Duncan Dam Water Use Plan

Monitoring Program Terms of Reference

CULTURAL RESOURCES MONITORING PLAN

- DDMMON-13  Duncan Reservoir Erosion Monitoring of Archaeological Sites

December 15, 2008
CULTURAL RESOURCES MONITORING PLAN
TERMS OF REFERENCE

1.0 OVERVIEW

This document presents Terms of Reference for the monitoring programs in the Duncan Dam Cultural Resources Monitoring Plan (Table 1). These programs will implement archaeological overview and erosion monitoring assessments focused on the effects of normal reservoir operations on heritage sites situated within the drawdown zone of the Duncan Lake reservoir.

This document provides detailed Terms of Reference for the following programs:

1) DDMMON 12 – Archaeological Overview Assessment: a one-year archaeological overview assessment of the drawdown zone of the Duncan Lake reservoir drawdown zone.

2) DDMMON-13 – Erosion Monitoring of Archaeological Resources: a five-year erosion monitoring study of archaeological resources located in the drawdown zone of the Duncan Lake reservoir.

Table 1: Cultural Resources Monitoring Program Terms of Reference Submission Information

<table>
<thead>
<tr>
<th>Name of Monitoring Program</th>
<th>Order Clause Fulfilled</th>
<th>Submitted with this Package</th>
<th>Previously Submitted To CWR</th>
<th>Submission Date</th>
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<tr>
<td>DDMMON-12 Archaeological Overview Assessment</td>
<td>Section 5.f</td>
<td>Yes</td>
<td>No</td>
<td>7 Dec 2009</td>
<td>-</td>
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<tr>
<td>DDMMON-13 Erosion Monitoring of Archaeological Resources</td>
<td>Section 5.g</td>
<td>Yes</td>
<td>No</td>
<td>7 Dec 2009</td>
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2.0 FIRST NATION INTERESTS

BC Hydro recognizes that heritage management is an important issue for First Nations who have particular heritage management interests in the Duncan watershed. As part of the implementation of this Cultural Resources Monitoring Plan, BC Hydro will seek to work with representatives of the Ktunaxa Nation Council, the Okanagan Nation Alliance, the Shuswap Nation Tribal Council, and their communities.
Terms of Reference for the Duncan Dam Water Use Plan Monitoring Programs
Cultural Resources Monitoring Plan

1.0 MONITORING PROGRAM RATIONALE

During the Duncan Dam Water Use Planning (WUP) process, the WUP Committee recognized the importance of cultural sites and locations of historic and ongoing cultural activity to the First Nations with an interest in the area. The effects of reservoir operations on cultural sites represented by archaeological materials were a key concern raised during the WUP process. Two archaeological sites were identified in the draw down zone of Duncan reservoir during an archaeological overview conducted in 2002 (Choquette 2005) and it is expected that other undocumented cultural sites of significance may exist within areas affected by reservoir operations. Concern for the maintenance of the cultural, aesthetic and ecological context of cultural resource areas and spiritual sites was also raised. The WUP Committee was not able to fully evaluate the potential effects of operations on heritage and cultural sites due to incomplete information on their locations and condition.

A Cultural Resources monitoring plan was recommended by the WUP Committee to provide a more accurate understanding of the impacts of BC Hydro operations on cultural sites. The WUP Committee recommended a two-part program to be implemented over a five-year timeline consisting of an archaeological survey of the reservoir basin and an erosion study that would combine the collection of traditional use and cultural preference information, site investigations through excavation and an erosion monitoring study.

Subsequently, the Comptroller of Water Rights (CWR) clarified that only non-intrusive heritage work could be included in an Order issued under the Water Act, thereby excluding any study that would require a permit under the Provincial Heritage Conservation Act such as: 1) inventories involving subsurface testing; 2) placement of physical structures onto an archaeological site for monitoring purposes; or 3) investigative excavations. As a result, terms of reference (TOR) for studies in the Cultural Resources Monitoring Plan have been designed as non-intrusive studies to reflect this new understanding.

DDMMON-12 Archaeological Overview Assessment is a one-year study intended to address a knowledge gap regarding the number, location, elevation, condition, use, susceptibility to erosion and relative importance of cultural sites within the Duncan reservoir. This study will provide base information for DDMMON-13.

DDMMON-13 Erosion Monitoring of Archaeological Resources will be conducted annually for five years. Erosion monitoring techniques will be used at one or more locations to measure the effect of current reservoir operations on cultural sites. This study together with DDMMON-12 will provide information for the next Duncan Dam WUP review.
The detailed approach, methods and budget for these two studies are presented in the attached terms of reference.

A note on terminology: the language of professional archaeology uses the term “monitoring” for a specific purpose which can lead to confusion regarding the way this term is used in the WUP process. For the purpose of this document, a monitoring program is a general reference for scientific study intended to provide information to future WUP processes by the collection of data distinguishable from a program of physical works which typically involves a construction project such as a boat ramp.
Monitoring Program No. DDMMON-13
Duncan Dam – Erosion Monitoring of Archaeological Resources

1.0 INTRODUCTION

During the Duncan Dam Water Use Planning (WUP) process, the WUP Committee recognized the importance of cultural sites and locations of historic and ongoing cultural activity to the First Nations with an interest in the area. The WUP Committee was not able to fully evaluate the effects of reservoir operations on cultural sites due to gaps in existing documented information. The WUP Committee report recommended a Cultural Resources Monitoring Plan that would address the Duncan Dam WUP objectives to:

1) Protect cultural sites and resources from erosion in Duncan Reservoir;

2) Protect cultural sites and resources from exploitation in the Duncan Reservoir;

3) Provide opportunities for archaeological investigation in the Duncan Reservoir; and

4) Maintain the cultural, aesthetic and ecological context of important cultural resources and spiritual sites.

As part of the Cultural Resources Monitoring Plan, DDMMON-13 is intended to provide information on the effects of reservoir operations, specifically the raising and lowering of water levels, on archaeological sites in the Duncan Reservoir. Information gained through this study is primarily aimed at addressing the first WUP objective however this study is also expected to inform future WUP discussions regarding all four stated objectives.

Based on the four objectives outlined by the WUP Heritage and Culture subcommittee a performance measure was developed for use in evaluating operating alternatives with regard to cultural resource values. This performance measure is described as:

The number of days the reservoir elevation is operated in each band where cultural sites exist multiplied by a weighting factor to consider the impacts of dewatering or inundation.

Recognizing that this performance measure needed the support of archaeological evidence in order to have a comprehensive understanding of how cultural sites may be affected by reservoir operations within the study area, the WUP Committee recommended the studies that comprise the Cultural Resources Monitoring Plan.

Subsequent to the completion of the WUP Committee recommendations, the Comptroller of Water Rights clarified that only non-intrusive heritage work could be included in an Order issued under the Water Act, thereby excluding any study that would require a permit under the Provincial Heritage Conservation Act (e.g., subsurface testing or the collection of artifacts).
In a parallel process, established through a Memorandum of Understanding, by which the Archaeology Branch of the Ministry of Tourism, Culture and the Arts and BC Hydro are in engaged in for the purpose of managing archaeological sites, a Reservoir Archaeology Program is in development. This Program is expected to address the aspects of long-term archaeological management, such as mitigative excavations, recommended by the Duncan Dam consultative committee that are not included in these Terms of Reference. It should be noted that Heritage Conservation Act permits have requirements over and above Water Use Plan requirements and that the Archaeology Branch will likely require an AIA be completed before alterations to archaeological sites resulting from operation of the Duncan Reservoir will be authorized.

2.0 STUDY RATIONALE

2.1 Background

The Duncan Dam was constructed in 1967 as a result of the Columbia River Treaty between Canada and the United States. The dam impounds the Duncan Reservoir which provides storage and flood control downstream. There are no power generation facilities at the Duncan Dam. The Duncan Reservoir lies north of the dam and is 45 km long covering an area of 7,150 ha at full pool.

In accordance with Provincial heritage law at the time of dam construction, an archaeological inventory study was carried out along the shoreline of then Duncan Lake. A period of 30 years passed with no formal archaeological assessments taking place at the Duncan Reservoir. Then, in the late 1990s, a number of archaeological impact assessments were conducted within and adjacent to the reservoir in relation to specific forestry developments (Arcas 2006). Following these assessments, information collection aimed at supporting WUP discussions included an archaeological overview staged over four years beginning in 2002 (Choquette 2005).

Collectively, 11 archaeological sites have been documented along and adjacent to the shoreline of the Duncan Reservoir through these various archaeological overview and impact assessments. Several documented sites appear to contain materials that are considered scientifically significant from an archaeological perspective as well as being of importance to local First Nation communities.

In 2005, as part of the WUP archaeological overview, a monitoring station consisting of a grid of rebar stakes installed for the purpose of formal geospatial mapping was established in the vicinity of one known cultural site, EbQf-7, located at the Glacier Creek recreational use site. This grid was installed in an effort to capture information regarding the effects of erosion and deposition on cultural resources due to ongoing reservoir operations. This monitoring station was revisited in 2006 for the purpose of detailed topographic mapping and recording of observations on site condition based on surface visibility of artifacts and intact native soils (Choquette 2006). High water levels in 2007 limited the research to cursory observations of a portion of the site’s surface area. The monitoring at Glacier Creek has indicated that a blanket of silt is alternately laid down and eroded away by the actions of the reservoir in this location. Cultural materials are variously exposed on the surface of the parent soil and then...
obscured by the silt deposits. Quantitative measures could be obtained by measuring changes in soil depth in relation to the established grid.

A review of First Nation traditional use and traditional ecological knowledge undertaken during the WUP indicates that, aside from a brief ethnographic mention of the general area, information of this nature has not been comprehensively captured for the study area due in part to the distance from modern communities (Keefer 2002).

In 2006 BC Hydro’s Generation Engineering Services conducted a map review to determine the area potentially subjected to reservoir induced erosion, flooding, landslides and groundwater impacts along the shoreline of the Duncan reservoir above the maximum normal reservoir level (MNRL). This review provides information on the geology, geomorphology and configuration of the shoreline that can be used to understand these factors within the draw down zones.

The condition of a documented archaeological site is typically assessed only once, at the time of recording, and few sites are formally re-assessed. Since erosion in a reservoir takes place in a complex environment involving landform, aspect, de-vegetation, surface debris, surficial geology, weather, and human or animal intervention in addition to reservoir operations, the cumulative effect can be difficult to interpret. In order to develop an understanding of taphonomic process (post-depositional effects on archaeological materials) related to reservoir operations, repeated visits to a site over time are required. An important feature of erosion monitoring is the application of quantitative measures on a scale and frequency appropriate to the effects.

To date, evaluations of the erosion effects related to ongoing reservoir operations (i.e., the raising and lowering of water levels) on heritage sites in the Duncan reservoir have been limited primarily to qualitative observations of accreted reservoir sediment or exposure of intact soils and numbers of artifacts on the surface. Consequently, erosion effects related to reservoir operations are not well understood in terms of their magnitude, severity, rate of change or duration.

This erosion monitoring study will provide a long-term opportunity to observe and measure the effects of reservoir operations on selected heritage sites.

### 2.2 Heritage Monitoring Purpose

The purpose of this erosion monitoring study is to provide information that can be used in future WUP processes. This erosion monitoring study is primarily concerned with gaining a better understanding of the first two objectives that were raised during the WUP consultative process: 1) protect cultural sites and resources from erosion in Duncan Reservoir and 2) protect cultural sites and resources from exploitation in the Duncan Reservoir. Quantitative information regarding the effects of reservoir operations on heritage sites will also help to identify meaningful performance measures in the next Duncan Dam WUP review.
3.0 ARCHAELOGICAL EROSION MONITORING PROPOSAL

3.1 Objective and Scope

The objective of the planned erosion monitoring study is to collect quantitative measures of the magnitude, severity, rate of change and estimated duration of erosion effects caused by reservoir operations on selected heritage sites situated within the draw down zone of the Duncan reservoir. The typical draw down elevation of the Duncan Reservoir is between 549.0 m and 576.7 m. This draw down area constitutes the geographical scope of the study area (Fig 3-1).

3.2 Approach

This project will involve research and analysis, as well as an in-field component for establishing monitoring stations and subsequent data collection. Erosion monitoring stations will be established at a minimum of two locations within the study area and re-visited annually. The project budget has been designed to accommodate three locations but the actual number will depend on a variety of conditions including access. One of these locations will include the established stationary grid that was installed at Glacier Creek in 2005 in order to build on the observations that have been taking place there since 2005 and to compare data collection methods and resulting information.

In selecting the other monitoring station location(s), the study team will conduct a review of the landscape and geology of Duncan reservoir. Locations suitable for long-term monitoring will be situated in areas that appear to be affected by reservoir operations, showing the presence of cultural materials on the ground surface with good accessibility.

In accordance with the Order, this erosion monitoring study will be conducted using non-intrusive methods.

The results of the landscape and geology review will be shared with interested First Nations in order to seek their input into the additional monitoring station location(s) so that the location(s) reflects cultural preferences to the degree possible. The Duncan Dam Water Use Plan consultative committee report had recommended a broad program that included “conservation excavations” aimed at “characterization of the sites and the information they contain” and “traditional use and cultural preference information collection” aimed at collecting “site specific knowledge and preferences for disposition of cultural sites” as components of the erosion monitoring study. In designing these TOR to meet the stipulation for non-intrusive studies it was not possible to engage in investigative excavations of sites therefore collecting preferences for the disposition of cultural sites would be premature.

In keeping with the spirit of the consultative committee recommendations, however, the incorporation of cultural preferences into the selection of monitoring station locations necessitates the collaboration of the study team with the Ktunaxa Nation Council, the Okanagan Nation Alliance, the Shuswap Nation Tribal Council and their communities and ensures a high level of engagement throughout the course of the study.
It is not the intent of this study to restrict the definition of “cultural preference” other than noting that its application within this study will be to aid in the selection of erosion monitoring stations.

Ideally, monitoring stations will be situated in differing landscape contexts in order to provide information on how erosion is affecting different landforms and/or aspects related to surficial geology. Each monitoring station should measure no less than 0.04 ha (e.g., 20 m x 20 m) and no greater than 0.25 ha (e.g., 50 m x 50 m) in area. Configuring the monitoring stations to capture a maximum amount of archaeological information in addition to a landform setting that exhibits the effects of erosion related to reservoir operations will be critical to the success of the study.

Locations exhibiting archaeological materials and/or features on the surface will be selected to ensure that effects specific to archaeological resources can be measured. Locations with either documented or previously undocumented archaeological sites may be suitable. The limits of the monitoring station will be clearly defined and recorded. No intrusive materials will be placed within the station other than the grid installation already in place at Glacier Creek, and no materials or equipment brought in for the purpose of the study will be left on site. As this study is not being carried out under a Provincial Heritage Inspection Permit, no artifacts or other cultural materials will be collected from the monitoring stations and no subsurface testing will be conducted.

The project will take a collaborative multi-disciplinary team approach directed by a professional archaeologist and including a survey engineer, a quaternary geologist and technical assistants throughout the project. The archaeologist will be responsible for facilitating monitoring station selection with the study team and for seeking input from interested First Nations into the process of site selection as well as for identification, recording, mapping and interpretation of cultural materials and features present on the ground surface within the limits of the station. The archaeologist will be responsible for collating all collected data and project reporting.

Using terrestrial-based LIDAR, the survey engineer will collect a complete scanned dataset of the selected monitoring stations. This dataset will be geospatially tied to the UTM grid (NAD 83). The resulting point cloud will be converted into a detailed topographic map (DTM) at a suitable scale (e.g., 1:500). The DTM will include a related (thematic) layer of information regarding the archaeological features, artifacts and other materials observed on the ground surface. In addition, a physical datum will be established offsite for elevation control and as a reference point to aid in relocation.
Figure 3-1: Location of Duncan Erosion Monitoring of Archaeological Resources study area.
Despite its additional cost when compared to more traditional means (intrusive physical structures combined with GPS or photogrammetry) there are several advantages in using LIDAR for measuring erosion effects. Laser scanning technology is a highly accurate method for collecting geospatial information at a fine scale. The resulting point cloud can be similar to the pixels in a digital photographic image but in the case of LIDAR, each point is geo-referenced to a chosen grid, in this case UTM. Unlike GPS where geo-reference points are collected individually by the GPS operator while moving over an area, LIDAR can be positioned off-site and can collect millions of individual data points as close as 5 cm apart with one scan. Topographical undulations require that the scanner position be re-positioned for collecting multiple overlapping scans, which are stitched together to create a combined point cloud from which 3-dimensional surface representations can be generated. Subsequent data analysis is required to create a DTM and related sections or other products. Features, such as vegetation, can create interference during the scans and this should be considered and addressed to minimize “shadows” in the scans during the data collection.

LIDAR is a particularly appropriate technology for this erosion monitoring study because;

1) it is non-intrusive,

2) it has suitable resolution for recording spatial areas in fine detail,

3) DTMs can be created from the data, lessening time required for field mapping, and

4) changes in volume (i.e., erosion or accretion) between comparable scans over time can be readily calculated.

At the Glacier Creek monitoring station, the existing stationary grid that was installed at archaeological site EbQf-7 in 2005 will be used to take direct measures of the ground surface. These direct measurements will be used as a control and compared to the data obtained through LIDAR at the same location. New physical grids will not be installed at other monitoring station(s) established during this study as this method is considered intrusive, but taking advantage of the opportunity to compare two different data collection methods at a single site is expected to contribute to the overall veracity of the study.

In Year 1, the quaternary geologist will assist in the selection of monitoring station(s) and develop a geological (stratigraphic) model, including an assessment of erosion susceptibility, for each station. The geological models would be based on visual inspections of exposed soil layers with no excavation. The potential for extrapolation of the geological models to the rest of the reservoir draw down zone outside the study areas should be considered in the model development. In Years 3 and 5, the geologist will re-visit each monitoring station, inspect the changes to the exposed sections, review the collected geo-spatial (LIDAR) data and provide a report that compares the observed and measured effects with those predicted from the Year 1 model.

All final annual reports will be shared with interested First Nations.
The project team will conduct accurate surveys in accordance with BC Hydro’s General and Technical Standards for Reservoir Archaeological Work, meeting all relevant requirements.

3.3 Methods

The erosion monitoring will involve five basic tasks outlined below:

3.3.1 Task 1: Project Management

Project management will involve the general administrative and technical oversight of the project. This task will include, but not be limited to:

1) budget management,
2) study team management,
3) logistic coordination,
4) technical oversight of field and analysis components, and
5) facilitation of data transfer among other investigators, as required.

A safety plan must be developed and submitted to the BC Hydro study implementation lead for all aspects of the study involving field work, in accordance with BC Hydro’s procedures and guidelines. This safety plan must be submitted and accepted by BC Hydro prior to any fieldwork being undertaken. Specific safety training may be required.

3.3.2 Task 2: Research

This task includes, but is not limited to:

1) a review of published and unpublished reports, including the preliminary findings of DDMON-12 – Duncan Dam Archaeological Overview Assessment which will be conducted concurrently;
2) a review of all documented archaeological sites within the study area as described in Section 3.1;
3) a review of available air photos, orthophotos and digital elevation models of the drawdown zone; and
4) a review of First Nation cultural preferences regarding monitoring station location within the Duncan Reservoir.

Preliminary selection of appropriate monitoring station locations will be made by the study team in collaboration with interested First Nations and according to the criteria described in Section 3.2. BC Hydro will advise the study team regarding the appropriate means of contacting and coordinating with interested First Nations in determining cultural preferences for monitoring station locations.

3.3.3 Task 3: Monitoring Station Site Selection and Erosion Susceptibility Model Development

Final monitoring station selection will take place in the field to ensure that both archaeological and landform aspects are well represented and that each station is
configured to capture appropriate data. The selection and establishment of monitoring stations in the field will be combined with the collection of baseline data during a single field trip in Year 1. An individual offsite datum will be established for each monitoring station.

Year 1 will also include the development of an erosion susceptibility model for each established monitoring station by a quaternary geologist.

3.3.4 Task 4: Data Collection

Both archaeological and geospatial data collection will take place in each of the five years of this study. Baseline LIDAR scans will be established in Year 1, with successive LIDAR scans (epochs) in each of Years 2–5, inclusive.

Within each monitoring station, the position, type and morphological characteristics of all surface artifacts, cultural features and exposed sediments will be recorded by the professional archaeologist and technical support staff. Digital photographs with a minimum 300 dpi will be taken of the monitoring station and of all archaeological features and artifacts observed within. Information required for submitting or updating B.C. Archaeological Site Inventory Forms will be recorded.

Geospatial data collection will include LIDAR scans of the entire monitoring station. Multiple overlapping scans may be required to account for all topographic undulations and to maximize the completeness of scanned ground. The position of each scan will be recorded using GPS and linked to UTM (NAD 83). A set of colour digital photographs will be collected from the same position as each LIDAR scan to capture the area covered in each scan.

At the Glacier Creek monitoring station, the existing stationary grid that was installed at archaeological site EbQf-7 in 2005 will be used to take direct measures of the ground surface. The grid consists of a series of rebar pins with floating washers situated at ground surface at each pin. Measurements taken at each pin location should include: 1) top of pin to ground surface, 2) ground surface to washer and 3) top of pin to washer. These measurements are to be recorded in a spreadsheet format for each year. The direct measurements obtained in this way will be used as a control and compared to the data obtained through LiDAR at the same location.

3.3.5 Task 5: Analysis and Reporting

A final report for the study will include:
- an executive summary;
- a description of the monitoring station(s) selection, set up and data collection methods;
- a detailed summary of the archaeological data collection findings for each monitoring station;
- a detailed summary of the geomorphologic data collection findings for each monitoring station;
- a detailed analysis of the observed measured erosion at each monitoring station as compared to the erosion susceptibility model(s);
- hard copy and digital maps, in an acceptable format, showing the monitoring
station locations and the position of all surface archaeological features and artifacts per year;

- detailed scans (maps and sections) showing the recorded changes between successive epochs; and

- a detailed quantitative analysis of the collected data regarding the effects of the reservoir on archaeological resources expressed in terms of magnitude (volumetric and dimensional changes), severity, rate of change and duration.

A yearly interim report that summarizes the methods employed and study findings will be prepared shortly after the conclusion of the data collection each year. These interim reports will follow the structure outlined above for the final report but will focus on the work in a given year with preliminary analysis and conclusions as appropriate.

Draft versions of all reports will be submitted for review by BC Hydro.

Reports will follow the standard format that is being developed for WUP monitoring programs. All reports will be provided in hard-copy and as Microsoft Word and Adobe Acrobat (*.pdf) format, and all maps and figures will be provided as embedded objects in the Word file and as separate GIS files.

The preparation and submission of B.C. Archaeological Site Inventory Forms for all newly identified sites or updates to previously documented site data records is also required.

3.4 Schedule

The study will take place over five years starting in spring of 2011. The exact timing will depend on site conditions, but it is expected that the greatest extent of the Duncan reservoir drawdown zone will be exposed in the spring; typically between March and May when the area is free from snow and ice but is not yet inundated from rising reservoir levels. Low water levels and minimal snow cover on the ground are needed for effective mapping.

3.5 Budget

The budget for this study is estimated at $227,000.

3.6 References

Arcas Consulting Archeologists Ltd. 2006. Archaeological Data Summary to 2005 in BC Hydro Reservoirs Archaeological Data Collection Project. Prepared for BC Hydro (Duncan Reservoir section).


