Columbia River Project Water Use Plan

Monitoring Program Terms of Reference

KINBASKET RESERVOIR
FISH AND WILDLIFE INFORMATION PLAN

- **CLBMON-1 Mica Dam Total Gas Pressure Monitoring and Abatement Program**

24 October 2007

Terms of Reference for the Columbia River Project Water Use Plan Monitoring Programs Kinbasket Reservoir Fish and Wildlife Information Plan

1.0 OVERVIEW

This document presents Terms of Reference for monitoring programs under the Kinbasket Reservoir Fish and Wildlife Information Plan (Table 1). These programs will evaluate the potential effects of Mica Dam and Kinbasket Reservoir operations on fish habitat and fish populations, wildlife habitat and wildlife populations.

This document provides detailed Terms of Reference for the following programs:

1) CLBMON-1 Mica Dam Total Gas Pressure Monitoring and Abatement Program: a 2-year study to determine dissolved gas supersaturation with synchronous condense operation of Units 3 and 4 in relation to Units 1 and 2, which have been previously monitored.

2) CLBMON-2 Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring: a 12-year program to monitor trends in the biological characteristics, distribution and abundance of kokanee populations in Kinbasket and Revelstoke reservoirs, and provide information required to link the effects of reservoir operation to population levels.

3) CLBMON-3 Kinbasket and Revelstoke Reservoirs Ecological Productivity Monitoring Program: a 12-year study to define the trophic web mechanisms and dynamics of Kinbasket and Revelstoke reservoirs, and determine if changes in pelagic productivity are associated with reservoir operations.

4) CLBMON-4 Kinbasket Reservoir Fish Stranding Assessment: a 3-year study to qualitatively evaluate the extent of fish stranding caused by the annual drawdown of Kinbasket Reservoir.

5) CLBMON-5 Kinbasket Reservoir Burbot Life History and Habitat Use Assessment: a 3-year study to obtain baseline data on the biological characteristics of burbot populations in Kinbasket Reservoir, and provide information to evaluate potential effects of reservoir operation on burbot population productivity

6) CLBMON-6 Kinbasket Reservoir Bull Trout Life History and Habitat Use Assessment: a 3-year study to obtain baseline data on the life history and habitat characteristics of juvenile bull trout in Kinbasket Reservoir, and provide preliminary information to determine if reservoir operations could have an effect on bull trout populations.

7) CLBMON-7 Kinbasket Reservoir Rainbow Trout Life History and Habitat Use Assessment: a 3-year study to obtain baseline data on the biological characteristics of rainbow trout in Kinbasket Reservoir, and provide the information required to evaluate the impacts of reservoir water levels on the productivity of rainbow trout populations.

8) CLBMON-8 Kinbasket Reservoir Monitoring of the Valemount Peatland: a 3-year monitoring program to address key uncertainties regarding the relative contribution and importance of the current reservoir operating regime to the erosion processes affecting the

wetland, obtain an inventory of plant and wildlife species, and determine whether the long-term viability of the wetland, and associated plant and animal species, are being affected by erosion processes related to reservoir operations, and how these effects may be mitigated.

Table 1 Kinbasket Reservoir Fish and Wildlife Information Plan Monitoring Program Terms of Reference Submission Information

Name of Monitoring Program	Order Clause Fulfilled	Submitted with this Package	Previously Submitted To CWR	Submission Date	Leave to Commence
CLBMON-1 Mica Dam Total Gas Pressure Monitoring and Abatement Program	Schedule A: 5.a	Yes	No	24 October 2007	No
CLBMON-2 Kinbasket and Revelstoke Reservoirs Kokanee Population Monitoring	Schedule A: 5.b Schedule B: 1.a	Yes	No	24 October 2007	No
CLBMON-3 Kinbasket and Revelstoke Reservoirs Ecological Productivity Monitoring Program	Schedule A: 5.c Schedule B: 1.b	Yes	No	24 October 2007	No
CLBMON-4 Kinbasket Reservoir Fish Stranding Assessment	Schedule A: 5.d	Yes	No	24 October 2007	No
CLBMON-5 Kinbasket Reservoir Burbot Life History and Habitat Use Assessment	Schedule A: 5.e	Yes	No	24 October 2007	No
CLBMON-6 Kinbasket Reservoir Bull Trout Life History and Habitat Use Assessment	Schedule A: 5.f	Yes	No	24 October 2007	No
CLBMON-7 Kinbasket Reservoir Rainbow Trout Life History and Habitat Use Assessment	Schedule A: 5.g	Yes	No	24 October 2007	No
CLBMON-8 Kinbasket Reservoir Monitoring of the Valemount Peatland	Schedule A: 5.h	Yes	No	24 October 2007	No

2.0 MONITORING PROGRAM RATIONALE

Early on in the Columbia River Water Use planning (WUP) process, the WUP Consultative Committee (WUP CC) recognized that there was a great deal of uncertainty regarding whether the lack of constraints on operation of Kinbasket Reservoir was having a significant impact on fish and wildlife and associated habitat. A number of key hypothesized impacts were identified during the issue scoping phase (e.g., entrainment at Mica Dam, and interruption of natural sturgeon recruitment processes).

However, a general lack of data on the relative abundance, distribution, life history and seasonal patterns of habitat use and supporting ecosystem processes in the upper Columbia River and Kinbasket Reservoir, precluded incorporation of these concerns into Water Use Plan assessments.

The WUP CC explored alternative ways of operating Kinbasket Reservoir to provide benefits to fish and wildlife by imposing minimum elevation constraints. However, the ability to track the performance of the alternatives was limited to use of habitat-based measures (pelagic productivity), which were developed based on limited site-specific data and professional judgment. Initial modeling results showed that some improvements to pelagic productivity could be achieved through a minimum elevation constraint, but that this constraint would incur a high cost in foregone power generation. While the WUP CC agreed to stop exploring water management options for Kinbasket Reservoir for more cost-effective non-operational works, it was acknowledged that this decision was based on a number of uncertain assumptions about reservoir ecology and the influence of reservoir operations. The WUP CC underscored the need for better information to support future decision-making as a key outcome of the Columbia River Water Use planning process.

The operational link for many of the proposed monitoring studies, developed to address current data gaps, was considered tenuous given that there were no operational changes being considered for Kinbasket Reservoir. However, the WUP CC recognized that a large obstacle to recommending operational or physical works for the reservoir was the lack of quantitative data on fish and wildlife populations. Therefore, the proposed monitoring studies were accepted as meeting the Water Use Plan monitoring criteria, because they are the only tool available to validate the assumptions made by the WUP CC when deciding on operational changes.

Although no operating changes were considered for Revelstoke Reservoir, the WUP CC recommended that some of the fish-related studies in Kinbasket be linked to studies in Revelstoke to provide a comparison of trends to inform on operational impacts.

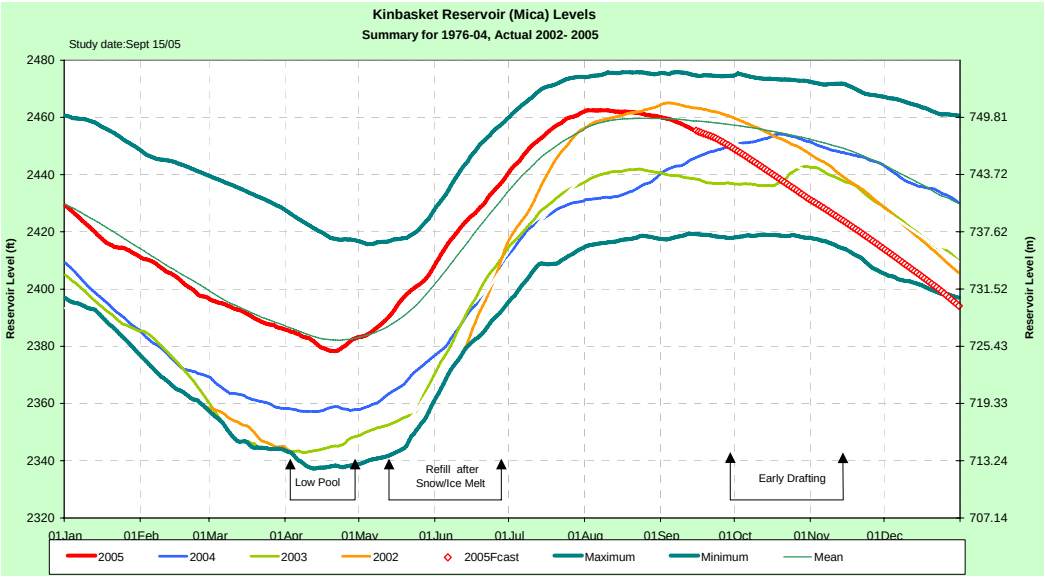

Figure 1 Seasonal pattern of water level drawdown and refill for Kinbasket Reservoir

Monitoring Program No. CLBMON-1 Mica Dam Total Gas Pressure Monitoring and Abatement Program

1.0 MONITORING PROGRAM RATIONALE

1.1 Background

Mica Generating Station has four generating units, with Units 1, 2, and 3 discharging into Tailrace 1, and Unit 4 into Tailrace 2. Units 1 and 2 were the only units historically capable of synchronous condense operation[1], which is used to provide voltage support and quick unit return to service, and can result in higher localized total dissolved gas pressure (TGP) levels below Mica Dam. Localized dissolved gas supersaturation (DGS) in the draft tube occurs when surface water is exposed to pressurized air, and through mixing of water with entrained air from wicket gate leakage. Synchronous condense operation increases DGS by injecting air (16 psi) into the draft tube to force water below the runner (to allow the runner to spin in air). Water surface turbulence from the spinning runner combined with the increased air pressure forces additional gas into the water column, creating supersaturation. Because the water in the immediate vicinity of the unit is stagnant during synchronous condense operation, supersaturation increases (volume of water supersaturated) over time. Cooling water and dam leakage in the draft tube then carries supersaturated water near the units down the draft tube and into the tailrace after 3-4 hours of synchronous condense operation. Units are operating in synchronous condense mode to some extent every month, although this operation occurs primarily during spring (March to May) and fall (October and November). Fish are able to move up into the draft tubes when units are operating in synchronous condense mode due to the limited discharge from the units, resulting in particular concern by BC Hydro staff and the fisheries regulatory agencies regarding fish mortalities in September and October when kokanee congregate at the base of the dam.

Fish mortalities in the Mica Dam tailrace were formally investigated by BC Hydro in 1996 and 1997. Potential causes of these mortalities included: entrainment from Kinbasket Reservoir; fish moving into the draft tube and potentially becoming injured during unit start up; fish dying at the completion of their life cycle (kokanee); and gas supersaturation. From 1996 to 1998, dissolved gas supersaturation data were collected at Mica Dam during a variety of unit operations. These data showed that DGS levels can reach levels of 200% saturation in the draft tube when both Units 1 and 2 were operated in synchronous condense mode; however, there was no conclusive relationship between DGS levels and time spent operating in synchronous condense mode. BC Hydro implemented a DGS best management practice in 1996, which was developed in consultation with fisheries regulatory agencies. The current operating criteria stipulate a 15 minute flushing operation (300 MW or 5000 cfs) for each generating unit for a cumulative 12 hours of synchronous condense.

Since 1998, periodic DGS data collection and observations for further fish mortalities have been conducted. Although there have been no further fish kills observed since the best management practice (BMP) was implemented, the WUP CC Fish Technical Sub-

[1] Synchronous condense operation is currently being installed into Units 3 and 4 and will be in service by July 2007.

Committee recommended further study should be undertaken to determine the downstream extent of TGP impacts, and to assess whether the BMP are most effective in maintaining local TGP levels below acceptable thresholds. In 2005, BC Hydro undertook a comprehensive review of all previously collected DGS data and conducted monitoring to confirm DGS levels (Fidler et al. 2005). This study, which characterized DGS levels and downstream extent for the two units with existing synchronous condense capability, showed that elevated DGS still exist in the draft tubes and tailrace, extending as far downstream as the Mica Blue Bridge. The question of downstream extent posed by the WUP CC was therefore addressed for existing synchronous condense operations; however, it is still uncertain whether there are benefits or additional impacts associated with installation of synchronous condense into Units 3 and 4. The goal of this monitoring program is to evaluate DGS levels and extent for synchronous condense operations of Units 3 and 4, when operated either separately or in conjunction with Units 1 and 2.

1.2 Management Questions

The key management question to be addressed through the monitoring program is:

Is there a difference in dissolved gas supersaturation depending on which of the four units at Mica Generation Station are operated in synchronous condense mode?

1.3 Management Hypothesis

The primary hypothesis associated with this management question is:

H_0: High DGS supersaturation exists when Mica generation units are operated in synchronous condense mode, regardless of which combination of units is used.

1.4 Key Water Use Decision Affected

The key water use decision affected by the results of the monitoring program is whether the existing best management practice (dissolved gas supersaturation flush operation) is sufficient to minimize risks to fish health.

2.0 MONITORING PROGRAM PROPOSAL

2.1 Objective and Scope

As a result of new data becoming available (Fidler et al. 2005), the scope of this study has changed from that recommended by WUP CC, and will now focus on impacts of operating Units 3 and 4 in synchronous condense mode. The primary objective of the monitoring program is to determine dissolved gas supersaturation with synchronous condense operation of Units 3 and 4 in relation to Units 1 and 2, which have been previously monitored. Monitoring will occur for a total of two years, instead of the five years initially recommended.

The original recommendation of the WUP CC also included monitoring to inform on whether operations can be optimized with respect to duration and timing to reduce costs of the BMP. However, because the results of the 2005 study indicated that DGS levels

were still elevated despite current best management practices, new options for reducing DGS levels will now be investigated through a separately-funded engineering scoping study, scheduled for 2007.

2.2 Approach

Monitoring will focus on DGS levels produced by operation of Units 3 and 4 in synchronous condense mode, either alone or in conjunction with Units 1 and 2. The monitoring approach will replicate monitoring activities undertaken in 2005 with respect to locations and duration (Fidler et al. 2005), using a combination of spot and continuous dissolved gas supersaturation measurements under a variety of operating scenarios defined by BC Hydro (BC Hydro, unpublished data).

Annual spring and fall monitoring will occur during two of the first five years of the Columbia River Water Use Plan implementation, as described in Section 2.3.3. The dissolved gas supersaturation monitoring will occur during periods of extended synchronous condense operation (two or more units on synchronous condense operation with no other units generating). As such, a protocol between the BC Hydro Generation Resource Management planning engineer, the Mica Generating Station and the field crew will need to be established for: (1) communication; (2) operation scheduling; and (3) safety.

2.3 Tasks

2.3.1 Task 1: Project Coordination

Project coordination will involve the general administrative and technical oversight of the program. This coordination will include, but will not be limited to: 1) budget management; 2) study team management; 3) logistic coordination; 4) technical oversight for field and analysis components; and 5) facilitation of data transfer among related investigations.

A safety plan must be developed and submitted to the BC Hydro contact, for all aspects of the study involving field work, in accordance with BC Hydro procedures and guidelines. Specific safety training may be required.

2.3.2 Task 2: Development of Study Plan

In consultation with BC Hydro Environment staff and Operations Planners, a study plan to monitor dissolved gas supersaturation will be developed, using a variety of unit operations at index sites established in 2005. Additional operating scenarios to those already monitored will be tested. The following methodologies are suggested as possibilities and have been used as the basis for establishing the budget. Alternative methodologies may be proposed during the contracting process.

2.3.3 Task 3: Data Collection and Management

DGS monitoring at the Mica Dam is expected to occur over four days during the first session. Continuous on-site presence is expected during this monitoring session to ensure meters are operating correctly. Subsequent monitoring periods may be modified depending on the results observed during Session 1. Physical monitoring at the Mica

Dam will be conducted from one of the following locations: fixed monitoring sites on dam structures (e.g. draft tube galleries and the Tailrace Tunnel 1 and 2 outlet port structure); the eastern bank of Revelstoke Reservoir; or within the reservoir from a power boat. Dissolved gas supersaturation meters, provided by BC Hydro, will be serviced and calibrated at the BC Hydro offices in Revelstoke, with field re-calibration as required. All data obtained from the recording instruments will be downloaded to a computer in the field and backup copies of the computer files will be produced.

All field data collection shall follow the detailed methods used for monitoring described in Fidler et al. (2005). BC Hydro will maintain records of unit operation and air injection into the units, and provide this information for presentation with the data report.

A MS Excel database, consistent with the 2005 monitoring program, will be developed to enter all collected data, and QA/QC of all data will be undertaken against spot measurements and unit operation.

2.3.4 Task 4: Reporting

A brief technical report of the findings of the program will be prepared annually. Upon completion of the monitoring program, a comprehensive final synthesis report will be prepared for use in the next review of the Columbia River Water Use Plan, which will include:

a) an executive summary;
b) a description of the methods employed;
c) a data summary of dissolved gas supersaturation information collected (spot and continuous measurements) in MS Excel format; data will also be summarized using graphical representations consistent with Fidler (2005);
d) photographs and a map of dissolved gas supersaturation monitoring sites;
e) a comparison of results between years;
f) a detailed summary of the findings as they relate to the ecological hypotheses and the key management questions; and
g) recommendations towards future monitoring (if any).

Reports will follow the standard format that is being developed for WUP monitoring programs. 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 either as embedded objects in the Word file or as separate files.

2.4 Interpretation of Monitoring Program Results

Dissolved gas supersaturation data collected during various combinations of synchronous condense operation at the Mica Generating Station will be compared to the BC Water Quality Criteria for dissolved gas supersaturation (Fidler 1997 and 2004) to determine the effects of synchronous condense operation of Units 3 and 4 in relation to Units 1 and 2, and on overall DGS levels. Results from the various operational scenarios will be examined in conjunction with findings from the engineering scoping study to evaluate options to reduce DGS levels, and recommendations will be made.

2.5 Schedule

It is proposed that this program be conducted during two of the first five years of implementation of the Columbia River Water Use Plan.

2.6 Budget

The total annual budget for the Mica Dam Total Gas Pressure Monitoring and Abatement Monitoring Program is estimated at $31,356 (in 2004 dollars). The estimated budget breakdown by task is provided below in the Table CLBMON-1-1.

3.0 REFERENCES

Fidler, L.E., et al. 2005. Dissolved Gas Supersaturation at the Mica Dam, 2005. Draft report prepared by Aspen Applied Sciences Ltd. for BC Hydro. 74 pp.

Fidler, L.E., and Miller, S.B. 1997. British Columbia Water Quality Criteria for Dissolved Gas Supersaturation - Technical Report. Contract report to the B.C. Ministry of Environment, Department of Fisheries and Oceans, and Environment Canada. Aspen Applied Sciences Ltd., Cranbrook, B.C., Canada.

Fidler, L.E. 2004. Addendum to the "British Columbia Water Quality Guidelines for the Protection of Aquatic Biota from Dissolved Gas Supersaturation (DGS)" and Protocols for Development of Site-specific Guidelines for DGS. Contract report to Fisheries and Oceans Canada, Habitat and Enhancement Branch, Pacific Region, Vancouver, B.C., Canada by Aspen applied Sciences Ltd., Kimberley, B.C., Canada.