

**Columbia River Project Water Use Plan**

**Monitoring Program Terms of Reference**

**Physical Works Terms of Reference**

**KINBASKET AND ARROW LAKES RESERVOIRS  
REVEGETATION MANAGEMENT PLAN**

- **CLBWORKS-1 Kinbasket Reservoir Revegetation Program Physical Works (Years 2-5)**

**25 January 2008**

# KINBASKET AND ARROW LAKES RESERVOIRS REVEGETATION MANAGEMENT PLAN TERMS OF REFERENCE

## 1.0 OVERVIEW

This document presents Terms of Reference for the physical works and effectiveness monitoring programs for the Kinbasket and Arrow Lakes Reservoirs Revegetation Management Plan (Table 1). These programs will involve 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-1 Kinbasket Reservoir Revegetation Program Physical Works provide a detailed plan, scope and budget for the second implementation phase (Year 2-5). Leave to Commence for Year 1 (Phase 1) of this program has been received, as has Leave to Commence for Year 1 (Phase 1) of CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program. Leave to Commence has also been received for the monitoring programs CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources and CLBMON-33 Mid Columbia and Arrow Lakes Reservoir Inventory of Vegetation Resources. Terms of Reference for CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program (Years 2 and 3) will be submitted by the revised ordered date of 26 February 2008.

An overview of the two physical works and seven effectiveness monitoring programs, which form part of this management plan, is provided below.

## 1.1 Physical Works

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

Development of the final revegetation program for CLBWORKS-1 has incorporated feedback from public and First Nation consultation processes to ensure that:

- a) the plan is not in conflict with other land uses (e.g., motorized and non-motorized recreation, beach areas);
- b) revegetation prescriptions are compatible with First Nation archaeological site protection requirements; and,
- c) revegetation prescriptions incorporate plant species traditionally valued by First Nations, where possible.

## Monitoring Programs

- 1) CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis: a 10-year program to evaluate plant survival and monitor representative planting sites under the various revegetation treatments in Kinbasket Reservoir. This study will also assess changes in existing vegetation communities at the site (local) level in response to the operating regime of Kinbasket Reservoir.
- 2) CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources: a 10-year program to assess and map spatial extent, structure and composition of existing vegetation communities at the landscape scale within Kinbasket Reservoir to determine inter-community changes over time in response to ongoing operation of Kinbasket Reservoir. This program also identified riparian wildlife habitat in Year 1.
- 3) CLBMON-11 Kinbasket and Arrow Lakes Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works: an 11-year program to conduct effectiveness monitoring of wildlife habitat utilization in response to revegetation efforts in Kinbasket Reservoir, and revegetation efforts and wildlife physical works in the mid Columbia River and Arrow Lakes Reservoir.
- 4) CLBMON-12 Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis: a 10-year program to evaluate plant survival and monitor representative revegetation sites under the various revegetation treatments in the mid Columbia River and Arrow Lakes Reservoir. This study will also assess changes in existing vegetation communities at the site (local) level in response to the soft constraints operating regime of the Arrow Lakes Reservoir.
- 5) CLBMON-13 Monitoring of Mosquito Populations in the Revelstoke Area: a 2-year program to monitor the distribution and abundance of larval and adult mosquitoes in relation to physical environmental variables (elevation, temperature) and biotic variables (habitat) in the Revelstoke area.
- 6) CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources: a 10-year program to assess and map vegetation distribution by elevation and identify riparian wildlife habitat in relation to inundation cycles and revegetation efforts in the mid Columbia River and Arrow Lakes Reservoir.
- 7) CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation: a 5-year program to evaluate responses of plants of different ages, seedlings to mature plants, and species to inundation cycles in the mid Columbia River and Arrow Lakes Reservoir.

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

<b>Name of Monitoring Program or Physical Works</b>	<b>Order Clause Fulfilled</b>	<b>Submitted with this Package</b>	<b>Previously Submitted To CWR</b>	<b>Submission Date</b>	<b>Leave to Commence</b>
CLBWORKS-1 Kinbasket Reservoir Revegetation Program	Schedule A: 1.a	Yes	Yes	04 April 2007	Yes – Year 1 only
CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program	Schedule C: 1.a Schedule D: 1.a	No <sup>1</sup>	Yes	04 April 2007	Yes – Year 1 only
CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts	Schedule A: 2.a	Yes	No	25 January 2008	No
CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources	Schedule A: 2.b	No	Yes	04 April 2007	Yes
CLBMON-11A Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir	Schedule A: 2.c	Yes	No	25 January 2008	No
CLBMON-11B Effectiveness Monitoring of Revegetation in the mid Columbia River and the Arrow Lakes 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	Yes	No	25 January 2008	No
CLBMON-13 Inventory of Mosquito Populations in the Revelstoke Area	Schedule C: 5.b	Yes	No	25 January 2008	No
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	Yes
CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation	Schedule C: 2.c Schedule D: 2.d	Yes	No	25 January 2008	No

<sup>1</sup> Terms of Reference for the implementation phase (Years 2-3) of CLBWORKS-2 Arrow Lakes Reservoir Revegetation Program will be submitted by the revised ordered date of February 26, 2008.

## 2.0 PROGRAM RATIONALE

The Columbia River Water Use Plan Consultative Committee (WUP CC) recognized the value of riparian 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 zone. As a result, the protection and enhancement of high quality riparian vegetation emerged as a key environmental objective for Columbia River Water Use Plan, and operational, as well as non-operational alternatives to maximize vegetation diversity and wildlife habitat were a fundamental consideration throughout the water use planning process.

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. The revegetation approach consists of multi-year programs with intervention over five years to facilitate long-term 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<sup>2</sup> in the drawdown zones; and,
- provide benefits to littoral productivity, wildlife habitat, recreation, shoreline erosion and archaeological site protection.

Monitoring programs and physical works Terms of Reference presented herein collectively form the Kinbasket and Arrow Lakes Reservoirs Revegetation Management Plan (RMP).

### *Kinbasket Reservoir Revegetation Program*

During the WUP process, the regulation of reservoir filling and changes to minimum annual elevations were explored by the WUP CC as a means of achieving a number of environmental and social benefits for Kinbasket Reservoir; however, modeling of these alternatives revealed that these incremental changes in operations would incur very high costs in foregone power generation (BC Hydro 2005). In addition, preliminary work on developing revegetation strategies for the drawdown zone of Kinbasket Reservoir (Moody and Carr 2003) indicated that the greatest limiting factor to vegetation establishment was not the operation of the reservoir (based on reservoir operation data between 1991 and 2001), but lack of initial vegetation establishment, which could likely be addressed through targeted planting. The WUP CC therefore agreed to reject further analysis of operating alternatives for the purpose of enhancing vegetation potential, and recommended instead a revegetation program for Kinbasket Reservoir, aimed at maximizing vegetation growth in the drawdown zone to meet the environmental and social objectives stated above. This program will be implemented through the revegetation physical works CLBWORKS-1 (Kinbasket Reservoir Revegetation Program).

This document provides detailed Terms of Reference for the implementation phase (Years 2-5) of CLBWORKS-1, based on results obtained during Year 1 of this program<sup>3</sup> (Keefer 2007). Incorporated into the final revegetation program are feedback from public and First

<sup>2</sup> Vegetation growth can be defined as the increase in area of self-sustaining vegetation cover.

<sup>3</sup> Phase 1 work included field verification of revegetation potential and prioritization of revegetation sites, collection of seed and initiation of nursery stock.

Nation consultation processes to ensure that the planned approach does not conflict with other land uses (e.g., motorized and non-motorized recreation, beach areas), and that revegetation prescriptions are compatible with First Nation archaeological site protection requirements and incorporate traditional use species, where possible.

In association with the revegetation physical works, the WUP CC recommended inventory and effectiveness monitoring programs to ensure that the Kinbasket Reservoir revegetation efforts are providing the intended environmental and social benefits over the long term. The monitoring programs include the following Terms of Reference:

- Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis (CLBMON-9)
- Kinbasket Reservoir Inventory of Vegetation Resources (CLBMON-10)

#### *Mid Columbia River and Arrow Lakes Reservoir Revegetation Program*

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

Recognizing the importance of this vegetation as a means of achieving a number of environmental and social benefits for Arrow Lakes Reservoir, the WUP CC explored several operating alternatives, designed to maintain existing vegetation in the mid Columbia (Revelstoke Reach) and 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, frequency, duration and depth of inundation on the distribution, biomass and diversity of vegetation.

To address these concerns, the WUP CC recommended a multi-year revegetation program between elevations 434 m and 440 m in those areas that have a good potential to become self-sustaining after five years of treatment as a more cost-effective means of maximizing vegetation growth in the drawdown zone of Arrow Lakes Reservoir. The goal of the program is to provide benefits to littoral productivity, large river habitat, wildlife habitat, shoreline erosion and archaeological site protection. The program will be implemented through the Mid Columbia and Arrow Lakes Reservoir Revegetation Program Physical Works (CLBWORKS-2). The WUP CC agreed that annual monitoring of the revegetation program would be critical to evaluate the effectiveness of planting efforts, and confirm the effectiveness of techniques for vegetation and wildlife habitat enhancement. The monitoring program includes the following Terms of Reference:

- Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis (CLBMON-12)
- Arrow Lakes Reservoir Inventory of Vegetation Resources (CLBMON-33)
- Arrow Lakes Reservoir Plant Response to Inundation (CLBMON-35)

## 2.1 Additional Monitoring Programs

Two additional programs are included in the Kinbasket and Arrow Lakes Reservoir Revegetation Management Plan (RMP), specifically:

- Kinbasket and Arrow Lakes Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works (CLBMON-11)
- Monitoring of Mosquito Populations in the Revelstoke Area (CLBMON-13)

CLBMON-11 will monitor the effectiveness of wildlife habitat utilization in the Kinbasket and Arrow Lakes reservoir drawdown zones, with the goal of assessing the benefits of revegetation efforts and physical works (mid Columbia and Arrow Lakes only) to wildlife.

The goal of CLBMON-13 is to gain a better understanding of the species, life history and habitat requirements of mosquito species occupying habitats in the Revelstoke area, to determine the effect that dam discharge and reservoir management have on mosquito levels in the area. Because water pockets that form in revegetated areas and in other vegetated spots when reservoir levels recede may provide additional mosquito breeding habitat, this program will also examine potential effects of revegetation efforts in the drawdown zone on mosquito production (species and abundance).

## 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.

Carr, W.W. and A.I. Moody. 2003. Mica - Revelstoke - Keenleyside Water Use Plan: Potential areas for vegetation establishment in the Kinbasket Reservoir. Report prepared for BC Hydro. 40 pp.

Keefer, M.E., T. Ross and K. Kettenring. 2007 Kinbasket Reservoir Revegetation Program Physical Works (Phase 1) Site Verification and Seed Collection. Report prepared for BC Hydro. 34 p. plus appendices.

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.

## **Physical Works No. CLBWORKS-1 Kinbasket Reservoir Revegetation Program – Implementation Phase**

### **1.0 PROGRAM RATIONALE**

During the Columbia River Water Use (WUP) planning process, the WUP Consultative Committee (WUP CC) recognized the value of vegetation for improving aesthetic quality, controlling dust, protecting cultural heritage sites from erosion and human access, and enhancing littoral productivity and wildlife habitat. The WUP CC further recognized that the most significant opportunity for accomplishing these objectives lay in restoring and expanding riparian and wetland vegetation in the reservoir drawdown zone, because the drawdown zone is the only area that can be substantially affected by changes in BC Hydro's operation of the reservoir.

After considering several operating alternatives, the WUP CC supported a reservoir-wide planting and enhancement program in lieu of operational changes during the growing season, to maximize vegetation growth in the drawdown zone and to facilitate the development of long-term self-sustaining riparian vegetation. This program will target the upper elevations of the drawdown zone between elevations 747 m and 754 m, and investigations will be undertaken to examine the feasibility of extending vegetation into lower portions of the drawdown zone, to a lower limit of 741 m<sup>4</sup>. Key environmental and social objectives of the revegetation program are to provide benefits for littoral productivity, wildlife habitat and archaeological site protection (also see Section 1.1).

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

- Revegetation will be undertaken only in areas that have a 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.
- 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 targeted treatments over several years, the revegetation program is being implemented as a multi-year project requiring intervention over five years. The first year of the program (Phase 1) has been completed, which included field verification of revegetation potential and prioritization of sites, collection of seed and initiation of nursery stock.

In accordance with the guiding principles for the revegetation program stated above (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 the plan does not conflict with other land uses (e.g., motorized and non-motorized recreation, beach areas), and that revegetation prescriptions are compatible with First Nation archaeological site protection requirements. In addition,

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<sup>4</sup> The operating range of Kinbasket Reservoir is between 707 m (2320 ft) and 754 m (2474 ft). The lower limit of 741 m (2431 ft) for revegetation has been set based on the observations that 741 m was the lowest limit of vegetation growth in 2002 (Moody and Carr 2003).

vegetation types valued in traditional use by First Nations, as identified through meetings with First Nation elders, have been incorporated into the prescriptions, where feasible.

## 1.1 Scope and Objectives

The scope of the physical works includes revegetation of suitable sites over four years (2008-2011) between elevations 741 m and 754 m in the drawdown zone of Kinbasket Reservoir. The main focus of the program are the upper eight meters of the drawdown zone (747-754 m), with experimental treatments in the lower six meters (741-746 m) informing on the potential for successful revegetation over the course of the program (see Section 2.1.6). Twenty-six sites, between elevations 747 m and 754 m, were surveyed during Year 1 of the project, and are identified on the attached maps (Appendix I). Also included in the scope of the physical works is verification of revegetation potential, prioritization of sites, and testing of revegetation treatments for suitable sites between elevations 741-747 m, which were inaccessible in Year 1 as a result of high water levels.

Key environmental and social objectives of the Kinbasket Reservoir Revegetation Program physical works are to:

- maximize vegetation growth in the drawdown zone<sup>5</sup>;
- provide benefits to littoral productivity and wildlife habitat through increased plant species diversity;
- improve shoreline stability through targeted planting, where possible;
- increase the species diversity of native plants, particularly those of interest to First Nations; and,
- provide increased protection for known archaeological sites, where possible.

These objectives will be achieved through application of a variety of prescriptions (see Section 2.2.7) in suitable sites that specifically target the above values. Therefore, the proposal shall clearly identify how specified treatments, as applied to different elevation zones and priority areas, will accomplish these objectives. Specifically, the proposal shall include information on:

- a) which treatment (or combination of treatments) is recommended for each identified site (or combination of sites) and/or elevation ranges;
- b) why this treatment is deemed suitable for the identified site(s) and/or elevation ranges;
- c) which objective(s) the treatment(s) will address;
- d) in which year(s) of the program the treatment is expected to be applied; and,
- e) the approximate cost of each identified treatment per year, by hectare, and total cost of all treatments per year.

## 1.2 Consideration of the Kinbasket Reservoir Operating Regime

Development of riparian and wetland vegetation is believed to depend on the duration and timing of inundation of emergent vegetation during the growing season, as well as the maximum full pool level of the reservoir (Moody and Carr 2003). In any

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<sup>5</sup> Vegetation growth can be defined as the increase in area of self-sustaining vegetation cover.

given year, conditions that favour the growth of riparian vegetation may or may not be met, depending on the operating regime of the reservoir.

Because reservoir water levels will greatly influence the viability of existing vegetation communities and the successful establishment of revegetated areas, they must be explicitly considered in each year of program implementation. For example, high reservoir levels in 2006 and 2007 (Table CLBWORKS-1-1) resulted in the mortality of almost all terrestrial vegetation species that had established in the upper elevations of the drawdown zone (752-754 m) over the previous six growing seasons (Keefer et al. 2007).

Projected reservoir levels will be provided to the consultant in early February of each year to assist with planning of revegetation strategies for the upcoming field season.

**Table CLBWORKS-1-1. Proportion of time (year) that Kinbasket Reservoir elevations exceeded a particular elevation band (m ASL) for the period 1997 – 2007 (from Hawkes et al. 2007).**

Elevation Band	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007*	Avg
741 – 742	0.43	0.54	0.47	0.41	0.16	0.40	0.38	0.45	0.47	0.55	0.51	0.43
742 – 743	0.42	0.50	0.47	0.37	0.10	0.38	0.36	0.41	0.44	0.55	0.48	0.41
743 – 744	0.42	0.47	0.45	0.33	0.01	0.36	0.33	0.34	0.41	0.53	0.46	0.37
744 – 745	0.42	0.41	0.40	0.30		0.34	0.20	0.28	0.38	0.50	0.43	0.33
745 – 746	0.40	0.37	0.37	0.25		0.32	0.08	0.26	0.35	0.48	0.41	0.30
746 – 747	0.38	0.33	0.33	0.23		0.30		0.21	0.30	0.45	0.38	0.26
747 – 748	0.35	0.30	0.28	0.19		0.28		0.16	0.24	0.43	0.36	0.23
748 – 749	0.32	0.27	0.25	0.15		0.25		0.08	0.21	0.41	0.33	0.21
749 – 750	0.30	0.24	0.23	0.09		0.22		0.01	0.18	0.38	0.30	0.18
750 – 751	0.28	0.20	0.20	0.02		0.18			0.14	0.33	0.26	0.15
751 – 752	0.25	0.15	0.17			0.12			0.08	0.29	0.22	0.12
752 – 753	0.22	0.07	0.14			0.03				0.23	0.19	0.08
753 – 754	0.19		0.11								0.16	0.04

\* Percent exceedance estimated based on data for January through August 2007.

### 1.3 Integration with other Monitoring Programs and Physical Works

An additional important objective of the revegetation program is integration of the physical works with related studies and other physical works (e.g., debris removal) that will be carried out in the drawdown zone of Kinbasket Reservoir under BC Hydro's Water Licence Requirements implementation. Collaboration and data exchange between the revegetation program and other such programs is an explicit contract requirement.

The following studies are directly affected by, or have the potential to affect, activities for CLBWORKS-1:

- 1. CLBMON-8 Kinbasket Reservoir Monitoring of the Valemount Peatland:**  
 CLBMON-8 is a 3-year program, implemented over a 10-year period, to assess rates and causes of erosion affecting the peatland at the north end of Kinbasket Reservoir, and includes an inventory of vegetation and wildlife species. Implementation will start in 2008, and the program will also run in 2009 and 2016.  
 During the first two years of implementation, coordination between this study and revegetation efforts will be required to ensure that respective impacts are minimized, specifically during the inventory portion. Revegetation efforts are

expected to have a positive impact on the peatland by implementing vegetation treatments targeted at reducing erosion.

**2. CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts:**

CLBMON-9 is a 10-year program to evaluate the long-term effectiveness of the revegetation program at expanding the quality<sup>6</sup> and quantity of vegetation in the drawdown zone for ecological and social benefits, and assessing the costs and benefits of the recommended treatment options. Implementation will be initiated in 2008, and monitoring will occur bi-annually, starting in 2009.

Close collaboration between CLBWORKS-1 and CLBMON-9 is an essential component for the success of both programs. During the first year of implementation for CLBMON-9 (2008), work will focus on establishing monitoring plots and associated reference plots in areas chosen for revegetation, and obtaining data on baseline conditions. Collaboration between the two programs is critical during this stage to ensure that representative monitoring sites and appropriate reference locations can be selected.

**3. CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources:**

CLBMON-10 a 10-year program to assess and map spatial extent, structure and composition of existing vegetation communities at the landscape scale within Kinbasket Reservoir to determine inter-community changes over time in response to ongoing operation of Kinbasket Reservoir. This program also identified riparian wildlife habitat in Year 1. Program implementation was initiated in 2007.

Close collaboration between CLBWORKS-1 and CLBMON-10 is an essential component for the success of both programs. CLBMON-10 depends on retaining control sites for each identified community type of the course of the monitoring period, and ensuring that these sites are unaffected by revegetation efforts is a key requirement of the revegetation program.

**4. CLBMON-11 Kinbasket and Arrow Lakes Reservoirs Effectiveness**

**Monitoring of Revegetation and Wildlife Physical Works:** CLBMON-11 is an 11-year program to monitor wildlife utilization patterns in response to revegetation efforts in Kinbasket Reservoir, the mid Columbia River and Arrow Lakes Reservoir. Implementation is scheduled to commence in 2009.

Coordination between this study and revegetation efforts will be required to ensure that information about treatment goals (e.g., habitat enhancement) and areas treated each year is shared, as well as to ensure that wildlife monitoring sites are not negatively impacted by revegetation treatments.

**5. CLBWORKS-16 Kinbasket Debris Inventory, Management Strategy and**

**Removal:** CLBWORKS-16 is a conditional physical works, in lieu of operational constraints, which has not been ordered by the Comptroller of Water Rights to date. If ordered, CLBWORKS-16 will address new debris that enters the system from tributaries and sloughing of the reservoir banks during high water events, by managing debris stranded in “bathtub rings” around the reservoir that may be re-introduced to the reservoir during high water events.

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<sup>6</sup> “Quality” is defined as a measure of how effectively the established/enhanced vegetation meets the interests expressed by the WUP CC, including improving aesthetic quality, protecting cultural heritage sites from erosion and human access, and enhancing littoral productivity and wildlife habitat.

Debris removal activities, such as debris piling and burning, have the potential to impact revegetation efforts by disturbing previously treated sites, and altering soil chemistry and physical features. Information exchange between CLBWORKS-1 and CLBWORKS-16, which will be coordinated by BC Hydro, is critical to ensure that relevant information about revegetation sites, access and site sensitivities is provided to the debris program manager for planning of debris removal activities.

## 2.0 PHYSICAL WORKS PROPOSAL

### 2.1 Revegetation Approach

#### 2.1.1 Revegetation Site Locations

Field work conducted in Year 1 of CLBWORKS-1 has confirmed that approximately 1525 ha above elevation 747 m in the drawdown zone of Kinbasket Reservoir are suitable for vegetation enhancement (Keefer et al. 2007). An overview of sites by size and geographic area is provided in Table CLBWORKS-1-2 (from Keefer et al. 2007), and detailed maps of all sites are included in Appendix I.

**Table CLBWORKS-1-2. Geographic Areas and Polygon Sizes for Revegetation**

Polygon #	Geographic Area	Polygon Size (ha)	Polygon #	Geographic Area	Polygon Size (ha)
3	Canoe Reach	23	80a	Bush Arm	18
8	Canoe Reach	508	80b	Bush Arm	18
12	Canoe Reach	79	80c	Bush Arm	18
15/16	Canoe Reach	59	80d	Bush Arm	307
25	Canoe Reach	8	83	Bush Arm	106
31	Canoe Reach	11	84	Bush Arm	17
34	Canoe Reach	12	87	Bush Arm	21
37	Canoe Reach	1	88/91	Bush Arm	35
39	Canoe Reach	2	92	Bush Arm	69
33	Canoe Reach	24			
36	Canoe Reach	26	119	Beavermouth	25
			120a-b	Beavermouth	21
45,46,47	Wood Arm	32			
48/49	Wood Arm	77	63	Sullivan Reach	8
<b>TOTAL</b>		<b>862</b>			<b>663</b>

It is expected that additional suitable sites are located below the 747m elevation limit of the 2007 survey, based on work conducted under CLBMON-10 (Hawkes et al. 2007). These sites will be identified in 2008, as described in Task 2 (Section 2.2.2).

### 2.1.2 Previous Revegetation Efforts

Between 2001 and 2004, BC Hydro aerial seeded, drill seeded and fertilized numerous sites on Kinbasket Reservoir, which included the following areas:

- a) sites between Chatter Creek and Prattle Creek on the north side of Bush Arm;
- b) sites on the south side of Bush Arm, downstream of the B-Road Causeway;
- c) sites on Fantasy Island and Bear Island; and
- d) sites in Esplanade Bay and Sprougue Inlet.

At sites a) and b), grass seed mix was applied between elevations 754.38 m (full pool) and 743.71 m at a rate of 10 lbs/acre. In addition, reed canary grass (*Phalaris arundinacea*) (10 lbs/acre) was applied at some sites, between elevations 745.24 m and 739.14 m. All of these sites were fertilized through aerial application of 16-20-12-7S fertilizer at 100 lbs/acre. A control site for areas a) and b) was established at the reservoir access road west of Goodfellow Creek, where no seeding or fertilization occurred. Sites c) and d) were seeded with fall rye, reed canary grass, Richardson Seed mix and Dawson Erosion Control mix, and received an aerial application of fertilizer.

BC Hydro also conducted willow (three species) and cottonwood staking in Canoe Reach (on the west side of Canoe River, opposite Packsaddle Creek) in 2003, treating approximately one hectare.

As part of the revegetation site assessment (Section 2.2.2), these sites should be visited in 2008 to evaluate the success of these previous revegetation efforts, and to identify which species have survived to the present day. This information should then be utilized for the development of additional treatments in subsequent years of the program.

### 2.1.3 Reference and Control Sites for Monitoring Programs

Under CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources (Hawkes et al. 2007), 18 distinct vegetation communities were identified in the drawdown zone of Kinbasket Reservoir between elevations 742 m and 754 m. The goal of CLBMON-10 is to track changes in the spatial extent, structure and composition of these existing communities over time, to determine key factors that influence existing vegetation at the landscape scale. To ensure that effects of reservoir operations and environmental influences can be separated from the effects of revegetation efforts, certain areas that are suitable for enhancement will remain untreated to act as control areas for CLBMON-10 and other monitoring programs under the Kinbasket & Arrow Lakes Reservoirs Revegetation Management Plan (e.g. CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts, CLBMON-11 Kinbasket and Arrow Lakes Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works). Certain areas with very well established vegetation communities have also been identified as reference communities, which will serve as a benchmark for revegetation efforts.

Specifically, for each existing vegetation community, 25% of the area will remain untreated, and transects in all locations (including non-reference areas) will be buffered from any treatments to ensure monitoring results for CLBMON-10 (and the intra-community monitoring component of CLBMON-9) are unaffected by the revegetation program. Reference and control areas, as well as transect locations are

identified on the maps in Appendix I UTM coordinates for transects will be provided upon contract award.

The proposal shall clearly describe how planned revegetation approaches will ensure that reference and control areas remain unaffected, by:

- a) identifying potential impacts of specific prescriptions on reference and control sites and transects (e.g. seed dispersal by wind, water and animals, ground disturbance caused by accessing sites or treatment mechanisms, fertilizer spread, etc.); and,
- b) describing how the above impacts may be avoided through targeted implementation of prescriptions.

#### **2.1.4 Archaeological Site Protection and Traditional Use Species**

As stated in Section 1.1, a goal of the revegetation program is to provide increased protection for known archaeological sites, where possible. To achieve this goal, and to ensure that revegetation activities are undertaken in a manner that considers the specific requirements of these sites, targeted low impact prescriptions will be developed for those areas where First Nation heritage sites are known to exist. These prescriptions will be included in a planting plan, which will be submitted to BC Hydro for review and acceptance prior to commencement of field work. It should be noted that not all areas identified for revegetation have been evaluated for the presence of archaeological sites. It is BC Hydro's expectation that the contractor's team will include an archaeologist who can assess the potential for archeological sites for all previously unassessed sites where invasive prescriptions area proposed.

The location of heritage sites for those areas that have been assessed in Kinbasket Reservoir is available through the Kinbasket and Revelstoke Reservoirs Archaeological Site Overview Assessment (CLBMON-51) and associated maps, which will be made available to the proponent upon contract award. The proposal shall demonstrate how the development of specific treatments and selection of planting mechanisms will be linked with information gained through the archaeological overview to ensure that identified sites or areas considered to have a high potential for the presence of archaeological information are a) adequately protected from any intrusive works, and b) additionally protected from erosion and/or discovery, where possible.

During the Columbia River WUP, agreement was reached that plants traditionally used by First Nations would be included in revegetation prescriptions in the drawdown zone, provided identified species are suited to site conditions. A list of traditional use species is provided in Appendix II.

#### **2.1.5 Wildlife Habitat Enhancement**

The fundamental wildlife objective of the Columbia River WUP was to maximize wildlife abundance and diversity in the Columbia River system. While the WUP CC did not make recommendations around operational changes or physical works in lieu of operational changes for Kinbasket Reservoir due to lack of quantitative data for wildlife populations (BC Hydro 2005), the WUP CC did recommend maximizing riparian habitat area to improve wildlife values. Revegetation prescriptions will

therefore incorporate species beneficial for wildlife<sup>7</sup>, where feasible, and the proposal shall outline:

- a) which plant species may be utilized, based on information provided in Appendix II;
- b) which habitat values are expected to be addressed; and,
- c) which wildlife species will benefit.

It should be noted, that during a preliminary assessment of wildlife habitat (Hawkes et al. 2007), several geographic areas were identified as having high quality<sup>8</sup> wildlife habitat, including Bush Arm, Beavermouth, Canoe Reach, and Encampment Creek. Further enhancement of wildlife values in these areas may not be necessary, however, other areas, including Hugh Allan Bay, Grouse Creek, Sullivan Arm, Howard Creek, and Yellow Jacket Creek could benefit from more extensive revegetation treatments aimed at enhancing wildlife habitat.

### 2.1.6 Adaptive Management

Only very limited information is available regarding revegetation of drawdown zones of reservoirs in general, and in southeastern British Columbia specifically (Moody and Carr 2003, Moody 2002a and 2002b, Carr et al. 1993, Carr 1992, Carr and Moody 1992). Therefore, all proposed prescriptions must be considered experimental, and the revegetation program must be designed in a manner that can be statistically evaluated by the associated monitoring programs (CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts, and CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources). In addition to this comprehensive 10-year monitoring, it is important for the revegetation contractor to evaluate the success of specific treatments in a manner that will best suit the rapid adaptation of approaches and work practices.

To ensure that the performance of specific prescriptions can be evaluated, and that practices can be adapted over time as experience with revegetation in the drawdown zone of Kinbasket Reservoir is gained, the revegetation program will continue to be implemented in stages over the remaining four years of the program. In 2008, previous revegetation efforts carried out by BC Hydro (Section 2.1.2) should be assessed, and test plots should be set up to evaluate the success of proposed blanket prescriptions (Section 2.2.7) on different soils, slopes, aspects and elevations. The proposal shall describe how program actions will be designed to facilitate learning and to integrate flexible practices which incorporate new information gained from monitoring programs and field trials. An experimental approach and adaptive management will be particularly important in the lower elevation range of 747-741 m, since longer inundation periods in this range will significantly reduce the potential for species establishment and survival. Therefore, the proposal shall describe experimental strategies that may be employed to assess the success of different treatments in this elevation range, keeping in mind that detailed, long-term monitoring of revegetation efforts<sup>9</sup> is outside the scope of this program. Any experimental approaches must allow for rapid evaluation of results,

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<sup>7</sup> i.e. species that provide forage, cover, nesting opportunities, etc.

<sup>8</sup> The rankings of high, medium, or low are largely subjective, based on the total number of species and number of species with conservation status that occurred in a given area.

<sup>9</sup> A 10-year monitoring program of revegetation efforts will be implemented under CLBMON-9.

and should complement, not duplicate, monitoring under CLBMON-9, Kinbasket Reservoir Monitoring of Revegetation Efforts.

## **2.2 Methods**

### **2.2.1 Task 1: Project Coordination**

Project coordination involves the general administration and technical oversight of the program, which will include, but not be limited to: 1) budget management, 2) program team management, 3) logistics coordination, 4) technical oversight in field and reporting components, 5) participation in planning processes for other programs under the Kinbasket and Arrow Lakes Reservoirs Revegetation Management Plan, and 5) facilitation of data transfer among other programs under the Kinbasket and Arrow Lakes Reservoirs Revegetation Management Plan.

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

### **2.2.2 Task 2: Revegetation Site Assessment**

Because field work in 2007 was limited to drawdown zone evaluations above 747 m due to high water levels, a key task of this project is the identification, field verification and mapping of sites with revegetation potential between elevations 747 m and 741 m. It should be noted that elevation 741 m has not been confirmed as the lower limit of vegetation growth in the Kinbasket Reservoir drawdown zone. If vegetation does not exist at or below 741 m, the highest elevation of viable growth will become the new lower limit of revegetation efforts.

As part of public consultation, the following sites were also identified as potential revegetation candidates, and should be examined in 2008:

- Area around the Quartz Creek Delta at the confluence of the Columbia River and Quartz Creek, on the South side (nearest currently identified revegetation sites are Sites 119-120).
- Sites 89-91 – consultation indicated that substantially more area could be planted with willow than is currently shown on the site mapping. This additional planting potential should be assessed and mapped.
- Sites 80, 83-84 – assess potential for revegetating delta area of the Gold River, which is slowly building up; also, the area around Succour Creek has been identified for willow and sedge planting. Consultation also identified that the channel between Bear Island and the reservoir shoreline may be a good candidate for willow planting, because it is seldom covered with water. Similarly, the reservoir shoreline directly west of Bear Island may also be suitable for willows. These areas should be assessed for planting potential and mapped.
- Area across from Esplanade Bay – sloughing was identified for this area, which should be examined for potential mitigation through willow staking or cover crops.

The proposal shall outline how site verification will be completed within the budget constraints. It will also be the responsibility of the consultant to determine priority areas for revegetation, based on the site classification of revegetation potential, location, size, ease of access, wildlife potential and treatment approach. To aid in the identification and mapping of sites, BC Hydro will provide 1:5,000 normal colour

aerial photographs and a digital elevation model (DEM) of Kinbasket Reservoir to the consultant upon contract award.

Data to be collected during site verification include (but may not be limited to):

- elevation
- aspect
- slope
- substrate (depth, type, physical and chemical properties)<sup>10</sup>
- species composition
- species density
- measure of overall health (as defined by plant size and vigour) or status of vegetation species/community
- site potential for collection of sedge seed, and herbaceous or woody species propagules (availability, access and estimated time window for collection of seed or cuttings)

The standard methodology used for terrestrial ecosystem data collection can be found in the joint publication of the Ministries of Environment and Forests "Field manual for describing terrestrial ecosystems"<sup>11</sup> (1998).

During the assessment of revegetation sites in 2008, a site visit to areas previously treated by BC Hydro between 2001 and 2004 (Section 2.1.2) should also be conducted to determine the success of these seeding and fertilization efforts. Data on the site locations and previously areas will be made available upon contract award.

### 2.2.3 Task 3: Selecting Candidate Species for Revegetation

Based on results of field work conducted in 2007 (Hawkes et al. 2007, Keefer et al. 2007), a list of vegetation species which may be suitable candidates for revegetation has been compiled, and is in Appendix II. Any species from the list which is selected for inclusion in a revegetation prescription, should meet the following criteria:

- survives under the reservoir's operating conditions;
- has capacity to hold soil (i.e., reduces erosion and traps sediment);
- can reproduce in the drawdown zone;
- improves littoral and/or terrestrial habitat conditions;
- is indigenous to the Kootenays (unless is non-invasive and has demonstrated positive benefit);
- has First Nations' traditional use value, if possible; and,
- can be propagated economically in large quantities.

With the exception of the three species specified at the end of Appendix II, all of the listed plants have been found in the drawdown zone of Kinbasket Reservoir; however, it should be noted that this list was compiled prior to the high inundation levels experienced in 2007. Consequently, inundation intolerant species (e.g.,

<sup>10</sup> Due to the potential for disturbance of archaeological sites, no soil pits will be dug in those areas where identified sites are present or no assessment data is available. For areas with no assessment data, soil cores of up to 60 cm in depth are acceptable, or cut banks may be used to estimate soil characteristics.

<sup>11</sup> <http://www.for.gov.bc.ca/hfd/pubs/docs/Lmh/Lmh25.htm>

conifers) will no longer be present, and should not be included as candidate species for revegetation prescriptions.

For 2008, blanket prescriptions utilizing a limited number of target species have been prepared (Section 2.2.7), based on a 2007 assessment of vegetation currently found in the drawdown zone, as well as site and substrate conditions. The application of these prescriptions (and any additional treatments proposed by the proponent) will be described in a planting plan, to be submitted to BC Hydro for review and acceptance prior to commencement of field work. The planting plan will also provide additional details about the value of each prescription for enhancing wildlife habitat by specifying:

- which habitat values are expected to be addressed;
- which wildlife species will benefit; and,
- at which elevations in the drawdown zone the chosen prescriptions are expected to provide wildlife benefits, given the operating regime of Kinbasket Reservoir.

For all remaining years (2009-2011), it is expected that the successful contractor will develop annual planting plans, which utilize species from Appendix II, and incorporate findings gained during the previous years. Each new prescription must be designed for site and substrate conditions, and must consider elevation and location (e.g. exposure, slope, moisture, etc.) in the drawdown zone.

#### **2.2.4 Task 4: Live Stake Collection**

##### Willow Species

Fieldwork in 2007 near Mica Dam and in the Bush Arm area identified suitable collection sites for high quality willows and cottonwood, in or adjacent to roads and powerline right-of-ways. Sites near Mica Dam include logging roads and the 5L71/72 BC Hydro right-of-way. In the Bush Arm area, willows of high quality are growing along roads that have been brushed. The most common larger willow encountered was Scouler's willow (*Salix scouleriana*), which is a highly desirable species for use in willow staking. Willow stakes from Scouler's willow and other suitable species (e.g., *Salix commutata*, *S. bebbiana*, *S. brachycarpa*, *S. discolor*, *S. drummondiana*, *S. lucida* ssp. *lasiandra*, *S. pedicellaris*, *S. pseudomyrsinites*, *S. sitchensis* - Appendix II) are to be collected in early April 2008 (prior to bud break) in areas near the planting sites to maximize genetic compatibility and minimize costs. The proposal shall outline how many willow stakes will be collected in each year of implementation, given site, budget and labour constraints. Based on 2007 field assessments of available stock, approximately 75,000 quality stakes could be collected per year within the project area, subject to budget and labour considerations.

Stakes are to be collected at an appropriate length (minimum length is 2 m), with a top diameter of at least 1.5 cm and a base diameter of at least 2.5 cm. All branches will be removed with sharp tools to minimize the foliar area of the plants while their roots develop. Cuttings will be collected from healthy dormant plants; diseased or otherwise damaged cuttings will not be used. Cuttings will be obtained using sharp tools to avoid fraying or burred ends, will be protected from desiccation and will be soaked for 10 days prior to planting.

Prior to collection of willow stock, the consultant will submit a procedure for review and acceptance by BC Hydro, outlining where and how cuttings will be obtained, the number and sizes of cuttings to be collected, and storage plans. In addition,

collection of willow live stakes must not impact established vegetation communities nor diminish the value of the collection area to breeding birds, and must not damage any active nests,. Best management practices to minimize the risk of these impacts should be included as part of the collection procedure.

#### Other Herbaceous or Woody Species

Due to the less severe site conditions at the very top of the drawdown zone (750-754 m), it is anticipated that additional terrestrial species (e.g. Cottonwood (*Populus trichocarpa*), trembling aspen (*Populus tremuloides*), mountain alder (*Alnus incana* ssp. *tenuifolia*), and red-osier dogwood (*Cornus stolonifera*) will survive. Based on the candidate species list in Appendix II, and taking into account requirements under Section 2.1 (monitoring program reference sites, archaeological site protection, erosion control and wildlife habitat enhancement), the proposal shall identify additional species that may be established in the upper elevations of the drawdown zone.

While the herbaceous and woody species listed in Appendix II have been found in the drawdown zone of Kinbasket Reservoir, their viability in revegetation treatments has not been verified. Therefore, propagation of planting stock should only occur on a limited scale in each year of the program, using the approach discussed in Section 2.1.6. The proposal shall describe how local, native live stakes or other propagules for potentially viable species could be collected, how container stock may be grown for outplanting in each year of the revegetation program, and how survival of different species will be evaluated across an elevation range of 750 m to 754 m.

### **2.2.5 Task 5: Seed Collection**

To ensure availability during implementation of the revegetation program, sufficient locally adapted, native seed for a variety of suitable species (Appendix II) must be collected in each year of the program. Seed will be required for nursery stock, seeding trials (2008) and large-scale application of seed by different methods in subsequent years (2009-2011), based on the results of field trials. If reservoir conditions prohibit the collection of local seed in any given year, certain types of commercial seed may also be obtained from pre-identified sources, subject to discussion with and authorization by BC Hydro.

#### Lenticular Sedge (*Carex lenticularis*)

Lenticular sedge is the second most common vegetation community type to occur in the vegetated portion of the drawdown zone of Kinbasket Reservoir after the common horsetail (*Equisetum arvense*) community. It is widely distributed across geographic areas and elevations, occurring between 743 m and 752 m on imperfectly to moderately well drained sites with slopes up to 20 degrees (Hawkes et al. 2007). Lenticular sedge in the drawdown zone was also found to be locally adapted to reservoir operating conditions, ripening up to six weeks earlier than specimens in non-reservoir environments (Keefer et al. 2007).

Because of its local adaptation, ability to retain soil and prevalence across a wide range of site conditions, lenticular sedge is a target species for further expansion across all suitable elevations in the drawdown zone. Locally adapted lenticular sedge seed is not available commercially. Therefore, custom seed collection from existing sedge communities must occur during each growing season. Lenticular sedge seed in Kinbasket Reservoir has been found to mature in early July, just prior to inundation

(Keefer et al. 2007). Consequently, seed will be collected each year after sedge seeds have reached maturity, but before they are inundated by rising water levels. Because lenticular sedge loses its seed soon after maturity, the most appropriate time for seed collection must be determined by site inspection.

Seed collection will occur by manual gathering of mature seeds, using hand stripping into containers and/or mechanical seed stripping (preferred). The proposal shall describe how locations for seed collection will be identified and by which methods seed will be collected. As much seed as possible should be collected each year from available sites, taking care to ensure that natural seeding is not adversely affected during seed collection. Prior to initiating seed collection, the contractor will provide a collection procedure for review and acceptance by BC Hydro, outlining the proposed methods of seed collection, stratification and storage of seed material as well as procedures to ensure that natural regeneration of lenticular sedge is not adversely affected.

#### Other Species

The proposal shall outline what other species from Appendix II may be suitable for seed collection in sufficient quantities to either raise nursery stock or obtain seed for treating areas directly. Limited seed collection of wool grass (*Scirpus atrocinctus*), small-flowered bulrush (*Scirpus microcarpus*) and squashberry (*Viburnum edule*) were successfully carried out in 2007, but seed collection efforts will have to be expanded substantially in 2008-2010 to ensure that all suitable areas can be treated with a variety of species over the course of the program. Prior to initiating seed collection, the contractor will provide a collection procedure for review and acceptance by BC Hydro, outlining the proposed methods of seed collection, stratification and storage of seed material.

#### **2.2.6 Task 6: Nursery Stock Propagation**

A key component of the revegetation program will be the production of nursery stock. It is expected that a minimum of 90,000 lenticular sedge seedlings and 35,000 seedlings of a variety of other species will be grown each year, including woody plant stock that require more than one year of growth. Appendix III outlines detailed requirements which must be addressed in the proposal, to demonstrate that the proponent has the capacity to produce the required nursery stock in a facility that meets industry standards. Experience in raising wetland and riparian species native to BC will be considered an asset.

To reduce risk, no more than of 50% of the required crop per year may be grown in the same commercial facilities. A minimum of two separately owned and operated companies must be retained to produce the required stock.

#### **2.2.7 Task 7: Blanket Prescriptions**

Provided below are a number of blanket prescriptions, which were developed based on field work results in 2007 (Keefer et al. 2007). These prescriptions are considered preliminary, and must be tested for viability as per Section 2.1.6 to confirm tolerances and survival rates between elevations 747 m and 754 m. Prescriptions #1, #6, #7 and #8 may also be applied on an experimental basis between elevations 741 m and 746 m. Prior to commencement of field work each year, the successful contractor will submit a detailed planting plan to BC Hydro for review and acceptance that describes:

- which prescription (or combination of prescriptions) is recommended for each identified site (or combination of sites) and how much area can be treated;
- why this prescription is deemed suitable for the identified site(s) and/or elevation ranges;
- which objective(s) the prescription(s) will address (see Section 1.1);
- how archaeological sites, or areas that have a high potential for the presence of archaeological information, will be adequately protected from any intrusive works, and how additional protection from erosion and/or discovery may be provided;
- how potential impacts of implementation of specific prescriptions on reference sites and transects will be avoided;
- how the effects of site and substrate conditions, as well as elevation and location (e.g., exposure, slope, moisture, etc.) will be tested for a given prescription or combination, and how requirements for adaptive management (Section 2.1.6) will be met;
- how soil physical and chemical properties will be assessed, in particular for areas where fertilization and the use of cover crops is proposed; and,
- an alternate treatment sequence (contingency approach) in the event that high reservoir levels in any given year prevent access to lower elevation sites.

#### Blanket Prescription #1 – Sedge Seedlings

This prescription is designed to be implemented on all sites suitable for revegetation between elevations 747m and 754 m, and may be extended to lower elevations, if site assessments identify appropriate growing conditions. Sites are to be hand planted with lenticular sedge nursery stock in mid-April to mid-May, at interplant spacings of 25 cm, 50 cm and 100 cm, as well as in tight clumps (10 cm) with interclump spacing of 50-100 cm. This method is expected to work in all substrates encountered in the reservoir other than bedrock.

With additional stock being raised as part of Phase 1 for CLBWORKS-1, an estimated 30,000 seedlings will be ready for planting in the spring of 2008. The proposal shall outline how many hectares may be treated with the available stock to gain the maximum information possible about the utility of this treatment for large scale application across a range of elevation zones.

#### Blanket Prescription #2 – Wool Grass Seedlings

This prescription is similar to Prescription #1, but involves the use of wool grass (*Scirpus atrocinctus*) plugs. Approximately 15,000 seedlings will be available for planting in spring of 2008. The proposal shall outline how these seedlings may be utilized to obtain information about the viability of this species for revegetation, and the utility of this treatment for large scale application across a range of elevations and site conditions.

#### Blanket Prescription #3 – Bluejoint Reedgrass Seedlings

This prescription is similar to Prescriptions #1 and #2, but involves the use of bluejoint reedgrass (*Calamagrostis canadensis*) plugs. Approximately 5,000 seedlings will be available for planting in spring of 2008. The proposal shall outline how these seedlings may be utilized to obtain information about the viability of this

species for revegetation, and the utility of this treatment for large scale application across a range of elevations and site conditions.

#### Blanket Prescription #4 – Small-Flowered Bulrush

This prescription is similar to Prescriptions #1 and #2, but involves the use of small-flowered bulrush (*Scirpus microcarpus*) plugs. Approximately 5,000 seedlings will be available for planting in spring of 2008. The proposal shall outline how these seedlings may be utilized to obtain information about the viability of this species for revegetation, and the utility of this treatment for large scale application across a range of elevations and site conditions.

#### Blanket Prescription #5 – Mixed Seedlings

This prescription involves the use of mixed bag plantings of lenticular sedge, wool grass and bluejoint reed grass. Plants are to be hand planted, using a randomized mix of species, at interplant spacings of 25 cm, 50 cm, 100 cm, as well as in tight clumps (10 cm) with interclump spacing of 50-100cm. If this prescription is implemented in 2008, seedlings from the available pool for each species (above) will have to be utilized. The proposal shall outline how this treatment may be utilized to obtain information about its utility for large scale application across a range of elevations and site conditions.

#### Blanket Prescription #6 – Drill Seeding

The key to successful implementation of this prescription is seeding on suitable substrates with stratified lenticular sedge seed. Following the treatment recommendations in Moody and Carr (2003), this method will employ the use of a seed drill. Given the relative scarcity of lenticular sedge seed available for 2008 seeding trials (~20 kg), this method is to be applied on small test plots (0.1-0.25 ha), using a randomized block design at seeding rates of 0, 1, 2, 5 and 10 kg per ha. This prescription should only be used on sites with silty to sandy substrates and low coarse fragment content.

#### Blanket Prescription #7 - Hydroseeding

This prescription also involves the use of stratified lenticular sedge seed; however, seed is to be distributed using a small hydroseeding unit along with wood or paper mulch. Seed is to be applied at rates of 0, 1, 2, 5 and 10 kg per ha. This method may be applied on silty, sandy and gravelly substrates. As above, it is recommended that this treatment be evaluated with small test plots, using a randomized block design.

#### Blanket Prescription #8 – Hand Seeding

This prescription will employ the use of hand seeding equipment with lenticular sedge seed (and other species, based on availability) to be applied at 0, 1, 2, 5 and 10 kg per ha. This method should be applied on all substrates other than rock, using small test plots and a randomized block design.

#### Blanket Prescription #9 – Willow and Cottonwood Whips

Within areas mapped for willows (approximately 200 ha – Appendix I), elevations above 750 m will be targeted because high survival is expected. The proposal shall outline how many hectares will be treated per year with willow and cottonwood, given budget constraints, available stock and labour requirements, to ensure all suitable areas (minus reference sites) are treated over the 4-year program duration.

Willow stakes are to be collected as described in Section 2.2.4. The minimum length for whips is 2 m. Above elevation 750 m, whips should be planted in clumps. Due to the relatively high ground moisture levels in these sites, it is recommended that whips be planted at depths greater than 40 cm. For staking, holes should be created by forcing steel bars into the substrate and widening the holes, then inserting the willow whips and firming the soil around the base of the whip by hand to reduce the presence of air in the rooting zone. Because of the intrusive nature of this prescription, willows and/or cottonwood stakes are not to be planted at or near identified archaeological sites.

Because willow survival below 750 m is more uncertain, the minimum possible elevation for willow establishment in the drawdown zone will be explored through transect planting in a variety of substrates that extend to 747 m in elevation. The proposal will outline how this investigation of willow survival will be accomplished.

Of the areas mapped for willow and cottonwood, those that were subject to debris removal in the summer and fall of 2007 should be targeted for planting on a priority basis in 2008. While these areas will be stabilized prior to April 2008, further treatment through the revegetation program may be beneficial to avoid ingrowth of weedy invasive species, and these sites are therefore key targets for spring staking. The detailed planting plan (see Section 2.2.3) shall outline how these areas will be treated.

#### Blanket Prescription #10 – Sedge Farming

In the interest of increasing the quantity of lenticular sedge seed collections in subsequent years, exploring methods of enhancing the seed resource is recommended. Additional soil data analysis may reveal the nutrient regime of those sites that are most productive for lenticular sedge. By applying or augmenting existing limiting nutrients through fertilization, the potential seed resource may be improved. Because this type of fertilization has not been done previously, experimental trials are recommended to evaluate the success of this prescription.

#### Blanket Prescription #11 – Legume Cover Crops

With the goal of increasing available nitrogen in the soils, this prescription employs the use of clovers. Given that white clover (*Trifolium repens*), red clover (*T. pratense*), and alsike clover (*T. hybridum*) all occur in the drawdown zone of Kinbasket Reservoir and have been seeded previously by BC Hydro, it is recommended that all three species be seeded and evaluated. This prescription should be applied to all types of sites on an experimental basis. Seeds may be direct seeded by hand, drill or hydroseeding.

#### Blanket Prescription #12 – Fertilization

Because substrates in the drawdown zone are very nutrient poor, fertilization should be considered on conjunction with all of the above prescriptions, or it may be applied as separate treatment in targeted areas. Because only limited information on previous fertilization efforts in Kinbasket Reservoir is available, experimental fertilization trials should be carried out to evaluate the success of this approach.

### **2.2.8 Task 8: Reporting**

A technical report will be prepared at the conclusion of each implementation year, which will include:

- an executive summary;
- a description of the methods employed;
- a data summary;
- an assessment of priority sites for revegetation for the current year, and the rationale for their selection;
- an assessment of revegetation prescriptions and their suitability for different elevations, substrates and geographic locations;
- a summary of the experimental treatments and any challenges encountered;
- a discussion of the objectives which were met by implementation of specific prescriptions in target areas; and,
- any recommendations.

For the seed collection and nursery stock propagation, reporting requirements will include a field memo describing the following:

- species and locations (with GPS coordinates) for seed and live cutting collections;
- quantity of seed and live stakes collected with associated time and labour requirements;
- storage and propagation requirements;
- a summary of nursery stock production and challenges encountered; and,
- recommendations for future collection efforts and nursery propagation.

The report and field memo will follow the standard format that has been developed for WUP program physical works. All reports will be provided in hard-copy and in 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.

### 2.3 Schedule

The revegetation program physical works will be implemented annually between March and September, as dictated by snow and water levels. Table CLBWORKS-1-3 provides a detailed task schedule.

**Table CLBWORKS-1-3. Proposed Schedule for the Kinbasket Reservoir Revegetation Physical Works**

<b>Task</b>	<b>Month</b>	<b>Year</b>
Live stake collection (willow, cottonwood)	February - April	2008-2011
Planting of live stakes	April	2008-2011
Site verification and prioritization (747m – 741 m)	April - May	2008
Planting of seedlings and seed application	April -June	2008-2011
Assessment of previous revegetation efforts	May - June	2008
Seed collection - sedge	June - July	2008-2010
Seed collection - other species	As required by phenology	2008-2010
Nursery stock production	July - March	2008-2011

### 2.4 Budget

The annual cost for the implementation of Years 2 to 5 of the revegetation program physical works is estimated at \$579,606 (in 2004 dollars). This cost is higher than the WUP CC estimate of \$400,000 annually over five years; however, Year 1 of the program was implemented as a planning year, and expenditures were well below the WUP CC

budget estimate, making additional funds available for subsequent years. Table CLBWORKS-1-4 provides a budget estimate, assuming a 2% rate of inflation and a 5% contingency for the program.

### **3.0 REFERENCES**

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## **APPENDIX I – MAPS OF REVEGETATION SITES**

**APPENDIX II – CANDIDATE SPECIES LIST  
(including traditional use species)**

Plant Type	Common Name	Latin Name	Habitat Type	Elevation	Methods of Propagation	Found in DDZ (Y/N)	Comments
<b>Graminoids</b>	water sedge	<i>Carex aquatilis</i>	moist	higher	seedling	y	found occasionally in wet sites
	lenticular or lakeside sedge	<i>Carex lenticularis</i>	all types	all	seedling, seed	y	ubiquitous in wide range of sites
	Bluejoint reedgrass	<i>Calamagrostis canadensis</i>	all	all	seedling, seed	y	ubiquitous in wide range of sites
	tufted hairgrass	<i>Deschampsia cespitosa</i>	mesic to dry	upper	seed	y	seed available commercially
	blue wild rye	<i>Elymus glaucus</i>	drier	mid-upper	seed	y	seed available commercially
	wool grass	<i>Scirpus atrocinctus</i>	mesic to wet	all	seedling	y	found on many sites
	small-flowered bulrush	<i>Scirpus microcarpus</i>	wet organic	higher	seedling	y	ubiquitous in wide range of sites
<b>Forbs</b>	sharp toothed angelica	<i>Angelica arguta</i>	mesic	upper	seedling	y	don't confuse with water hemlock
	various leaved pondweed	<i>Potamogeton gramineus</i>	wet/ submergent	higher	unknown	y	responds positively to flooding in protected sites
	swamp horsetail	<i>Equisetum fluviale</i>	wet	all	unknown	y	propagation unknown
	hemlock water parsnip	<i>Sium suave</i>	wet	upper	seedling	y	don't confuse with water hemlock
	arum leaved arrowhead	<i>Sagittaria cuneata</i>	submergent	upper	corms	n	important First Nation/wildlife plant
	clover	<i>Trifolium spp.</i>	all	all	seed	y	non-native, but cheap cover crop
	wapato	<i>Sagittaria latifolia</i>	submergent	upper	corms	n	important First Nation/wildlife plant

Plant Type	Common Name	Latin Name	Habitat Type	Elevation	Methods of Propagation	Found in DDZ (Y/N)	Comments
<b>Woody Plants</b>	Sitka alder	<i>Alnus viridis sinuata</i>	all	top 2m	seedling	y	all 2006 flooded plants found dead
	mountain alder	<i>Alnus incana tenuifolia</i>	all	top 4m	seedling	y	plants survived 2006 flood
	beaked hazelnut	<i>Corylus cornuta</i>	mesic	top 2m	seedling	y	rare
	red-osier dogwood	<i>Cornus stolonifera</i>	all	top 2m	seedling or livestock	y	lower plants killed in 2006
	black twinberry	<i>Lonicera involucrata</i>	moist	top 4m	seedling	y	found occasionally
	trembling aspen	<i>Populus tremuloides</i>	all	top 4m	seedling	y	widespread, survived 2006/7 flooding at upper elevations
	black cottonwood	<i>Populus balsamifera trichocarpa</i>	all	top 5m	livestake or seedling	y	widespread, plants immersed to tops killed in 2006
	prickly rose	<i>Rosa accicularis</i>	dry	top 2m	seedling	y	Likely to die from flooding
	wood rose	<i>Rosa woodsii</i>	dry to mesic	top 2m	seedling	y	Likely to die from flooding
	red raspberry	<i>Rubus idaeus</i>	dry	top 2m	seedling	y	Likely to die from flooding
	thimbleberry	<i>Rubus parviflorus</i>	dry to mesic	top 2m	seedling	y	Likely to die from flooding, should re-colonise from rhizomes
	Bebb's willow	<i>Salix bebbiana</i>	all	top 5m	livestake	y	
	Drummond's willow	<i>Salix drumondii</i>	all	top 5m	livestake	y	
	Scouler's willow	<i>Salix scouleranai</i>	all	top 5m	livestake	y	widespread survival of flooding observed
	hardhack	<i>Spirea douglasii</i>	wet	top 3m	seedling	y	
	squashberry	<i>Viburnum edule</i>	all	top 3m	seedling	n	good wildlife species, prominent in areas out of reservoir

## APPENDIX III – PROPOSAL REQUIREMENTS FOR NURSERY STOCK PRODUCTION

The following information will be provided as part of the proposal to address requirements under Section 2.2.6 (Nursery Stock Propagation):

1. Introduction

- a general description of the proposed approach

2. Background of applicant, affiliated and associated companies, including:

- share of ownership by individuals, companies, province and country; and
- an outline identifying the principals (including active and silent partners), as well as the on-site personnel who are or will be running the operation on a day to day basis, including relevant background and qualifications.

3. Location of the nursery or proposed nursery and reasons for selection of particular location, in terms of:

- climate and environment;
- water quality and water supply;
- risk of overwintering damage, if applicable;
- logistics, including access and availability of various means of transportation (air, rail, highway); and,
- other characteristics and considerations, if any.

4. Description of current and/or proposed facilities to accommodate production for this contract, including:

- description of the site;
- description of services and utilities, including backup emergency systems;
- description of the following: service buildings; greenhouses, including type and manufacturer, and/or open compounds; equipment for lighting and blackout systems for daylength extension and short-day treatments; irrigation and fertilization systems; benching system; environmental controls and other improvements;
- description of production capacity of greenhouses and/or open compounds in number of blocks and seedlings; and,
- if applicable, projected construction schedule relative to commencement of this contract.

5. Projected Production Schedules

- description of growing methods, including details on sowing and oversowing, sowing equipment, sowing dates and procedures, growing medium (physical and chemical characteristics) and its components, seed cover, environmental control procedures, fertilization schedules, cultural techniques relative to seedling quality standards, including conditioning and hardening regimes, provisions for minimizing risk factors and quality control techniques.

6. Pest Management

- description of the pest management program, including identification, preventative and control measures, application of pesticides (insecticides/fungicides) if used, pesticide reporting responsibilities, and a description of the applicator's certification and qualifications with respect to regulatory requirements.

## 7. Financing

- assurance that access to sufficient financing for both capital assets and operating costs has been secured. This may be submitted as a letter(s) or other appropriate documents(s) from a recognized financial institution or backer indicating that financing for producing a certain number of seedlings under the terms of this contract is in place or is forthcoming, if a contract is awarded to the applicant.