over the study period and will be recalibrated as needed. Meters should be monitored daily by remote links (e.g., satellite) to verify proper functioning and ensure malfunctions are corrected in a timely manner.

Spot measurements will be taken over the course of the monitoring period (e.g., four to six times, depending on length of spill) to determine the TGP production of a specific facility or tributary. Portable meters will be used to investigate mixing assumptions and for cross-checking continuous monitoring stations as a measure of quality control. Quality control will ensure proper functioning of the continuous monitoring stations. In addition to cross-checking the continuous monitoring stations, spot measurements (minimum of two repeated measurements per visit) will be taken at (if safety permits):

- Dinosaur Reservoir near Johnson Creek (both banks and middle of reservoir)
- PCN tailrace (both banks)
- immediately upstream of and within the Halfway River
- immediately upstream of and within the Pine River
- Cross channel TGP profiles of the latter two locations

Spot measurement will be taken when possible to coincide with significant changes in total discharge during the course of the spill. Data collection during spot measurements will include but not be limited to:

- Date, time, and crew
- Site id and GPS references
- Calibration information
- Total gas pressure (ΔP , TGP %)
- Barometric pressure
- Water temperature
- Dissolved oxygen
- Water depth

Water temperature data will be collected from data loggers installed as part of the Peace River Baseline TGP/Temp implementation project. Two weeks after the completion of the spill event, TGP equipment will be removed and temperature data will be downloaded as part of the Peace River Spill TGP/Temp monitoring program. Temperature data will be shared with the Peace River Baseline TGP/Temp implementation project.

2.3.4 Task 4: Data Entry and Analysis

All data will be entered into a Microsoft Access database. Descriptive statistics summarizing the data will be conducted in addition to analyses showing the relationship between TGP and discharge, as well as temporal variation in both the variables. This will also include identifying spill discharge rates and environmental conditions that cause TGP levels to reach lethal and sub-lethal effects for fish and the potential duration of exposure to fish.

2.3.5 Task 5: Reporting

A report will be compiled following the spill which will include:

- a) an executive summary of the project;
- b) field methods, including maps that indicate sampling locations, and photos;
- c) environmental data collected including elevation of forebay and tailrace, presented in tabular and graphical form;
- d) relationship between TGP and other parameters measured;
- e) an assessment of the findings as they relate to management question and objectives;
- f) any recommendations towards future monitoring (if any) needed to determine the effects of TGP levels on fish populations.

A report will be provided in hard-copy and as Microsoft Word and Adobe Acrobat (*.pdf) format. The required maps and figures will 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

Results will describe the relationship between TGP levels and discharge during a spill event at GMS and Peace Canyon Dam. High TGP levels may indicate a need to assess spill strategies such that the negative impacts on fish populations in the Peace River can be minimized negative impacts. Additionally, if evidence is strong that TGP levels during a spill are not of concern to fish health, then further monitoring may not be required.

2.5 Schedule

Monitoring is conditional on a spill event meeting the criteria specified in *Section 5.1 Objective and Scope*. If the spill criterion is met, then monitoring will begin just prior to the start of the spill and continue for two weeks following the spill. Monitoring will occur following each spill event that meets the spill criterion unless strong evidence suggests that TGP levels are not negatively impacting fish health.

2.6 Budget

The estimated cost per spill event for the monitoring program is \$25,068. Table 11-1 summarizes the budget estimated in 2007 dollars.

Table 11-1: Estimated costs for the Peace River Spill TGP/Temp monitoring program.

Sub-total		\$21,200
Inflation	2%	\$2,675
Contingency	5%	\$1,194
Total		\$25,068

2.7 References

Antcliffe, B.L., L.E. Fidler., I.K. Birtwell. 2002. Effect of dissolved gas supersaturation on the survival and condition of juvenile rainbow trout (*Oncorhynchus mykiss*) under static and dynamic exposure scenarios. Canadian Technical Report of Fisheries and Aquatic Sciences 2370.

BC Hydro. 1999. Total Gas Pressure at Peace River Generating Facilities. Strategic Fisheries Report No. SF98-PR-01. June 1999.

BC Hydro. 2003. Consultative committee report: Peace River water use plan. Prepared by the Peace River water use plan consultative committee.

Fidler, L.E. and S.B. Miller. 1997. British Columbia Water Quality Guidelines for the Protection of Aquatic Biota from Dissolved Gas Supersaturation. Summary Report. Prepared for B.C. Ministry of Environment, Lands and Parks, Environment Canada, and Department of Fisheries and Oceans. Aspen Applied Sciences Ltd., Cranbrook, British Columbia. August 13, 1997.

Schmidt, D., C. Powell, K. Wilby, and S. Wilson. 2001. BC Hydro Total Dissolved Gas Pressure Monitoring Protocol. Prepared for the BC Hydro Total Gas Pressure Steering Committee. BC Hydro Power Supply Environment Report No. SFP99-Gen-09. 49 p+4 app.