

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**

26 April 2007

KINBASKET AND ARROW LAKES RESERVOIRS REVEGETATION MANAGEMENT PLAN TERMS OF REFERENCE

1.0 OVERVIEW

This management plan 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 implement revegetation physical works, monitor representative planting sites under various revegetation treatments, map vegetation distribution by elevation, identify riparian wildlife habitat and monitor wildlife utilization patterns in response to revegetation efforts in Kinbasket and Arrow Lakes reservoirs, and the mid Columbia River.

This document provides detailed Terms of Reference for Phase 1 of CLBWORKS-1 Kinbasket Reservoir Revegetation Program and CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program.

Leave to Commence has been received for 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 the other monitoring programs will be submitted within the timelines specified in the Order under the *Water Act* (File No. 76975-35/Columbia), issued by the Comptroller of Water Rights on 26 January 2007.

An overview of the two physical works and eight effectiveness monitoring programs included in this management plan is provided below.

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, aesthetics, dust control 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, aesthetics, dust control and recreation.

These physical works Terms of Reference are not the final design for each revegetation program, but rather a description of how field verification and prioritization of revegetation sites will be carried out, and how materials, including plant seed and nursery stock, will be collected in Year 1 of the program.

Development of a final revegetation program will require public consultation to ensure that the plan is not in conflict with other land uses (e.g., motorized and non-motorized recreation, beach areas), and will require that planting prescriptions are compatible with First Nation archaeological site protection requirements. This consultation will be carried out in 2007, and revised Terms of Reference with detailed revegetation physical works plans will be submitted within the timelines specified in the Order.

Monitoring Programs:

- 1) CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts: a 10-year program to evaluate plant survival and monitor representative planting sites under the various revegetation treatments in Kinbasket Reservoir.
- 2) CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources: a 10-year program to assess and map vegetation distribution by elevation and identify riparian wildlife habitat within Kinbasket Reservoir.
- 3) CLBMON-11 Kinbasket and Arrow Lakes Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works: a 12-year program to monitor wildlife utilization patterns in response to revegetation efforts in Kinbasket Reservoir, the mid Columbia River and Arrow Lakes Reservoir.
- 4) CLBMON-12 Mid Columbia River and Arrow Lakes Reservoir Monitoring of Revegetation Efforts: a 10-year program to evaluate plant survival and monitor representative planting sites under the various revegetation treatments in the mid Columbia River and 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-34 Arrow Lakes Reservoir Vegetation Composition and Analysis: a 10-year program to monitor vegetation distribution and composition by elevation in relation to inundation cycles to establish plant status in the mid Columbia River and Arrow Lakes Reservoir.
- 8) 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

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	Yes	No	April 2007	No
CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation	Schedule C: 1.a Schedule D: 1.a	Yes	No	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
Program					
CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts	Schedule A: 2.a	No	No		No
CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources	Schedule A: 2.b	No	No	April 2007	Yes
CLBMON-11 Kinbasket and Arrow Lakes Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works	Schedule A: 4.c	No	No		No
	Schedule C: 5.a				
	Schedule D: 2.a				
CLBMON-12 Mid Columbia River and Arrow Lakes Reservoir Monitoring of Revegetation Efforts	Schedule C: 2.a	No	No		No
	Schedule D: 2.b				
CLBMON-13 Monitoring of Mosquito Populations in the Revelstoke Area	Schedule C: 5.b	No	No		No
CLBMON-33 Mid Columbia and Arrow Lakes Reservoir Inventory of Vegetation Resources	Schedule C: 2.b	No	No	April 2007	Yes
	Schedule D: 2.c				
CLBMON-34 Arrow Lakes Reservoir Vegetation Composition and Analysis	Schedule C: 2.b	No	No		No
	Schedule D: 2.c				
CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation	Schedule C: 2.c	No	No		No
	Schedule D: 2.d				

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 in the drawdown zone and provide benefits to littoral productivity, wildlife habitat, shoreline erosion and archaeological site protection.

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

2.1 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. In addition, preliminary work on developing revegetation strategies for the drawdown zones of Kinbasket Reservoir (Carr and Moody, 2003) indicated that the greatest limiting factor to vegetation establishment was not the operation of the reservoir, but lack of initial vegetation establishment, which could 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. The program will be implemented through the revegetation physical works CLBWORKS-1 (Kinbasket Reservoir Program Physical Works).

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

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

2.2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program

Riparian vegetation in Arrow Lakes Reservoir, and in particular Revelstoke Reach, 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 2003).

Recognizing the importance of this vegetation, the WUP CC explored several operating alternatives, designed to maintain existing vegetation in 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, 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 in areas between elevations 434 m and 440 m 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 Revelstoke Reach and 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 CLBWORKS-2 (Mid Columbia and Arrow Lakes Reservoir Revegetation Program Physical Works). 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 (CLBMON-12)
- Arrow Lakes Reservoir Inventory of Vegetation Resources (CLBMON-33)
- Arrow Lakes Reservoir Vegetation Composition and Analysis (CLBMON-34)
- Arrow Lakes Reservoir Plant Response to Inundation (CLBMON-35)

2.3 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 provide qualitative data on mammal use of the Kinbasket and Arrow reservoir drawdown zones, with the goal of assessing the benefits of revegetation efforts and physical works 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

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.

Moody, A.I. 2003. Mica-Revelstoke-Keenleyside Water Use Plan: potential areas for vegetation establishment in the Arrow Lakes Reservoir. Prepared for BC Hydro.

Physical Works CLBWORKS-2

Mid Columbia River and Arrow Lakes Reservoir Revegetation Program - Phase 1

1.0 PROGRAM RATIONALE

During the Columbia River Water Use (WUP) planning process, the WUP Consultative Committee (WUP CC) recognized the value of vegetation in 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 enhancing riparian vegetation, wetland vegetation and the riparian/wetland interface, because these are the only areas that can be substantially affected by changes in BC Hydro operations. 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 development of long-term self-sustaining riparian vegetation between elevation 434m and 440m¹.

The WUP CC set out principles by which the mid Columbia River and Arrow Lakes Reservoir revegetation programs should be implemented, 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.
- Revegetation efforts on the Arrow Lakes Reservoir are to be directed above elevation 434m (1424ft). Areas below this elevation are still to be addressed as required by the BC Hydro dust control program.
- Above Arrow Lakes Reservoir elevation 434m (1424ft), 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.

Development of a 'permanent' riparian/wetland cover in the reservoir is expected to involve planting over several years to facilitate the development of long-term vegetation cover. Experience gained with other reservoir revegetation programs (e.g., Arrow Lakes Reservoir) suggests that a period of three to five years would be required to establish conditions for natural re-colonization, with success being governed by plant responses to the operational regime of the reservoir. Therefore, the revegetation program is proposed as a multi-year project requiring intervention over five years² to facilitate long-term vegetation cover.

¹ The operating range of Arrow Lakes Reservoir is between 422 m (1384 ft) and 440 m (1443 ft); the revegetation program is proposed for the upper elevations, between 434 m (1424 ft) and 440 m (1443 ft).

² Implementation may occur over non-consecutive years.

As stated in the final bullet of the guiding principles for the revegetation program, it was agreed by the WUP CC that development of a final revegetation program will require public consultation to ensure that the plan is not in conflict with other land uses (e.g., motorized and non-motorized recreation, beach areas), and will require that planting prescriptions are compatible with First Nation archaeological site protection requirements. It was also acknowledged that there are opportunities to incorporate vegetation types valued in traditional use by First Nations in the planting program. The Committee recommended a number of studies to inventory vegetation and archaeological resources, and to monitor the effectiveness of revegetation efforts on vegetation communities and wildlife habitat use. These studies are described as part of the Kinbasket and Arrow Lakes Reservoir Revegetation Management Plan and the Heritage Management Plan.

1.1 Objectives and Scope

The revegetation plan has been designed as a multi-year physical works program with treatments spread over five years. Key environmental and social objectives of the physical works are to maximize vegetation growth in the drawdown zone and provide benefits to littoral productivity and wildlife habitat, to reduce shoreline erosion and to protect archaeological sites.

The WUP CC supported reservoir-wide revegetation programs for the mid Columbia and Arrow Lakes Reservoir based on the assumption that the soft constraints operating regime for Arrow Lakes Reservoir agreed to by the Committee would be effective in maintaining current levels of vegetation. While no specific operating targets were identified in the soft constraints, the objective for the revegetation program is to maintain the current level of vegetation in the drawdown zone through maintaining lower reservoir water levels during the growing season. In supporting the soft constraints for Arrow Lakes Reservoir, the WUP CC recommended a 5-year review period upon initiation of the Water Use Plan to evaluate the effectiveness of the soft constraints to meet the above objective.

The physical works will be implemented in three phases:

- Verification and selection of proposed planting locations, collection of seed stock, initiation of nursery stock and cutting of live stakes
- Design of revegetation plan based on consultation with First Nations, regulatory agencies and stakeholders
- Implementation of revegetation physical works

A detailed plan for Phase 1 is provided below. Revised Terms of Reference describing Phases 2 and 3 of the program will be submitted to the Comptroller of Water Rights within the timelines required by the Order.

The final terms of reference for the revegetation physical works will incorporate information from consultation with stakeholders, First Nations and regulatory agencies, as well as information obtained from the synthesis of the following activities and sources:

- Arrow Lakes Reservoir Inventory of Vegetation Resources (CLBMON-33)
- Arrow Lakes Reservoir Archaeological Site Overview Assessment (CLBMON-52)

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 adequately protected from any intrusive works.

2.0 PHYSICAL WORKS PROPOSAL

2.1 Phase 1: Site verification, seed collection and nursery stock initiation

As part of the WUP process, a study was undertaken to identify areas with the highest potential for successful vegetation establishment (Moody 2005). This study identifies areas within the drawdown zone of Arrow Lakes Reservoir with high, medium and low potential for long-term riparian vegetation establishment and suggests five revegetation enhancement treatments. Because of the limited time and resources available for this study during the WUP process, suggested areas for revegetation were not comprehensively verified (ground-truthed) to assess the suitability of individual sites for revegetation or determine specific treatments and planting mechanisms. Consequently, further analysis is required to confirm initial classifications of sites as having high or medium potential for revegetation and to prioritize sites according to other considerations (e.g. ease of access, location, wildlife potential, etc.).

Detailed prescriptions for specific sites will be developed during Phase 2 of the Revegetation physical works; however, the basic treatment options proposed include:

- Fall rye seeding across all elevations zones to promote surface substrate stabilization, provide organic matter for improvement of soil fertility, and promote native species colonization.
- Direct seeding of lenticular sedge (*Carex lenticularis*), in conjunction with a carrier seed (e.g. fall rye or alfalfa) or sequential seeding with nurse crop seed.
- Planting of terrestrial species (e.g. willow spp.) in the upper elevation(s) of the drawdown zone, using species that provide traditional use value and/or increase the complexity of wildlife habitat.
- Planting of wetland species in areas not suited for direct seeding, using container grown native species from locally collected seed.
- Fertilization of existing vegetation areas to promote a more vigorous plant community in a nutritionally stressed environment.

While final selection of planting mechanisms cannot be made until after the completion of the consultation process and confirmation of site classifications, potential treatment options will be evaluated for individual sites as part of the field verification process and preliminary prescriptions provided.

In addition to site verification and prioritization, Phase 1 of the revegetation program will also involve collection of lenticular sedge seed and initiation of nursery stock of willows and other vegetation species to ensure that container stock is available for planting for implementation of the program. Sedge seed collection will occur after sedge seeds have reached maturity but before reservoir elevations exceed 437m (inundation level for seed stock).

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 selection, 3) logistics coordination, 4) technical oversight in field and analysis components, and 5) facilitation of data transfer among other investigations associated with the Kinbasket and Arrow Lakes Reservoir Revegetation Management Plan.

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

2.2.2 Task 2: Revegetation Site Verification

Because the initial evaluation of revegetation potential for sites in the mid Columbia River and Arrow Lakes Reservoir drawdown zone was based primarily on satellite imagery, further analysis is required to confirm initial assessments for sites with high and medium potential (low potential sites will not be investigated further). This task may result in reclassification of some sites. The proposal shall outline how this 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 classifications and other considerations, and to provide a rationale for the selections.

A vegetation mapping inventory (CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources) will be conducted by others, starting in spring 2007, to determine the current distribution of vegetation in the drawdown zone prior to implementation of physical works and as a basis for monitoring performance measures. Certain areas of existing vegetation identified in this inventory will be used as controls to a) determine the effects of reservoir operation on vegetation communities over time, and b) assess the effectiveness of revegetation efforts at enhancing existing vegetation communities. For this purpose, a collection of 1:5,000 normal colour aerial photographs of Revelstoke Reach and vegetated areas of the Upper and Lower Arrow Lakes Reservoir will be acquired in the summer of 2007, and over five non-consecutive years to map and measure existing vegetation communities in the drawdown zones. Year 1 aerial photography will be made available, and should be utilized for re-assessing the revegetation potential for identified sites, in conjunction with the following information:

- DEM for Arrow Lakes Reservoir (to be obtained from BC Hydro)
- Reservoir levels when planning site inspections. It is anticipated that only sites in the higher elevation bands of the drawdown zone can be field verified in 2007. Field verification of site in lower elevations of the drawdown zone will need to occur in 2008 during low water levels (March-April)

Detailed site inspections for a sub-sample of the identified sites are recommended to confirm substrate, slope, aspect and elevations of the sites. These field inspections should concentrate on areas classified as having high potential for enhancement;

however, to increase the efficiency of the cost per unit-effort of site verification, sites with medium enhancement potential adjacent to high potential sites should also be included in the assessment. Sites should be selected based on the interpretation of aerial photography provided by CLBMON-33 (Arrow Lakes Reservoir Inventory of Vegetation Resources). It is recommended that all sites be stratified by broad type (e.g. sandy/flat vs. coarse/steep, etc.), and that field verification occurs on a proportion of each site type to confirm existing classifications or reclassify.

Data to be collected during site verification will include:

- elevation
- aspect
- slope
- substrate (type, depth)
- species composition
- species density
- measure of overall health or status of vegetation species/community
- site status for collection of sedge seed, and herbaceous or woody species (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 Ministries of Environment and Forests "Field manual for describing terrestrial ecosystems"³ (1998).

2.2.3 Task 3: Live Stake Collection and Nursery Stock Initiation

Willow Species

Collection of local, native willow species from the mid Columbia River and Arrow Lakes Reservoir for propagation by hardwood cuttings will be carried out in winter 2007/2008. Recommended species include Bebb's (*Salix bebbiana*), Scouler's (*S. scouleriana*) and tea-leaved willow (*S. planifolia*). To estimate required numbers, it should be assumed that 20% of the treatment area for the mid Columbia River and Arrow Lakes Reservoir will be affected by willow planting over 5 years and that willow planting will be applied only in the upper 2-3m of the drawdown zones, if analysis of water levels deems this appropriate.

The proposal shall outline how and where the appropriate number of cuttings may be obtained for each species from local, native stock, and what storage requirements will be followed to ensure the cutting remain viable until 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, any collection of willow live stakes must not to impact established vegetation communities and be carried out in such a way as to not destroy any active nests, nor to diminish the value of the collection area to breeding birds. Best management practices to minimize the risk of these impacts should be included as part of the collection procedure.

³ <http://www.for.gov.bc.ca/hfd/pubs/docs/Lmh/Lmh25.htm>

Other Herbaceous or Woody Species

Due to the less severe site conditions at the very top of the drawdown zone (438-440m), it is anticipated that additional terrestrial species will survive here. For this elevation, the following species are recommended for their traditional use and wildlife values:

- American bush cranberry (*Viburnum opulus*) and highbush cranberry (*V. edule*)
- Black hawthorn (*Crataegus douglasii*)
- Black cottonwood (*Populus balsamifera*)
- Mock orange (*Philadelphus lewisii*) (lower Arrow Lakes)
- Beaked hazelnut (*Corylus cornuta*)
- Native roses (e.g. Nootka rose)
- Cascara (*Rhamnus purshiana*)

The viability of these species in the drawdown zone of Arrow Lakes Reservoir has not been tested, and seed collection/propagation should therefore only occur on a limited scale in Year 1 of the program. The proposal shall describe how local, native seed for these and other potentially viable species could be collected, and how container stock may be grown for outplanting in Phase 3 of the revegetation program.

2.2.4 Task 4: Lenticular Sedge Seed Collection

To ensure seed availability during implementation of the revegetation program, sufficient lenticular sedge seed must be obtained to allow for direct seeding. Because locally adapted lenticular sedge seed is not available commercially, custom seed collection must occur during the previous growing season from existing vegetated areas. Consequently, seed will be collected during the 2007 growing season, after sedge seeds have reached maturity (mid-June), but before they are inundated by rising water levels. Timing of seed collection will partly depend on reservoir water levels in the spring of 2007 for site access and seed development. Because lenticular sedge loses its seed soon after maturity, the most appropriate date should be determined by site inspection.

Seed collection will occur by manual gathering of mature seeds in the drawdown zone of the mid Columbia River and Arrow Lakes Reservoir. Sufficient seed will be collected for application in the mid Columbia River and Arrow Lakes Reservoir revegetation sites, assuming that one quarter of the identified treatment sites will be seeded in the following year, at an application rate of 10kg/ha of sedge seed. The proposal shall describe how locations for seed collection will be identified and by which methods seed will be collected. Care should be taken during seed collection to ensure that natural seeding is not adversely affected.

Prior to initiating seed collection, the consultant will provide a procedure for review and acceptance by BC Hydro, outlining the proposed methods of seed collection and storage of seed material. If insufficient seed source can be collected to meet the direct seeding application rate, the consultant shall provide recommendations on alternative approaches for obtaining seed material.

Some seed will also be used to grow plugs for planting in spring of 2008. This seed should be germinated immediately on collection, grown to an appropriate size, and plugs should be kept in cold storage over the winter until outplanting. The proposal

shall outline how storage requirements will be accomplished and how sedge plugs will be provided for planting in the spring of 2008.

2.2.5 Task 5: Reporting

A brief technical report will be prepared at the conclusion of the revegetation site field verification phase, which will include:

- an executive summary;
- a description of the methods employed;
- a data summary;
- an assessment of priority sites for revegetation and rationale;
- a detailed summary of the findings as they relate to the original data being verified; and,
- any recommendations.

Specifically, the report will include a detailed assessment of each proposed revegetation site, including any reclassifications based on field observations. If sites are deemed unsuitable, a rationale will be provided as to the factor(s) prohibiting revegetation (i.e. biological, social, terrain, etc.). In addition, the report shall provide recommendations for potential revegetation methods for each site.

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 collection and live cuttings;
- quantity of seed collected and time/labour requirements;
- storage and propagation requirements; and,
- recommendations for future collection efforts

The report and field memo will follow the standard format that is being developed for WUP program physical works. All reports will be provided in hard-copy and as Microsoft Word and Adobe Acrobat (*.pdf) format, and all maps and figures will be provided either as embedded objects in the Word file or as separate files.

2.3 Schedule

Field verification of revegetation sites will be carried out in the 2007 field season, provided that water levels are low enough to access the required number of sites. If verification of lower elevation sites is precluded by rising reservoir levels, a representative portion of these sites will be verified during the 2008 field season during Phase 2 of the program. Based on results of the consultation process, a design for the revegetation physical works will be finalized in the winter of 2007 for submission to the Comptroller of Water Rights in January 2008. Initiation of nursery stock will commence up to six months prior to the implementation of the revegetation programs. Table CLBWORKS-2-1 provides a detailed schedule by program milestone.

Table CLBWORKS-2-1 Proposed Schedule for the Mid Columbia and Arrow Lakes Reservoir Revegetation Physical Works

Task	Month	Year
Preparation of draft Terms of Reference (TOR) for Phase 1 of Revegetation Physical Works	February	2007
Review of draft TOR for Phase 1 of Revegetation Physical Works	February - March	2007
Preparation of Revegetation Physical Works background summary for consultation	March	2007
Round 1 - Consultation	April/May	2007
Verification of revegetation site classifications through use of DEM and air photos (to be obtained in May under CLBMON-33)	May - June	2007
Stratification of all sites by broad type (e.g. sandy/flat vs. coarse/steep, etc.) and field verification of a proportion of each site type to confirm existing classifications or reclassify	June - July	2007
Sedge seed collection and initiation of nursery sedge plugs	June	2007
Incorporation of information from consultations, revegetation site verifications, KIN Vegetation Inventory and Archaeological Overview Assessment into draft TOR	September	2007
Preparation of preliminary prescriptions for each site type, including species and treatments by elevation band	September	2007
Collection and stratification of other herbaceous seed species	September-October	2007
Round 2 – Consultation	November	2007
Finalize Phase 2 TOR incorporating results of all field work, data analysis and consultations	December	2007
Submission of Phase 2 TOR to CWR	January	2008
Collection of willow live stakes	January - February	2008
Initiate implementation of revegetation physical works	May-August	2008

2.4 Budget

The total cost for Phase 1 of the revegetation program physical works is estimated at \$93,979 (in 2004 dollars).

Table CLBWORKS-2-2 provides a budget estimate assuming a 2% rate of inflation and a 5 % contingency for Phase 1 of the program.

3.0 REFERENCES

Moody, A.I. 2005. Mica - Revelstoke - Keenleyside Water Use Plan: Potential Areas for Vegetation Establishment in the Arrow Lakes Reservoir. Report prepared for BC Hydro.

B.C. Ministry of Environment, Lands and Parks and B.C. Ministry of Forests. 1998. Field manual for describing ecosystems in the field. Land Management Handbook Number 25. Victoria, B.C.