Columbia River Project Water Use Plan
Monitoring Program Terms of Reference

Arrow Lakes Reservoir Operations Management Plan and

Mica Units 5 and 6 Project Commitments

- CLBMON-37 Kinbasket and Arrow Lakes Reservoir: Amphibian and Reptile Life History and Habitat Use Assessment

- CLBMON-58 Monitoring of Impacts on Amphibians and Reptiles from Mica Units 5 and 6 in Kinbasket Reservoir
Monitoring Study No. CLBMON-37
Kinbasket and Arrow Lakes Reservoir: Amphibian and Reptile Life History and Habitat Use Assessment and
Monitoring Study No. CLBMON 58
Monitoring Impacts on Amphibians and Reptiles from Mica Units 5 and 6 in Kinbasket Reservoir

1.0 MONITORING PROGRAM RATIONALE

1.1 Background

Amphibians and reptiles are increasingly becoming threatened worldwide (IUCN et al. 2004). Over one third of all amphibians are threatened (IUCN et al. 2004) and reptiles are not faring much better (Whitfield et al. 2000). Factors implicated in these declines include introduced species (Bradford 1989; Case & Bolger 1991), pollution and UV-B radiation (Blaustein et al. 2003), disease (Daszak et al. 1999; Johnson et al. 2006), habitat loss (Dodd & Smith 2003; Lehtinen 1999), climate change (Pounds 2001), or a combination of these (Blaustein & Kiesecker 2002; Pounds et al. 2006).

Of the 16 species of herptiles that occur in the Columbia Basin, 7 species of amphibians and 3 species of reptiles occur along the impounded waters of the Columbia River (Table 37-1). Of these, 4 species are considered at risk; the northern leopard frog is listed as endangered and western toad, western skink, and painted turtle are listed as special concern. Recently, concerns have been raised over the status of Columbia spotted frogs (Wente et al. 2005).

Changes to hydrological regime as a result of hydroelectric developments have been attributed to the decline of many species of amphibians (see Brandao & Araujo 2007; Lind et al. 1996). Lind (1996) found that flow rates and water levels may affect pond breeding amphibians by egg and larval mortality caused by flooding, habitat loss, changes in water temperature (which affects larval development and survival), and changes to prey base.

During the Columbia River Water Use Planning process (WUP), the Consultative Committee (CC) expressed concerns related to the potential impacts of the reservoir operations on amphibians and reptiles. However, a lack of information with respect to the abundance, distribution, life history, and habitat use made it difficult to assess the impact of current operations and operating alternatives of the Arrow Lakes and Kinbasket Reservoirs on these species. The CC therefore recommended a multi-year life history and habitat study to evaluate the operational impacts of the Arrow Lakes and Kinbasket Reservoirs, and to evaluate the effectiveness of physical works and revegetation on amphibians and reptiles.

In addition to the uncertainties raised during the Columbia WUP, concerns were raised over the potential impacts of the installation of Units 5 and 6 at Mica Dam on amphibian and reptile populations in Kinbasket Reservoir. To optimize reservoir storage for power generation associated with the new units, it was predicted that reservoir levels may increase by 0.6 meters during the summer months. It was suggested that this could impact larvae survival of amphibian populations that utilize wetland habitats in the upper elevations of the reservoir. Consequently, the Mica 5/6 Core Committee recommended additional monitoring
to augment the existing Columbia WLR study (CLBMON 37) on amphibian and reptiles to assess whether these elevated summer levels impact amphibian populations in the drawdown zone. Minor revisions to the sampling conducted under CLBMON 37 may be required to address this uncertainty. It is not anticipated that these revisions will require changes to the budget of CLBMON 37 or significant changes to the overall study design.

Table 37-1: Status and potential impact of reservoir operations on amphibians and reptiles of the Columbia Basin

<table>
<thead>
<tr>
<th>Species</th>
<th>Region</th>
<th>Status</th>
<th>CDC*</th>
<th>COSEWIC†</th>
<th>Possibly affected by Reservoir Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amphibians</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern Leopard Frog (Rana pipiens)</td>
<td>Kinbasket</td>
<td>R</td>
<td>E</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Columbia Spotted Frog (Rana luteiventris)</td>
<td>Arrow/Kinbasket</td>
<td>Y</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Wood Frog (Rana sylvatica)</td>
<td>Kinbasket</td>
<td>Y</td>
<td></td>
<td>Uncertain**</td>
<td></td>
</tr>
<tr>
<td>Pacific Tree Frog (Hyla regilla)</td>
<td>Arrow/Kinbasket</td>
<td>Y</td>
<td></td>
<td>Uncertain**</td>
<td></td>
</tr>
<tr>
<td>Western Toad (Bufo boreas)</td>
<td>Arrow/Kinbasket</td>
<td>Y</td>
<td></td>
<td>SC</td>
<td>Yes</td>
</tr>
<tr>
<td>Long-toed Salamander (Ambystoma macrodactylum)</td>
<td>Arrow/Kinbasket</td>
<td>Y</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Couer d’Alène Salamander (Plethodon idahoensis)</td>
<td>Arrow</td>
<td>B</td>
<td>SC</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Rocky Mountain Tailed Frog (Asaphus montanus)</td>
<td>-</td>
<td>R</td>
<td>E</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td><strong>Reptiles</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Painted Turtle (Chrysemys picta)</td>
<td>Arrow/Kinbasket (?)</td>
<td>B</td>
<td>SC</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Western Terrestrial Garter Snake (Thamnophis elegans)</td>
<td>Arrow/Kinbasket</td>
<td>Y</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Common Garter Snake (Thamnophis sirtalis)</td>
<td>Arrow/Kinbasket</td>
<td>Y</td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Rubber Boa (Charina tenuis)</td>
<td>Arrow</td>
<td>Y</td>
<td>SC</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Western Racer (Coluber constrictor)</td>
<td>Arrow</td>
<td>B</td>
<td>SC</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Western Rattlesnake (Crotalus oreganos)</td>
<td>Arrow</td>
<td>B</td>
<td>T</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Western Skink (Eumeces skiltonianus)</td>
<td>Arrow</td>
<td>B</td>
<td>SC</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Northern Alligator Lizard (Elgaria coerulea)</td>
<td>Arrow</td>
<td>Y</td>
<td></td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

* CDC status: R = Red list; B=Blue list; Y = Yellow list
** These species has not been observed in Kinbasket reservoir in recent years.
† COSEWIC Status E = Endangered; T = Threatened; SC = Special Concern

1.2 Management Questions

Management questions to be addressed by this monitoring program relating to the impacts of the operations of Arrow Lakes Reservoir and Kinbasket Reservoir on amphibians and reptiles include:

1) Which species of reptiles and amphibians occur (utilize habitat) within the drawdown zone and where do they occur?
2) What is the abundance, diversity, and productivity (reproduction) of reptiles and amphibians utilizing the drawdown zone and how do these vary within and between years?

3) During what portion of their life history (e.g., breeding, foraging, and overwintering) do reptiles and amphibians utilize the drawdown zone?

4) Which habitats do reptiles and amphibians use in the drawdown zone and what are their characteristics (e.g., pond size, water depth, water quality, vegetation, elevation band)?

5) How do reservoir operations influence or impact reptiles and amphibians directly (e.g., desiccation, inundation, predation) or indirectly through habitat changes?

6) Can minor adjustments be made to reservoir operations to minimize the impact on reptiles and amphibians?

7) Can physical works projects be designed to mitigate adverse impacts on reptiles and amphibians resulting from reservoir operations?

8) Does revegetating the drawdown zone affect the availability and use of habitat by reptiles and amphibians?

9) Do physical works projects implemented during the course of this monitoring program increase reptile or amphibian abundance, diversity, or productivity?

10) Do increased reservoir levels in Kinbasket Reservoir during the summer months resulting from the installation of Mica 5 and 6 negatively impact amphibian populations in the drawdown zone through increased larval mortality or delayed development?

1.3 Management Hypothesis

The management hypotheses to be tested under this monitoring program are:

H1: Annual and seasonal variation in water levels in the Arrow Lakes and the Kinbasket Reservoirs and the implementation of soft operational constraints and potential effects of Revelstoke Unit 5 in Arrow Lakes Reservoir (“reservoir operations”) do not directly or indirectly impact reptile and amphibian populations.

H1A: Reservoir operations do not result in a decreased abundance of amphibians or reptiles in the drawdown zone.

H1B: Reservoir operations do not increase the stage specific (e.g. larval, juvenile, or adult) mortality rates of amphibians or reptiles in the drawdown zone.

H1C: Reservoir operations do not result in decreased site occupancy of amphibians or reptiles in the drawdown zone.

H1D: Reservoir operations do not result in decreased productivity of amphibians or reptiles in the drawdown zone.

H1E: Reservoir operations do not reduce the availability and quality of breeding habitat, foraging habitat and overwintering habitat for amphibians or reptiles in the drawdown zone.
H2: The physical works projects and revegetation efforts do not increase the utilization of habitats by amphibians or reptiles in the drawdown zone.

H2A: Revegetation and physical works do not increase species diversity or seasonal (spring/summer/fall) abundance of amphibians or reptiles in the drawdown zone.

H2B: Revegetation and physical works do not increase amphibian or reptile productivity in the drawdown zone.

H2C: Revegetation does not increase the amount or improve habitat for amphibians and reptiles in the drawdown zone.

1.4 Key Water Use Decision Affected

The key operating decisions affected by this monitoring program are the operating regimes for the Kinbasket Reservoir and Arrow Lakes Reservoir and the implementation of soft constraints for the Arrow Lakes Reservoir to balance the requirements of reptiles and amphibians with recreational opportunities, flood control, power generation, and other environmental objectives. Results of this monitoring program will help influence the scope of measures required to minimize or mitigate potential impacts, as well as to evaluate the efficacy of works undertaken to improve habitat for reptiles and amphibians. Information on the life history requirements of herptiles will also help inform management decisions regarding the design and location of revegetation efforts and physical works projects within Arrow Lakes and Kinbasket Reservoirs.

For Arrow Lakes Reservoir, operational changes to be considered will be limited to soft constraints that govern daily operations such as timing, magnitude and flow rate as opposed to hard constraints that include reservoir and turbine capacities, spillway rating, licensing requirements and Columbia River Treaty obligations.

2.0 MONITORING PROGRAM PROPOSAL

2.1 Objectives and Scope

The key objectives of this monitoring program are to:

- Determine reptile and amphibian use of the drawdown zones of the Arrow Lakes and Kinbasket Reservoirs. This will entail determining their abundance, species diversity, distribution, productivity, and patterns of habitat use.

- Inform BCHydro on how reservoir operations affect reptile and amphibian populations by monitoring their abundance, diversity, distribution, productivity, and patterns of habitat use over time.

- Determine whether minor adjustments can be made to reservoir operations to minimize impacts on reptile and amphibian populations or determine if mitigation strategies can be developed to reduce these impacts?

- Inform BCHydro on how physical works and revegetation can be designed and implemented to mitigate adverse impacts resulting from reservoir operations on amphibian and reptile populations.
- Provide the data necessary to evaluate whether physical works projects or revegetation initiatives benefit amphibian and reptile populations through increased abundance, site occupancy, species diversity, or increases to habitat availability or quality.

- Assess the potential for impacts on amphibian larval survival and metamorphic success in Kinbasket Reservoir as a result of installation of Units 5 and 6 at Mica Dam.

The objective for Year 1 (2008) is to conduct a literature review, review existing data, and conduct reconnaissance surveys to determine the distribution of amphibians and reptiles within the drawdown zone of the Arrow Lakes and Kinbasket Reservoirs. This data will help in developing a long-term monitoring program to measure the effects of reservoir operations, revegetation, and physical works on reptiles and amphibians.

The duration of this monitoring program specified in WUP is 5 years; however a longer-term monitoring program may be required. This will be evaluated during an interim Columbia River WUP review scheduled for 2012. Technical progress reports will be prepared annually. An interim technical report will be prepared in 2012 and final technical report will be prepared in 2018.

In addition to the uncertainties raised during the Columbia WUP, the Mica 5/6 Core Committee recommended additional monitoring to augment the existing Columbia WLR study (CLBMON 37). This will entail additional monitoring in 2011, 2013, 2015, and 2017 (Section 2.6). Additional resources will be required in 2018 to supplement the write up of the final report for both CLBMON 37 and 58. These are detailed under Section 2.7.

### 2.2 Approach

In order to develop a sound monitoring program, reconnaissance surveys will be carried out in the first year of the study to determine the distribution of amphibians and reptiles within the drawdown zones of the Arrow Lakes and Kinbasket Reservoirs. Prior to beginning the reconnaissance surveys, a review of the aerial photographs and other relevant spatial data (such as TRIM data and the vegetation types described in CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources Project and CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources Project) will be conducted to identify potential habitat for reptiles and amphibians. Data obtained from additional sources may also be helpful in this regard (e.g., Dykstra 2004; Maltby 2000; Ohanjanian et al. 2006). In evaluating the results of the reconnaissance surveys, the use of focal species (Lambeck 1997) will be considered for monitoring in future years as several species occur throughout the area, occupy different habitat types, and are relatively easy to detect (e.g., western toad, spotted frogs, pacific tree frogs - Matsuda et al. 2006). The trapping of amphibians or reptiles to detect cryptic species will also be evaluated.

In subsequent years, sites will be surveyed using standardized sampling methodologies to monitor abundance, occupancy, productivity, and patterns of habitat use. As the detectability of amphibians and reptiles varies among species and can vary within species depending on season and habitat (Bailey et al. 2004;
Campbell Grant et al. 2005), several survey methods are required. Table 37-2 outlines the survey methods appropriate for individual species or species group. Due to the extent of the study area and significant differences in climate regimes, three rotations of surveys will be carried out. The first round of surveys will be conducted during the early/mid spring; the second, during late spring and early summer; and the third, during mid to late summer. These sampling sessions will facilitate an assessment of how rising water levels affect reptile and amphibian populations.

During the first sampling session, nocturnal calling surveys (NCS), egg mass surveys (EMS), and larval surveys (LVS) will be employed to detect breeding amphibians and confirm reproduction. Visual encounters surveys (VES) will also be conducted to detect anurans (frogs and toads), painted turtles, and garter snakes. Each site will be visited on a least three occasions. Surveys will incorporate “double survey”, and/or “double observer” approaches to account for imperfect detection probabilities (p<1). Incorporating detection probabilities in wildlife surveys is imperative as the probability of detecting wildlife can obscure actual trends in population size and habitat occupancy (Boulinier et al. 1998; Mackenzie et al. 2002; Royle & Nichols 2003). Factors such as species of interest, habitat type, weather, time of day, and observer experience can influence the detectability of amphibians and reptiles (Bailey et al. 2004; Campbell Grant et al. 2005; Gooch et al. 2006).

Visual encounter surveys (VES) will be conducted outside of the breeding season in the second and third sampling sessions. These surveys will confirm the success of amphibian reproduction to determine productivity by detecting the presence and abundance of metamorphs. LVS will also be conducted in the northern portions of the study area or in cooler bodies of water during the second survey session. Each site will be visited on at least three occasions. One approach to assessing habitat suitability for amphibians may be to monitor the seasonal growth rates of amphibian larvae or young-of year. Slow growth may suggest poor site conditions indicative of low nutrients or cool temperatures. This approach will be particularly useful in assessing the potential impacts of Mica units 5 and 6 on amphibian larval development and survival in Kinbasket Reservoir.

2.3 Methods

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.

Task 2: Literature Review, Data Mining, and Habitat Suitability Mapping

Prior to surveying in year one, data from sources such as the Ministry of Environment Wildlife Species Inventory Database, from other wildlife inventory projects (Dulisse and Hausleitner 2009 and 2010, Dykstra 2004; Hawkes et al. 2007; Ohanjanian et al. 2006), and from information obtained from local naturalists and wildlife professionals
will be reviewed to provide a preliminary assessment of the distribution of amphibians and reptiles along the Arrow Lakes and Kinbasket Reservoirs. Potential habitats will be identified from CLBMON-33, CLBMON-10, digital elevation models (DEM), TRIM data, and aerial photographs. Suitable habitats will be identified using expert knowledge, information obtained from the literature, and from outside data sources such as the Columbia Basin wildlife habitat relationship database (Steeger et al. 2001).

**Task 3: Reconnaissance Surveys – Work Completed**

Reconnaissance level surveys will be conducted to determine the distribution of amphibian and reptiles along the Arrow Lakes and Kinbasket Reservoirs. This data, along with the information obtained from Task 2, will form the basis of the monitoring program.

Between April and June, NCS, EMS, and LVS, will be conducted to detect pond breeding amphibians and their breeding habitats. Procedures for carrying out these surveys are described in Appendix A (see also Donnelly et al. 1994; Olson et al. 1997; Resources Inventory Committee 1998a, b). VES may also be effective in detecting painted turtles and western terrestrial and common garter snakes. VES for these species differ from those for amphibians in terms of in the habitats surveyed, and, for snakes in particular, the ambient weather conditions (Resources Inventory Committee 1998a, b). Of particular interest will be den sites and nest sites.
<table>
<thead>
<tr>
<th>Survey Method</th>
<th>Applicable Species</th>
<th>Information</th>
<th>Abundance Estimate</th>
<th>Timing</th>
<th>Recommended Frequency</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **Nocturnal Calling Surveys** | Pacific Tree Frogs, Wood Frogs, Northern Leopard Frog†, Western Toads†† | i) Presence/Occupancy  
ii) Index of calling intensity  
iii) Population Trend  
iv) Habitat Use | Relative Abundance | Early April to Mid-June | 4 times a season | Advantage  
- Can be conducted prior to egg mass surveys to assist in locating egg masses  
- Easily Standardized  
Disadvantages  
- Affected by environmental conditions such as wind, rain, and clouds  
- Only males detected |
| **Egg Mass and Larval Surveys** | All amphibian species | i) Presence/Occupancy  
ii) Reproductive output  
iii) Population Trend  
iv) Habitat Use | Relative Abundance | Mid April to Mid-June | 4 times a season | Advantage  
- Provides a direct measure of reproductive output  
Disadvantages  
- Affected by environmental conditions such as wind, rain, and clouds  
- Detection probability decreases due to phenology of aquatic vegetation  
- Risk of trampling egg masses  
- Estimates often generated without confidence intervals |
| **Visual Encounter Surveys** | Anurans and Snakes | i) Presence/Occupancy  
ii) Reproductive output  
iii) Population Trend  
iv) Habitat Use | Relative Abundance | Spring Summer Fall | 4 times a season | Advantage  
- Easiest method to employ  
- Easily done in conjunction with Mark-Recapture techniques  
Disadvantage  
- Estimates often generated without confidence intervals  
- Assumptions of VES inevitably violated |
| **Trapping** | Snakes, Painted Turtles, All amphibians | i) Presence/Occupancy  
ii) Reproductive output  
iii) Population Trend  
iv) Habitat Use | Relative Abundance | Spring Summer Fall | Requires predetermined sampling sessions | Advantage  
- Can be very efficient  
- Easily done in conjunction with Mark-Recapture techniques  
Disadvantage  
- Setting up traps often labour intensive  
- Often results in mortality |
| **Mark-Recapture** | All Species | i) Population Estimate  
ii) Life History information  
iii) Habitat Use | Absolute/Relative | Spring Summer Fall | Requires predetermined sampling sessions | Advantage  
- Only method for obtaining absolute population estimate  
- Easily obtained by photographing body markings or spot patterns  
Disadvantage  
- Time consuming due to intensive sampling periods  
- Review photographs is very time consuming |

* Includes area and time constrained surveys and transects surveys  
** Including cover boards  
†† Exirpated from Kinbasket Reservoir  
††† Does not call consistently
Nocturnal calling surveys will be conducted to detect pacific tree frogs and wood frogs; however western toads and Columbia spotted frogs may also be detected. Egg mass surveys will be conducted in aquatic environments to identify breeding ponds for long-toad salamanders, western toads, Columbia spotted frogs, wood frogs, and pacific tree frogs. Larval surveys may also be conducted in July for populations that develop more slowly or breed later in the season.

Between June and August, area constrained VES will be conducted for anurans (frogs and toads), painted turtle, and the two species of garter snakes. Surveys will be conducted on warm days to increase the likelihood of encountering garter snakes.

Habitat information will be collected at each survey site and at each location where amphibians and reptiles are detected following Luttmerding et al. 1998; MacKenzie & Moran 2004, and Resources Inventory Committee 1998a and 1998b. Habitat data will include emergent and submergent vegetation (plant community, species lists, structural stage, and percent cover), water depth, water quality (e.g., pH, conductivity, dissolved oxygen), water temperature, substrate, ground cover (woody debris, boulders, etc.), size of habitat polygon, distance to water, and the presence of fish, aquatic insects (e.g., dragonfly nymphs), or other predators. Landscape and habitat features such as basking logs for turtles, rock outcrops for snakes and skinks, shallow isolated water bodies (depressions or puddles) for amphibians will be noted.

Environmental conditions (e.g., air temperature, water temperature, wind, precipitation, cloud cover, etc.) and the level of survey effort will be recorded during each survey.

Task 4: Monitoring Program

Following the reconnaissance surveys in Year one, a monitoring program employing the methods outlined in Table 27-2, and described in greater detail in Appendix A, will be carried out in subsequent years to (1) determine the impacts of reservoir operations on reptile and amphibian populations and (2) to evaluate the efficacy of physical works and revegetation initiatives to enhance amphibian and reptile populations or their habitats.

The monitoring program will need to consider a sampling scheme to monitoring the effectiveness of revegetation efforts and wildlife physical works. This will need to be coordinated between CLBWORKS-1 and CLBWORKS-2: Kinbasket and Arrow Lakes Reservoir Revegetation Program, CLBWORKS-29 and 30: Feasibility and Implementation of wildlife physical works, and CLBMON-11A and 11B Kinbasket and Arrow Lakes Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works, as well as the other wildlife and vegetation studies monitoring undertaking effectiveness monitoring. Sampling may need to incorporate treated ( revegetated or site of physical works), control sites (untreated areas in the drawdown zone), and reference sites (untreated sites above the drawdown zone).
Task 4.1: Spring Survey

Depending on seasonal conditions, NCS, LVS, EMS and VES surveys will begin in mid-April\(^1\) in the southern, milder portions of the study area. Each survey area will be georeferenced and animals captured during searches will be measured (snout to vent length, SVL), weighed, sexed, aged, and their health and breeding condition determined. Evidence of reproduction will be documented and quantified (e.g., number of breeding individuals, number of egg masses, the presence and abundance of larvae or young-of-year). Evidence of mortality related to reservoir levels, or evidence of predation will be documented. Habitat information and environmental data will be collected as described in Task 3.

Task 4.2: Summer- Fall Surveys

Sampling sessions will be conducted during the summer and fall to monitor seasonal patterns of abundance, habitat use, and to account for seasonal differences across the study area and life history strategies. Sampling will occur during late-spring to early-summer (mid June to early July\(^2\)), the second during mid to late summer (August\(^2\)), and the third in the fall (September/October\(^2\)). Visual encounter surveys following standardized procedures (See Appendix A and Donnelly et al. 1994; Resources Inventory Committee 1998a, b) will be conducted along ponds and associated riparian areas occurring near or in the drawdown zone, and in riparian habitats along the reservoir edge. Sample sites will be georeferenced and marked for use on subsequent surveys. Cover objects and funnel traps may be employed to detect cryptic species such as long-toed salamanders and the two species of garter snakes. To minimize disturbances that may influence animal use between surveys, all natural cover objects will be returned to their original position. The use of cover objects and funnel traps is to be determined in Year 1.

Each animal captured will be georeferenced, identified, measured (SVL length), weighed, sexed, age class determined, and its condition determined. Animal processing time will not be included in the time spent searching. Where evidence of reproduction has been documented, efforts will be made to confirm successful development. Evidence of mortality related to reservoir levels and predation will be documented. Habitat and environmental information will be collected as described above.

To answer the management questions associated with CLBMON58, amphibian larval development and metamorphosis will be monitored to assess the potential impacts of increased reservoir levels resulting from Mica 5 and 6.

Task 5: Monitoring Habitat Characteristics, Use, and Availability

To characterize and monitor habitat use, habitat information will be collected at each survey site and at each location where amphibians and reptiles are detected following Luttmerding et al. 1998; MacKenzie & Moran 2004, and Resources Inventory Committee 1998a and 1998b. Habitat data will include emergent and submergent vegetation (plant community, species lists, structural stage, and percent cover), water depth, temperature, water quality (e.g., pH, conductivity, dissolved

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\(^1\) The timing of surveys will be determined following reconnaissance surveys in year one.
oxygen), substrate, ground cover (woody debris, boulders, etc.), size of habitat polygon, distance to water, and the presence of fish, aquatic insects (e.g., dragonfly nymphs), or other predators. Landscape and habitat features such as basking logs for turtles, rock outcrops for snakes and skinks, shallow isolated water bodies (depressions or puddles) for amphibians will be noted.

Habitat availability will be assessed for the entirety of Arrow Lakes and Kinbasket Reservoir using habitat data obtained under CLBMON11B1; Arrow Reservoir Wildlife Effectiveness Monitoring, CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources, CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources, CLBMON 61 Kinbasket Wetland Habitat and Vegetation Monitoring and from other available sources. CLBMON61 will begin in 2012.

Task 6: Data Analysis

A brief summary of the data collected during each year will be provided in annual progress report. This will include a summary of sampling effort expended and an overview of the data. The intent of the data summary is to provide a synopsis of the sampling effort and results, and to ensure data is QA’d on an annual basis.

Testing hypothesis H1A-E that reservoir operations and the implementation of soft operational constraints do not have an effect on reptile and amphibian populations will require a long-term dataset to detect trends in abundance, site occupancy, species diversity, and productivity. Analysis (e.g., analysis of variance, linear regression, logistic regression, and capture-recapture modeling of species richness) will examine within year and between year variation in abundance, species diversity, distribution, and productivity of reptiles and amphibians in relation to local factors such as water levels in the Arrow Lakes and Kinbasket Reservoirs and external factors such as weather.

Recent methods in modeling the proportion of area occupied by species appear to be powerful alternatives for monitoring trends in abundance and assessing species distribution and richness, and habitat use and selection (Mackenzie & Nichols 2005; Mackenzie et al. 2006); particularly for rare or infrequently detected species (Mackenzie et al. 2005) such as amphibians (Bailey et al. 2004; Weir 2005). Detection probabilities and proportion of area occupied can be calculated using programs such as PRESENCE or MARK which can also be used to analyze the Capture-Mark-Recapture data (Mackenzie et al. 2003).

Analyzing the effectiveness of physical works and revegetation efforts on reptiles and amphibians will depend on the how this component of the study is designed and the data obtained. Analysis may entail goodness-of-fit tests, ANOVA, regression or logistic regression to assess whether physical works or revegetation efforts increase site occupancy, animal abundance, productivity, or habitat use.

Task 7: Reporting

A brief progress report will be prepared annually to summarize the methods employed during the program and the data obtained. The progress report for Year 1 will also include an assessment of the survey methodology. A comprehensive interim report will be prepared in Year 5.
Annual progress reports will include:

i) A brief description of the project background
ii) A brief description of the methods
iii) A summary of the sampling effort and preliminary results including:
    a. a summary of seasonal patterns in abundance, site occupancy, distribution, and diversity of amphibian and reptile species within the drawdown zone
    b. a summary of habitat use for each species
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:
    a. MS Excel spreadsheet of UTM coordinates for survey sites.
    b. A database of amphibian and reptile observations (location data) following BC Governments Wildlife Species Inventory (WSI) standards.
    c. A database of vegetation and habitat measurements

Also 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.

Interim and Final Report

At Years 5 and 11, comprehensive technical report will be prepared. These report will include:

i) an executive summary;
ii) a description of the methods employed;
iii) a data summary;
iv) a comparison of results between years;
v) a detailed summary of the findings as they relate to the fundamental gaps in knowledge concerning amphibians and reptiles and the key management questions including the management questions and hypothesis associated with the impacts of Mica 5 and 6;
vi) and recommendations for (i) modifying the operating parameters of the Arrow Lakes and Kinbasket Reservoir to reduce negative effects on amphibians and reptiles and/or (ii) management efforts (revegetation or physical works) that can mitigate any negative effects of operating regimes.

vii) A final digital appendix with:
    a. MS Excel spreadsheet of UTM coordinates for survey sites.
    b. A database of amphibian and reptile observations (location data) following BC Governments Wildlife Species Inventory (WSI) standards.
    c. A database of vegetation and habitat measurements

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 maps and figures will be provided either as embedded objects in the Word file or as separate files. Amphibian and reptile locations and associated data or the location of other significant species such as species at risk will be provided to the Ministry of Environment (e.g. CDC) following the Wildlife Species Inventory (WSI) standards: http://www.env.gov.bc.ca/wildlife/WSI/formats.htm.
2.4 **Interpretation of Monitoring Program Results**

A key result of this monitoring program will be information on the abundance, site occupancy, species diversity, distribution, and productivity of reptiles and amphibians and patterns of habitat use within the drawdown zone of Kinbasket and Arrow Lakes Reservoirs. This information will be used to address uncertainty regarding the benefit of minor modifications to operating conditions that could enhance habitat within the drawdown zone to support amphibian and reptile populations. The significance of any impacts of reservoir operations on these populations will be assessed by determining the extent to which water levels influence the abundance, site occupancy, mortality and habitat quality, species diversity, and productivity of herptiles.

This information will also inform mitigative efforts aimed at providing habitat for amphibians and reptiles in the drawdown zone and facilitate the effectiveness of revegetation and physical works in this regard.

The results of the additional sampling under CLBMON 58 will also facilitate an assessment of the potential impacts of Mica 5 and 6 on amphibian and reptile populations in Kinbasket Reservoir.

2.5 **Study Design Limitations**

Monitoring changes in wildlife populations and habitats can be complicated by numerous factors and limitations such as a poor study design or sampling strategy. Despite efforts to reduce these limitations, we acknowledge that this monitoring.

One constraint is that reservoir operations (water levels, filling and drafting rates) varies between seasons and years which may reduce the ability to correlate specific reservoir conditions to reptile and amphibian populations. This may further be complicated by the implementation of soft constraints over the course of the monitoring program.

As conditions on the Kinbasket and Arrow 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.

2.6 **Schedule**

CLBMON 37 and 58 will be implemented over 11 years period from 2008 to 2018 (Table 37-3), and will be synchronized with the wildlife physical works and revegetation effectiveness monitoring programs for Kinbasket and Arrow Lakes reservoirs (CLBMON -11A and 11B). The anticipated annual schedule of tasks for CLBMON37 and **CLBMON 58** are presented in Table 37-4.
### Table 37-3 Monitoring schedules

**CLBMON 37**

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 5</th>
<th>Year 7</th>
<th>Year 9</th>
<th>Year 11</th>
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<tr>
<td>2008</td>
<td>2009</td>
<td>2010</td>
<td>2012</td>
<td>2014</td>
<td>2016</td>
<td>2018</td>
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</tbody>
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**CLBMON 58**

<table>
<thead>
<tr>
<th>Year 4</th>
<th>Year 6</th>
<th>Year 8</th>
<th>Year 10</th>
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<tr>
<td>2011</td>
<td>2013</td>
<td>2015</td>
<td>2017</td>
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### Table 37-4 CLBMON 37 and CLBMON 58 Annual schedule of Tasks

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<tbody>
<tr>
<td>1) Project Coordination</td>
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<td>2) Pre-Stratification of Habitat</td>
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<td>3) Reconnaissance Surveys*</td>
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<td>4.1) Spring surveys</td>
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<td>4.5) Summer/Fall surveys</td>
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<td>5) Habitat Monitoring</td>
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<tr>
<td>6) Data Analysis</td>
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<td>7) Reporting</td>
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* work completed

### 2.7 Budget

**CLBMON 37**

No changes have been proposed to the budget of CLBMON 37.

The original annual cost estimate in 2004 by the CC for this monitoring program was $75,000. The estimated average annual cost of this monitoring program over 11 years including 2% inflation is $141,322 (Table 37-5).

**CLBMON 58**

Total estimated cost for this project is $428,789 including 2% inflation and 5% contingency. The estimated average annual cost of this monitoring program including 2% inflation and 5% contingency is $105,057 (Table 37-6). In 2018, $11,970 will be available to incorporate the analysis and write up into a joint final report for CLBMON37 and 58.
3.0 References


Appendix A – Summary of Survey Methods

Egg Mass Surveys (EMS)

EMS provide an estimate of relative abundance, habitat use, and reproductive output. When possible, EMS should be conducted following an NCS conducted the prior evening. Upon arrival at the site, weather and location information is recorded. Depending on the visibility, observers should space themselves two meters to four meters apart and systematically walk the pond in a grid pattern. In smaller ponds, the entire site is searched, but in larger ponds searches should focus on shallow warmer portions of the pond or where calling males were detected during NCS. While conducting EMS, observers walk slowly to minimize sediment disturbance. When an egg mass is found, its location is documented using a GPS, and physical measurements and habitat attributes are recorded, taking great care to minimize disturbance to the egg mass itself. The species of egg masses are to be identified and the health of the egg mass is noted (i.e. the proportion of unfertilized eggs) and digital photographs are taken of the egg mass and its surrounding habitat.

Factors that affect egg mass sight-ability include cloud cover, wind, glare from the sun, aquatic vegetation, and the attentiveness of the observer and their experience (e.g., Campbell Grant et al. 2005). Polarized sunglasses are recommended as they dramatically improve visibility by reducing the glare from the water surface. Observers must be careful when visibility is poor as it increases the chance of trampling egg masses. Survey routes are to be recorded using GPS.

Nocturnal Calling Surveys (NCS)

NCS will target pacific tree frogs. Although western toads, spotted frogs, and wood frogs may be detected, the use of calling surveys for these anurans is not reliable.

Ideally NCS should be conducted prior to conducting EMS or VES, however this is not always advisable for safety reasons, particularly when surveying a site for the first time. Upon arrival at survey stations, observers record weather and location information and then remain quiet for several minutes to reduce affects of observer disturbance. The survey itself is comprised of two 5 minute listening intervals during which observers estimate the number of frogs heard calling using the Wisconsin Index (Mossman et al. 1998). Each listening interval is separated by one minute of silence.

Wisconsin Index
0 = no frogs, of a given species, can be heard calling;
1 = individual calls, not overlapping;
2 = calls are overlapping; but individuals are still distinguishable;
3 = numerous frogs can be heard; chorus is constant and overlapping.

The ability to detect calling frogs can be impeded by wind, rain and cold temperatures. Calling surveys should therefore be cancelled or rescheduled on evenings when it is raining steadily, when winds exceed 15 km/hr, or when air temperatures are less than 5°C. One main drawback to NCS is that only males are detected and no information can be collected on the abundance of females. Survey routes are to be recorded using GPS.
**Visual Encounter Surveys (VES)**

Visual encounter surveys (VES) are an effective technique for surveying conspicuous amphibians. VES provides information on presence, species richness, habitat use, and abundance. Both relative and absolute estimates of abundance can be generated from VES surveys. Relative abundance can be estimated using catch per effort calculations or from density estimates where the size of the sampling area is known. Neither of these estimates are ideal for at least three reasons; (1) the large size of the study area makes it difficult to sample thoroughly, (2) habitats are not homogenous resulting in varying detection probabilities, and (3) animals may cluster in preferred habitats, which change over the course of the year. Absolute abundance can be estimated using Mark-Recapture techniques.

Upon arriving at a site, environmental conditions, location, observers and survey start and end times are recorded. VES are conducted systematically by walking through previously identified habitat and visually searching for amphibians and reptiles. Efforts should be made to capture every animal encountered. When an animal is captured, weight and snout-to-vent length measurements are obtained and the animal’s condition is assessed. Digital photographs are to be taken of the animal’s dorsal and ventral surface, to facilitate mark-recapture. Care must be taken to ensure the photo is in focus and exposed properly. Survey routes are to be recorded using GPS.

**Larval Surveys (LVS)**

Larval surveys (LVS) include several techniques to survey amphibian larvae. These include visually surveying for larvae, dip netting, and trapping. These techniques can provide information on the presence, diversity, habitat use, and the relative abundance of amphibian larvae. Larval surveys can also provide important information on larval growth and development, which can reflect habitat conditions (e.g. food availability, water temperature). Estimating absolute abundance of amphibian larvae is problematic due to the temporal nature of metamorphosis and the difficulties associated with marking larvae.

Relative abundance can be estimated using catch per effort calculations or from density estimates where the size of the sampling area is known. Neither of these estimates are ideal for at least three reasons; (1) the large size of the study area makes it difficult to sample thoroughly, (2) habitats are not homogenous resulting in varying detection probabilities, and (3) animals may cluster in preferred habitats, which change over the course of the year.

Visual LVS follow the same procedure as described above for Visual Encounter Surveys, except that the emphasis of surveys is on aquatic habitat. Dip netting is an effective technique to survey for amphibian larvae that are secretive (e.g. long-toed salamander larvae) or were visibility is poor, and provides a measure of relative abundance. The procedure entails sweeping the habitat of interest with a net a predetermined number of times at predetermined intervals. The Resource Inventory Committee (1998) recommends intervals of 5 meters. Larval trapping is typically preformed using minnow traps that are set in a stratified and random manner, and yields a measure of relative abundance. The recommended trapping intensity is 2 traps for every 25 m², adding an additional trap as the area doubles. It is imperative that traps be checked at least daily as tadpoles are susceptible to predation from fish and aquatic invertebrate that are trapped incidentally.