

**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 interests¹. 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.

1.2 Scope and Objectives

The scope of the physical works includes revegetation of suitable sites over two years (2009-2010) between elevations 434 m and 440 m in the drawdown zone of the Arrow Lakes Reservoir and Revelstoke Reach. Work in Year 1 of the project identified 28 sites (nine in Revelstoke Reach and 19 sites in the Arrow Lakes) as suitable for revegetation. These sites are identified on the attached maps (Appendix II).

Key environmental and social objectives of the mid Columbia and Arrow Lakes Reservoir Revegetation Program physical works are to:

- 1) maximize vegetation growth in the drawdown zone²;
- 2) provide benefits to littoral productivity and wildlife habitat through increased plant species diversity;
- 3) improve shoreline stability and control dust through targeted planting, where possible;
- 4) increase the species diversity of native plants, particularly those of interest to First Nations; and,
- 5) provide increased protection for known archaeological sites, where possible.

These objectives will be achieved through application of a variety of prescriptions (see Section 2.2.6) in suitable sites that specifically target the above values.

1.3 Consideration of the Arrow Lakes 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 2005). In any given year, conditions that favour the growth of vegetation may or may not occur, depending on which of the soft constraints can be met, based on weather variability in the Columbia Basin, operational load requirements and constraints under the Columbia River Treaty.

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. A summary of historic levels is presented in Table CLBWORKS-2-1. 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.

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

Table CLBWORKS-2-2. Proportion of time (year) that Arrow Lakes Reservoir elevations exceeded a particular elevation band (m ASL) for the period 1997 – 2007 (from Enns et al. 2007).

Band	Elevation	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average
1	433-434	0.81	0.53	0.13	0.53	0.35	0.52	0.59	0.57	0.69	0.62	0.55		0.31	0.33	0.29	0.15	0.33	0.58	0.44
2	434-435	0.77	0.51	0.06	0.48	0.23	0.51	0.40	0.56	0.66	0.59	0.50		0.26	0.31	0.21	0.07	0.29	0.39	0.38
3	435-436	0.72	0.48		0.38		0.48	0.36	0.55	0.61	0.54	0.48		0.22	0.28	0.12		0.25	0.29	0.32
4	436-437	0.68	0.46		0.20		0.40	0.30	0.51	0.54	0.48	0.41		0.18	0.23	0.05		0.22	0.25	0.27
5	437-438	0.61	0.44				0.18	0.25	0.43	0.39	0.33	0.20		0.15	0.17			0.19	0.20	0.20
6	438-439	0.56	0.36				0.07	0.20	0.21	0.12	0.21	0.16		0.12	0.11			0.16	0.13	0.13
7	439-440	0.42	0.25					0.12	0.14		0.09	0.08		0.09	0.02			0.10		0.07

1.4 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 Arrow Lakes 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-2:

1. **CLBMON-11B Mid Columbia and Arrow Lakes Reservoir Wildlife Effectiveness Monitoring of Revegetation and Wildlife Physical Works:** CLBMON-11B is an 11-year program to monitor wildlife utilization patterns in response to revegetation efforts in 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 impacted by revegetation treatments.

2. **CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources:** CLBMON-33 is a 10-year program to assess and map spatial extent, structure and composition of existing vegetation communities and revegetated areas at the landscape scale within the mid Columbia and the Arrow Lakes Reservoir to determine inter-community changes over time in response to the soft constraints operating regime. This program also identified riparian wildlife habitat in Year 1. Program implementation was initiated in 2007.

Close collaboration between CLBWORKS-2 and CLBMON-33 is an essential component for the success of both programs. CLBMON-33 depends on retaining control sites for each identified community type over the course of the monitoring period, and ensuring that these sites are unaffected by revegetation efforts is a key requirement of the revegetation program.

3. **CLBMON-12 Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis:** CLBMON-12 is a 10-year program to monitor the response of existing vegetation communities, at the site level, to the soft constraints operating regime. This program will also evaluate the long-term effectiveness of the revegetation program at expanding the quality³ and quantity of vegetation in the drawdown zone for ecological and social benefits, and assess the costs and benefits of the recommended treatment options. Implementation will be initiated in 2008, and monitoring will occur bi-annually, starting in 2009.

³ "Quality" is defined as a measure of how effectively the established/enhanced vegetation meets the interests expressed by the WUP CC.

Close collaboration between CLBWORKS-2 and CLBMON-12 is an essential component for the success of both programs. During the first year of implementation for CLBMON-12 (2008), work will focus on establishing monitoring plots and associated control plots in areas chosen for revegetation, and obtaining data on baseline conditions. On initiation of revegetation efforts in 2009, collaboration between the two programs will be critical to ensure that monitoring sites are not adversely affected by revegetation treatments.

- 4. CLBWORKS-17 Arrow Lakes Debris Inventory, Management Strategy and Removal:** CLBWORKS-17 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-17 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.

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-2 and CLBWORKS-17, 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-2 has confirmed that approximately 393 ha in the drawdown zone of the Arrow Lakes Reservoir and Revelstoke Reach are suitable for vegetation enhancement (Moody 2007b). An overview of sites by size and geographic area is provided in Table CLBWORKS-2-2 (from Moody 2007b), and detailed maps are included in Appendix II.

Table CLBWORKS-2-3. Summary of Potential for Revegetation Success by Location.

SITE	HIGH	MEDIUM	LOW	Total by Area (ha)
<i>Revelstoke Reach (RR)</i>				
F	0.6	0.5		1.1
M	3.8			3.8
S	0.4			0.4
U		0.4		0.4
V		19.3		19.3
W		39.7		39.7
X	16.3			16.3
Y	35.1			35.1
Total RR	56.2	59.9		116.1

SITE	HIGH	MEDIUM	LOW	Total by Area (ha)
<i>Arrow Lakes (ARR)</i>				
1	8.8	8.6		17.4
5		7.6	13.4	21.0
6	12.8			12.8
7	18.8	11.8		30.6
8	53.4			53.4
9	6.2	7.9		14.2
10	13.7	48.2	2.5	64.3
11		16.7	5.7	22.4
12			21.3	21.3
13	17.8	0.9	1.2	20.0
Total ARR	131.5	101.8	44.1	277.4
Grand Total (RR + ARR)	187.9	161.7	44.1	393.4

During site verification of potential revegetation areas in the drawdown zone, virtually all sites identified in Moody 2005 were re-examined (Moody 2007 a, b) through stereoscopic interpretation of large-scale colour aerial photos obtained in May 2007. Sites considered unvegetated or less than optimally vegetated were identified for mandatory field verification to confirm site conditions and to determine remediation or enhancement options. Sites showing uniform solid vegetation cover on the air photos were considered to be well vegetated with further treatment unnecessary to achieve self-sustaining status. Sites with ownership concerns and/or recreational conflicts were excluded from revegetation consideration.

The areas that have been identified as candidate sites in Table CLBWORKS-2-2 appear to be “problem sites”, where wind or water erosion and substrates present unique challenges to vegetation establishment. Revegetation of these sites will occur over two years (Years 2 and 3 of program implementation), commencing in 2009. Collection of seed stock for lenticular sedge and other suitable species will take place in the summer of 2008 (water levels permitting) to ensure that local seed is available for raising nursery stock in 2009. The final two years of the revegetation program (Years 4 and 5) 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 the program (2011 and 2012).

2.1.2 Selecting Candidate Species for Revegetation

Based on results of field work conducted in 2007 (Enns 2007; Enns et al. 2007; Moody 2007a, b), a list of vegetation species that may be suitable candidates for revegetation is presented in Appendix I.

Any species from the list which is selected for inclusion in a revegetation prescription should meet the following criteria:

- likely to survive 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 economically propagated in large quantities.

Annual Planting Plan

For each of the areas identified for revegetation, proposed prescriptions utilizing a limited number of target species have been prepared (Section 2.2.6), based on findings from previous studies (Moody 2005), a 2007 assessment of vegetation, as well as site and substrate conditions (Moody 2007a, b). The application of these prescriptions (and any additional treatments proposed by the contractor) over the 2-year implementation of the program will be described in an annual planting plan, to be submitted to BC Hydro for review and acceptance prior to commencement of field work. The planting plan will describe:

- 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 1.2);
- 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 control sites 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 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.

In addition to the above requirements, the planting plan should also include detailed and approved planting specifications to facilitate monitoring of planting quality.

Criteria should include:

- spacing of seedlings,
- spacing from existing vegetation,
- planting depth,
- planting hole preparation (including tools used, site preparation (if any), etc.),
- protection of seedlings from grazing, browsing and other damage; and,
- utilization of microsites to enhance survival.

The planting plan will also need to demonstrate how any additional prescriptions, or modifications of existing prescriptions, will address wildlife habitat values 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 soft constraints operating regime (Appendix III) of the Arrow Lakes Reservoir.

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.

2.1.3 Control Sites for Monitoring Programs

Under CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources (Enns 2007; Enns et al. 2007), 16 distinct vegetation communities were identified in the drawdown zone of the Arrow Lakes Reservoir between elevations 433 m and 440 m. The goal of CLBMON-33 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 may remain untreated to act as control areas for CLBMON-33 and other monitoring programs under the Kinbasket & Arrow Lakes Reservoirs Revegetation Management Plan (e.g. CLBMON-12 Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis; CLBMON-11B Mid Columbia and Arrow Lakes Reservoir Wildlife Effectiveness Monitoring of Revegetation and Wildlife Physical Works).

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

- a) identifying potential impacts of specific prescriptions on control sites (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 1.2, 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 (e.g. willow staking) are proposed.

The location of heritage sites for those areas that have been assessed in the Arrow Lakes Reservoir and Revelstoke Reach is available through the Arrow Lakes Reservoir Archaeological Site Overview Assessment (CLBMON-52) and associated maps, which will be made available to the contractor 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 I.

2.1.5 Wildlife Habitat Enhancement

The fundamental wildlife objective of the Columbia River WUP was to maximize wildlife abundance and species diversity in the Columbia River system. The WUP CC made recommendations for physical works in lieu of operational changes to enhance wildlife habitat in the mid Columbia River (Revelstoke Reach) (BC Hydro 2005), and these physical works will be implemented under CLBWORKS-30 (Arrow Lakes Reservoir Wildlife Physical Works in Lieu), starting in 2010. To ensure that the wildlife habitat benefits of these physical works are maximized, revegetation efforts for the final two years of the program (Years 4 and 5) will be implemented in conjunction with the construction of these physical works, and separate Terms of Reference will be prepared.

While revegetation of the 393 ha identified in Section 2.1 above will not occur in conjunction with wildlife physical works, it is nevertheless important that prescriptions maximize the amount of riparian habitat created to improve wildlife values.

Revegetation prescriptions will therefore incorporate species beneficial for wildlife⁴, where feasible, and the proposal shall outline:

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

During a preliminary assessment of wildlife habitat, habitat suitability rankings were developed for each vegetation community identified under CLBMON-33 (Enns et al. 2007). The vegetation composition of communities with a high suitability ranking should be reviewed and considered when developing prescriptions aimed at

⁴ i.e. species that provide forage, cover, nesting opportunities, etc.

improving wildlife habitat. Detailed prescriptions will be provided in an annual planting plan (Section 2.1.2), which will be submitted to BC Hydro for review and acceptance prior to initiating field work.

2.1.6 Adaptive Management and Monitoring

Only very limited information is available on revegetating the drawdown zones of reservoirs in general; however, a number of studies have been carried out in southeastern British Columbia, specifically in the Revelstoke Reach of the Arrow Lakes Reservoir (Moody and Carr 2003, Moody 2002a and 2002b, Carr et al. 1993, Carr 1992, Carr and Moody 1992). Species in Appendix I with a “high” likelihood of success have been previously tested and have demonstrated good survival in Revelstoke Reach. Therefore, these species are good candidates for larger scale application. To ensure that revegetation efforts meet the objectives set by the WUP CC, prescriptions must also incorporate traditional use plants and species beneficial to wildlife, where feasible, but survival of these species is less certain and must be monitored. To evaluate the success of the prescriptions, the revegetation program must be designed in a manner that can be statistically evaluated by the associated monitoring programs (CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources, and CLBMON-12 Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis).

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 the Arrow Lakes Reservoir is gained, the revegetation program will continue to be implemented in stages for the remainder of the program. In 2008, small scale fertilization trials will be initiated to test a variety of fertilizers and application rates (Section 2.2.2). Based on the results of these trials, fertilization efforts will be expanded in 2009 and 2010. Planting of nursery seedlings will commence in 2009 and continue for the duration of the program, but individual prescriptions will be adapted based on findings from previous years.

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.

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: Fertilization Field Trials

To date, comparative fertilizer studies have not been undertaken in BC reservoirs, and studies of terrestrial fertilization treatments are not readily transferable to aquatic and semi-aquatic environments. Therefore, determining appropriate fertilizers and fertilization rates for representative revegetation sites is a contract requirement. The proposal shall describe how fertilizer trials may be implemented in 2008 to determine optimal fertilizer type(s) and application rate(s) at representative sites.

Information should include (but may not be limited to):

- types(s) of fertilizer proposed for trials, including ratios, grade (e.g. food or commercial) and type of release;
- proposed methods for evaluating different fertilizer types (including information on controls sites, biomass and/or foliar analysis, if applicable);
- fertilizer application methods and rates;
- amount of area proposed for trial sites (in hectares);
- proposed location of trial sites and reason for location selection; and
- assessment of soil physical and chemical properties⁵ (including proposed analytical laboratory).

2.2.3 Task 3: Seed Collection

To ensure availability during implementation of the revegetation program, sufficient locally adapted, native seed for a variety of suitable species (Appendix I) must be collected in each year of the program. Seed will be required for large scale nursery stock production; therefore, the collection of local seed in any given year of the program must be maximized if reservoir levels permit. If reservoir conditions prohibit the collection of local seed, seed may be obtained from the Kinbasket Reservoir through collection efforts under CLBWORKS-1 Kinbasket Reservoir Revegetation Program.

Lenticular Sedge (*Carex lenticularis*)

Lenticular sedge is a very common species in the reservoir drawdown zone, which is widely distributed across geographic areas and elevations (Enns 2007; Enns et al. 2007). This species also appears to be locally adapted to reservoir operating conditions, producing seed both before and after inundation (spring and fall) (Moody 2007b).

Lenticular sedge is a target species for further expansion across all suitable elevations in the drawdown zone for the following reasons:

⁵ 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.

- Commonly occurring, abundant and long-lived native plant with large seed sources throughout the reservoir;
- Grows easily from seed and produces large quantities of seed, which are naturally distributed around the plant and eventually redistributed by water;
- Stabilizes mobile substrates, particularly in sandy sites;
- Has large root strength and root biomass;
- Builds a deep organic mat that raises the ambient substrate elevation by several centimeters;
- Functions as a pioneer species that could eventually be replaced by a more diverse wetland community, if hydrologic conditions remain unaltered;
- Is resistant to goose cratering, but provides surface grazing for a variety of organisms;
- Has high nutrient value for wildlife and is preferentially chosen by ungulates⁶;
- Is capable of producing a second flush of growth and second seed set in the fall; and,
- Is easily identified in the field, which provides a logistical collection and planting advantage.

Because locally adapted lenticular sedge seed is not available commercially, custom seed collection from existing sedge communities must occur during each growing season. Lenticular sedge seed in the Arrow Lakes Reservoir has been found to mature in late June, just prior to inundation (Moody, pers. comm.). 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. 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 I may be suitable for seed collection in sufficient quantities to raise nursery stock. Appendix I does not provide an indication of density or abundance of the species identified, or their locations in the reservoir. Because these are critical factors in determining whether identified species may be suitable candidates for collection and propagation as part of the revegetation program, seed sources for suitable species must therefore be identified during seed collection in 2008. Information on potential seed sources for candidate species may also be obtained through collaboration with the contractor for

⁶ Boulanger et al. 2002; Carr and Moody 2002b; Moody 2002b.

CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources, who conducted an extensive assessment of vegetation communities in the drawdown zone in 2007. BC Hydro will coordinate a meeting between contractors shortly after contract award.

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.

2.2.4 Task 4: Live Stake Collection

Willow Species

Approximately 205 ha of the area identified for revegetation is suitable for live staking of willows. Willow staking has been ongoing in Revelstoke Reach and the Arrow Lakes for several years as part of BC Hydro's dust control program, and establishment of willows has been very successful. Appendix I lists willow species recommended for collection, including Scouler's willow (*Salix scouleriana*), Plane-leaf willow (*S. planifolia*) and Bebb's willow (*S. bebbiana*). Willow stakes are to be collected prior to bud break in areas near the planting sites to maximize genetic compatibility and minimize costs. The following sites were identified in Phase 1 as suitable collection sites:

- Machete Island (north of the airport);
- Area "F" - possible collection sites should be field verified;
- Area "P" - Drimmie Creek area;
- Area "S" - north of Mulvyhill Creek (property ownership needs to be verified - road access is private); and,
- South of area "S", north of Blanket Creek - embayment with good shrub cover, which must be accessed by boat.

The proposal shall outline how many willow stakes will be collected in each year of implementation, given the goal of planting 205 ha, as well as site, budget and labour constraints.

Prior to collection of willow stock, the contractor 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 (including top and base diameters), 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. Because of the intrusive nature of this prescription, willows and/or cottonwood stakes are not to be planted at or near identified archaeological sites.

Other Herbaceous or Woody Species

Due to the less severe site conditions at the very top of the drawdown zone (438-440 m), it is anticipated that additional terrestrial species will survive. Based on the candidate species list in Appendix I, and taking into account requirements under Section 2.1 (monitoring program control 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 I have been found in the drawdown zone of the Arrow Lakes Reservoir, their viability in revegetation treatments has not been verified. Therefore, 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 out planting in each year of the revegetation program, and how survival of different species will be evaluated across an elevation range of 438 m to 440 m.

2.2.5 Task 5: Nursery Stock Propagation

A key component of the revegetation program will be the production of nursery stock. It is expected that a minimum of 245,000 lenticular sedge seedlings and 5,000 seedlings of a variety of other species will be grown each year, including woody plant stock that requires more than one year of growth. Appendix V outlines detailed requirements which must be addressed in the proposal, to demonstrate that the contractor 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.

2.2.6 Task 6: Recommended Prescriptions

Provided below are three basic prescriptions, which were developed based on field work results in 2007 (Moody 2007b). These prescriptions include:

- P1 – Willow planting using either hardwood cuttings and/or container stock.
- P2 – Wetland planting using container grown native species from locally collected seed.
- P3 – Fertilization of existing vegetation areas to promote a more vigorous plant community in this nutritionally stressed environment.

Details on the revegetation sites for which these prescriptions are recommended are provided in Appendix IV. It should be noted, however, that these are basic prescriptions, which may not adequately address all objectives identified by the WUP CC. **In the proposal, the consultant shall indicate if/how these prescriptions may be modified to address the objectives in Section 1.2.** 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.

The annual planting plan (Section 2.1.2) will provide additional site specific details on how individual prescriptions meet the WUP CC objectives. If the proponent feels that all values can be addressed, the proposal shall describe how the current prescriptions meet each of the objectives listed in Section 1.2.

Recommended Species – Lenticular Sedge (*Carex lenticularis*)

The original prescriptions identified for revegetation (Moody 2005) in the Arrow Lakes included additional options, specifically seeding of fall rye and lenticular sedge; however, the seeding treatments have been deleted, because there are no longer large areas of barren substrate requiring seeding as a means of initiating vegetation cover. Wetland planting (P2) is planned instead, with lenticular sedge as the primary species for propagation and planting into challenging environments.

Based on 2007 field observations (Moody 2007b), seeding of sites with lenticular sedge seed has not been recommended as a prescription, because data suggest that there is already a large seedbank established throughout the drawdown zone area. Given suitable revegetation areas that are much smaller than originally projected, and an objective of rapid remediation, plugs or sprigs are considered the most effective means of achieving success. Lenticular sedge can be greenhouse cultivated to obtain plugs for manual planting into challenging environments (e.g. sites requiring erosion control, archaeological protection, wildlife enhancement). Sandy substrates are ideal for sedge growth, while sparse developing sedge marshes may be enhanced with fertilizer application.

Recommended Species – Willow (*Salix spp.*) and Cottonwood (*Populus balsamifera spp. trichocarpa*)

Willows (several species) and black cottonwood have been selected for higher elevation sites (437-440 m) in coarse substrates where deeper rooting is required (Appendix IV). In addition, these woody species are recommended for experimental treatment in locations where clay soils are of concern. The willow/cottonwood group is valuable for wildlife diversity, rapid growth and of benefit in poor drainage conditions, as long as tops are above water. Willows have been recommended for elevations where they are likely to succeed and for steeper slopes where longer stakes can be installed deeper to maintain slope stability. Use in clay soils is a suggested experimental treatment at higher barren sites to see if willows can survive under these conditions. Sedges will not tolerate these site conditions. The proposal shall outline how such experimental treatments may be implemented to assess survival of selected willow species under these conditions. The planting plan will provide additional site specific details on the experimental approach, including proposed species, rationale for species selection and methods for assessing results of the experimental treatments.

Recommended Prescription – Fertilization

Application of fertilizer is recommended as a cost-effective, rapid treatment prescription, which can be implemented during growth periods when plants have the greatest nutrient requirements. Sites which have been identified for fertilization are

listed in Appendix IV. Fertilization may be particularly beneficial in the Narrows area of the Arrow Lakes Reservoir, where narrow, linear, partially vegetated zones lend themselves to this type of treatment. Because there have been few examples of this type of program in reservoirs, it should be considered an experimental program, which will be tested for effectiveness through the application of different fertilizers, application rates and application methods (see Section 2.2.2).

2.2.7 Task 8: Reporting

A short summary report will be required on completion of the fertilization field trials in 2008. This report will include:

- a summary of the results of the experimental treatments, including information on:
 - locations, sizes, elevations, slope and aspect of trial sites;
 - soil chemical and physical characteristics of trial sites;
 - existing vegetation communities (if any);
 - fertilizer type (ratios, grade, and type of release);
 - cost per pound and hectare;
 - application rates, application methods and plant response;
 - methods used for evaluating different fertilizer types (including information on controls sites and biomass analysis, if applicable);
- a discussion of the results and any challenges encountered; and,
- recommendations for use of specific fertilizers and application rates/methods for large scale application in subsequent years of the revegetation program.

A short report will also be provided to summarize the 2008 seed collection efforts, which will include the information below.

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

- methods, types and amount of seed collected, with associated time and labour requirements;
- location of seed collection sites (GPS coordinates required);
- cleaning, stratification and storage requirements for seeds;
- locations (with GPS coordinates) for live stake collections;
- a summary of nursery stock production, including propagation requirements and challenges encountered; and,
- recommendations for future collection efforts and nursery propagation.

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 discussion of the objectives which were met by implementation of specific prescriptions in target areas; and,
- any recommendations.

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. All map data, including meta data, will also be provided electronically in ARC GIS compatible format.

2.3 Schedule

The revegetation program physical works will be implemented annually between March and September, as dictated by snow and water levels. Nursery stock will be initiated in January 2009 to provide three months of growth for sedge seedlings. If other nursery stock species are proposed, the proposal shall outline growth and timing requirements. Table CLBWORKS-2-3 provides a detailed task schedule.

Table CLBWORKS-2-3 Proposed Schedule for the Arrow Lakes Reservoir Revegetation Physical Works

Task	Month	Year
Fertilization Trials	May-June, September	2008
Seed collection - sedge	June	2008-2010
Seed collection - other species	As required by phenology	2008-2010
Live stake collection (willow, cottonwood)	February - March	2009-2010
Nursery stock production	January - May	2009-2010
Planting of live stakes	March - April	2009-2010
Planting of seedlings	May -June	2009-2010

2.4 Budget

The average annual cost for the implementation of Phase 2 of the revegetation program physical works is estimated at \$529,856 (including inflation and contingency). This cost is higher than the WUP CC estimate of \$420,000 annually over five years, but the estimate includes costs for travel, and accounts for the large increases in labour and fertilizer costs since 2004. Table CLBWORKS-2-4 provides a budget estimate, assuming a 2 % rate of inflation and a 5 % contingency for the program.

A separate budget will be prepared for the final two years of the Arrow Lakes Revegetation Program, which will be implemented in conjunction with CLBWORKS-30 Arrow Lakes Reservoir Wildlife Physical Works in Lieu.

3.0 REFERENCES

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APPENDIX I – CANDIDATE SPECIES LIST (including traditional use species)

Plant Type	Scientific Name	Common Name	Traditional Use	Min. Elev. (m)	Likelihood of Success	Comments
Trees	<i>Populus trichocarpa</i>	Black cottonwood	Y	434	High	can be used in any site prescriptions stating "willow"
	<i>current nomenclature= P. balsamifera ssp. trichocarpa</i>					Very uncommon at 434m, but does occur, especially in silts and gravels
Shrubs	<i>Salix melanopsis</i>	Dusky willow	Y	436	High	appropriate for drawdown zone
	<i>Salix planifolia</i>	Plane-leaved willow	Y	437	High	appropriate for drawdown zone, but not common
	<i>Salix bebbiana</i>	Bebb's willow	Y	437	High	appropriate for drawdown zone
	<i>Salix scouleriana</i>	Scouler's willow	Y	435	High	appropriate for drawdown zone on gravels, silts, sands
	<i>Alnus viridis</i>	Sitka alder	Y	435	Exp	could be tested for success
	<i>Prunus virginiana</i>	Choke cherry	Y	435	Exp	could be tested for success
						on small hummocks at very low elevation in some areas of RR and Arrow
Herbs and Forbs	<i>Ranunculus flammula</i>	Lesser spearwort	n/a	n/a	Exp	possible, but small stature and low rootmass make this a questionable choice
Grasses	<i>Poa compressa</i>	Canada bluegrass		436	High	successful at higher elevations
	<i>Calamagrostis canadensis</i>	Bluejoint reedgrass	Y	436	Med	sands mixed with gravels on hummocks occurs only in patchy distribution, poor competitor silty boundaries on edges of gravel bars, in gravel depositional areas

Plant Type	Latin Name	Common Name	Traditional Use	Min. Elev. (m)	Likelihood of Success	Comments
Grasses	<i>Agrostis scabra</i>	Rough bentgrass	n/a	435	Exp	has been tested , little long term success, may have greater success under present water regime
						in silts and seepage sites, fresh water inputs, stable areas
	<i>Danthonia spicata</i>	Poverty oatgrass	n/a	438	Exp	occurs in elevations that are already well vegetated
						in lower Arrow, in sands
	<i>Elymus cinereus</i>	Giant wild rye	Y	435	Exp	possible candidate but unlikely
	<i>Elymus sibiricus</i>	Siberian wild rye	n/a		Exp	possible candidate but unlikely
	<i>Panicum occidentale</i> (<i>Dichanthelium acuminatum</i>)	Western panicum	n/a	436	Exp	possible candidate but unlikely
						sands mixed with gravels on hummocks
Sedges, Rushes, Reeds	<i>Carex lenticularis</i>	Lakeshore sedge	Y	433	High	Extremely successful in drawdown zone. Meets all objectives of planting program.
	<i>Carex aquatilis</i>	Water sedge	Y	437	Med	Has been tested and is successful where planted but does not spread fast or spread by seed from planted stock
						uncommon, in silts and small depressional areas
	<i>Carex rostrata</i>	Beaked sedge	Y	435	Med	Has been tested and has been successful where planted, but does not spread fast or spread by seed from planted stock. Appears to have a finite life span - clones disappear after a few years.
						uncommon, in silts and small depressional areas
	<i>Carex sitchensis</i>	Sitka sedge	Y	435	Exp	Does not appear to be a strong competitor.
					uncommon, in silts and small depressional areas	
	<i>Carex disperma</i>	Soft-leaved sedge	Y	437	Exp	Possible candidate.

APPENDIX II – MAPS OF REVEGETATION SITES

APPENDIX III – SOFT CONSTRAINTS OPERATIONS FOR THE ARROW LAKES RESERVOIR

Consensus agreement was reached around developing soft operating constraints for Arrow Lakes Reservoir to meet the interests and stated objectives of the CC. In supporting soft constraints for the reservoir, the Committee recommended a 5-year review period upon implementation of the Water Use Plan to evaluate the effectiveness of the soft constraints.

The CC agreed that there are a number of conflicting interests, which will vary in degree according to water year. The Committee acknowledged that BC Hydro would need to balance these trade-offs internally when selecting its water management strategy. This balance would be informed by the expressed values of the Committee members, the performance measures calculated to date, the efficacy of the physical works, and the evolution of knowledge arising from the monitoring programs to guide operational decisions.

Following is a summary of the soft operating constraints for Arrow Lakes Reservoir.

Interest	Constraint
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Vegetation

- Maintain current level of vegetation in the drawdown zone by maintaining lower reservoir water levels during the growing season. No specific operating targets were identified to meet this general objective.
- If vegetation is showing signs of stress as a result of inundation during the early part of the growing season (May to July), target lower reservoir levels in the fall to allow exposure of plants during the latter part of the growing season.
- Preservation of current levels of vegetation at and above elevation 434 m (1424 ft) is considered a priority.

Wildlife

- Ensure that inundation of nesting bird habitat by rising reservoir water levels in early summer is no worse than that which occurred on average over recent history (1984 to 1999). Match operating levels to inundation statistics for elevations 434 m (1424 ft) and above over the 1984 to 1999 period, which were used to produce the average historic performance measure score for spring/summer nesting short-eared owl habitat.
- Ensure that availability of migratory bird habitat in the fall is as good as or better than that which has been provided on average over recent history (1984 to 1999). Draft the reservoir quickly after full pool is reached, targeting a reservoir level of 438 m (1437 ft) or lower by August 7.

Fish

- Ensure appropriate reservoir elevations for tributary access during the kokanee spawning period (late August to early November). Reservoir levels of or below 434 m (1424 ft) could cause tributary access to be restricted in some streams under certain conditions. Proposed monitoring study aimed at determining reservoir level thresholds under a range of tributary streamflow conditions below which spawner access becomes a problem.

Recreation

- Target reservoir water levels between 437 m (1433 ft) and 439 m (1440 ft) from May 24 to September 30.
- Flexibility to achieve lower reservoir levels of 434 m (1424 ft) during the recreation season would be acceptable with proposed construction/upgrade of boat ramps for recreation interests served by these formal access points.

Culture and Heritage

- Maintain reservoir water levels at or below 436 m (1430 ft) for as long as possible.
- First Nations are willing to accept water levels above this 20 % of the time (or for 2.5 months) provided that it is timed in accordance with the vegetation efforts. First Nations would be willing to relax this constraint if the archaeological site protection plan is underway.

Erosion

- Minimize duration of full pool events. Reservoir water levels of 439 m (1440 ft) are ideal.
- Avoid sudden drawdown once full pool has been reached (particularly if high runoff has saturated the reservoir banks) to avoid slumping of the shores.

Power Generation

- Optimize power values.

APPENDIX IV – PROPOSED REVEGETATION SITE PRESCRIPTIONS

AREA	Site ID	Veg. Type	Substrate	Recommended Treatment Approach	Base Prescription	Estimate Potential of Success	Max. Elev. (m)	Min. Elev. (m)	Area (sq.m.)	Area (ha)
REVELSTOKE REACH	F	MARSH	SAND	PLANT	WILLOW	HIGH	439	436	4139.4	0.4
	F	MARSH	SAND	PLANT	WILLOW	HIGH	440	436	2008.5	0.2
	F	UNVEGETATED	SANDSILT	PLANT	WILLOW	HIGH	438	436	1911.9	0.2
	F	UNVEGETATED	SANDSILT	PLANT	WILLOW	HIGH	437	435	2956.7	0.3
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	433	433	12339.3	1.2
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	433	433	12226.5	1.2
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	433	432	6617.4	0.7
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	433	433	1888.4	0.2
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	433	433	1371.2	0.1
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	433	433	1477.5	0.1
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	433	433	3047.2	0.3
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	434	434	2289.5	0.2
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	434	433	1985.8	0.2
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	435	433	5626.8	0.6
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	433	433	16850.5	1.7
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	434	434	248.7	0.0

AREA	Site ID	Veg. Type	Substrate	Recommended Treatment Approach	Base Prescription	Estimate Potential of Success	Max. Elev. (m)	Min. Elev. (m)	Area (sq.m.)	Area (ha)
REVELSTOKE REACH	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	434	434	736.4	0.1
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	434	434	768.3	0.1
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	434	434	525.6	0.1
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	433	433	248.7	0.0
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	434	434	813.6	0.1
	M	UNVEGETATED	SAND	PLANT	WILLOW	HIGH	436	435	3265.2	0.3
	M	UNVEGETATED	SAND	PLANT	WILLOW	HIGH	436	434	4782.3	0.5
	M	UNVEGETATED	SAND	PLANT	WILLOW	HIGH	436	436	507.2	0.1
	M	UNVEGETATED	GRAVEL	PLANT	WILLOW	HIGH	438	434	12626.3	1.3
	M	UNVEGETATED	SAND	PLANT	WILLOW	HIGH	437	435	5455.9	0.5
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	435	434	8052.5	0.8
	M	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	435	433	5639.0	0.6
	M	UNVEGETATED	SAND	PLANT	WILLOW	HIGH	440	435	336.5	0.0
	S	MARSH	SAND/SILT	PLANT	WILLOW	HIGH	436	435	3693.6	0.4
	U	UNVEGETATED	SAND	PLANT	<i>C. lenticularis</i> plugs	HIGH	434	431	1338.6	0.1
	U	UNVEGETATED	SAND	PLANT	WILLOW	HIGH	436	434	2746.7	0.3
	V	MARSH	SILT	FERTILIZE & PLANT	WILLOW & <i>C. lenticularis</i> plugs according to elevation	MEDIUM	439	431	193210.9	19.3
W	MARSH	SILT	FERTILIZE & PLANT	WILLOW & <i>C. lenticularis</i> plugs according to elevation	MEDIUM	438	430	257532.1	25.8	

AREA	Site ID	Veg. Type	Substrate	Recommended Treatment Approach	Base Prescription	Estimate Potential of Success	Max. Elev. (m)	Min. Elev. (m)	Area (sq.m.)	Area (ha)
REVELSTOKE REACH					WILLOW & C. lenticularis plugs according to elevation					
	W	MARSH	SILT	FERTILIZE & PLANT		MEDIUM	435	432	139355.1	13.9
	X	MARSH	SILT	FERTILIZE		HIGH	434	431	114329.1	11.4
	X	MARSH	SILT	FERTILIZE		HIGH	437	432	48656.0	4.9
	Y	MARSH	SILT	FERTILIZE		HIGH	434	432	103895.7	10.4
	Y	MARSH	SAND	FERTILIZE & PLANT	C. lenticularis plugs	HIGH	435	434	25205.0	2.5
	Y	MARSH	SILT	FERTILIZE		HIGH	435	433	119547.8	12.0
	Y	MARSH	SAND	FERTILIZE & PLANT	C. lenticularis plugs	HIGH	434	432	27364.1	2.7
	Y	MARSH	SAND	FERTILIZE		HIGH	435	432	75077.9	7.5

AREA	Site ID	Veg. Type	Substrate	Recommended Treatment Approach	Base Prescription	Estimate Potential of Success	Max. Elev. (m)	Min. Elev. (m)	Area (sq.m.)	Area (ha)
UPPER ARROW	1	MARSH	GRAVEL/COBBLE	FERTILIZE		MEDIUM	440	432	60353.6	6.0
	1	MARSH	SILT	FERTILIZE		MEDIUM	434	432	6072.6	0.6
	1	MARSH	SILT	FERTILIZE		MEDIUM	434	432	9141.7	0.9
	1	MARSH	SILT	FERTILIZE		MEDIUM	434	433	10894.4	1.1
	1	MARSH	GRAVEL	FERTILIZE		MEDIUM	439	433	17951.9	1.8
	1	MARSH	SILT	FERTILIZE		HIGH	438	434	24961.3	2.5
	1	MARSH	GRAVEL/COBBLE	FERTILIZE		HIGH	438	432	37354.0	3.7
	1	MARSH	GRAVEL/COBBLE	FERTILIZE		HIGH	439	432	50577.8	5.1
	5	UNVEGETATED	GRAVEL/COBBLE	PLANT	WILLOW & C. lenticularis plugs according to elevation	LOW	437	432	76985.7	7.7
	5	UNVEGETATED	GRAVEL/COBBLE	PLANT	WILLOW & C. lenticularis plugs according to elevation	MEDIUM	437	436	2752.9	0.3
	5	UNVEGETATED	GRAVEL/COBBLE	PLANT	WILLOW & C. lenticularis plugs according to elevation	LOW	440	434	57193.9	5.7
	5	RIPARIAN	GRAVEL/COBBLE	PLANT	WILLOW & C. lenticularis plugs according to elevation	MEDIUM	440	435	26760.5	2.7
	5	RIPARIAN	GRAVEL	PLANT	WILLOW & C. lenticularis plugs according to elevation	MEDIUM	440	434	46194.0	4.6
	6	MARSH	SAND	FERTILIZE		HIGH	440	432	13594.1	1.4
	6	MARSH	SAND	FERTILIZE		HIGH			2667.6	0.3
	6	MARSH	SAND	FERTILIZE		HIGH	440	432	110792.9	11.1

AREA	Site ID	Veg. Type	Substrate	Recommended Treatment Approach	Base Prescription	Estimate Potential of Success	Max. Elev. (m)	Min. Elev. (m)	Area (sq.m.)	Area (ha)
UPPER ARROW	6	MARSH	SAND	FERTILIZE		HIGH			460.6	0.0
	7	MARSH	SAND	FERTILIZE		HIGH	440	432	125807.8	12.6
	7	MARSH	SAND/GRAVEL	FERTILIZE		HIGH	439	432	4295.7	0.4
	7	MARSH	SAND/GRAVEL	FERTILIZE		HIGH	440	432	80206.8	8.0
	7	MARSH	SAND/GRAVEL	FERTILIZE		HIGH	440	432	58318.9	5.8
	7	MARSH	SAND/CLAY	FERTILIZE		MEDIUM	440	432	23767.2	2.4
	7	MARSH	SAND/CLAY	FERTILIZE		MEDIUM	440	433	10358.4	1.0
	7	MARSH	SAND/CLAY	FERTILIZE		MEDIUM	440	433	3319.4	0.3
	8	MARSH	SAND/CLAY	FERTILIZE		HIGH	439	432	45079.3	4.5
	8	MARSH	SAND/CLAY	FERTILIZE		HIGH	440	433	58185.3	5.8
	8	MARSH	SILT/SAND/GRAVEL	FERTILIZE & PLANT	WILLOW & C. lenticularis plugs according to elevation	HIGH	440	434	203677.1	20.4
	8	UNVEGETATED	SILT/SAND/GRAVEL	FERTILIZE & PLANT	WILLOW & C. lenticularis plugs according to elevation	HIGH	439	432	227271.8	22.7
	9	MARSH	SAND	FERTILIZE & PLANT	C. lenticularis plugs	HIGH	434	433	37440.0	3.7
	9	MARSH	SAND/SILT	FERTILIZE		MEDIUM	434	432	11165.1	1.1
	9	MARSH	SAND	FERTILIZE & PLANT	C. lenticularis plugs	HIGH	434	432	41944.4	4.2
	9	MARSH	SAND/SILT	FERTILIZE & PLANT	C. lenticularis plugs	HIGH	434	433	51275.6	5.1

AREA	Site ID	Veg. Type	Substrate	Recommended Treatment Approach	Base Prescription	Estimate Potential of Success	Max. Elev. (m)	Min. Elev. (m)	Area (sq.m.)	Area (ha)
LOWER ARROW	10	MARSH	SILT	FERTILIZE		HIGH	440	433	65185.1	6.5
	10	UNVEGETATED	SAND	PLANT	WILLOW & C. lenticularis plugs according to elevation	HIGH			8579.5	0.9
	10	UNVEGETATED	SAND/SILT	PLANT	WILLOW & C. lenticularis plugs according to elevation	HIGH			5493.8	0.5
	10	UNVEGETATED	SAND	PLANT	WILLOW & C. lenticularis plugs according to elevation	MEDIUM	440	432	16233.3	1.6
	10	MARSH	GRAVEL	FERTILIZE		MEDIUM	440	434	135362.7	13.5
	10	UNVEGETATED	GRAVEL	PLANT	WILLOW & C. lenticularis plugs according to elevation	HIGH	440	432	65970.0	6.6
	10	MARSH	GRAVEL	PLANT	WILLOW & C. lenticularis plugs according to elevation	MEDIUM	440	432	79753.4	8.0
	10	UNVEGETATED	SAND/GRAVEL	PLANT	WILLOW & C. lenticularis plugs according to elevation	MEDIUM	440	433	135556.2	13.6
	10	MARSH	SAND/GRAVEL	FERTILIZE		MEDIUM	439	432	130992.2	13.1
	11	MARSH	SAND	FERTILIZE		MEDIUM	440	433	31907.0	3.2
	11	UNVEGETATED	SAND/GRAVEL	PLANT	WILLOW & C. lenticularis plugs according to elevation	MEDIUM	440	431	135381.3	13.5
	11	MARSH	SAND/GRAVEL	FERTILIZE		HIGH	440	434	56689.9	5.7

AREA	Site ID	Veg. Type	Substrate	Recommended Treatment Approach	Base Prescription	Estimate Potential of Success	Max. Elev. (m)	Min. Elev. (m)	Area (sq.m.)	Area (ha)
LOWER ARROW	12	MARSH	SAND/GRAVEL	FERTILIZE		MEDIUM	440	434	78252.0	7.8
	12	UNVEGETATED	SAND/GRAVEL	FERTILIZE & PLANT	WILLOW & C. lenticularis plugs according to elevation	LOW	440	432	45358.5	4.5
	12	UNVEGETATED	SAND	FERTILIZE & PLANT	WILLOW & C. lenticularis plugs according to elevation	LOW	440	432	64202.3	6.4
	12	UNVEGETATED	SAND/GRAVEL	PLANT	WILLOW & C. lenticularis plugs according to elevation	LOW	440	432	25346.1	2.5
	13	MARSH	GRAVEL	FERTILIZE		MEDIUM	438	435	9448.3	0.9
	13	MARSH	SILT/SAND/GRAVEL	FERTILIZE & PLANT	WILLOW & C. lenticularis plugs according to elevation	HIGH	438	435	9691.1	1.0
	13	UNVEGETATED	SAND/SILT	FERTILIZE & PLANT	WILLOW & C. lenticularis plugs according to elevation	HIGH	440	434	168643.5	16.9
	13	UNVEGETATED	SAND	FERTILIZE & PLANT	WILLOW & C. lenticularis plugs according to elevation	LOW	440	432	11846.9	1.2

APPENDIX V- PROPOSAL REQUIREMENTS FOR NURSERY STOCK PRODUCTION

The following information will be provided as part of the proposal to address requirements under Section 2.2.5 (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;
- description of field storage methods and sites, including how watering and shading needs are addressed, and maximum allowable storage times;
- description of how target plant size, target root mass, and their allowable limits for each species will be established;
- description of anticipated delivery methods (e.g. are seedlings containerized or bagged, refrigerated, etc.);
- field delivery methods, schedule and capacity (e.g. open or closed trailers, protection of the plants from sun and wind during transportation); 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, containers to be used, cavity (plug) dimensions length and width for proposed species, 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.