Columbia River Project Water Use Plan
Physical Works Terms of Reference

KINBASKET AND ARROW LAKES RESERVOIRS REVEGETATION MANAGEMENT PLAN

- **CLBWORKS-2 Mid Columbia and Arrow Lakes Reservoir Revegetation Program Physical Works (Phase 2)**

22 February 2008

KINBASKET AND ARROW LAKES RESERVOIRS REVEGETATION MANAGEMENT PLAN TERMS OF REFERENCE

1.0 OVERVIEW

This document presents Terms of Reference for the Arrow Lakes Reservoir physical works being implemented under the Kinbasket and Arrow Lakes Reservoirs Revegetation Management Plan (Table 1). This Plan involves implementation of revegetation physical works, monitoring of representative planting sites under various revegetation treatments, mapping and inventory of vegetation communities at different spatial scales, identification of riparian wildlife habitat and monitoring of wildlife utilization patterns in response to revegetation efforts in Kinbasket and Arrow Lakes reservoirs, and the mid Columbia River.

The Terms of Reference for CLBWORKS-2 Arrow Lakes Reservoir Revegetation Program Physical Works provides a detailed plan, scope and budget for the second implementation phase (2008-2010). Leave to Commence for Phase 1 (2007) of this program was received by the CWR and the first year of work has been completed.

1.1 Physical Works

1) CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program: a 5-year reservoir-wide revegetation program to enhance sustainable vegetation growth within the drawdown zone of the mid Columbia River and the Arrow Lakes Reservoir to benefit fish, wildlife, archaeological site protection, shoreline stabilization, aesthetics, dust control and recreation.

Table 1 Kinbasket and Arrow Lakes Reservoir Revegetation Management Plan Physical Works and Monitoring Program Terms of Reference Submission Information

Name of Monitoring Program or Physical Works	Order Clause Fulfilled	Submitted with this Package	Previously Submitted To CWR	Submission Date	Leave to Commence
CLBWORKS-1 Kinbasket Reservoir Revegetation Program	Schedule A: 1.a	No	Yes	04 April 2007 25 January 2008	Yes (Phases 1 & 2)
CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program	Schedule C: 1.a Schedule D: 1.a	Yes	Yes	04 April 2007	Yes (Phase 1)
CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts	Schedule A: 2.a	No	Yes	25 January 2008	No
CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources	Schedule A: 2.b	No	Yes	04 April 2007	No

Name of Monitoring Program or Physical Works	Order Clause Fulfilled	Submitted with this Package	Previously Submitted To CWR	Submission Date	Leave to Commence
CLBMON-11A Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir	Schedule A: 2.c	No	Yes	25 January 2008	Yes
CLBMON-11B Effectiveness Monitoring of Revegetation in the Mid Columbia and Arrow Reservoir	Schedule C:5.a Schedule D: 2.a	No	No		No
CLBMON-12 Mid Columbia River and Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis	Schedule C: 2.a Schedule D: 2.b Schedule D: 2.c	No	Yes	25 January 2008	No
CLBMON-13 Inventory of Mosquito Populations in the Revelstoke Area	Schedule C: 5.b	No	Yes	25 January 2008	Yes
CLBMON-33 Mid Columbia and Arrow Lakes Reservoir Inventory of Vegetation Resources	Schedule C: 2.b Schedule D: 2.c	No	Yes	04 April 2007	No
CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation	Schedule C: 2.c Schedule D: 2.d	No	Yes	25 January 2008	No

2.0 PROGRAM RATIONALE

The Columbia River Water Use Plan Consultative Committee (WUP CC) recognized the value of riparian and wetland vegetation surrounding Kinbasket and Arrow Lakes reservoirs for enhancing littoral productivity, providing physical, structural and biological character for wildlife habitat, protecting cultural heritage sites and providing aesthetic benefits (e.g., reduction of dust storms) within the drawdown zones. As a result, the protection and enhancement of high quality riparian and wetland vegetation emerged as a key environmental objective for the Columbia River Water Use Plan.

The WUP CC supported reservoir-wide revegetation programs for Kinbasket and Arrow Lakes reservoirs in lieu of maintaining lower elevations during the growing season than those provided under current operations to maximize vegetation growth in the drawdown zones (BC Hydro 2005). The revegetation approach consists of multi-year programs with interventions over five years to facilitate the growth of vegetative cover in those areas that have good potential to become self-sustaining. Key environmental and social objectives of the revegetation program are to maximize vegetation growth in the drawdown zones to benefit littoral productivity, wildlife habitat, shoreline erosion, dust control, recreation and archaeological site protection.

2.1 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program

Riparian vegetation in Arrow Lakes Reservoir, and in particular the mid Columbia (Revelstoke Reach), presently extends over an elevation range of about 10 m (430 m to 440 m). Expansion of vegetation into the lower elevations appears to have occurred largely as a result of a fall rye (*Secale cereale*) seeding program that began in the early 1990s, and which may have facilitated the spread of natural vegetation (sedge and grass). A series of low water years from 1990 to 1999 also allowed for the establishment of natural vegetation by providing seedlings sufficient growing time to develop into mature plants that are capable of tolerating subsequent extended inundation. Data indicate that these factors have worked in concert over the past decade to allow for the establishment and persistence of extensive areas of vegetation, which now dominate the drawdown zone of Revelstoke Reach and smaller areas in the main body of the Arrow Lakes Reservoir (Moody 2005).

Recognizing the importance of riparian and wetland vegetation in the drawdown zone, the WUP CC explored several operating alternatives designed to maintain existing vegetation in the mid Columbia and the Arrow Lakes Reservoir by imposing lower reservoir elevations for longer periods during the early part of the growing season (late spring and early summer). Modeling of these alternatives showed that stricter elevation constraints would provide varying levels of protection to vegetation, but could incur very high costs in lost power generation in some years. There was also concern around the high level of uncertainty in many of the assumptions used to develop elevation constraints, particularly around the relative importance of timing, duration and depth of inundation on the distribution, biomass and species diversity of vegetation. To address these concerns, the WUP CC recommended a multi-year revegetation program in areas between elevations 434 m and 440 m, and stated that areas below the 434m elevation should continue to be addressed as required by BC Hydro's dust control program (BC Hydro 2005). The final decision of the WUP CC to support a revegetation program for the mid Columbia and Arrow Lakes Reservoir was based on the assumption that the soft constraints operating regime (available at http://www.bchydro.com/rx_files/environment/environment51070.pdf) would be effective in maintaining current levels of vegetation, and that revegetation activities would be a more cost-effective means of remediating and expanding vegetation cover for ecological and social benefits than imposing hard constraints on the operation of the reservoir (BC Hydro 2005).

The mid Columbia and Arrow Lakes Reservoir revegetation program will target areas that have a good potential to become self-sustaining after five years of treatment as a cost-effective means of maximizing vegetation growth in the drawdown zone of the Arrow Lakes Reservoir. The program's environmental and social objectives are to:

- enhance littoral productivity;
- improve physical, structural and biological features of wildlife habitat;
- protect cultural heritage sites;
- provide benefits to recreation and shoreline stability; and,
- provide aesthetic benefits (e.g., reduction of dust storms).

The WUP CC agreed that monitoring of the revegetation program would be critical to:

- evaluate the effectiveness of revegetation efforts at enhancing sustainable vegetation cover in the drawdown zone;

- determine effects of the soft constraints operating regime on existing vegetation; and,
- assess benefits of the revegetation program to wildlife habitat, archaeological site protection and shoreline stability.

The monitoring component of the mid Columbia and Arrow Lakes Reservoir Revegetation Program includes the following Terms of Reference:

- Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis (CLBMON-12) – implementation to be initiated in 2008.
- Arrow Lakes Reservoir Inventory of Vegetation Resources (CLBMON-33) – the program was initiated in 2007, and bi-annual monitoring will commence in 2008.
- Arrow Lakes Reservoir Plant Response to Inundation (CLBMON-35) – implementation to be initiated in 2010.

3.0 REFERENCES

BC Hydro. 2005. Consultative Committee report: Columbia River Water Use Plan, Volumes 1 and 2. Report prepared for the Columbia River Water Use Plan Consultative Committee by BC Hydro, Burnaby, BC. 924 pp.

Moody, A.I. 2005. Mica-Revelstoke-Keenleyside Water Use Plan: potential areas for vegetation establishment in the Arrow Lakes Reservoir. Prepared for BC Hydro. 49 pp.

Moody, A.I. 2007a. Mid Columbia and Arrow Lakes Reservoir Revegetation Program – Phase 1 (2007). Report prepared for BC Hydro. 20 p. plus appendices.

Moody, A.I. 2007b. Mid Columbia and Arrow Lakes Reservoir Revegetation Program – Phase 1 (2007). Addendum to Final Report. Report prepared by AIM Ecological Consultants Ltd. for BC Hydro. 37 pp.

Physical Works No. CLBWORKS-2
Mid Columbia and Arrow Lakes Reservoir Revegetation Program – Phase 2

1.0 PHYSICAL WORKS RATIONALE

The WUP CC supported revegetation programs in Revelstoke Reach and the Arrow Lakes Reservoir based on the assumption that the soft constraints operating regime for Arrow Lakes Reservoir (Appendix III) would be effective in maintaining existing levels of vegetation. To verify this assumption and evaluate how effectively revegetation efforts are meeting the multiple objectives set by the WUP CC, the Committee recommended associated vegetation monitoring programs, which include:

- CLBMON-11B Wildlife Effectiveness Monitoring of Revegetation and Wildlife Physical Works in the mid Columbia and the Arrow Lakes Reservoir
- CLBMON-12 Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis
- CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources
- CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation

These monitoring programs, for which separate Terms of Reference have been prepared, will be implemented in parallel with revegetation efforts.

The WUP CC set out guiding principles by which the revegetation programs should be implemented, as outlined below (BC Hydro 2005):

- Revegetation will be undertaken only in areas that have good potential to become self-sustaining in five years.
- Any revegetation activity must be done in a manner that is respectful of existing First Nation archaeological sites.
- Revegetation efforts on the Arrow Lakes Reservoir are to be directed above elevation 434 m (1424 ft). Areas below this elevation are still to be addressed as required by the BC Hydro dust control program.
- Above Arrow Lakes Reservoir elevation 434 m (1424 ft), planting efforts to address erosion and dust control issues are a high priority.
- Planting will not occur where efforts will be disrupted by or interfere with other forms of public use. This will require consultation with local stakeholders.

Because development of a ‘permanent’ riparian/wetland cover in the reservoir is expected to involve treatments over several years, the revegetation program is being implemented as a multi-year project requiring intervention of up to five years. The first year of the program (Phase 1) was completed in 2007, and included field verification of revegetation potential, as well as prioritization of revegetation sites and initiation of nursery stock. These Terms of Reference address Phase 2 of the program (2008-2010), during which all areas identified in Phase 1 will be revegetated. The final two years of the program (2011-2012) will be implemented in conjunction with CLBWORKS-30 Arrow Lakes Reservoir Wildlife Physical Works to ensure that revegetation efforts are targeting those areas where wildlife habitat

benefits can be maximized. Separate Terms of Reference will be prepared for the final two years of program implementation.

In accordance with the above guiding principles for the revegetation program (from BC Hydro 2005), the specifics of the program, as described in these Terms of Reference, have been developed through public and First Nations consultation to ensure that revegetation prescriptions are compatible with other land uses (e.g., motorized and non-motorized recreation, beach areas) and requirements for First Nation archaeological site protection. In addition, vegetation types valued for traditional use by First Nations have been incorporated into the prescriptions, where feasible.

1.1 Available Areas for Revegetation

During the WUP process, potential impacts of reservoir operations were modeled separately (BC Hydro 2005) for three elevations in the drawdown zone, due to differences in the characteristics of the vegetation communities that have become established within these zones and their importance to various interests[1]. These elevation zones include:

- Elevation 434 to 436 m – Vegetation present, low biomass, low diversity; dominated by perennial sedge and reed canary grass.
- Elevation 436 to 438 m – Vegetation present, high biomass, moderate diversity; dominated by perennial sedge and reed canary grass, but supports a number of other species.
- Elevation 438 to 440 m – Vegetation present, moderate biomass, high diversity; more terrestrial in nature. Significant component of shrubs and lower biomass of herbaceous species than at 436 to 438 m.

While some vegetation has also become established between elevation 430 and 434 m, the WUP CC recognized that this establishment has occurred largely in recent years, likely as a result of a series of low water years. The WUP CC therefore agreed that it was not reasonable to expect that vegetation at elevations below 434 m be maintained, given the variability in reservoir water levels across years. A recent re-evaluation (Moody 2007a, b) of sites initially identified for revegetation has revealed that there is substantially less area available for revegetation than identified in preliminary work (Moody 2005). The reduced area available for revegetation has resulted from a combination of the WUP CC decision to establish 434 m as the lower boundary for the revegetation program physical works, and a recent pattern of low water levels in the latter part of the growing season, which has been beneficial for vegetation growth and expansion in the drawdown zone. Because of favorable growing conditions, many of the sites above 434 m, which were unvegetated at the time of the previous vegetation mapping, are now partially to fully vegetated. The areas not currently vegetated appear to be “problem sites”, where wind or water erosion and substrates present unique challenges to vegetation establishment.

[1] Interests included recreation, wildlife, vegetation, culture and heritage, and erosion control.