Columbia River Project Water Use Plan

Monitoring Program Terms of Reference

Physical Works Terms of Reference

KINBASKET AND ARROW LAKES RESERVOIRS REVEGETATION MANAGEMENT PLAN

- **CLBMON-11A Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir**

25 January 2008

KINBASKET AND ARROW LAKES RESERVOIRS REVEGETATION MANAGEMENT PLAN TERMS OF REFERENCE

1.0 OVERVIEW

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

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

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

1.1 Physical Works

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

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

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

a) the plan is not in conflict with other land uses (e.g., motorized and non-motorized recreation, beach areas);

b) revegetation prescriptions are compatible with First Nation archaeological site protection requirements; and,

c) revegetation prescriptions incorporate plant species traditionally valued by First Nations, where possible.

Monitoring Programs

1) CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis: a 10-year program to evaluate plant survival and monitor representative planting sites under the various revegetation treatments in Kinbasket Reservoir. This study will also assess changes in existing vegetation communities at the site (local) level in response to the operating regime of Kinbasket Resevoir.

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

3) CLBMON-11 Kinbasket and Arrow Lakes Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works: an 11-year program to conduct effectiveness monitoring of wildlife habitat utilization in response to revegetation efforts in Kinbasket Reservoir, and revegetation efforts and wildlife physical works in the mid Columbia River and Arrow Lakes Reservoir.

4) CLBMON-12 Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis: a 10-year program to evaluate plant survival and monitor representative revegetation sites under the various revegetation treatments in the mid Columbia River and Arrow Lakes Reservoir. This study will also assess changes in existing vegetation communities at the site (local) level in response to the soft constraints operating regime of the Arrow Lakes Reservoir.

5) CLBMON-13 Monitoring of Mosquito Populations in the Revelstoke Area: a 2-year program to monitor the distribution and abundance of larval and adult mosquitoes in relation to physical environmental variables (elevation, temperature) and biotic variables (habitat) in the Revelstoke area.

6) CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources: a 10-year program to assess and map vegetation distribution by elevation and identify riparian wildlife habitat in relation to inundation cycles and revegetation efforts in the mid Columbia River and Arrow Lakes Reservoir.

7) CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation: a 5-year program to evaluate responses of plants of different ages, seedlings to mature plants, and species to inundation cycles in the mid Columbia River and Arrow Lakes Reservoir.

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

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	Yes	04 April 2007	Yes – Year 1 only
CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program	Schedule C: 1.a Schedule D: 1.a	No[1]	Yes	04 April 2007	Yes – Year 1 only
CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts	Schedule A: 2.a	Yes	No	25 January 2008	No
CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources	Schedule A: 2.b	No	Yes	04 April 2007	Yes
CLBMON-11A Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir	Schedule A: 2.c	Yes	No	25 January 2008	No
CLBMON-11B Effectiveness Monitoring of Revegetation in the mid Columbia River and the Arrow Lakes Reservoir	Schedule C: 5.a Schedule D: 2.a	No	No		No
CLBMON-12 Mid Columbia River and Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis	Schedule C: 2.a Schedule D: 2.b Schedule D: 2.c	Yes	No	25 January 2008	No
CLBMON-13 Inventory of Mosquito Populations in the Revelstoke Area	Schedule C: 5.b	Yes	No	25 January 2008	No
CLBMON-33 Mid Columbia and Arrow Lakes Reservoir Inventory of Vegetation Resources	Schedule C: 2.b Schedule D: 2.c	No	Yes	04 April 2007	Yes
CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation	Schedule C: 2.c Schedule D: 2.d	Yes	No	25 January 2008	No

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

2.0 PROGRAM RATIONALE

The Columbia River Water Use Plan Consultative Committee (WUP CC) recognized the value of riparian vegetation surrounding Kinbasket and Arrow Lakes reservoirs for enhancing littoral productivity, providing physical, structural and biological character for wildlife habitat, protecting cultural heritage sites, and providing aesthetic benefits (e.g., reduction of dust storms) within the drawdown zone. As a result, the protection and enhancement of high quality riparian vegetation emerged as a key environmental objective for Columbia River Water Use Plan, and operational, as well as non-operational alternatives to maximize vegetation diversity and wildlife habitat were a fundamental consideration throughout the water use planning process.

The WUP CC supported reservoir-wide revegetation programs for Kinbasket and Arrow Lakes reservoirs in lieu of maintaining lower elevations during the growing season than those provided under current operations, to maximize vegetation growth in the drawdown zones. The revegetation approach consists of multi-year programs with intervention over five years to facilitate long-term vegetative cover in those areas that have good potential to become self-sustaining. Key environmental and social objectives of the revegetation program are to:

- maximize vegetation growth[2] in the drawdown zones; and,
- provide benefits to littoral productivity, wildlife habitat, recreation, shoreline erosion and archaeological site protection.

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

Kinbasket Reservoir Revegetation Program

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

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

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

[3] Phase 1 work included field verification of revegetation potential and prioritization of revegetation sites, collection of seed and initiation of nursery stock.

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

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

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

Mid Columbia River and Arrow Lakes Reservoir Revegetation Program

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

Recognizing the importance of this vegetation as a means of achieving a number of environmental and social benefits for Arrow Lakes Reservoir, the WUP CC explored several operating alternatives, designed to maintain existing vegetation in the mid Columbia (Revelstoke Reach) and Arrow Lakes Reservoir, by imposing lower reservoir elevations for longer periods during the early part of the growing season (late spring and early summer). Modeling of these alternatives showed that stricter elevation constraints would provide varying levels of protection to vegetation, but could incur very high costs in lost power generation in some years. There was also concern around the high level of uncertainty in many of the assumptions used to develop elevation constraints, particularly around the relative importance of timing, frequency, duration and depth of inundation on the distribution, biomass and diversity of vegetation.

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

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

2.1 Additional Monitoring Programs

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

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

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

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

3.0 REFERENCES

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

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

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

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

Monitoring Study No. CLBMON-11A
Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir

1.0 MONITORING PROGRAM RATIONALE

1.1 Background

The Columbia River Water Use Plan (WUP) was developed as a result of a multi-stakeholder consultative process to determine how to best operate BC Hydro's Mica, Revelstoke, and Keenleyside facilities in order to balance environmental values, recreation, power generation, culture/heritage values, navigation, and flood control. The WUP process followed the guidelines established by the Government of British Columbia (BC Hydro 2000; Government of British Columbia 1998) and involved a number of interest groups, First Nations, government agencies and other stakeholders collectively referred to as the Consultative Committee (CC). Initiated in 2000, the WUP was completed in 2004 (BC Hydro 2005a, b) and was approved by the Comptroller of Water Rights in January of 2007 (Comptroller of Water Rights 2007).

The CC supported reservoir-wide revegetation programs for the Kinbasket and Arrow Lakes reservoir to increase vegetation growth in the drawdown zones in lieu of maintaining lower reservoir levels. The revegetation program proposed for Kinbasket Reservoirs under the WUP (CLBWORKS-1 Kinbasket Reservoir Revegetation Program) is a multi-year program aimed at increasing vegetative cover in those areas that have good potential to become self-sustaining after five years. Key environmental and social objectives of the revegetation program are to:

1) maximize vegetation growth in the drawdown zone;
2) provide benefits to littoral productivity and wildlife through increased habitat diversity;
3) increase the diversity of native plants, particularly those of interest to First Nations;
4) provide increased protection for known archaeological sites, where possible.

These objectives will be achieved by applying a variety of prescriptions at sites within the Kinbasket Reservoir drawdown zone between the elevations of 741 m and 754 m. The scope of the revegetation program entails treating sites over four years (2008-2011) with an emphasis on revegetating the upper eight meters of the drawdown zone (747-754 m). Experimental treatments will be attempted in the lower six meters (741-746 m) to determine whether this portion of the drawdown zone can be successfully revegetated. The primary methods proposed for revegetation include: (1) planting of willow and cottonwood stakes at elevations above 750 m, and (2) the seeding and planting of grasses, sedges, and rushes between elevations of 747 and 754 m. Below 747 m, experimental planting/seeding of grasses, sedges, and rushes will be attempted. Approximately 1525 ha of area above 747 m has been identified as suitable for revegetation in the drawdown zone of Kinbasket Reservoir (Hawkes et al. 2007). Sites located below 747 m will be identified in 2008.

Descriptions of the proposed treatment methods based on field surveys conducted in 2007 (Keefer 2007) are provided in Appendix A.

The wildlife objectives of the WUP are to maximize wildlife abundance and diversity along the reservoirs of the Columbia River and reduce any negative effects on wildlife populations (e.g. flooding of nests). The CC did not make recommendations around operational changes or physical works in lieu of operational changes for Kinbasket Reservoir due lack of quantitative wildlife data (BC Hydro 2005b); however the CC did recommend maximizing riparian habitat area to improve wildlife values. During a preliminary assessment of wildlife habitat conducted in 2007, the Bush Arm, Beavermouth, Canoe Reach, and Encampment Creek were identified as having adequately vegetated high quality wildlife habitat; while Hugh Allan Bay, Grouse Creek, Sullivan Arm, Howard Creek, and Yellow Jacket Creek were identified as areas that could benefit from vegetation enhancement (Hawkes et al. 2007).

In association with the revegetation program, the CC recommended effectiveness monitoring to ensure that the Kinbasket Reservoir revegetation efforts are providing the intended environmental benefits. The effectiveness of the revegetation program will be monitored under the following Terms of References:

- Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis (CLBMON-9); to be initiated in 2008.
- Kinbasket Reservoir Inventory of Vegetation Resources (CLBMON-10); initiated in 2007.
- Kinbasket (CLBMON-11A) and Arrow Lakes (CLBMON -11B) Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works to be in 2008 and 2009, respectively.

In addition to the above projects, additional information will be provided from the following monitoring programs:

- CLBMON-36: Kinbasket and Arrow Lakes Reservoirs Nest Mortality of Migratory Birds due to Reservoir Operations); to be initiated in 2008.
- CLBMON-37: Kinbasket and Arrow Lakes Amphibian and Reptile Life History and Habitat Use Assessment); to be initiated in 2008.

This document provides a detailed Terms of Reference to monitor the effectiveness of wildlife habitat utilization in response to revegetation in Kinbasket Reservoir (CLBMON-11A). In January 2009, a separate Terms of Reference will be prepared for monitoring the effectiveness of revegetation and wildlife physical works for improving habitat in the Arrow Lakes Reservoir (CLBMON-11B). This Terms of Reference will incorporate the results of a feasibility study that will define the scope of physical works projects to enhance wildlife habitat in Revelstoke Reach (CLBWORKS-29A).

1.2 Management Questions

This monitoring program is designed to address key management questions relating to the effectiveness of the revegetation program at improving wildlife habitat in the Kinbasket Reservoir. To assess the effectiveness of the revegetation program at meeting the CC wildlife objectives, this monitoring study will focus on how effectively the revegetation program enhances amphibian habitat, bird habitat, small mammal habitat, and ungulate habitat. In addition, this monitoring program will assess the impact of revegetation efforts on the abundance of arthropods, which are a fundamental component of the food chain, particularly for birds, amphibians, and several species of small mammals

The primary management questions to be addressed by the monitoring program are:

- How effective is the revegetation program at enhancing and increasing the utilization of habitat in the drawdown zone by wildlife such as amphibians, birds, small mammals, and ungulates?
- To what extent does revegetation increase the availability of invertebrate prey (e.g. arthropods) in the food chain for birds, amphibians and small mammals?
- Are revegetation efforts negatively impacting wildlife in the drawdown zone? For example, does revegetation increase the incidence of nest mortality in birds or create sink habitat for amphibians?
- Which methods of revegetation are most effective at enhancing and increasing the utilization of wildlife habitat in the drawdown zone?

1.3 Management Hypothesis

The management hypotheses to be tested by this study include:

H_1: Revegetation does not increase the utilization of habitats by amphibians in the drawdown zone.

- H_{1A}: Revegetation does not increase species diversity or seasonal (spring/summer/fall) abundance of amphibians in the drawdown zone.
- H_{1B}: Revegetation does not increase the abundance of amphibian prey (e.g. arthropods).
- H_{1C}: Revegetation does not increase amphibian productivity (eg. egg laying and young of year survival).
- H_{1D}: Revegetation does not increase the amount of amphibian habitat in the drawdown zone.

H_2: Revegetation does not increase the utilization of habitats by birds in the drawdown zone.

- H_{2A}: Revegetation does not increase the species diversity or abundance of birds utilizing the drawdown.

H_{2B}: Revegetation does not reduce nest mortality of birds that nest in the drawdown zone.

H_{2C}: Revegetation does not increase the survival of juvenile birds in the drawdown zone.

H_{2D}: Revegetation does not increase the abundance of bird, shorebird, or marshbird prey (e.g., arthropods).

H_{2E}: Revegetation does not increase the amount of bird habitat in the drawdown zone.

H_3: Revegetation does not increase the utilization of habitats by small mammals in the drawdown zone.

H_{3A}: Revegetation does not increase the diversity or abundance of small mammals in the drawdown zone.

H_{3B}: Revegetation does not increase the abundance of small mammal prey (e.g. arthropods).

H_{3C}: Revegetation does not increase the amount of small mammal habitat in the drawdown zone.

H_4: Revegetation does not increase the utilization of habitat by ungulates in the drawdown zone.

H_{4A}: Revegetation does not increase the seasonal abundance (winter/spring) of ungulates in the drawdown zone.

H_{4B}: Revegetation does not increase the abundance (tones per hectare) of ungulate forage.

H_{4C}: Revegetation does not increase the amount of ungulate habitat in the drawdown zone.

H_5: Revegetation does not increase the area of extent of high value wildlife habitat in the drawdown zone.

1.4 Key Water Use Decision Affected

The key water use planning decision affected by the results of this monitoring program is whether revegetation in lieu of changes to reservoir operations is effective at enhancing wildlife habitat and reducing the negative effects of reservoir operations on wildlife populations (e.g. nest mortality). Results from this study will support more informed decision-making with respect to the need to balance the requirements of wildlife dependent on riparian areas with other values such as recreational opportunities, flood control and power generation.

2.0 MONITORING PROGRAM PROPOSAL

2.1 Objectives and Scope

The CC provided the following direction with respect to the revegetation-wildlife effectiveness monitoring program (BC Hydro 2005b):

***Project Description**: Seasonal wildlife surveys (point counts, nest searches, ground track counts) to document wildlife use (birds, ungulates, bears) of revegetated areas.*

***Rationale**: There is uncertainty about current utilization of the drawdown zone by wildlife species and the effects of reservoir operations. Monitoring will inform on the effects of revegetation efforts in Kinbasket and Arrow Lakes reservoirs on wildlife utilization patterns, and the effectiveness of Arrow Lakes Reservoir physical works on wildlife habitat quality and quantity.*

The objectives of this study are to:

1) Develop an effectiveness-monitoring program to assess whether revegetation efforts in the drawdown zone of Kinbasket Reservoir improve habitat for wildlife.
2) Assess how effective the revegetation efforts are at improving habitat for wildlife in the drawdown zone between 741 m and 754 m elevation.
3) Report and provide recommendations on the effectiveness of the revegetation program on improving habitat for wildlife in the drawdown zone in Years 5 and 10 (2012 and 2018, respectively).

The CC recommended that baseline data be collected in Years 1 and 2, followed by monitoring every other year. At Years 5 and 10, results from this study and related studies will be evaluated to assess effectiveness of revegetation program. A list of related studies is presented in Table CLBMON-11A-1.

Table CLBMON-11A-1. List of related monitoring studies and physical works

Management Plan/Study	Description
Arrow Reservoir Operations Management Plan	
CLBMON-36: Kinbasket and Arrow Lakes Reservoirs Nest Mortality of Migratory Birds due to Reservoir Operations	10-year study to assess impacts of reservoir operations on nest mortality. Effectiveness monitoring of physical works on nesting success included within this study.
CLBMON-37: Kinbasket and Arrow Lakes Amphibian and Reptile Life History and Habitat Use Assessment	5-year study to assess impacts of reservoir operations on herptiles and their habitats. Effectiveness monitoring of physical works on herptiles included in this study.
Kinbasket and Arrow Lakes Reservoirs Revegetation Management Plan	
CLBWORKS-1: Kinbasket Reservoir Revegetation Program	Revegetation of sites in the drawdown zone of Kinbasket Reservoir between 741 and 754 m over a five-year period
CLBMON-9: Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis	10-year study to assess the effectiveness of the revegetation efforts in Kinbasket Reservoir and assess the effects of the current operating regime on existing vegetation communities.
CLBMON-10: Kinbasket Reservoir Inventory of Vegetation Resources	10-year program to assess and map spatial extent, structure and composition of existing vegetation communities at the landscape scale within Kinbasket Reservoir.
CLBMON-11:Kinbasket and Arrow Lakes Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works	10-year study to conduct effectiveness monitoring of wildlife habitat utilization in response to revegetation and wildlife physical works.

2.2 Approach

An effectiveness monitoring program is a monitoring program designed to determine how well management activities, decisions, or practices meet their intended objectives (Houde et al. 2005; Noon 2003). Key to designing an effectiveness monitoring program is the selection of statistically testable response variables appropriate to the objectives of the management action (Machmer & Steeger 2002). Recognizing that monitoring the response variables for all species of interest is not feasible, an effectiveness monitoring program must focus on indicator species, taxa, or ecological process; however the selection of the specific indictors can be a challenging process (Andersen 1999).

The selection of indicator species/processes should be guided by their sensitivity to the management practice, the ease of collecting data, and the usefulness of the information. Potential indicators may include keystone species, species at risk, species sensitive to specific habitat requirements, species of management concern, or species that can be monitored easily (Feinsinger 2001); and their selection should be appropriate to the spatial scale. The selection of indicator species must also take into consideration

environmental factors external to the monitoring program such as inter and intra-specific competition, predation, climatic change, disease, seasonal precipitation rates, and reservoir operations. As such, it is desirable to monitor several indicator species over an extended period of time.

In selecting indicator species, it is also important to have some preliminary information to aid in the appropriate selection (Noon 2003). Unfortunately, there is little existing data to support the selection of indicator species for the Kinbasket Reservoir. While a number surveys have been conducted in the Kinbasket area over the past several decades (e.g. Andrusiak & Simpson 1994; Bindernagel et al. 1991; Fraker & Robertson 1995; Holroyd 1993; Klafki In. prep; Tinker et al. 1997), there have been no studies specifically directed at sampling within or along the perimeter of the drawdown zone. Based on the wildlife concerns identified in the Columbia WUP report, limited data (e.g. Hawkes et al. 2007; Klafki In. prep), expert opinion, and the ability to dovetail effectiveness monitoring with concurrent monitoring programs, a list of potential indicators species is proposed in Table CLBMON-11A-2. It must be stated that this list is tentative and has been used as the basis for establishing the budget. Alternative approaches/indictor species will be considered in Year 1.

The proposed approach will entail monitoring the response of the proposed taxa in treated (revegetated) sites, control sites (site below the drawdown zone), and at reference sites (sites above the drawdown zone). This approach will allow for comparison of wildlife abundance, diversity, and habitat use between treated and untreated sites in the drawdown zone. This approach will also allow for a comparison to reference sites above the drawdown zone.

2.3 Methods

The following sampling methods are proposed for monitoring the effectiveness of revegetation effort of five indicator taxa: terrestrial arthropods, birds, amphibians, small mammals, and ungulates. The sampling window will vary by taxa and reservoir water levels. On average, water levels reach an elevation of 747 m by the third week of July (July 20); however water levels have reached 747 m as early as June 19 (Appendix B). Water levels may continue to rise to an elevation of 754 m, which has been attained in early August. Between 1976 and 2005, the mean height of full pool was 750 m, reached during mid-August. On average, water levels do not return below 747 m until November. As such, water levels will seriously constrain the sampling windows.

2.3.1 Task 1: Project Coordination

Project coordination involves the general administration and technical oversight of the program, which will include, but may not be limited to: 1) budget management, 2) program team management, 3) logistics coordination, 4) technical oversight of fieldwork, data analysis and report preparation, 5) facilitation of data transfer among other investigations associated with the Arrow Reservoir Operations Management Plan and the Kinbasket and Arrow Reservoir Revegetation Management Plan, 6) permit applications, and 7) liaison with regulatory agencies, as required.

The logistics of the surveys described in this study will need to be coordinated among the other wildlife and vegetation studies (Table 11A-1) that will be

occurring concurrently to: coordinate the location of sample sites, prevent interference between studies, and facilitate the transfer of information. Considerable resources have been allocated to ensure that these projects are coordinated successfully.

The necessary research permits must be obtained from the Ministry of Environment and Canadian Wildlife Service prior to the initiation of fieldwork. In Year 1, protocols will be developed detailing the sampling methods and animal handling/tagging procedures, where applicable. These protocols will be submitted along with future permit requests and will be made available for review by animal care committees.

A safety plan must be developed and submitted to the BC Hydro for all aspects of the study involving field work, in accordance with BC Hydro procedures and guidelines. Specific safety training will be required (e.g. first aid, small boat operation).

2.3.2 Task 2: Study Plan and Information Review

In consultation with BC Hydro water license requirement staff, and consultants delivering the related monitoring studies and revegetation program (Table CLBMON-11A-1), an effectiveness monitoring program will be developed in Year 1. This process will require the involvement of a biostatistician to ensure that the study design and sampling parameters (e.g. sample sizes, sampling frequency, sampling effort) are sound. To assist in this process, data from agencies, such as the Ministry of Environment (e.g. Wildlife Species Inventory Database), Canadian Wildlife Service, and the Fish and Wildlife Compensation Program, as well as information obtained from local naturalists and wildlife professionals will be reviewed. The purpose will be to (1) design a sampling strategy that specifies the required sampling effort and intensity, (2) identify the location of treatment areas, controls, and reference sites[4], (3) review and refine the list of proposed indicator species (Table CLBMON-11A-2), (4) clearly identify the statistical methods for data analysis, and (5) ensure that the wildlife and vegetation monitoring programs are coordinated. The sampling plan will need to consider how the sampling effort is stratified, and should employ a randomized design (e.g. BACI design). Considerations for stratification include River Reach (Bush Arm, Kinbasket, Canoe Reach), treatment (treated/untreated/reference), treatment method (Appendix A), elevation band, biogeoclimatic zone, substrate and topography.

A preliminary list of sampling methods for five groups of indicator taxa are described in Tasks 3 to 7 and have been used as the basis for establishing the budget. Alternative approaches, indicator species/processes, and sampling methods will be considered in Year 1.

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[4] Reference areas are sites that have naturally revegetated. These differ from control (untreated) sites, which are sites that could benefit from revegetation but are left untreated to act as a control for monitoring.

Table CLBMON-11A-2. Preliminary list of indicator species/species groups and sampling methodology for monitoring the effectiveness of revegetation efforts in Kinbasket Reservoir by taxa

Species	Rationale	Response Variable	Suggested Methods	Reference‡	Related WUP Monitoring Program
Arthropods	Arthropods are an important prey base for amphibians, birds, and small mammals. Establishing vegetation cover will provide suitable habitat for multiple life history requirements resulting in increased abundance and species diversity.	Relative Abundance Species Diversity	Traps Sweeps Hand Searching	(Resources Inventory Committee 1998f) (Finnamore et al. 2001)	N/A
Amphibians Reptiles*	Establishing vegetation cover will provide foraging habitat and may enhance breeding habitat	Relative Abundance Species Diversity	Visual Encounter Surveys Cover Boards	(Resources Inventory Committee 1999b) (Heyer et al. 1994) (Resources Inventory Committee 1998e)	**CLBMON-37**
Birds **	The establishment of willow and sedge/grass communities will provide nesting habitat and foraging habitat.	Nest Abundance , Nest Success/Mortality, Productivity, and Juvenile Survival Relative Abundance Species Diversity	Nest surveys Point Count Surveys Transect Surveys Mist Netting	(Martin & Geupel 1993; Mayfield 1961) (Resources Inventory Committee 1999a)	**CLBMON-36**
Ungulates†	The establishment of willow communities will provide browse for moose, elk, and deer and the establishment of grass/sedge communities will provide forage for deer and elk	Relative Abundance	Pellet Counts Winter aerial surveys	(Resources Inventory Committee 1998b) (Resources Inventory Committee 2002)	N/A
Small mammals††	The establishment of grass/sedge communities will provide habitat for these species	Relative Abundance Species Diversity	Trapping with animal marking	(Resources Inventory Committee 1998d)	N/A
			Pellet counts	(Resources Inventory Committee 1998c)	N/A

* Western toad, Columbia spotted frogs, Pacific tree frogs, long-toed salamanders, and garter snakes
*****Songbirds***: e.g. Yellow Warbler, Wilson's Warbler, Orange-Crowned Warbler, Dark-Eyed Junco, Savannah sparrow; ***Waterfowl***: e.g. Canada Goose, Mallard, American Wigeon, Cinnamon Teal, Pied-billed Grebe; ***Marshbirds***: e.g. Sora, Marsh Wren, Red-winged Blackbird, Yellow-headed Blackbird, Grey Catbird; ***Shorebirds***: e.g. Common snipe, Killdeer, Greater Yellow Legs, Lesser Yellow Legs. ***List is not complete***
† Moose, Elk, White-tailed deer, Mule deer
†† House mouse, Deer mice, red-back vole, water vole, common shrew, pygmy shrew, dusky shrew, water shrew, long-tailed vole, meadow vole, shoewshoe hare
‡ See Sutherland (2006) as a general reference

Environmental and vegetation data will be obtained under CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis, which will describe intra-community changes of existing and enhanced vegetation communities in the drawdown zone. Data will include species composition (i.e., distribution, distribution and vigour), cover, abundance and biomass of existing and enhanced vegetation communities, as well as sites and soil characteristics. Data will be collected following provincial sampling standards (Resources Inventory Committee 1998a). This data will be collected by bi- annually in Years 1,2,3,5,7,9,11 and will and provide the basis for monitoring the extent and character of wildlife habitats.

2.3.3 Task 3: Sampling Terrestrial Arthropods

Sampling terrestrial arthropods is recommended as they (1) are an important prey base for many species of amphibians, birds, and small mammals, (2) are relatively easy to sample, and (3) provide a means of estimating the overall productivity of a site. A variety of sampling methods may be required to sample a cross-section of arthropod taxa and habitats (Table CLBMON-11A-3). These sampling methods are described in detail in Ausden & Drake (2006), Finnamore et al. (2001) and Resources Inventory Committee (1998f). The sampling plan for monitoring terrestrial arthropod should employ at least two of these techniques (e.g. searching, and sweeping) and sampling may require multiple visits to each site. As the abundance of arthropods can fluctuate significantly in response to seasonal conditions (e.g. weather, plant phenology); it will be necessary to consider these effects in developing the sampling plan (Task 2). This will likely require obtaining multiple samples during the sampling window to account for seasonal variability. While sampling arthropods can be done relatively efficiently, the identification of arthropods can be time consuming, requiring considerable skill in taxonomic identification. Additional resources have been incorporated into the budget to account for this.

2.3.4 Task 4: Amphibian and Reptile Sampling

Visual surveys will be conducted to determine the response by amphibians and reptiles to revegetation treatments, both as a function of relative abundance and species diversity. The sampling methods are described in CLBMON-37 Kinbasket and Arrow Lakes Reservoir Amphibian and Reptile Life History and Habitat Use Assessment. This project will be delivered separately under CLBMON-37.

2.3.5 Task 5: Avian sampling

Nest surveys will be conducted to monitor the use of treated/untreated/reference habitats in the drawdown zone by migratory birds under CLBMON-36 Kinbasket and Arrow Lakes Reservoir Nest Mortality of Migratory Birds due to Reservoir Operations. This study will compare nesting success, productivity rates and juvenile survival of birds in treated/untreated/reference sites. This project will be delivered separately under CLBMON-36.

Table CLBMON-11A-3. Potential methods for sampling terrestrial arthropods by habitat type and taxa

Habitat/Niche	Taxa	Method	Comments
Surface habitats	Ground dwelling and low flying taxa: eg. Arachnida, Coleoptera, Hemiptera, Hymenoptera, Mollusca Orthoptera,	Pitfall or Pan traps	- Easy to install - Efficient - Effective at collecting large numbers of specimens
Grasses, Herbs, and Low Shrubs	Herb dwelling insects: eg. Arachnida, Coleoptera, Lepidoptera, Hymenoptera	Searching*	- Requires no equipment - Time-consuming - Requires greater taxonomic field skills
		Sweep netting	- Efficient - Not effective in some vegetation types (e.g. bulrush)
Tall Shrubs /Low Trees	Foliage dwelling insects: eg. Arachnida, Coleoptera, Lepidoptera	Searching	* As above
		Beating	- Efficient - Not effective in some vegetation types (e.g. bulrush)
Day flying Insects	Flying insects: eg. Coleoptera Diptera, Ephemeroptera, Hymenoptera, Lepidoptera, Odanata, Tricoptera	Malaise Traps	- Effective at trapping flying insects - Some equipment required - Time-consuming
		Window traps	- Biased towards sampling large flying beetles

2.3.6 Task 6: Small mammals sampling

Revegetation efforts will enhance habitat for a variety of small mammals (Table CLBMON-11A-2), which are in turn prey for reptiles, raptors, and carnivorous mammals. Trapping and marking animals is an effective way of determining the relative abundance of small mammals. Sherman traps (www.shermantraps.com) will be set out along transects within pre-stratified treatment polygons at approximately 10 m intervals. The traps will be operated for a two-week sampling session prior to the reservoir reaching full pool (e.g. mid-to-late June); and the traps will be visited twice a day. Captured animals will be marked to facilitate mark-recapture population analysis. Sampling methods are described in greater detail in Resources Inventory Committee (1998d). Care must be taken (e.g. gloves and respirators must be worn) when handling small mammals due to the diseases that can be transmitted.

The final sampling strategy (the number of polygons, the number and length of transects, the number of traps per transect, and duration of a trapping effort) will be established in Year 1. For the purpose of estimating the number of traps required for the budget, we presume the sampling strategy outlined in Table CLBMON-11A-4.

Table CLBMON-11A-4. Proposed pre-stratification scheme for small mammal trapping

Strata	- Sampling units	Description
River Reach	3	Canoe Reach, Bush Arm, Kinbasket
Treatment types	2	Sedge/Grass & Willow/Cottonwood
Treatment levels	3	Treated; Untreated (control); Reference sites
Polygons	3	For replication within treatment types
Transects	2	For replication within polygons
Traps	10	For sample size and replication along transects
Total- of Polygons	**36**	
Total- of Transects	**72**	
Total- of Traps	**720**	

2.3.7 Task 7: Ungulate surveys

Ungulate surveys will monitor seasonal abundance and habitat use of the treated, untreated, and reference sites in the drawdown zone. Aerial surveys will be conducted by helicopter twice during the winter (between December and February) to monitor the abundance and distribution of ungulates along Kinbasket Reservoir drawdown zone. Survey procedures for aerial surveys and classification criteria are described in Resources Inventory Committee (2002). The timing of the surveys is important, as it is necessary to schedule surveys with seasonal weather conditions. For example, surveys should be conducted in ideal weather conditions several days after a recent snowfall. Survey will be conducted using two experienced observers, with a third person recording data. The person recording data should use a GPS in conjunction with a laptop running GIS software with the coverage of the revegetation treatment units to accurately record ungulate observations. The software program DNR Garmin (Minnesota Department of Natural Resources 2007) is particularly useful for recording aerial ungulate data.

Pellet group counts are proposed as a means of assessing the utilization of revegetation treatment types by moose, elk, and deer[5]. Pellet group surveys provide a simple measure of relative abundance from which habitat utilization can be inferred (Resources Inventory Committee 1998b). Pellet surveys may be conducted by monitoring plots along fixed transects or by following a distance sampling method based on nearest-neighbor mathematical modeling (Batcheler 1975). As the plot-transect method requires establishing permanent sample plots which may be difficult to relocate in the drawdown zone due to flooding and siltation caused by high water, the distance method is recommended. The distance method is also advantageous in that it requires considerably less resources to establish (50%) and monitor (16%) than the plot-transect method (Freddy & Bowden 1983). One caveat regarding the use of the distance method is the ability to distinguish between new (within year) and old pellet groups. However, due to the high rates of precipitation in the region and the fact that the reservoir will flood much of the drawdown zone in most years, aging pellet groups should not be problematic (Persson 2003).

[5] Pellet group surveys can also provide data on the relative abundance of snowshoe hares.

2.4 Data Analysis

The study plan shall clearly demonstrate how the data analysis will address the management questions and associated hypotheses. Variability caused at the landscape and local scales (e.g. seasonal weather variability, site disturbance, regional population dynamics) must be anticipated to the extent possible. Environmental and vegetation data obtained under CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts will be made available for correlating habitat utilization.

Data collected over the first year of this study will be used to refine the sampling plan. The primary methods for assessing the effectiveness of revegetation efforts will entail ANOVA, chi square goodness of fit, and regression; however alternative methods may be required for some data sets (e.g. multivariate analysis to incorporate vegetation composition and nonparametric tests for species richness). Procedures for analyzing the data will be further clarified under Task 2.

2.5 Reporting

Progress reports will be prepared following each year in which field work is undertaken. Progress reports will summarize the methods employed, the data obtained, and provide a summary of the data using descriptive statistics and any important results and recommendations. The progress report for Year 1 will also include an assessment of the survey methodologies and provide recommendations with respect to the overall study design and sampling methods. Comprehensive reports will be prepared in Year 5 (2012) and in Year 10 (2018).

Annual progress reports will include:

i) A description of the project background
ii) A description of the methods by taxa
iii) A summary of the sampling effort and preliminary results by taxa including:
    - a summary of sampling effort
    - descriptive statistics by taxa
    - important results and recommendations
iv) Maps of the study areas and locations of the study plots. Plot locations are to be provided as UTM coordinates in an MS Excel spreadsheet
v) A digital appendix with:
    - MS Excel spreadsheet of UTM coordinates for survey sites.
    - A database of wildlife observations (location data) following BC Governments Wildlife Species Inventory (WSI) standards.

In Year 1, a sampling protocol will be developed describing the location of survey transects and describing (in detail) the sampling procedures to be followed in future years.

Final Reports

At Year 5 and 10, detailed technical reports will be prepared. These reports will include:

i) an executive summary;
ii) a description of the methods employed;
iii) a data summary;
iv) a comparison of the results by taxa between years and strata
v) a detailed summary of the findings as they relate to the hypothesis and key management questions

vi) recommendations for improving the revegetation efforts to mitigate the negative effects of the reservoir operating regime.
vii) A digital appendix with:
- MS Excel spreadsheet of UTM coordinates for survey sites.
- A database of all data collected by taxa following BC Governments Wildlife Species Inventory (WSI) standards.

Reports will follow the standard format for WUP monitoring programs. All reports will be provided in hard-copy and as Microsoft Word and Adobe Acrobat (pdf) format. All map data, including meta data, will also be provided electronically in ARC GIS compatible format. Wildlife data or the location of other significant species such as species at risk will be provided to the Ministry of Environment following the Wildlife Species Inventory (WSI) standards: All rare or endangered species are to be reported to the BC Conservation Data Centre following the appropriate data submission format.

2.6 Interpretation of Results

By sampling a broad cross-section of wildlife, this monitoring program will assess the effectiveness of revegetation efforts within the drawdown of Kinbasket Reservoir (between 741 and 754 m) to enhance wildlife habitat. The information collected will also provide important data on the occurrence of wildlife species in this remote portion of the province.

2.7 Schedule

This study will begin in 2008 and conclude in 2018. Baseline data will be collected in Year 1 and 2, with monitoring occurring every second year between Years 3 and 10. As the study design and the sampling methods proposed above are tentative, data from the first year will be used to develop the overall study design and refine the sampling methodology for each taxa. The annual schedule of activities is presented in Table CLBMON-11A-5. The annual sampling schedule is presented in Table CLBMON-11A-6.

Table CLBMON-11A-5. Annual schedule of tasks

Tasks	Apr	May	Jun	Jul	Aug	Jan	Feb	Mar
1) Project Coordination	√	√	√	√	√	√	√	√
2) Literature Review and Study Design	√	√	√					
3) Arthropod Sampling			√	√	√			
4) Amphibian Sampling			√	√	√			
5) Avian Sampling			√	√	√			
6) Small mammals			√	√	√			
7) Ungulate surveys			√			√	√	
8) Data Analysis						√	√	
9) Reporting							√	√

Table CLBMON-11A-6. Annual sampling and reporting schedule.

Sampling	2008	2009	2010	2012	2014	2016	2018
	Year 1	Year 2	Year 3	Year 5	Year 7	Year 9	Year 11
Project Coordination	√	√	√	√	√	√	√
Literature Review and Study Design	√						
Field Sampling	√	√	√	√	√	√	√
Develop Sampling Protocols	√						
Annual Report	√	√					
Final Report				√			√

2.8 Budget

The average annual cost of the monitoring program is $242,239 over 11 years. The project costs for Year 1 are $248,787 (including 2% inflation). This includes the costs for refining the study design, conducting the literature/information review, equipment costs, and for developing the sampling protocols. The original budget set by the CC in 2004 was $250,000 per sampling year; however the budget proposed in these Terms of Reference only includes the Kinbasket study component and does not include the costs associated with monitoring the effectiveness of revegetation efforts and physical works projects undertaken in the Arrow Lakes Reservoir. A separate Terms of Reference for the Arrow Lakes Reservoir effectiveness monitoring will be prepared once detailed site-specific prescriptions for revegetation and design work for the habitat structures are prepared, which will allow determination of level of effort required and identification of target areas for monitoring.

Table CLBMON-11A-7A provides a detailed budget by task and year for the duration of the study.

2.9 Study Design Limitation

a) As conditions on the Kinbasket Reservoir are unpredictable, the sampling program maybe altered, interrupted, or curtailed in any given year. Components of the sampling program will be scheduled as required to provide the safest and most efficient delivery.

b) Alternative approaches or methods may provide a better assessment of the effectiveness of revegetation efforts at improving wildlife habitat in the drawdown zone than those presented here. The proposed approaches and sampling methods will be reassessed prior to beginning of field work (Task 2) and again at the end of the year one.

c) The coordination of the study design, fieldwork, and information exchange between related monitoring programs (Table 11A-1) will be paramount to the success of this project. Communication between the various projects and project leaders will be facilitated by BC Hydro to ensure the success of these projects. Policies on information exchange will be outlined in all Requests for Proposals.

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APPENDIX A: Revegetation Prescriptions

Provided below are a number of revegetation prescriptions taken from the Kinbasket Reservoir Revegetation Program (CLBWORKS-1). These prescriptions are considered preliminary at this stage. Prescriptions #1, #6, #7 and #8 may be applied on an experimental basis between elevations 741 m and 746 m.

Prescription #1 – Sedge Seedlings

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

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

Prescription #2 – Wool Grass Seedlings

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

Prescription #3 – Bluejoint Reed Grass Seedlings

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

Prescription #4 – Small-Flowered Bulrush

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

Prescription #5 – Mixed Seedlings

This prescription involves the use of mixed bag plantings of lenticular sedge, wool grass and bluejoint reed grass. Plants are to be hand planted, using a randomized mix between species, at 25 cm, 50 cm, 100 cm, as well as tight clumps (10 cm) with gaps of 50-100 cm.

If this prescription is implemented in 2008, seedlings from the available pool for each species (above) will have to be utilized.

Prescription #6 – Drill Seeding

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

Prescription #7 – Hydroseeding

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

Prescription #8 – Hand Seeding

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

Prescription #9 – Willow and Cottonwood Whips

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

Willows stakes are to be collected. Minimum length for whips is to be 2 m. Above elevation 750 m, whips should be planted in a clumped manner. Due to the relatively high ground moisture levels in these sites, it is recommended that whips be planted at depths of greater than 40 cm. For staking, holes should be created by forcing steel bars into the substrate, widening the holes, followed by the sticking of the willow whips. Because of the intrusive nature of this prescription, willows and/or cottonwood stakes are not to be planted at or near identified archaeological sites.

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

Of the areas mapped for willow and cottonwood, those that were subject to debris removal in the summer and fall of 2007 should be targeted for planting on a priority basis in 2008. While these areas will be stabilized through appropriate techniques prior to April 2008, further treatment through the revegetation program may be beneficial to avoid ingrowth of

weedy in invasive species, and these sites are therefore key targets for spring staking. The detailed planting plan shall outline how these areas will be treated.

Prescription #10 – Sedge Farming

In the interests of increasing the collection of lenticular sedge seed in subsequent years, exploring methods of enhancing the seed resource is recommended. Additional soil data analysis may reveal the nutrient regime of those sites that is most productive for lenticular sedge. By applying limiting nutrients through the application of fertilizer, the seed resource may be improved. Because this type of fertilization has not been previously carried out in Kinbasket Reservoir or elsewhere, experimental trials are recommended to evaluate the success of this prescription.

Prescription #11 – Legume Cover Crops

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

Prescription #12 – Fertilization

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

APPENDIX B: Minimum, maximum and mean elevations for Kinbasket Reservoir, 1976-2006