

# **Columbia River Water Use Plan**

## **Kinbasket & Arrow Reservoir Revegetation Management Plan**

### **Monitoring Program and Physical Works**

**Annual Report: 2016**

**Implementation Period: February 2015 to January 2016**

- **CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis**
- **CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources**
- **CLBMON-11A Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir**
- **CLBMON-11B Wildlife Effectiveness Monitoring of Revegetation and Wildlife Physical Works in the Arrow Lakes Reservoir**
- **CLBMON-12 Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis**
- **CLBMON-13 Inventory of Mosquito Populations in the Revelstoke Area**
- **CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources**
- **CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation**
- **CLBMON-57 Plant Communities**
- **CLBWORKS-1 Kinbasket Reservoir Revegetation Program Physical Works**
- **CLBWORKS-2 Arrow Lakes Reservoir Revegetation Program Physical Works**

**Conditional Water Licences for Kinbasket storage (27068 and 39432), Mica diversion (39431), Revelstoke diversion and storage (47215), and Arrow storage (27066)**

**February 29, 2016**

## **BC Hydro Columbia River Project Water Use Plan Kinbasket & Arrow Reservoir Revegetation Management Plan Monitoring Programs and Physical Works Annual Report: 2016**

### **1 Introduction**

This document represents a summary of the status and the results of the Columbia River Kinbasket and Arrow Reservoir Revegetation Management Plan Water Use Plan (WUP) monitoring programs and physical works to January 31, 2016, as per the Columbia River Order under the *Water Act*, dated January 26, 2007. There are nine monitoring programs and two physical works.

### **2 Status**

The following table outlines the dates that Terms of Reference (TOR) for the Kinbasket and Arrow Reservoir Revegetation Management Plan WUP monitoring programs and physical works were submitted to and approved by the CWR.

**Table: 2-1: Dates of Kinbasket and Arrow Reservoir Revegetation Management Plan WUP TOR Submissions and Approvals by the Comptroller of Water Rights**

Monitoring Program & Physical Works TOR	Order Clause	Original ToR Submission		Most Recent ToR Resubmission	
		Date Submitted	Date Approved	Date Submitted	Date Approved
CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis	Schedule A, Clause 2(a)	Jan 25, 2008	Mar 03, 2008	Sep 17, 2010	Oct 26, 2010
CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources	Schedule A, Clause 2(b)	Apr 04, 2007	Apr 19, 2007	Jan 12, 2009	Apr 08, 2009
CLBMON-11A Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir	Schedule A, Clause 2(c)	Jan 25, 2008	Feb 26, 2008	Oct 22, 2008	Dec 10, 2008
CLBMON-11B Wildlife Effectiveness Monitoring of Revegetation and Wildlife Physical Works in the Arrow Lakes Reservoir	Schedule C, Clause 5(a); Schedule D, Clause 2(a)	Apr 03, 2009	May 11, 2009		
CLBMON-12 ONR Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis	Schedule C, Clause 2(a) (b); Schedule D, Clause 2(b) (c)	Jan 12, 2009	Apr 08, 2009	Sep 17, 2010	Oct 26, 2010
CLBMON-12 OR Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis	Schedule C, Clause 2(a) (b); Schedule D, Clause 2(b) ©	Jan 25, 2008	Mar 03, 2008	Sep 17, 2010	Oct 26, 2010
CLBMON-13 Inventory of Mosquito Populations in the Revelstoke Area	Schedule C, Clause 5(b)	Jan 25, 2008	Feb 26, 2008		
CLBMON-33 ONR Arrow Lakes Reservoir Inventory of Vegetation Resources	Schedule C, Clause 2(b) Schedule D, Clause 2(c)	Jan 12, 2009	Apr 08, 2009		
CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources	Schedule C, Clause 2(b) Schedule D, Clause 2©	Apr 04, 2007	Apr 19, 2007	Jan 12, 2009	Apr 08, 2009
CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation	Schedule C, Clause 2(c); Schedule D, Clause 2(d)	Jan 25, 2008	Apr 08, 2008	Jan 13, 2016	pending
CLBMON-57 Plant Communities	Clause 2.a Amended Order	May 16, 2013	Jul 02, 2013		
CLBWORKS-1 Kinbasket Reservoir Revegetation Program Physical Works	Schedule A, Clause 1(a)	Apr 27, 2007	May 03, 2007	Jun 01, 2015	Jun 10, 2015
CLBWORKS-2 Arrow Lakes Reservoir Revegetation Program Physical Works (Phase 1)	Schedule C, Clause 1(a); Schedule D, Clause 1(a)	Apr 27, 2007	May 03, 2007		
CLBWORKS-2 Arrow Lakes Reservoir Revegetation Program Physical Works (Phase 2)	Schedule C, Clause 1(a); Schedule D, Clause 1(a)	Feb 26, 2008	Apr 23, 2008		
CLBWORKS-2 Arrow Lakes Reservoir Revegetation Program Physical Works (Phase 3)	Schedule C, Clause 1(a); Schedule D, Clause 1(a)	Jul 06, 2010	Aug 10, 2010		
CLBWORKS-2 Arrow Lakes Reservoir Revegetation Program Physical Works (Phase 4)	Schedule C, Clause 1(a); Schedule D, Clause 1(a)	Feb 18, 2013	Mar 05, 2013		

### 3 Schedule

The following table outlines the current schedule for the monitoring programs and physical works being delivered for the Kinbasket and Arrow Reservoir Revegetation Management Plan WUP.

**Table 3-1: Monitoring Programs and Physical Works Schedule as of January 31, 2016**

Monitoring Programs	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	WLR YR1	WLR YR2	WLR YR3	WLR YR4	WLR YR5	WLR YR6	WLR YR7	WLR YR8	WLR YR9	WLR YR10	WLR YR11	WLR YR12	WLR YR13
CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis		✓	✓		✓		✓		✓		■		
CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources	✓	✓		✓		✓		✓		■			
CLBMON-11A Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir		✓	✓	✓			✓*	✓	✓	■		■	
CLBMON-11B Wildlife Effectiveness Monitoring of Revegetation in the Arrow Lakes Reservoir			✓	✓	✓	✓	✓	✓	✓	■	■	■	■
CLBMON-12 Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis		✓	✓		✓		✓		✓		■		
CLBMON-13 Inventory of Mosquito Populations in the Revelstoke Area			✓										
CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources	✓	✓		✓		✓		✓		■			
CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation									x**	■			■
CLBMON-57 Plant Communities												■	
<b>Physical Works</b>													
CLBWORKS-1 Kinbasket Reservoir Revegetation Program Physical Works	✓	✓	✓	✓	✓	x	✓		✓	■			
CLBWORKS-2 Arrow Lakes Reservoir Revegetation Program Physical Works	✓	✓	✓	✓	✓								
Legend: ■ = Program to be undertaken/initiated in identified year ✓ = Program completed for the year x = Program started, but encountered operational or hydrological delays Footnote: * Deviation from TOR schedule in 2012, replacement year was 2013. ** Work deferred while adjusting methods													

#### 4 Monitoring Programs and Physical Works Terms of Reference

The monitoring programs and physical works being implemented under the Kinbasket and Arrow Reservoir Revegetation Management Plan WUP are described in Terms of Reference. These Terms of Reference and the reports for work completed to date can be found here:

[http://www.bchydro.com/about/sustainability/conservation/water\\_use\\_planning/southern\\_interior/columbia\\_river/kinbasket-revegetation.html](http://www.bchydro.com/about/sustainability/conservation/water_use_planning/southern_interior/columbia_river/kinbasket-revegetation.html)

#### 5 Status of Monitoring Programs

##### 5.1 CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis

This monitoring program was initiated in 2008 and will be carried out every other year over ten years. The Year 5 (2015) report will be submitted in the 2017 Annual Report.

In 2015 the focus was on monitoring vegetation response to the removal of woody debris in Valemount Reach, preparing monitoring plots for the CLBWORKS-1 construction of debris mounds in Bush Arm completed in the fall 2015, and continuing monitoring of the 2013 sedge planting at Bear Island. Monitoring of earlier CLBWORKS-1 revegetation under this program has been discontinued due to complete mortality of trees and shrubs planted in the 2007-2011 period in these plots.

## **5.2 CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources**

This monitoring program was initiated in 2007 and is implemented every other year for ten years. The program implemented in 2014, but review of the report was delayed due to the Revegetation Technical Review. Attached is the Year 5 report dated June 22, 2015.

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

This monitoring program was initiated in 2008 and will be carried out periodically over ten years. A minor deviation from the TOR schedule occurred whereby full monitoring did not occur in 2012, but the project resumed full implementation in 2013. Attached is the report for Year 7 (2014 field season) dated December 31, 2015. The Year 8 report will be submitted in the 2017 Annual Report.

We are piloting a new approach for CLBMON-11A; if deemed successful, the TOR revision outlining these modifications will be submitted to your office by March 16, 2017.

## **5.4 CLBMON-11B Wildlife Effectiveness Monitoring of Revegetation and Wildlife Physical Works in the Arrow Lakes Reservoir**

This monitoring program was initiated in 2009 and will be carried out over ten years. The program is divided into four components. Attached are the following reports:

- Year 5 report dated February 25, 2015 for 11B1; and
- Year 5 report dated August 4, 2015 for 11B3.

The Year 5 report for 11B2 will be submitted under the Annual Report for Management Plan 6 (as an appendix to CLBMON-40) in June 2016.

The Monitoring Program of Wetland and Riparian Habitat in Revelstoke Reach in Response to Wildlife Physical Works (CLBMON-11B4) did not implement in 2015. CLBMON-11B4 was put on hold because there is sufficient baseline data (pre-physical works) for all contemplated sites and we have been waiting for implementation of the physical works to conduct post-monitoring.

During the Revegetation Technical Review, it was made evident that the current Terms of Reference for all components of CLBMON-11B requires modification. The resubmission of the TOR has taken more time than anticipated as we are looking thoroughly at the management questions and methods to ensure that the monitoring program outlined in the TOR will meet the Order. The TOR resubmission outlining these modifications will be submitted to the Water Comptroller by January 28, 2017.

## **5.5 CLBMON-12 Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis**

This monitoring program was initiated in 2008 and will be carried out every other year over ten years. Attached is the report for Year 5 (2015 field season) dated January 28, 2016.

The Arrow Lakes Reservoir was exceptionally low in the 2015 field season which provided a good opportunity to assess the short term implications for vegetation growth under lower reservoir conditions. Fall sampling was conducted to assess any immediate effects (such as effects of non-flooding conditions on plant composition, survival, growth and reproduction) and we will be resubmitting the TOR budget to conduct an additional session for spring sampling in 2016 to ensure that we address management questions related to soft constraint performance by March 31, 2016.

## **5.6 CLBMON-13 Inventory of Mosquito Populations in the Revelstoke Area**

This monitoring program is complete.

## **5.7 CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources**

This monitoring program was initiated in 2007 and will be carried out periodically over ten years. The program implemented in 2014, but review of the report was delayed due to the Revegetation Technical Review. Attached is the Year 5 report dated October 26, 2015.

## **5.8 CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation**

During the Revegetation Technical Review, it was determined that a comprehensive analysis of successes and failures of all treated sites (within both Kinbasket and Arrow Lakes Reservoirs) is needed; this analysis would incorporate elements from CLBMON-9, CLBMON-10, CLBMON-12, CLBMON-33, CLBWORKS-1 and CLBWORKS-2.

A TOR revision outlining the methods to conduct and analyze data collected to date was submitted on January 13, 2016 and is pending approval from the Comptroller of Water Rights (CWR).

## **5.9 CLBMON-57 Plant Communities**

This monitoring study is carried out as an addendum to CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources. This monitoring program is scheduled to initiate in 2018.

# **6 Status of Physical Works**

## **6.1 CLBWORKS-1 Kinbasket Reservoir Revegetation Program Physical Works**

This physical works was initiated in 2007 and will be carried out periodically over ten years. Attached is the Year 7 report dated January 22, 2016.

During the Revegetation Technical Review in December 2014, the technical committee concluded that woody debris accumulation in Kinbasket Reservoir is a major limiting factor in revegetation success. The outcome of the Review was to pilot an approach to revegetation using existing woody debris and soil to create mounds for vegetation colonization. A TOR resubmission outlining the proposal was approved

by the CWR on June 10, 2015. The first debris mounds were constructed in October 2015 and monitoring of these mounds will take place in 2016.

## **6.2 CLBWORKS-2 Arrow Lakes Reservoir Revegetation Program Physical Works**

This physical works was initiated in 2007 and planting was carried out over the first five years of the Water Use Plan. A TOR for Phase 4 will be submitted for any revegetation requirements that may be required once construction of the Wildlife Physical Works under Management Plan 7 of the Columbia WUP is complete.

## **7 Monitoring Programs and Physical Works Costs**

The following table summarizes the Kinbasket and Arrow Reservoir Revegetation Management Plan WUP monitoring programs and physical works costs approved by the Comptroller and the Actual Costs to January 31, 2016.

**Table 7-1: Kinbasket and Arrow Reservoir Revegetation Management Plan WUP Monitoring Programs and Physical Works Costs**

Monitoring Programs	Costs approved by CWR	Life to Date Actuals (LTD)	Estimated to Complete (Forecast)	Total Forecast (LTD and Forecast)	Variance Total to Approved	Explanation	Corrective Action
<b>CLB MP2 Kin &amp; Arrow Reveg Annual Report</b>	\$18,280	\$5,448	\$4,527	\$9,975	\$8,305	Costs under forecast.	
<b>C02M09A KIN: Revegetation</b>	\$946,942	\$625,177	\$202,207	\$827,384	\$119,558	Efficiencies found during implementation.	
C02M09A KIN: Revegetation - OR DM	\$105,958	\$62,637	\$21,329	\$83,965	\$21,993		
C02M09A KIN: Revegetation - OR Imp	\$840,984	\$562,540	\$180,878	\$743,418	\$97,566		
<b>C02M10A KIN: Inv of Veg</b>	\$1,320,912	\$1,046,990	\$263,638	\$1,310,628	\$10,284	Efficiencies found during implementation.	
C02M10A KIN: Inv of Veg - OR DM	\$97,315	\$61,932	\$19,553	\$81,485	\$15,830		
C02M10A KIN: Inv of Veg - OR Imp	\$1,223,597	\$985,058	\$244,085	\$1,229,143	(\$5,546)		
<b>C02M11A KIN: Wild Eff</b>	\$2,186,700	\$1,302,765	\$813,601	\$2,116,366	\$70,334	Forecast will be reviewed as part of the TOR resubmission.	Resubmit TOR by March 31, 2017
C02M11A KIN: Wild Eff - OR DM	\$185,103	\$77,316	\$37,453	\$114,769	\$70,334		
C02M11A KIN: Wild Eff - OR Imp	\$2,001,597	\$1,225,449	\$776,148	\$2,001,597			
<b>C02M11B ARROW: Reveg &amp; Wild</b>	\$4,129,608	\$2,194,354	\$1,242,020	\$3,436,373	\$693,235	Forecast will be reviewed as part of the TOR resubmission.	Resubmit TOR by January 28, 2017
C02M11B ARROW: Reveg & Wild - OR DM	\$230,114	\$153,994	\$63,883	\$217,877	\$12,237		
C02M11B ARROW: Reveg & Wild - OR Imp	\$3,899,494	\$2,040,360	\$1,178,137	\$3,218,497	\$680,997		
<b>C02M12A Arr Rev&amp;Comp - ONR</b>	\$83,822	\$69,042	\$15,974	\$85,016	(\$1,194)	TOR budget change required to conduct additional sampling related to low Arrow reservoir levels in 2015.	Resubmit TOR budget by April 14, 2016.
C02M12A Arr Rev&Comp - ONR Imp	\$83,822	\$69,042	\$15,974	\$85,016	(\$1,194)		
<b>C02M12A Arr Rev&amp;Comp - OR</b>	\$655,495	\$511,485	\$122,225	\$633,710	\$21,785		
C02M12A Arr Rev&Comp - OR DM	\$110,327	\$72,766	\$18,321	\$91,087	\$19,240		
C02M12A Arr Rev&Comp - OR Imp	\$545,168	\$438,719	\$103,904	\$542,623	\$2,545		
<b>C02M13A MID COL Mosquito Pop</b>	\$111,650	\$86,894	\$2,443	\$89,338	\$22,312	Project Complete. Final Completion Report is outstanding.	
C02M13A MID COL Mosquito Pop - OR DM	\$26,962	\$25,622	\$2,443	\$28,065	(\$1,103)		
C02M13A MID COL Mosquito Pop - OR Imp	\$84,688	\$61,273		\$61,273	\$23,415		
<b>C02M33A ARROW: Veg Inventory - ONR</b>	\$41,154	\$29,754	\$6,764	\$36,518	\$4,636	Efficiencies found during implementation.	
C02M33A ARROW: Veg Inventory - ONR Imp	\$41,154	\$29,754	\$6,764	\$36,518	\$4,636		
<b>C02M33A ARROW: Veg Inventory - OR</b>	\$1,437,358	\$1,183,847	\$233,858	\$1,417,705	\$19,653	Efficiencies found during implementation.	
C02M33A ARROW: Veg Inventory - OR DM	\$89,191	\$81,768	\$12,020	\$93,788	(\$4,597)		
C02M33A ARROW: Veg Inventory - OR Imp	\$1,348,167	\$1,102,079	\$221,580	\$1,323,659	\$24,508		
<b>C02M35A ARROW: Plant Respons</b>	\$297,322	\$26,441	\$203,384	\$229,824	\$67,498	TOR revision submitted to CWR on January 13, 2016 with updated methods and budget.	
C02M35A ARROW: Plant Respons - OR DM	\$73,186	\$26,441	\$34,491	\$60,931	\$12,255		
C02M35A ARROW: Plant Respons - OR Imp	\$224,136		\$168,893	\$168,893	\$55,243		
<b>C02M57A ARROW Plant Com</b>	\$248,992	\$3,392	\$236,708	\$240,100	\$8,892	Project has not yet commenced.	
C02M57A ARROW Plant Com - ONR DM	\$24,675	\$3,392	\$12,391	\$15,783	\$8,892		
C02M57A ARROW Plant Com - ONR Imp	\$224,317		\$224,317	\$224,317			
<b>C02W01A KIN Reveg 1800 1500</b>	\$2,668,277	\$1,893,890	\$647,647	\$2,541,538	\$126,739	Current TOR is piloting new approaches to revegetation in Kinbasket.	
C02W01A KIN Reveg 1800 1500 - OR DM	\$198,883	\$162,109	\$31,131	\$193,240	\$5,643		
C02W01A KIN Reveg 1800 1500 - OR Imp	\$2,469,394	\$1,731,781	\$616,517	\$2,348,298	\$121,096		
<b>C02W02A MCR &amp; ARR Reveg P1</b>	\$142,450	\$136,476	\$2,793	\$139,269	\$3,181	Project Complete	
C02W02A MCR & ARR Reveg P1 - OR DM	\$37,732	\$35,077	\$2,793	\$37,869	(\$137)		
C02W02A MCR & ARR Reveg P1 - OR Imp	\$104,718	\$101,400		\$101,400	\$3,318		
<b>C02W02B MCR &amp; ARR Reveg P2 - OR</b>	\$1,636,415	\$1,636,415		\$1,636,415	(\$0)	Project Complete	
C02W02B MCR & ARR Reveg P2 - OR DM	\$46,846	\$40,955		\$40,955	\$5,891		
C02W02B MCR & ARR Reveg P2 - OR Imp	\$1,589,569	\$1,595,460		\$1,595,460	(\$5,891)		
<b>C02W02B MCR &amp; ARR Reveg P2 - ONR</b>		\$2,065		\$2,065	(\$2,065)	Overspend associated with CLBWORKS_2-Phase 2	Overspend considered non-remissable.
C02W02B MCR & ARR Reveg P2 - ONR Imp OS		\$2,065		\$2,065	(\$2,065)		
<b>C02W02C MCR &amp; ARR Reveg P3</b>	\$440,867	\$388,666		\$388,666	\$52,201	Project Complete	
C02W02C MCR & ARR Reveg P3 - OR DM	\$19,078	\$21,224		\$21,224	(\$2,146)		
C02W02C MCR & ARR Reveg P3 - OR Imp	\$421,789	\$367,442		\$367,442	\$54,347		
<b>C02W02D MCR &amp; ARR Reveg P4</b>	\$133,058	\$8,413	\$33,541	\$41,953	\$91,105	Project has not yet commenced.	
C02W02D MCR & ARR Reveg P4 - OR DM	\$13,186	\$5,623	\$483	\$6,105	\$7,081		
C02W02D MCR & ARR Reveg P4 - OR Imp	\$119,872	\$2,790	\$33,058	\$35,848	\$84,024		

OR - Ordered Remissible  
ONR - Ordered Non-Remissible

\* Red values in parentheses denote overage.