# Columbia River Water Use Plan

## Physical Works Terms of Reference

**CLBWORKS-30A Arrow Lakes Reservoir Wildlife Enhancement Program (Mid Columbia River) – Implementation Phase**

**Addendum 2**

**September 2015**

# 1.0 Introduction

This Terms of Reference (TOR) for CLBWORKS-30A Arrow Reservoir Wildlife Enhancement Program (Revelstoke Reach) is for the final implementation phase of the physical works project in the Revelstoke Reach originally identified in CLBWORKS-29A Arrow Feasibility Study of Wildlife Physical Works (Golder 2009a, 2009b). This TOR follows previous phases of the project undertaken under CLBWORKS-30 and incorporates recommendations from a detailed Ecological Impact Assessment ("EIA"; Hawkes, V.C., *et al.*, 2015) of the likely ecological impacts and benefits of the Golder 2009b proposed works for Site 14 and Site 15A. This TOR includes a modified design reflecting those recommendations but no increase in the previously approved Ordered Remissible budget (July 17, 2013).

This TOR is submitted under the schedule for Conditional Columbia Works and Effective Monitoring Studies, Clause 4 (a) of the Columbia River Project Water Use Plan implementation order (File: 76975-35/Columbia) issued January 26, 2007[1]. The related feasibility studies were completed under the same implementation order, Schedule C, Clauses 5 (h) and 6(a) and Schedule D, Clauses 5 (c) and 6 (a).

## 1.1 Background: BC Hydro's Approach to Physical Works

BC Hydro's overall approach to project and portfolio management on physical works reflects best practices principles of project management. For the purposes of common terminology, BC Hydro typically refers to the three key phases for physical works projects:

- **Identification Phase:** This typically includes conceptual design and feasibility design. This will typically identify options and narrow them. Using this common terminology, CLBWORK-29A and CLBWORKS-29B are considered the Identification Phases. This phase may also include some preliminary archeology work and stakeholder engagement.
- **Definition Phase:** This typically includes the preliminary design associated with the selected option and includes a cost estimate. In the case of WLR projects, this may also include the detailed design, as appropriate for the size and complexity of the project. At the end of this phase, the outcome will be a request to proceed to Implementation Phase with a related request for funding. BC Hydro has completed this work under CLBWORKS-30 for Site 6A, Site 14 and Site 15A.
- **Implementation Phase:** This phase typically includes detailed design, procurement, safety, permitting, including all necessary archeology, environmental and regulatory permitting and consultation requirements, and construction including completion reporting. For Site 6A, this phase is complete.

## 1.2 Background Summary of Previous Studies

Under CLBWORKS-29A Arrow Lakes Reservoir: Wildlife Physical Works Feasibility Study, the feasibility assessments undertaken in 2008 and 2009 started with sites originally identified in the Columbia Water Use Plan. BC Hydro established a Wildlife Physical Works Committee (WPWC) with representation from BC Hydro, Ministry of Environment, Ducks Unlimited, First Nations and local stakeholders to assess the

[1] Clause 4(a) relates to physical works projects in the Mid Columbia River. Terms of Reference for physical works projects that in the Arrow Lakes Reservoir will be submitted under Clause 7 (a) in a subsequent submission.

45 sites and narrow the options (Golder 2009a). The WPWC narrowed the projects to 35 on the basis of technical feasibility and costs, then to eight on the basis of biological and operational criteria. The eight were presented at an open house in Revelstoke in December 2009, and preliminary designs were subsequently developed for five projects (Golder 2009b). Following the review of project costs and anticipated benefits, the WPWC endorsed three of the projects: Site 6A, Site 14 and Site 15A, shown in Figure 1 below.

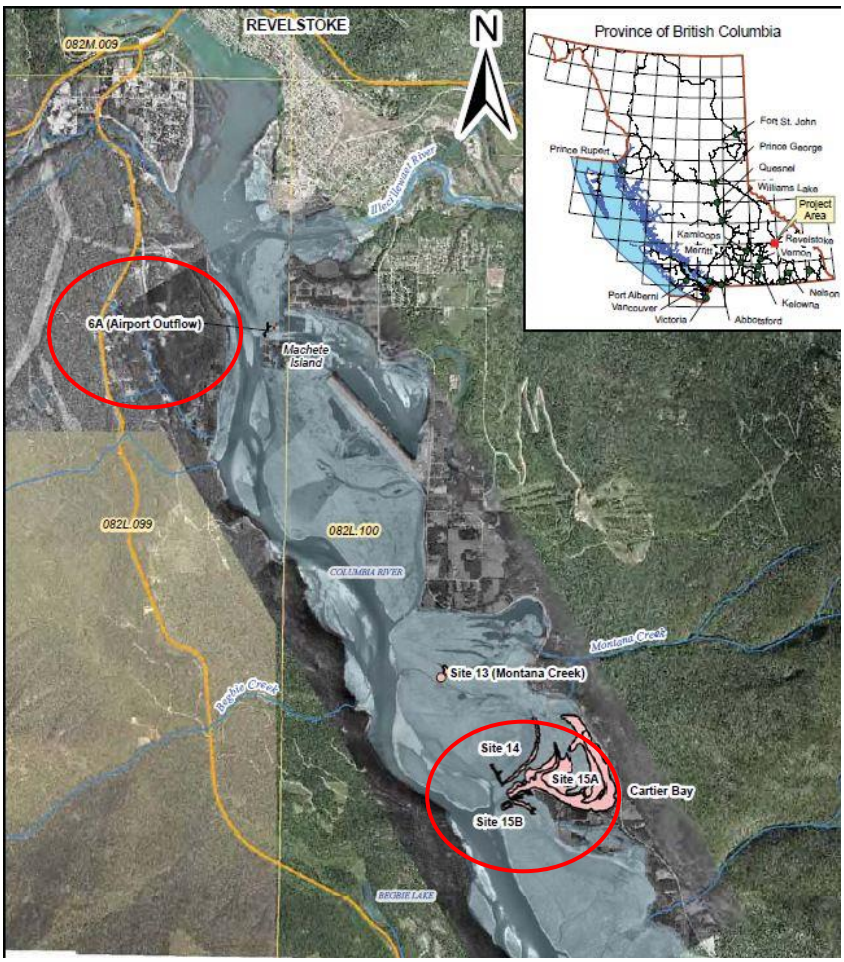



**Figure 1: Approximate location of Sites 6A, 14 and 15A (Scale is 1:50000; Figure from Golder 2009b)**

BC Hydro undertook further Definition phase work on these three sites under project CLBWORKS-30. This involved developing the detailed design (Issued for Construction drawings), and the preliminary Archeological Overview and Impact Assessments, and initiating the environmental permits in 2011 and 2012. Following an internal restructuring and a change in delivery model, works at Site 6A were scheduled for the spring of 2013 but were postponed due to water levels and then completed in October 2013.

Early Implementation work on Sites 14 and 15A was postponed in 2013 to complete a dam safety review which identified additional permitting requirements associated with the projects. In summer 2014, in response to stakeholder and agency concerns with the proposed designs, BC Hydro undertook the EIA of the Golder 2009b design for works at

Sites 14 and 15A (Hawkes, V.C. et al, 2015). The EIA reviewed the projected benefits to wildlife underlying the original feasibility study in light of the information that has been gathered under other Water Use Plan monitoring programs such as: CLBMON-11B (B2, B3, and B4), CLBMON-12, CLBMON-33, CLBMON-36, CLBMON-37, and CLBMON-40. It also considered advice from experts in wetland ecology and hydrology, and interviews with local experts and stakeholders. The EIA recommended not proceeding with the Golder 2009b design for Site 15A, and identified very limited benefit of the works proposed for Site 14.

The EIA report was peer reviewed in October 2015, and finalized in March 2015. The conclusions of the EIA for the Golder 2009b design of Site 14 and 15A are illustrated in Table 1 below.

To get a better understanding of the feasibility and cost associated with an alternative to the Golder 2009b design, BC Hydro completed an engineering design for the reinforcement of Site 15A in September 2015 (as approved on June 3, 2015).

**Table 1: Summary of current habitat suitability* and predicted changes to habitat with the implementation of Golder 2009b design physical works at Sites 14 and 15A**

| Flora and Fauna Summary | Site 14 | | Site 15A | |
|---|---|---|---|---|
| Component | Current state | With Golder 2009b works** | Current state | With Golder 2009b works** |
| Terrestrial vegetation | Low diversity | △ ⇔ | Intermediate diversity | △ ⇔ or ⇩ ▲ |
| Aquatic macrophytes | Intermediate diversity | △ ⇔ or ⇩ | Intermediate diversity | △ ⇔ or ⇩ ▲ |
| Waterfowl | Little to no use | △ ⇔ or ⇧ ▲ | High use | △ ⇔ |
| Songbirds | Little to no use | △ ⇔ or ⇧ ▲ | High use | △ ⇔ or ⇩ ▲ |
| Amphibians (Western Toad) | Little to no use | △ ⇔ or ⇧ ▲ | Important habitat | △ ⇔ or ⇩ ▲ |
| Reptiles (Western Painted Turtle) | Little to no use | △ ⇔ | Little use | △ ⇔ |
| Aquatic Invertebrates | No Data | △ ? | Intermediate diversity | △ ? |

Green triangle: consider proceeding; Yellow Triangle: reassess or do not proceed; red triangle: do not proceed with physical works (original design). Arrows indicate direction of predicted change in habitat suitability (increase, decrease, or no effect).

* Habitat suitability is the capacity for a given habitat to support a selected species in its current state.
** Golder 2009b works are is describe in Alternative 2 below

## 2.0 Physical Works Program

### 2.1 Physical Works Objectives and Measures

The following three objectives have been used to assess the project alternatives.

1. *Protect and enhance areas of high value wildlife habitat identified within the Revelstoke Reach area (*Schedule C, Clause 5(h)). Note this objective would be included in the assessment only if the site is considered 'high value'.
2. *Improve conditions for nesting and migratory birds and wildlife within Revelstoke Reach (Schedule C, Clause 6(a)).*
3. *Cost:* Cost has also been considered in the evaluation. The Columbia Consultative Committee anticipated a total budget for the implementation of all works project of $2.35 million including the feasibility and construction of the wildlife physical works projects.

The three objectives are measured using the following measures:

1. Habitat Suitability: For the purposes of evaluating options against the above Order objectives (1 and 2 above), BC Hydro has used habitat suitability as described in Table 1 above. Habitat suitability is the capacity for a given habitat to support a selected species (Hawkes, V.C. *et* al, 2015).
2. Cost: The estimated current cost of each alternative is provided based on the best available estimate with the confidence stated as a percentage +/-.

## 2.2 Site 14 (Cartier North Dike) Alternatives Description and Assessment

For Site 14 (Cartier North Dike), three alternatives have been identified:

1. Alternative 1: No change
2. Alternative 2 : Repair rail bed berm at Site 14 to 434 m (Golder 2009b design); and
3. Alternative 3: Repair rail bed berm at Site 14 to 434 m with stepped ponds, debris mounds (Hawkes, V.C. et al., 2015 recommendation).

These three alternatives are described further below and have been assessed on how well they meet the objectives specified in Section 2.1 above. Note that Hawkes V.C. et al. (2015) concluded that there is low or no use by key wildlife species groups at Site 14 presently, so the first objective in Section 2.1 arising from Schedule C Clause 5(h)) is not applicable.

**Figure 1: Site 14 gap in the rail bed looking North allowing water to pass into Cartier North in October 2013, (el 432.1 m) on the left and May, 2012 (el. 430.7 m) on the right**

*Alternative 1: No change*

The first alternative reflects the status quo and includes no berm repair work at Site 14. This alternative would not be expected to improve habitat suitability and thus there would be no change to the conditions for birds or wildlife. There would be no cost to this option.

*Alternative 2: Repair rail bed berm at Site 14 to 434 m (Golder 2009b design)*

This alternative involves completing the project to the original design as specified in Golder 2009b. It includes the construction of a dike within the gap of the existing rail grade, to an elevation of 434.0 m. This would retain water upstream of the grade, thereby creating approximately 3.8 ha of additional shallow wetland habitat (Hawkes, V, et al. 2015). Due to the impoundment of water, this structure would be considered a dam of low consequence, necessitating a water licence application.

Golder anticipated this design would create a seasonal staging habitat for water birds including migratory waterfowl, and breeding habitat for amphibians. However, the EIA (Hawkes, VC, et al. 2015) concluded that while there are possible benefits they would be mild at best, and there is significant uncertainty about whether these benefits would be realized.

Based on BC Hydro's experience at Site 6A, and based on factors including the need to improve the access to site to allow for machinery, BC Hydro forecasts the cost at approximately $732,000 (+25%/-20%).

*Alternative 3: Repair rail bed berm at Site 14 to 434 m with stepped ponds, debris mounds*

This alternative involves completing repairing the rail bed berm at Site 14 to 434 m, as described in Alternative 2 above, but also adding in additional works in the Cartier Area (on the wetland side of the berm), as described in the EIA report (Hawkes, V.C. et al. 2015). These works could take the form of additional berms with stepped ponds, or level ditching with debris mounds with live staked trees.

These additional works would be intended to increase heterogeneity in the habitat in the Cartier Area, and to increase the likelihood that works at Site 14 would improve conditions for wildlife at this site and better meet the Order objectives. The benefits, though more likely, would remain relatively minor and localized as in Alternative 2.

This alternative would require additional archeological studies as the area has been identified as having high archeological potential, and the impact studies to date were limited to the areas of the rail bed. Consequently, there would be an anticipated schedule delay to undertake the necessary archeological work. As with Alternative 2, as it would be a dam of low consequence, an applicable water licence would be required.

Any proposed design would need to ensure that the habitat created would be above the high water mark to prevent the creation of sink habitat for nesting birds and would ensure no navigational hazards (i.e., when the berm is breached at high water, boaters are known to frequent the area).

Preliminary cost estimate (+50%/-25%) is in the range of $946,000, with the additional schedule delay required to undertake archeological impact assessment studies.

## 2.3 Site 14 Assessment Summary and Recommendation

The summary of the Site 14 alternatives assessment is shown in Table 2 below. Each of the alternatives has been ranked relative to the other alternatives based on how well they meet the objective using the following legend:

- Green: best alternative for meeting objective
- Orange: second ranked alternative
- Red: worst alternative for meeting objective

**Table 2: Site 14 Alternative Assessment Table**

| | | Site 14 Alternatives | | |
|---|---|---|---|---|
| **Physical Work Objectives** | **Measure** | **Alternative 1: No change** | **Alternative 2: Repair Berm** | **Alternative 3: Repair berm with added structures** |
| *Improve conditions for nesting and migratory birds and wildlife (Schedule C Clause 6(a))* | Habitat suitability | No change | Possible improvement with high uncertainty | Possible improvement with reduced uncertainty |
| *Cost* | $ Estimate | $0 | $732K | $946K (with schedule impact) |
| **Recommended** | | **Yes** | **No** | **No** |

Legend: green: best alternative, orange: second ranked; red: worst alternative.

Given the uncertainty of wildlife habitat benefits arising from undertaking the works at Site 14, the minor, localized benefit even in the best case scenario, and the costs associated with both the original and modified works (Alternatives 2 and 3), BC Hydro recommends no change to the site (Alternative 1) at this time.

## 2.4 Site 15A (Cartier Bay Dike) Alternatives Description and Assessment

For Site 15A (Cartier North Dike), three alternatives have been identified and are described below according to how well they meet the objectives specified in Section 2.1. As this area of Cartier Bay would be considered “high value wildlife habitat”, the Order objective from Schedule C, 5 (h) is included in this assessment.

1. Alternative 1: No change to Site 15A, monitor site
2. Alternative 2: Remove the culvert and raise the berm by 1 m (Golder 2009b design)
3. Alternative 3: Reinforce and monitor the culvert

**Figure 2: Site of the wood-box culvert at Site 15A, el. 429.9 m (May 7, 2015)**

*Alternative 1: No change to Site 15A, monitor site*

This option involves no work to Site 15A. It would be anticipated that regular (annual) inspections of the site would occur to determine whether any changes in elevation at the culvert location have been detected. If changes are detected, remediation options would be investigated.

With this alternative, there would continue to be concerns with the stability of the wood-box culvert. Should the culvert collapse, it would risk draining the Cartier Bay area, and could have significant negative impacts on the value of the wetland habitat.

While monitoring may detect changes to the site, it would be after the change has already occurred and may be too late to prevent negative impacts. Therefore, this option fails to meet the Order objective to protect this high value habitat. Similarly, it would do nothing to enhance the habitat.

The cost for this option is minimal at $5200 (~$1000 for the site inspection per annum from 2016 to 2020), and does not include any cost for remediation.

*Alternative 2: Remove the culvert and raise the berm by 1 m (Golder 2009b design)*

Alternative 2 is the original Golder 2009b design and involves the replacement of an ad-hoc dike created at the location of an old wood-box culvert (currently filled with indeterminate fill) with an impermeable designed dike structure. The designed dike would increase the invert elevation by one m to 434.75 masl, to increase the existing wetland area by approximately 26 ha and increase the amount of shallow open water habitat for amphibians, waterfowl and migratory birds.

As this alternative puts at risk habitat quality in an area of high value habitat, it consequently does not meet either Order objectives.

In BC Hydro's previous estimates for the work at both Sites 14 and 15A, the work for Site 15A was dependent on repairing the berm at Site 14 to allow access of equipment and materials to the site. Reflecting standalone mobilization, site access and permitting costs, the cost of Alternative 2 at Site 15A is forecast to be approximately $843,000 (+25%/-20%)

*Alternative 3: Reinforce and monitor*

This alternative involves reinforcing the site to prevent the wood-box culvert from collapsing, with inspection and monitoring of the site. The design involves buttressing

the river-side of the site with riprap to prevent the wood box culvert, and adjacent berm, from collapsing, maintaining the current elevation of approximately 433.8 m, and maintaining as close as possible the existing permeability of the site.

This Alternative would protect the high habitat value area from the potential impacts of berm failure and associated draining of the adjacent wetland. The resulting increased stability of the site will increase the long-term value of this habitat.

The cost estimate of this alternative is approximately $169,000. This is based on the engineers estimate (+25%/-15%) for construction, and includes all the necessary permits, monitoring, project and construction management, and completion reporting in the Implementation phase.

## 2.5 Site 15A Assessment Summary and Recommendation

The summary of the Site 15A alternatives assessment is shown in Table 3 below. As in Section 2.3 above, each of the alternatives has been ranked relative to the other alternatives based on how well they meet the objective using the following legend:

- Green: best alternative for meeting objective
- Orange: second ranked alternative
- Red: worst alternative for meeting objective

**Table 3: Site 15A Alternative Assessment Table**

| | | Site 15A Alternatives | | |
|---|---|---|---|---|
| **Physical Work Objectives** | **Measure** | **Alternative 1: No change** | **Alternative 2: Replace & Raise 1m** | **Alternative 3: Reinforce and Monitor** |
| *Protect and enhance areas of high value wildlife habitat (Schedule C, Clause 5(h))* | Habitat suitability | Low stability | Decrease in habitat suitabilty | High stability, suitability |
| *Improve conditions for nesting and migratory birds and wildlife (Schedule C, Clause 6 (a))* | Habitat suitability | Low stability | Decrease in habitat suitability | High stability, suitability |
| *Cost* | $ Estimate | $5.2k | $843k | $169K |
| **Recommended** | | **No** | **No** | **Yes** |

Legend: green: best alternative, orange: second ranked; red: worst alternative.

Based on the high value habitat that currently exists, BC Hydro recommends reinforcing and monitoring (Alternative 3) to protect and enhance the stability of the current functioning of the wetland at Cartier Bay.

## 2.6 Wildlife Enhancement Structures

The EIA report continued to support the value of wildlife enhancement structures such as, but not limited to, nesting cavity boxes or loafing logs as an effective way to enhance wildlife habitat quality in the vicinity of Cartier Bay (Hawkes, V, et al. 2015, p103).

BC Hydro is recommending to proceed with additional wildlife enhancement structures as previously approved in TOR Addendum #1 (approved March 5, 2013).

## 3.0 Project Description – Implementation

Based on the recommendations in Section 2.3, 2.5, and 2.6 above, the proposed scope of the physical works for Site 15A includes the following scope:

- Supply and install a rip-rap buttress on the river side of the abandoned CPR embankment at the washout with the collapsed wood culvert;
    - Improve the existing access to Site 15A between the Old Arrowhead Highway, embankment and Site 15A sufficiently to withstand the construction traffic to site;
    - Construct a temporary turnaround for equipment and materials set down to facilitate the work adjacent to the embankment;
- As necessary, remove any temporary structures and clean up during and completion of the work; and
- Install wildlife enhancement structures.

The design drawings are attached as Appendix A.

### 3.1 Key Tasks - Implementation

The remaining Implementation tasks are listed below. The overall Implementation tasks remain similar to those in the June 6, 2012 TOR, and have been updated to reflect BC Hydro's project management practices, scaled for the lower complexity of this project.

Task 1: Project Management – Oversee all aspects of the project.

Task 2: Permitting: Obtain all necessary permits, as required.

Task 3: Drawings and Specifications: Prepare issue for construction drawings and technical specifications for construction.

Task 4: Safety and Environment: Prepare all necessary Safety Management Plans and Environment Management Plans.

Task 5: Construction and Construction Management: Undertake construction and construction management:

a) Construction procurement and contracting;

b) Construction of the scope in Section 3.0 above; and

c) Monitoring (including environmental and archaeological monitoring, and safety audits) as required.

Task 6: Project Completion and Closure:

a) Prepare completion reports and as built drawings; and

b) Final contract management.

Task 7: Post-Construction monitoring of the site[2].

## 3.2 Risks

The following are identified risks associated with the project.

| Risk | Mitigation/Management |
|---|---|
| Reinforcement to Site 15A will unintentionally alter the habitat at Cartier Bay | Site will be monitored as part of CLBMON-11B4, and if negative impacts are identified, a suitable mitigation plan will be developed. |
| Water levels necessary to complete the work | Work will be scheduled when highest likelihood of the work completed in the dry, once all necessary permits have been obtained, ideally corresponding to a declining hydrograph, and ahead of freshet. Water retention (sandbags) will be included in the construction plan, if required. |
| Archeological: Artefacts may be discovered on construction site leading to delays | Archeological impact assessments have been completed and determined the project to be low risk. The revised design has less ground disturbance than the original scope, further minimizing risk. |
| Unexpected geotechnical conditions may delay construction timing | Rip rap materials will be used from a source location previously approved for use in Site 6A in the area. If required, additional testing will be undertaken prior to construction start. |
| Environment incident: construction work may result in spill or other environmental incident while working near water | Develop Environmental Management Plan (EMP) and have environmental monitor on site during construction. EMP to include spill to land, water and species of interest management, including nest management. Work will be scheduled when water levels are at the lowest levels and furthest from the work site. |
| Safety incident: Safety incident may occur during construction leading to injury | Develop and implement a site specific safety management plan to identify and plan to manage the hazards. The Public Safety plan will include signage and appropriate public safety management activities. |
| Financial: Potential for cost overruns | Contingencies have been built into the cost estimate. |
| Security of construction equipment during build – theft | From previous experience in the area, additional security will be sourced during the construction period to ensure |

[2] Note the wildlife monitoring under CLBMON-11B-4 Wetland Effectiveness Monitoring for Wildlife Physical Works will resume once the works are in-service.

| Risk | Mitigation/Management |
|---|---|
| or vandalism of property | property remains secure. |

### 3.3 Schedule

Once all necessary permits and approvals are received, construction will be scheduled during the next available period of low water and when snow conditions allow. This window could occur between October and June, but typically occurs between February and June.

### 3.4 Budget

The estimated cost to complete the work as proposed in this TOR is within the previously approved Ordered Remissible budget for CLBWORKS-30.

## References

Golder Associates. 2009a. Columbia River Project Water Use Plan; Reference: CLBWORKS-29A. Volumes I and II: Arrow Lakes Reservoir Wildlife Physical Work feasibility Study: 2008. Prepared for BC Hydro. 60pp. + appendices, March 2009, Castlegar.BC

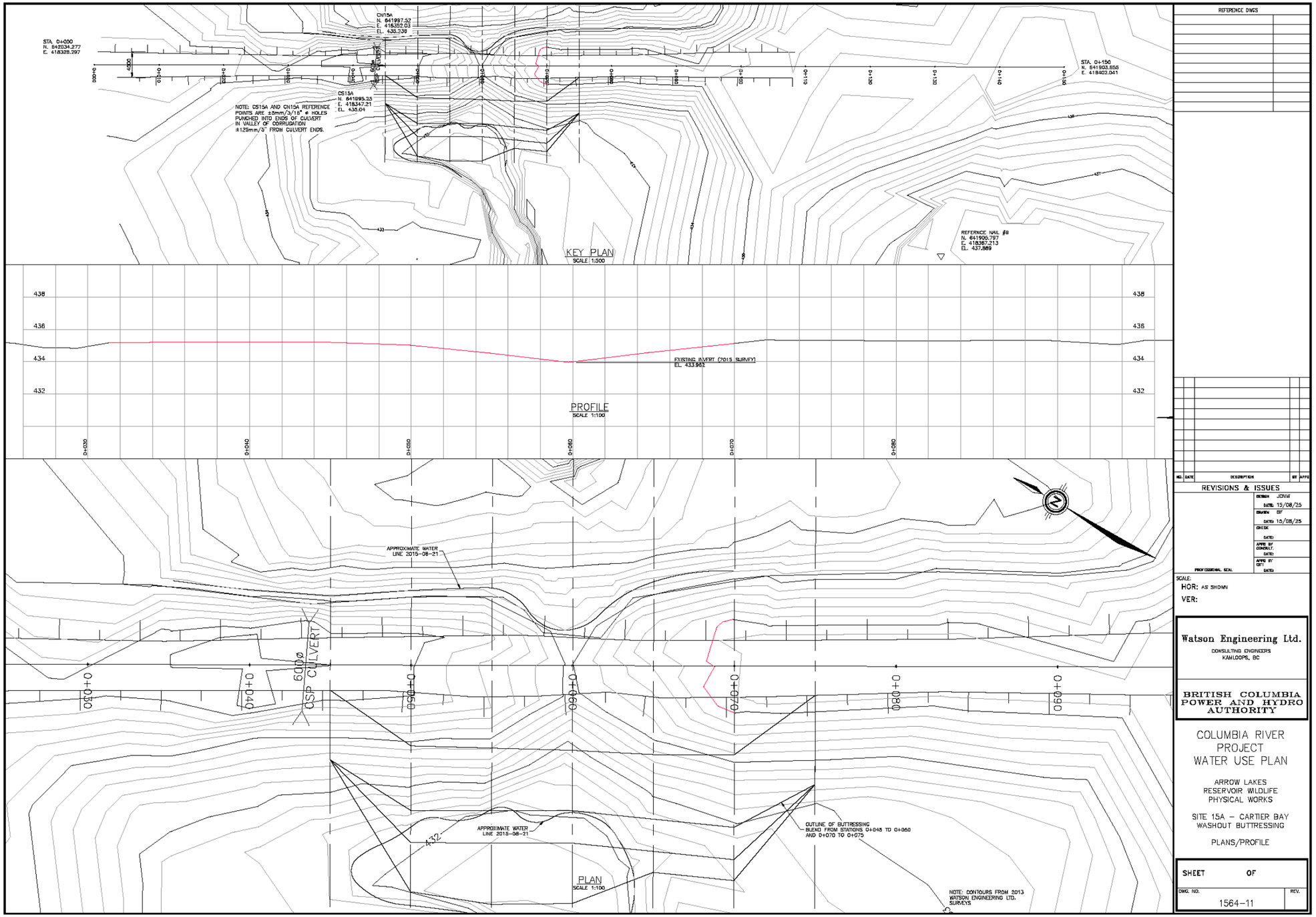
Golder Associates. 2009b. Arrow Lakes Reservoir wildlife physical works feasibility study Phase II. Columbia River Project water use plan: CLBWORKS-29A. Report to BC Hydro and Power Authority, Water Licence Requirements, December 2009, Castlegar, BC.

Hawkes, V.C., M.T. Miller, J.D. Fenneman and N. Winchester. 2011. CLBMON-11B4 Monitoring Wetland and Riparian Habitat in Revelstoke Reach in Response to Wildlife Physical Habitat Works. Annual Report – 2010. Report EA3232 to BC Hydro, Burnaby, BC.

Hawkes, V.C. and J. Howard. 2012. CLBMON-11B. Wildlife effectiveness monitoring and enhancement area identification for lower and mid-Arrow Lakes Reservoir: CLBWORKS-29B. Mid- and lower Arrow Lakes Reservoir wildlife enhancement prescriptions. LGL Report EA3274 for B.C. Hydro Generation, Water Licence Requirements, Burnaby, BC.

Hawkes, V.C., H. van Oort, M. Miller, N. Wright, C. Wood, and A. Peatt. 2015. CLBWORKS-30 Ecological Impact Assessment – Wildlife Physical Works Project 14 & 15A. Unpublished Report by LGL Limited environmental research associates, Cooper, Beauchesne and Associates, Ecofish Research Ltd. and Okanagan Nation Alliance for BC Hydro, Burnaby BC. 98 pp. + Appendices.

# Appendix 1: Design Drawings – Site 15A Modified


STA. 0+000
N. 642034.277
E. 418328.297
CN15A
N. 641997.52
E. 416352.03
EL. 435.230
600ø CULVERT
CS15A
N. 641995.25
E. 418347.21
EL. 435.04
NOTE: CS15A AND CN15A REFERENCE POINTS ARE ±3mm/3/16" ø HOLES PUNCHED INTO ENDS OF CULVERT IN VALLEY OF CORRUGATION ±125mm/5" FROM CULVERT ENDS.
STA. 0+150
N. 641903.556
E. 418402.041
REFERNCE NAIL #8
N. 641900.797
E. 418367.213
EL. 437.869
KEY PLAN
SCALE 1:500
EXISTING INVERT (2015 SURVEY)
EL. 433.982
PROFILE
SCALE 1:100
APPROXIMATE WATER LINE 2015-08-21
600ø CSP CULVERT
APPROXIMATE WATER LINE 2015-08-21
OUTLINE OF BUTTRESSING BLEND FROM STATIONS 0+045 TO 0+050 AND 0+070 TO 0+075
NOTE: CONTOURS FROM 2013 WATSON ENGINEERING LTD. SURVEYS
PLAN
SCALE 1:100
REFERENCE DWGS
REVISIONS & ISSUES
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DATE: 15/08/25
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DATE: 15/08/25
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Watson Engineering Ltd.
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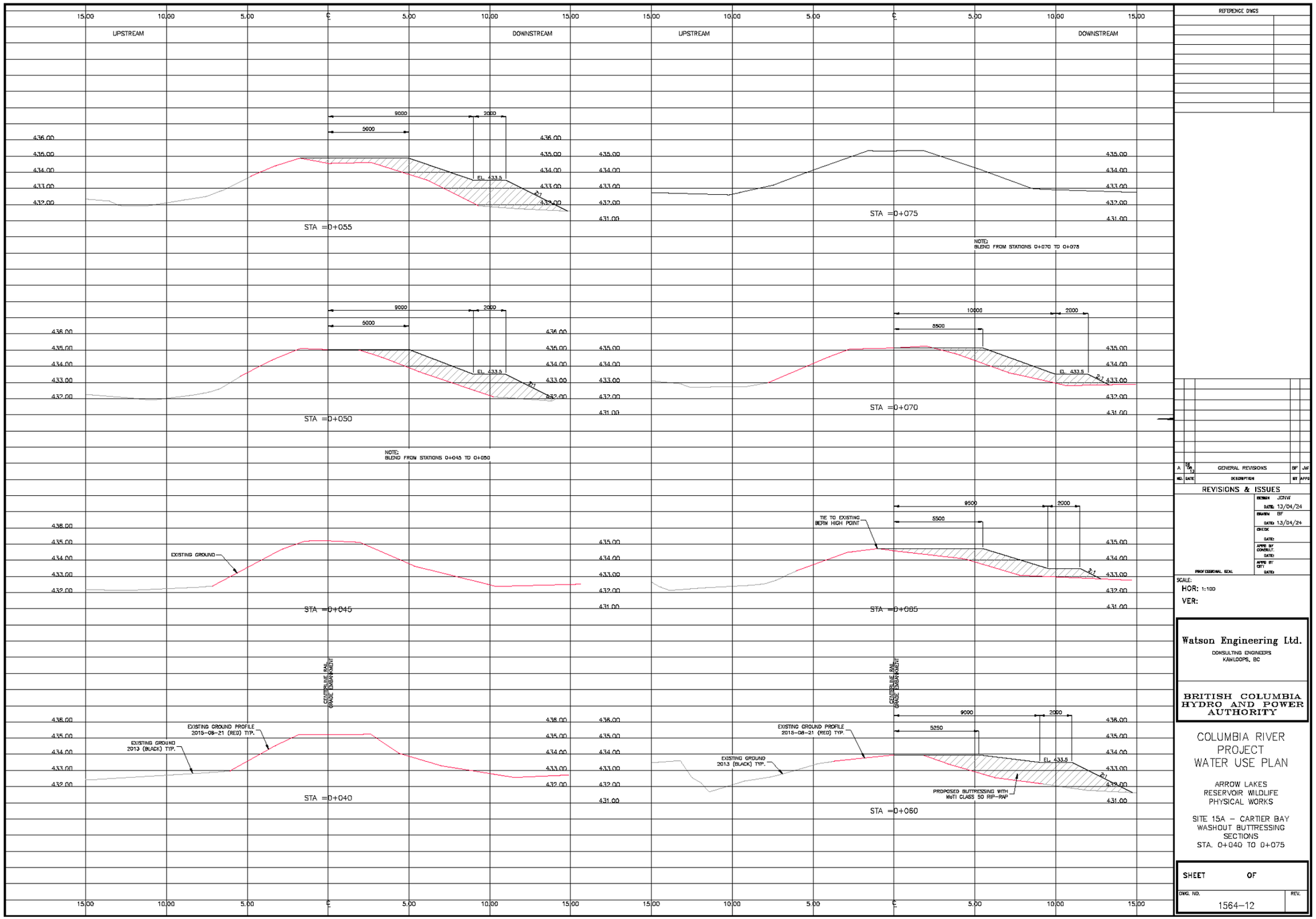
KAMLOOPS, BC
BRITISH COLUMBIA POWER AND HYDRO AUTHORITY
COLUMBIA RIVER PROJECT
WATER USE PLAN
ARROW LAKES RESERVOIR WILDLIFE PHYSICAL WORKS
SITE 15A – CARTIER BAY WASHOUT BUTTRESSING
PLANS/PROFILE
SHEET OF
DWG. NO. 1564-11
REV.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DOWNSTREAM
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STA =0+075
NOTE:
BLEND FROM STATIONS 0+070 TO 0+075
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NOTE:
BLEND FROM STATIONS 0+045 TO 0+050
STA =0+070
STA =0+045
EXISTING GROUND
STA =0+085
TIE TO EXISTING
BERM HIGH POINT
STA =0+040
EXISTING GROUND PROFILE
2015-08-21 (RED) TYP.
EXISTING GROUND
2013 (BLACK) TYP.
STA =0+060
PROPOSED BUTTRESSING WITH
MoTI CLASS 50 RIP-RAP
COLUMBIA RIVER
DIKE ENCROACHMENT
EL. 433.5
REFERENCE DWGS
GENERAL REVISIONS
DESCRIPTION
REVISIONS & ISSUES
DESIGN JDNW
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DRAWN BF
DATE 13/04/24
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APPR. BY CITY
PROFESSIONAL SEAL
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Watson Engineering Ltd.
CONSULTING ENGINEERS
KAMLOOPS, BC
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
COLUMBIA RIVER PROJECT
WATER USE PLAN
ARROW LAKES RESERVOIR WILDLIFE PHYSICAL WORKS
SITE 15A – CARTIER BAY WASHOUT BUTTRESSING SECTIONS
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SHEET OF
DWG. NO.
1564-12
REV.