BC Hydro

Columbia River Projects Water Use Plan

Kinbasket Reservoir and Mid-Columbia River Boat Launch Ramps Feasibility Study

Reference: CLBWORKS-18

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1.0 Introduction

1.1 Project Background

During the Columbia River Water Use Planning process, recreational boat access on the reservoirs of the Columbia River system was identified as an important issue. The lower ends of the ramps generally terminate at an elevation which is dry during the low water season, making the ramps unusable for much of the year. At the final meeting of the Water Use Plan Consultative Committee (WUP CC) in June 2004, it was recommended that physical works for recreational boat access to the reservoirs at low water levels be investigated in lieu of operational changes to the Columbia River Projects.

In response to the Order (File No. 76975-35/Columbia) issued by the Comptroller of Water Rights to BC Hydro (BCH), BCH issued a Terms of Reference (TOR) to undertake feasibility studies to evaluate the construction of new ramps or extension of existing ramps, including annual maintenance requirements, and recommend options for a number of recreational boat launch ramps on the Kinbasket Reservoir and Mid-Columbia River. BCH engaged the Moffatt & Nichol project team[1], to complete a feasibility study related to the extension or replacement of five of the ramps, namely those at Valemount Marina and Bulldog Creek near the Valemount end of the Kinbasket Reservoir; Nixon Creek and Bush Harbour near the Golden end of the reservoir, and; Centennial Park near Revelstoke on the Mid-Columbia River. The site locations are shown on Drawings 6258-100 to103 in Appendix A.

1.2 Scope of Work

In accordance with the TOR provided by BCH, the feasibility study includes the following tasks:

- Perform a reconnaissance survey of the existing boat launch ramp locations and other possible locations as identified by BCH.
- Determine the feasibility of extending or constructing ramps as recommended by the Columbia Water Use Plan Consultative Committee (WUP CC) based on engineering technical feasibility, a cost-benefit analysis, heritage and environmental criteria, and also provide recommendations for each site as per section 2.3.5 of the TOR.

1.3 Report Organization

The data collection and field investigation program for this study are described in Sections 2 and 3 below. Analysis of ramp design alternatives is provided in Section 4. Sections 5 and 6 respectively present a summary of the environmental and heritage issues associated with the proposed developments. Cost-benefit analyses of the development options are presented in Section 7, with conclusions and recommendations for further work in Section 8. Our closing remarks are in Section 9.

[1] The Team is comprised of Moffatt & Nichol (M&N), Golder Associates (Golder), Triton Environmental Consultants (Triton) and Atek Hydrographic Surveys Ltd. (Atek).

Appendix A contains drawings including a project location map, site plans of the existing facilities and potential improvements. Appendix B contains photographs taken during the field visits. Appendix C contains the full Environmental Overview Assessment report prepared by our team partner Triton Environmental (Triton). Appendix D contains the Archaeological Overview Assessment (AOA) report prepared by our team partner Golder Associates (Golder).

2.0 Data Collection

The following background data and information were provided by BCH:

- Columbia River Water Use Plan Consultative Committee Report Volumes 1 and 2, dated July 2005.
- Kinbasket Reservoir and Mica Dam Water levels 1984-March 2007, provided by Gordon Boyd, BCH.
- Kinbasket Reservoir, Archaeological Data Summary to 2005. Arcas Consulting Archaeologists dated March 2006.
- Terrain Resources Information Management (TRIM) AutoCAD drawing files provided by BCH.
- Boat Launch Proposal to the Columbia River Water Use Planning Committee, City of Revelstoke. Wildland Consulting Inc., Revelstoke, B.C. dated May 19, 2004.
- Overview of the Proposed Revelstoke Unit 5 Project, prepared by the Revelstoke Unit 5 Project Team dated October 2005.

Additional documents and information obtained from Don Bennett, Valemount Marina Association is listed as follows:

- Letter to Al Brotherston, BCH from Don Bennett dated February 25, 2003.
- Bulldog Ramp proposal cost estimate prepared by Don Bennett.
- Letter including photographs to Al Brotherston, Acting Environment and Social Issues Manager, BCH from Don Bennett dated March 31, 2007.
- Letter to Wayne Schnell, Valemount Marina Association from Serge Zoritch, BCH dated May 28, 2003.
- Undated aerial photograph of the Valemount Marina taken circa summer 2006.
- Plan drawing showing layout of potential boat launch ramp at Bulldog Creek prepared by Don Bennett.
- Elevation of potential boat launch ramp at Bulldog Creek including Mass-Haul diagram for cut and fill volumes prepared by Don Bennett.

3.0 Inspection Findings of the Existing Boat Launch Facilities and Potential Boat Launch Ramp Sites

3.1 Valemount Marina Boat Launch Ramp

The existing Valemount Marina boat launch ramp site is located approximately 24 km from the turn-off just past Cedarside, an eastbound exit off Highway 5 when heading towards Valemount. The location of the site and its proximity to Valemount is shown on Drawing 6258-100 in Appendix A.

The project team was met on site by Don Bennett of the Valemount Marina Association on Friday, May 25, 2007 who provided valuable information for both the Valemount Marina and Bulldog Creek boat launch sites. The information provided included an aerial photograph of the Valemount Marina site, preliminary alignment of a proposed route for a ramp at Bulldog Creek and copies of correspondence between BC Hydro and the Valemount Marina Association.

An unpaved forest service road (FSR) is the main access to the site. The Valemount Marina is located on the eastern shore of the northern-most end of the Kinbasket Reservoir. The upland section of the marina has parking, picnic, and camping areas including a covered dining area and toilet facilities. The existing boat launch ramp is oriented approximately north-south and is adjacent to the access road to the site. The boat launch site is protected from the prevailing wind and waves from the south by the spit as shown on Drawing 6258-103 in Appendix A. The spit also provides shelter to boats anchored in the marina area.

The concrete pavement of the existing boat launch ramp is approximately 6.0 m wide, 154 m long and 200 mm thick. The top of the boat launch ramp is at El. 755.5 m (2478.8 ft) and the end of the ramp is at approximately El. 738 m (2421 ft). The ramp is evenly graded at approximately 11.4%.

In general, the concrete surface of the existing ramp is in fair condition, with the exception of cracks in the concrete slab that run along the length of the ramps as shown in photographs 8 and 9 in Appendix B. The width of the cracks ranges from 5 mm to 20 mm. A close-up view of a typical crack is shown in photograph 11 in Appendix B. While these cracks do not currently interfere with the functionality of the ramp, annual freeze-thaw conditions will likely lead to further deterioration of the condition of the concrete slab if maintenance repairs to seal the cracks are not carried out in the near future.

At the time of the field visit, a portion of the existing concrete boat launch ramp was covered with sediment carried by rain and snow runoff from the adjacent road embankment. To alleviate the problem, a new ditch was excavated along the toe of the road embankment to channel the surface water away from the ramp. The road embankment slope will require stabilization works to prevent the embankment fill from migrating on to the boat launch ramp (see photograph 5 in Appendix B).

A cursory examination of the existing walkway and boat slip floats revealed that there is some minor corrosion of uncoated sections of the structural steel frame members of the walkway and marina floats as shown on photographs 16 and 18 in Appendix B.

There is adequate area at the top of the existing boat launch ramp for turning vehicles and boat trailers to launch or retrieve boats, also for parking.

It is possible to extend the end of the existing ramp to meet the WUP CC recommended El. 729.9 m as shown on Drawing 6258-103 in Appendix A.

3.2 Bulldog Creek Boat Launch Ramp

The alternative site for a low water level boat launch ramp for use by the Valemount community is located near the mouth of Bulldog Creek. This undeveloped site is located approximately 7 km further southeast of Valemount Marina and is situated on the western shore of Bulldog Creek. The location of the site and its proximity to Valemount is shown on Drawing 6258-100 in Appendix A.

Access to the potential boat launch ramp site from Valemount Marina is by the FSR. One section of this road rises from El. 760 m to El. 890 m at a 7.25% gradient. During the winter months, the steepness of the FSR road could make travelling to the Bulldog Creek site challenging if the FSR is not properly maintained and cleared of snow. There are also safety concerns for the public using this commercial logging road, especially in winter months when there is the possibility of avalanches. Furthermore, access may be restricted in winter months when log harvesting ceases in the area and logging companies may not need to keep the road cleared of snow (Personal communications with Denis Nordli on May 24, 2007).

At the Bulldog Creek location, there is a drop in elevation of approximately 12 m from the FSR down to an existing spit on which a boat launch ramp could be constructed. Therefore, substantial amounts of fill will be required to build the access road to the potential launch site as shown in photograph 24 in Appendix B. The north side of the spit is sloped at approximately 5%, which is flatter than the minimum gradient of 12% as recommended by the California Department of Waterways (CDW) guidelines for boat launch ramps. Additional fill will therefore be required to achieve the desired minimum gradient for a boat launch ramp at this site.

There is a sufficient water depth at the site to meet the requirements for the WUP CC recommended water level access of El. 723.9 m (2375 ft) as shown on Drawing 6258-104 in Appendix A.

3.3 Nixon Creek Boat Launch Ramp

The Nixon Creek boat launch ramp site is located approximately 93 km from the turn-off to Donald, a west-bound exit off Highway 1 when heading towards Revelstoke from Golden. The location of the site and its proximity to Golden is shown on Drawing 6258-101 in Appendix A.

The Nixon Creek site is an undeveloped site with no infrastructure for a boat launch ramp. Access to the reservoir is a gravel ramp with a natural slope of approximately 7%, with the end of the existing boat launch ramp facing south where it is exposed to prevailing southern winds and waves as shown in photograph 26.

There is a level upland area at the top of the access road which is used for parking RV and boat trailers as indicated in photograph 32 in Appendix B.

There is sufficient water depth at the Nixon Creek site to meet the WUP CC recommended water level access of El. 713.2 m as shown on Drawing 6258-105 in Appendix A.

3.4 Bush Harbour Boat Launch Ramp

The Bush Harbour site is located approximately 42 km from the exit to Donald, a westbound exit off Highway 1 when heading towards Revelstoke from Golden. The location of the site and its proximity to Golden is shown on Drawing 6258-101 in Appendix A.

The proposed Bush Harbour site is located a short distance from the Bush River FSR that serve as access to the area. The potential boat launch site is at the south end of a natural bay. On the west side of the bay, there is a private property with walkway floats for high water level access as shown in photograph 53.

The proposed site is located in a natural bay and is fairly sheltered from prevailing winds from the south. It is also closer to the main body water of the Kinbasket Reservoir than the existing boat launch ramp located at Bush Arm Recreational Camp site (see Figure 4.3).

At the time of the field visit, it appeared that there was recent grading of the slope to provide a gravel surface access to the reservoir as shown in photographs 45 and 46 in Appendix B. In general, the width of the slope is approximately 6 m wide; and the gradient of the existing slope was approximately 12% with the upper 120 m section of the ramp with a gradient from 6% to 8%. The end of the ramp is at El. 725.7 m which satisfies the WUP CC requirement for Bush Harbour. There are no appurtenances associated with the existing ramp.

There are large upland areas suitable for turnaround and parking for a potential boat launch ramp at this location. The upland area is, however, littered with derelict tugs and old log breakwaters connected with chains as shown in photographs 51 and 52 in Appendix B.

3.5 Centennial Park Boat Launch Ramp

The existing Centennial Park Boat Launch Ramp is located in the City of Revelstoke near the ball park fields of Centennial Park. The boat launch is sited approximately 8 km downstream of the Revelstoke Dam. The location of the site and its proximity to Revelstoke is shown on Drawing 6258-102 in Appendix A.

The existing boat launch ramp is approximately 5 m wide and 48 m long. The surface of the ramp is formed by rows of two precast concrete slabs adjacent to each other as shown in photographs 58, 59 and 62 in Appendix B. Each plank is 0.36 m wide and 2.3 m long and is separated by a 75 mm wide gap filled with gravel. It was reported that the ramp site was constructed on an old landfill site.

The end elevation of the ramp is at El. 437.2 m. The last two rows of precast concrete slabs were broken as shown in photograph 62 in Appendix B. Although the precast concrete planks were broken, the end of the ramp did not show any signs of erosion as the natural slope of the ramp continued into deeper water. The surface of the concrete planks appears to be in fair condition.

The gradient of the existing ramp is 9%, which is less than the CDW recommended minimum gradient. Previous similar experience with the existing Fauquier boat ramp on the Arrow Lakes Reservoir has shown that at this gradient, the rear wheels of vehicles will likely to be submerged during launches; an undesirable condition.

A strong current was observed at the end of the boat launch ramp which is a safety concern for launching boats at this location. Wildland Consulting reported that currents reach 3 - 4 knots at the end of the Centennial Park boat launch during low water months. During the site visit, river navigation hazards associated with the Centennial Park ramp were not specifically reviewed, however, this may be a significant issue when the reservoir water levels are down and there are many obstructions hidden just below the river surface of the mid-Columbia Reach.

There are no walkway floats at this boat launch ramp. A small unpaved, upland parking area of approximately 740 m^2 is available at the top of the existing boat launch ramp; see Drawing No. 6258 - 107.

3.6 Potential Boat Launch Ramps near Revelstoke

The project team was met on site by Brian Gabdois, recently retired from BCH, who provided valuable information for the potential boat launch sites in the Revelstoke area.

Mr. Gadbois indicated that there was a possible alternative site across the river at Big Eddy. However, the potential site is on private property and the project team was not able to access the site at the time of the field investigations. The Big Eddy site is located 6 km from the Revelstoke Dam and north of the existing boat launch ramp.

Further discussions with Mr. Gadbois on other possible sites determined that the eastern shoreline of the Columbia River south of Revelstoke had large areas of flat topography which would not be suitable for boat launching.

4.0 Feasibility Design of Boat Launch Ramp Extensions and Modifications, and New locations

4.1 Evaluation of Ramp Extension Requirements

For the Kinbasket Reservoir, BCH is authorized by Conditional Water Licences No. 27068 and 39432 to store a maximum of 7 million acre-feet (MAF) and 5 MAF, respectively. The normal operating range of the reservoir is between El. 754.38 m (2475.0 ft) and El. 706.96 m (2319.42 ft). BCH requires permission from the Comptroller of Water Rights for additional storage for economic, environmental, or other purposes.

Water level records obtained from BCH were analysed statistically to determine suitable ramp extension/ modification scenarios. The yearly water level records are shown in Figure 4.1 below.

The existing boat ramps at Valemount Marina, Nixon Creek and Bush Harbour terminate at different elevations, providing varying degrees of accessibility throughout the year (see Figure 4.1). The Nixon Creek ramp provides the best year-round access and Bush Harbour the worst. A comparison of the WUP CC recommended end-of-ramp elevations versus the present end-of-ramp elevations is Table 4.1 below.

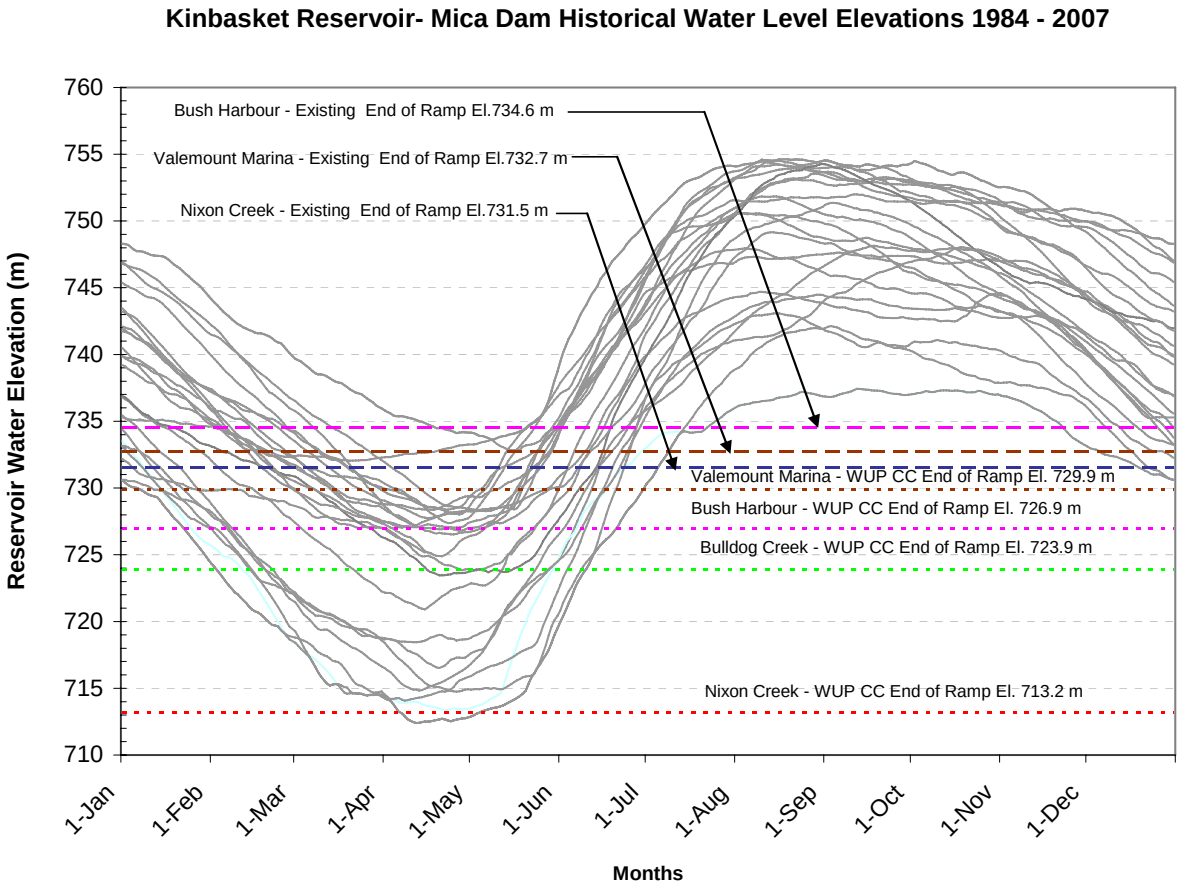

Figure 4.1: Ramp Elevations vs. Historical Water Levels at the Mica Dam

From Figure 4.1, the WUP CC recommended that the following end-of-ramp elevations for the each location in Table 4.1 can be summarized as follows below:

Table 4.1: Summary of End-of-ramp elevations for Boat Launch Ramps on the Kinbasket Reservoir

Location	Existing End of Ramp Elevation (m)	WUP CC End of Ramp Elevation (m)	Difference in End of Ramp Level Elevation (m)
Valemount Marina	732.7	729.9	2.8
Bulldog Creek	N/A	723.9	N/A
Nixon Creek	731.5	713.2	18.3
Bush Harbour	734.6	726.9	7.7

The WUP CC did not make a specific recommendation for an end-of-ramp elevation for the Centennial Park boat launch ramp at Revelstoke.

Extending the boat ramps to a lower elevation would extend the useful season by a corresponding amount. Determining exactly how far the ramps should be extended involves an economic trade-off that weighs the cost of construction against the incremental additional benefit. Construction costs escalate rapidly if underwater construction is needed, as would be the case if access is required at all conceivable reservoir water levels. However, the heaviest use periods tend to occur in summer months when the water levels are relatively high, and thus providing low water access during the less-used low water periods is a case of diminishing returns. Instead, a compromise approach which balances the additional cost against the added benefit is likely the most practical solution.

The water level data were analysed statistically to produce a series of exceedance curves, expressed as the percentage of time that the water level was higher than a given water elevation. This allows an analysis to be made of the degree of availability that would be provided by extending the ramps down to any particular elevation or more specifically, to elevations recommended by the Columbia Water Use Plan Consultative Committee (WUP CC). The analysis was conducted on a month-by-month basis to account for the seasonal effects.

Although the 22-year period of record (1984 to present) is too short to generate reliable long-term statistics, the data nonetheless provide a reasonable means of establishing performance thresholds (i.e. percent of time the ramps can be used throughout the year). In the discussion that follows, it should be remembered that the performance levels and reliability are relative to the period of data record only. Performance levels on a long term basis will likely vary somewhat from these figures, although the difference is likely to be slight provided that water level variations in future years are similar to those that have been experienced since 1984.

Water level data were first sorted into months of the year. For each water level between the low pool and high pool elevations, the number of days in that month which equalled or exceeded that water level were counted. This "exceedance count" was expressed as a percentage of the total number of daily records for that month, irrespective of the year in which they occurred. Strictly speaking, this approach is not statistically rigorous since it treats all such monthly records as statistically random events. In reality, water levels within a particular month are somewhat correlated to one another (i.e. water levels do not change too rapidly from one day to the next). Furthermore, one particular low or high month in the record can skew the overall results. Nonetheless, given the other inherent uncertainties in the seasonality data (e.g. the relatively short period of record, and variable power generation needs) this approach provides a reasonable indication as to the level of service that would be provided by extending the boat ramps down to any particular elevation.

The results of the exceedance plots for the Kinbasket monthly historic water levels over the period 1984 to 2007, as measured at Mica Dam, are shown in Figure 4.2.

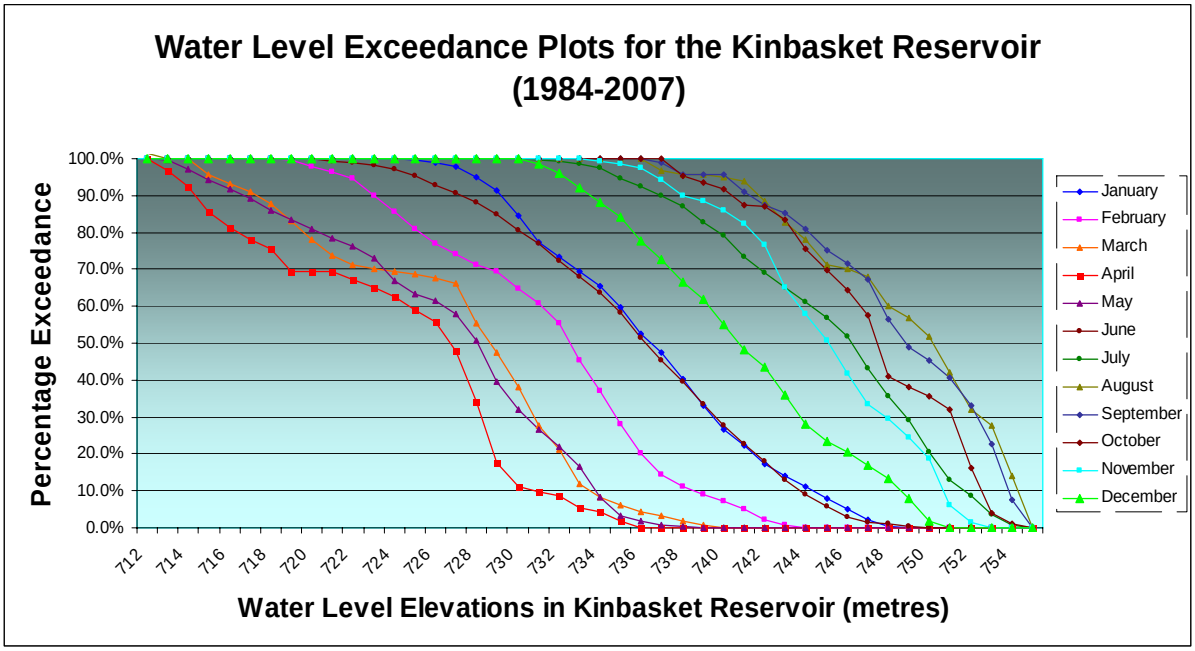

Figure 4.2: Monthly Water Level Exceedance Plots for Kinbasket Reservoir

From the above graph, the percentage availability of access to the reservoir for various ramp-end elevations is shown in Table 4.2:

Table 4.2: Percent Availability of Access to the Reservoir for Boat Ramps at Various Elevations by Month

Month	End of Ramp Elevations (metres)								
	713	716	719	722	725	728	731	734	736
January	100%	100%	100%	100%	100%	97%	84%	68%	56%
February	100%	100%	100%	96%	85%	73%	65%	40%	25%
March	100%	95%	87%	73%	69%	60%	35%	10%	6%
April	99%	84%	73%	68%	60%	40%	10%	5%	1%

Month	End of Ramp Elevations (metres)								
	713	716	719	722	725	728	731	734	736
May	100%	94%	85%	78%	66%	54%	29%	12%	3%
June	100%	100%	100%	99%	96%	90%	79%	66%	54%
July	100%	100%	100%	100%	100%	100%	100%	99%	94%
August	100%	100%	100%	100%	100%	100%	100%	100%	100%
September	100%	100%	100%	100%	100%	100%	100%	100%	100%
October	100%	100%	100%	100%	100%	100%	100%	100%	100%
November	100%	100%	100%	100%	100%	100%	100%	100%	99%
December	100%	100%	100%	100%	100%	100%	100%	99%	80%

The longest of the existing ramps (Nixon Creek) extends to just below El. 731.5 m. As can be seen from the exceedance curves, this provides essentially 100% access at high water and throughout the main summer months of the year, but progressively less access as the reservoir level falls. During the lowest water months of March and April, the Nixon Creek ramp is useable roughly 10-28% of the time, while the Bush Harbour ramp (at El. 734.6 m) can rarely, if ever, be used.

The conceptual designs given below are based on providing low maintenance boat launch facilities that have features that would normally be incorporated into a public boat launch. Less expensive options can be considered through reduction in scope and finishing details of the final designs. It is believed that the WUP CC had considered more basic designs to reach their recommendations.

4.2 Valemount Marina – Existing Boat Launch Ramp

The end-of-ramp elevation for the existing boat launch ramp at Valemount Marina is at El. 732.7 m which provides access in March and April about 19% and 8% of the time, respectively.

The WUP CC recommended access El. 729.9 m will improve access in the months of March and April to 43% and 14% respectively, a relatively small increase in accessibility over present conditions. Photograph 3 shows the location of the potential end of existing ramp.

It is possible that a dredged option at Valemount Marina could eliminate the need to develop the Bulldog Creek, site whose development will provide challenges as discussed in Section 4.3.

If the proposed end of the extended boat launch ramp is dredged to create an access channel invert at El. 724 m (WUP CC recommended access elevation for Bulldog Creek), accessibility to the reservoir will improve to 70% and 65% respectively for the low water level months of March and April at Valemount Marina, a significant improvement over the current situation. The proposed dredge channel would be approximately 160 m long from the proposed extended end of ramp.

The typical cross section for the dredged cut is shown on Drawing 6258-103, where low level berms on either side of the dredged channel would minimise littoral drift from filling in the channel and reduce the frequency for maintenance dredging.

The overall length of the proposed extended boat launch ramp is 226 m, which exceeds the recommended length of a single lane boat launch ramp without a turnaround. A proposed turnaround is therefore included in the ramp extension concept. The layout of the existing ramp and proposed modifications is shown on drawing 6258-103 in Appendix A.

It is assumed that the existing walkway floats will be modified by the owners/operators of the marina to accommodate the extended length of ramp.

Although not a part of the scope of the study, the existing access road embankment adjacent to the boat launch ramp will require slope stabilization work as well as site drainage improvements to channel surface water flows away from the embankment.

4.3 Bulldog Creek - Alternative Site

The WUP CC recommended end of ramp El. 722.7 m is attainable at the Bulldog Creek site as shown on Drawing 6258-104. Accessibility to the reservoir in the low water months of March and April will be approximately 70% and 65% respectively.

The conceptual layout shows an upper boat launch ramp with a turnaround and parking area near the FSR for launches when the water elevation is above El. 740.0 m, an intermediate ramp with turnaround for launches when the water levels are above El. 734.0 m, and a low water launch for water levels to El. 722.7 m.

A potential boat launch ramp at Bulldog Creek is technically feasible, but the following are several important site characteristics that will affect the cost of development:

1. Road elevations from the FSR to the potential boat launch site drop steeply over a vertical distance of 12 m. This implies a large volume of fill would be required to construct access from the FSR to the ramp. In addition, the low water level launch site is approximately 0.5 km from the FSR.
2. The existing ground has a natural slope of approximately 5% and is much less than the 12% minimum gradient recommended by the California Department of Waterways. As a consequence, the upper section of the access road would require a considerable amount of fill to achieve the ramp gradient of 12%. This is shown on Drawing 6258-104.
3. Personal communications with Dennis Nordi indicated that if logging activities are discontinued in areas beyond Bulldog Creek, the local logging company will cease maintenance of the FSR up to the Bulldog Creek boat ramp site, and it is quite likely that the Ministry of Forests and Range will not have budget allocation to maintain the FSR over the long term.

Taken collectively, these characteristics suggest that the Bulldog Creek site is not ideal for a boat launch.

4.4 Nixon Creek – Existing Boat Launch Ramp

The end-of-ramp elevation for the existing boat launch ramp at Nixon Creek is at El. 731.5 m which effectively allows boat launch accessibility to the reservoir of 35% and 10% respectively during the low water months of March and April.

The WUP CC recommended end of ramp El. 713.2 m is attainable at the Nixon Creek as shown on Drawing 6258-105. Accessibility to the reservoir in the low water months of March and April would be approximately 100% and 99% respectively at the recommended WUP CC elevation.

A potential boat launch ramp at Nixon Creek is technically feasible, however, two important issues regarding site topography and the FSR must be considered as follows:

1. When compared with the Bush Harbour site, Nixon Creek is the only site that has access to the lowest water depths in the reservoir. The existing slope to access the El. 713.2 m contour is approximately 15%, a suitable slope for a boat launch. However, the access road to the low water level ramp has only 7% slope which is well less than the minimum recommended grade of 12%. It is possible to re-grade the access road to the recommended slope of 12%, but large volumes of fill would be required to build up the grades necessary to form the access road for higher water level access. Therefore, only a low water level access launch ramp from El. 733.0 m to El. 713.2 m is considered suitable at this site. It is proposed to place a concrete slab surface for the ramp to improve traction and durability of the ramp. Floating log breakwaters on either side of the ramp are recommended to protect the ramp from wind and wave attack from the southeast. A floating walkway is also recommended for low water boat launches.

2. Personal communications with Bernie Heuvelman and Tahl Lunoch of Louisiana Pacific (LP) and Andrew Davies of the Ministry of Forests and Range (MOFR) indicated that in the short term, harvesting and new road construction is occurring past Nixon Creek which implies that the FSR access will remain open for several years for deactivation and silviculture needs. Long term access of the FSR is dependant on the economic viability of forestry operations, available timber volume and the costs of maintaining the infrastructure in the area. While these future scenarios are undefined at present, LP has indicated that they will not maintain the FSR if commercial logging is no longer possible in the area. LP has indicated that the permit for the 0.9 km long “non-service” access road from the FSR to the boat launch ramp at Nixon Creek had expired, and LP is no longer maintaining the access road.

   The MOFR indicated that its policy is for the FSR to revert to a “wilderness road” if LP leaves the area. This implies that no maintenance will be done other than for mitigation of environmental impact. Snow plowing, bushing and grading are not part of “wilderness road” maintenance and if the road were to fall into disrepair, it may not be fixed.

4.5 Bush Harbour- New Boat Launch Ramp

The end-of-ramp elevation for the existing boat launch ramp at Bush Harbour is at El. 734.6 m which effectively allows boat launch accessibility to the reservoir for 10% and 5% of the time respectively during the low water months of March and April.

The WUP CC recommended end of ramp at El. 726.9 m is attainable as shown on Drawing 6258-106. Accessibility to the reservoir in the low water months of March and April will be approximately 63% and 47% respectively at the recommended WUP CC elevation.

A single-lane boat launch ramp approximately 260m long with a parking area and turnarounds is proposed for this site. A new walkway float including pile anchors is also proposed to complete the infrastructure for the site.

4.6 Bush Arm – Existing Boat Launch Ramp

The existing Bush Arm boat launch ramp was not visited during the field visit of May 23-26, 2007. However, a desktop study was performed on the site using the available TRIM map data provided by BC Hydro and telephone discussions with the Ministry of Forests and Range.

The Bush Arm Recreational site is located near km 46, some 4 km further from the Bush Harbour site on the south side of Bush Arm. The existing ramp is a gravel ramp and is used during the summer months. From the TRIM data, it is possible to extend the ramp from El. 755 m to El. 727 m, at a grade of approximately 11% as shown in Figure 4.3 below. This deduction would be subject to site verification.

However, at this elevation boat launches would be into the river channel at low water and is not likely to be suitable for navigation to the main areas of the reservoir.

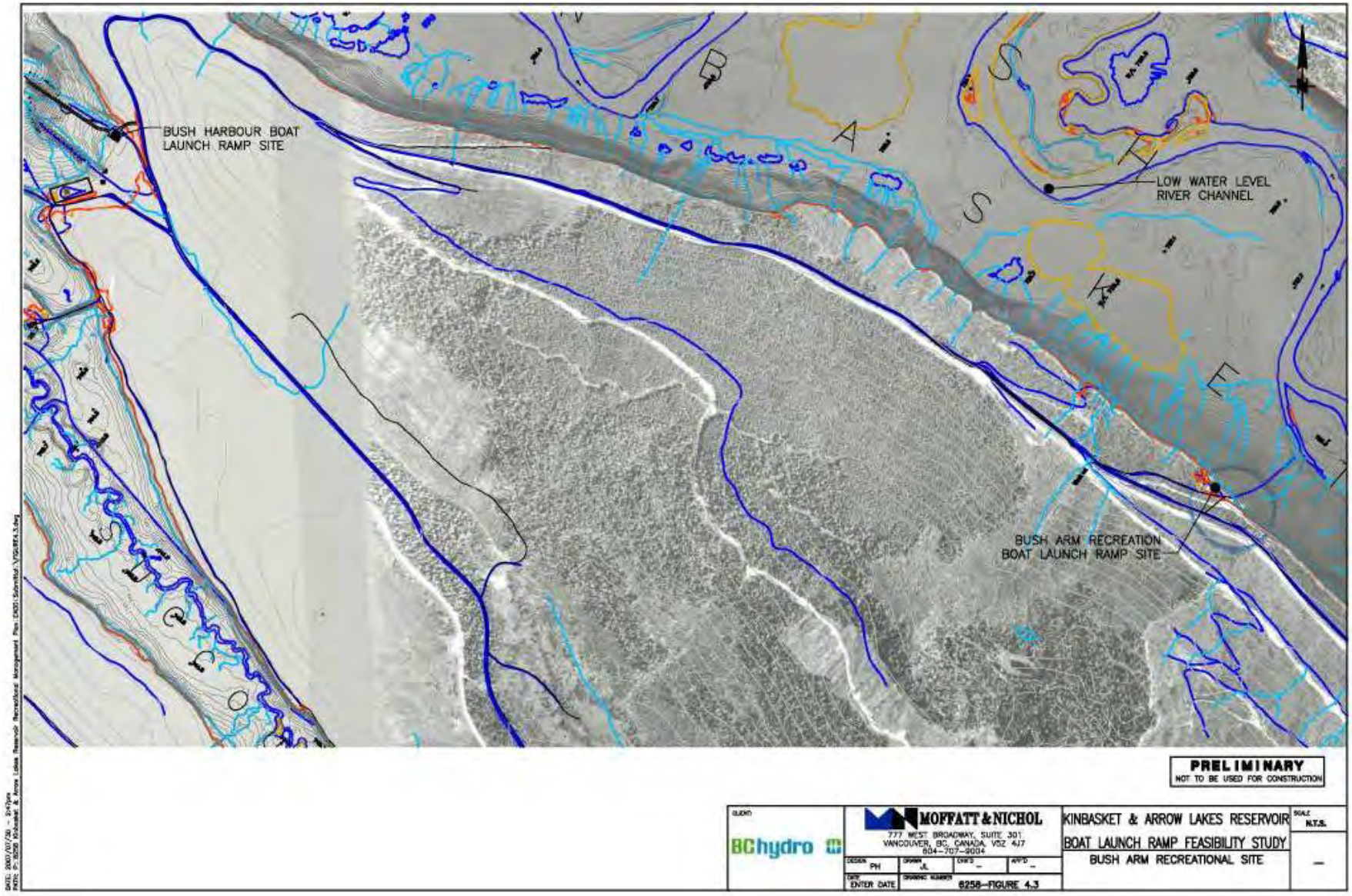

Figure 4.3: Location of Existing Boat Launch Ramp at the Ministry of Forests and Range Bush Arm Camp Site

4.7 Centennial Park – Proposed New Boat Launch Ramp

The Centennial Park boat launch ramp is conveniently located in the City of Revelstoke. In the summer months when the Arrow Lakes Reservoir is near its maximum level, the effects of the current at the boat launch are reduced. However, at low water levels in the winter and spring months, there is a strong current at the end of the boat launch. To mitigate the effects of the current at end of the boat launch, it is possible that a rubble-mound breakwater could be constructed using land-based equipment by pushing fill material from the shore and placing armour rocks on the sides of the fill for slope protection. Best practise methodology would be applied for the in-water construction of the breakwater. The breakwater would protect boats from the effects of strong currents and would provide a safe harbour for launching boats. However, a rubble mound breakwater would be very costly, especially when considering that the boat launch will be effectively used during the fishing season of mid June to mid August when the effects of current are reduced.

It is understood that the flow below the Revelstoke Dam will increase from about 64,000 cubic foot per second (cfs) to 96,000 cfs when turbines Five and Six are installed at the Revelstoke Dam. Examination of the backwater curves diagrams provided in the BCH report "Overview of the Proposed Revelstoke Unit 5 Project" indicates that the water level at 8 km from the dam will increase less than 1.0 m over current water levels. Further model studies will be required to determine the effects of the water level change and currents at the site.

The existing gradient at the Centennial Park ramp is approximately 9% and is not ideal for boat launches. It is proposed to remove the existing precast concrete slabs, re-grade the slope of the ramp to 12% and place a new concrete slab or precast concrete slab surface for the boat launch ramp. Currently, the site does not have a walkway to access the boats when launched, a new walkway is proposed near the boat launch ramp as shown on Drawing 6258-107 in Appendix A.

4.8 Big Eddy Site – Near Revelstoke

The Big Eddy site was not investigated as it was determined to be a privately-owned site and access was not possible. Should BCH decide that this site be further investigated, permission must be obtained to investigate the site.

5.0 Environmental Assessment Overview

5.1 General

M&N Team member Triton Environmental conducted a screening level environmental assessment of the sites. A summary of the assessment is provided below. In general, no significant environmental impacts are predicted for the majority of the proposed boat ramps. For the full Environmental Assessment report, please refer to Appendix C.

5.2 Valemount Marina, Nixon Creek and Bush Harbour

The extension of the Valemount Marina, Nixon Creek, and Bush Habour ramps will not negatively impact the ecosystem components observed at those locations and the extension of the boat ramps can proceed following their Environmental Management Plans. The Department of Fisheries and Oceans (DFO) have no concerns regarding these ramp extensions as proposed in this report. The Ministry of Environment (MOE) and Transport Canada should also be consulted but are not likely to object to the extension of these ramps.

5.3 Bulldog Creek

The construction of a new ramp at Bulldog Creek is not recommended based on the fish habitat available in the footprint area and its close proximity to Bulldog Creek. Since it is a new construction project, Transport Canada would need to review an application for works approval pursuant to the Navigable Water Protection Act. This site would require an Approval under the Water Act and DFO considers this to be a Harmful Alteration, Destruction or Disruption (HADD) to fish habitat and recommends relocation or redesign.

5.4 Centennial Park

The 24 m extension of the Centennial Park ramp can proceed provided that the environmental management plan is followed. DFO and MOE do not have concerns regarding the extension, however, if a potential breakwater is considered, it would require additional review by DFO as it is potentially a HADD. Transport Canada should also be consulted as it may be considered a navigational hazard.

5.5 Alternate Site for Revelstoke

While possible alternative sites to the Centennial Park ramp were discussed, no other sites were assessed. Given the flow levels in the Mid-Columbia River during which time the extension would be required, navigation through this section of river is difficult and ramps, if constructed, would not be usable. The Big Eddy was briefly visited but given that private property surrounds the area, it was not considered a feasible option.

6.0 Archaeological Assessment Overview

M&N Team member Golder Associates Ltd. (Golder) conducted an archaeological overview assessment (AOA) for six existing and proposed boat launch ramp locations in the vicinity of Valemount, Golden on the Kinbasket Reservoir and at Revelstoke on the Revelstoke Reach of the Arrow Lakes Reservoir. The AOA consisted of a combination of background research and a brief preliminary field reconnaissance (PFR). A total of four existing boat launch ramp locations and one proposed new location were examined for this study. A second proposed new location could not be field examined due to land access restrictions. A summary of the findings follows. For the full Archaeological Assessment report, please refer to Appendix D.

6.1 General

No archaeological material or features were observed on or adjacent to any of the existing or proposed boat launch ramp locations during the PFR.

6.2 Valemount Marina

No known archaeological sites are recorded within 500 m of the Valemount Marina project area. The existing ramp and adjacent area was examined during the PFR. The boat launch ramp area is situated on a valley slope with an approximate 11.4% slope. Both the terrain above and below the high-water mark has been modified by past heavy machinery construction activities, as the project area supports numerous structures in addition to the ramp, parking area and access road. The terrain below the high-water mark has been subject to erosion from reservoir fluctuations and wave action.

No artefacts or traces of archaeological remains, or intact sediments that would contain archaeological deposits were identified during reconnaissance. The archaeological potential of the proposed Valemount Marina extension is considered to be low.

It is recommended that no further archaeological work be conducted for this proposed Valemount Marina – Existing Ramp extension.

6.3 Bulldog Creek

No known archaeological sites are recorded within 500 m of the proposed Bulldog Creek ramp and associated facilities area. The area in which the ramp and facilities are proposed was examined during the PFR and occurs on a valley slope-side. The slope below the existing Forest Service Road that would be used to access the ramp is very steep, and previous construction activities and rock blasting have considerable impact to the area. As such, both the terrain above and below the high-water mark have been modified by past heavy machinery construction activities. The terrain below the high-water mark has been subject to erosion from reservoir fluctuations, seasonal and/or intermittent water discharges from Bulldog Creek, and wave action.

No artefacts or traces of archaeological remains, or intact sediments that would contain archaeological deposits were identified during reconnaissance and the archaeological potential is considered low.

It is recommended that no further archaeological work be conducted for the Bulldog Creek Proposed Ramp project.

6.4 Nixon Creek

No previously documented archaeological sites are within 500 m of the Nixon Creek existing ramp and associated facilities project area. The Nixon Creek project area is located on a valley side slope and fan landform. The ramp area itself is situated on an approximately 15% slope. Disturbance from reservoir fluctuations and wave action has removed intact sediments leaving behind a cobble and gravel surface below the high water mark. Above the high water mark, the access road leading from the Forest Service Road and parking facilities have been created by heavy machinery construction activities and, thus, are heavily disturbed.

No artefacts or traces of archaeological remains, or intact sediments that would contain archaeological deposits were identified during reconnaissance, and the archaeological potential is considered low.

It is recommended that no further archaeological work be conducted for this proposed Nixon Creek – Existing Ramp extension.

6.5 Bush Harbour

There are no recorded archaeological sites within 500 m of the Bush Harbour existing ramp and associated facilities project area. The existing ramp has been constructed on a valley side slope, which has a grade of approximately 12%. The current parking area has been deeply disturbed by ground levelling, and constructed access roads lead from the Forest Service Road through previously harvested forest into the parking area.

The below high-water area of the existing ramp project area has been eroded by reservoir fluctuation and wave action, and has been impacted by the construction of the gravel ramp structures. The presence of in-situ tree stumps suggests that the beach has been eroded to a depth of approximately 0.5 m.

No artefacts or traces of archaeological remains were identified during reconnaissance and the archaeological potential is considered low.

It is recommended that no further archaeological work be conducted for this proposed Bush Harbour – Existing Ramp extension.

6.6 Centennial Park

No previously recorded archaeological sites are found within 500 m of the Centennial Park existing ramp and associated facilities project area. Site EfQn-1 is approximately 3 km west of the property, across the Columbia River/Upper Arrow Lake Reservoir.

The ramp is constructed on the shoreline of the river/reservoir, which maintains a slope of approximately 9%. Prior to construction of the boat launch and associated parking and picnicking areas, the landform served the City of Revelstoke as a landfill site. As such, the entire boat launch area has been massively disturbed and reworked with imported materials. The ramp terminates on a gravel beach strewn with modern debris (i.e., concrete blocks, asphalt, etc.) and boulders.

No artefacts or traces of archaeological remains were identified during reconnaissance of the Centennial Park project area and the archaeological potential is considered low.

It is recommended that no further archaeological work be conducted for this proposed Centennial Park – Existing Ramp extension.

6.7 Alternate Site for Revelstoke

Big Eddy is an undeveloped, proposed alternative site for boat ramp and associated facilities construction. It is on the west side of the Columbia River/Upper Arrow Lake Reservoir. This location was not subject to pedestrian reconnaissance due to restricted private property access. As a result, a field reconnaissance to determine the archaeological potential of this proposed location could not be completed.

Previously recorded archaeological site EfQn-1 is in the Big Eddy area. Due to the private property access restriction, the site could not be accessed to determine if it is in conflict with the Big Eddy alternative ramp and associated facilities project area.

It is recommended that a field examination of any proposed ramp and facilities location in the Big Eddy area be conducted to determine if AIA is warranted prior to commencement of land altering activities.

7.0 Cost Benefit Analysis

While assessing the capital and maintenance costs of the proposed ramp improvements is relatively straight forward, assessing the benefits in this case is much more difficult, at least in quantitative terms. BCH does not currently charge a fee for using the boat ramps, so there are no actual revenues associated with these facilities. Apart from meeting BCH's goals and commitments under the Columbia River Water Use Planning Process, there does not appear to be any direct financial benefit to offset against the capital costs. There are also no usage statistics to indicate how many boaters take advantage of the Kinbasket Reservoir amenities, nor the seasonal distribution of that use. It is therefore impossible to quantify the non-financial societal benefits based on industry averages or other "rules of thumb".

To develop quantitative cost/benefit ratios or internal rates of return, it would first be necessary to conduct a number of socio-economic studies which are outside the scope of this assignment, such as collecting seasonal usage statistics, conducting market surveys, estimating population growth projections and demographic shifts over time, and so forth.

On a qualitative basis, some of the societal benefits which may accrue from the ramp improvements include:

- Improved access for area residents to recreational activities (e.g. fishing, boating);
- Short-term economic spin-off in the region from the construction program (employment wages, taxes, materials purchases, meals and accommodations during construction): and,
- Long-term economic spin-off from increased usage, tourism, and local resident day-trips to the area.

Since it is not possible to establish a "dollar value equivalent" for these societal benefits, it is necessary to make a value judgement on the viability of each project on its own merits.

The boat launch ramp concepts reviewed by the WUP CC were less sophisticated; for example, gravel surfacing for the ramps, no floating walkways, no turnarounds which are in line with the community needs and expectations. It is quite likely that costs were based on the work being done during early spring when there is lots of equipment available at reduced rates.

The estimated costs of making the improvements noted on the drawings are summarized in the tables below. Cost estimates are considered upper bound, order-of-magnitude estimates based on providing the maximum possible benefit. In each case, the proposed improvements could be scaled back to provide less benefit at a correspondingly reduced cost.

7.1 Valemount Marina

Table 7.1 provides the estimated construction cost for extending the existing ramp at Valemount Marina to the WUP CC recommended end of ramp El. 728.7 m. It is assumed that the existing walkway floats will service the boat ramp extension and no provision has been made for walkway floats at Valemount Marina.

Table 7.2 shows the estimated additional cost for dredging a 160 m long, 6 m wide access channel to the lake bed contour at El. 724 m. It is assumed that the dredging of the access channel can be done using land based excavators during the low water months of March and April. By dredging the access channel, the existing Valemount Marina boat launch ramp would also satisfy the WUP CC recommended end of ramp water level El. 723.9 m for Bulldog Creek. The Valemount community would therefore have access to lower reservoir water levels at the Valemount Marina, which has the advantages of being closer to the community and the existing upland infrastructure to accommodate boaters.

Table 7.3 illustrates the estimated annual maintenance cost for the boat launch ramp. The removal of sand debris on the ramp is based on a 150 mm build-up on the ramp. The other items in the Table are provisional sums.

Table 7.1: Valemount Marina – Extend Existing Ramp

Item No.	Item Description	Unit	Quantity	Rate	Total
1	Excavate, backfill and grade slope for ramp extension	m^3	439	$ 18	$ 7,900
2	Ramp extension including turnaround, include concrete reinforcement formwork	m^3	159	$ 275	$ 43,700
3	Scour protection for ramp extension	m^3	561	$ 28	$ 15,700
				Sub-Total	$ 67,300
				Mobilization / Demobilization (5% of Total)	$ 3,400
				Contingencies (10 %)	$ 6,700
				Total	**$ 77,400**

Table 7.2: Valemount Marina – Dredge Access Channel

Item No.	Item Description	Unit	Quantity	Rate	Total
1	Dredging	m^3	6250	$ 18	$ 112,500
2	Rock berm	m^3	960	$ 28	$ 26,900
				Total	**$ 139,400**

Table 7.3: Valemount Marina – Estimated Annual Maintenance

Item No.	Item Description	Unit	Quantity	Rate	Total
1	Remove sand build-up on ramp	m^3	110	$ 18	$ 2,000
2	Repair floats	Sum	-	-	$ 3,000
3	Repair cracks in existing concrete slab	Sum	-	-	$ 3,000
4	Maintain access channel	Sum	-	-	$ 3,000
5	Repair scour protection	Sum	-	-	$ 3,000
				Total	**$ 14,000**

7.2 Bulldog Creek

The Bulldog Creek site is an undeveloped site for an alternative boat launch site to Valemount Marina. Table 7.4 shows the estimated cost that would be required to build the potential boat launch ramp. It is assumed that the access road to the ramps would have a gravel surface and the slopes of the ramps would be made of concrete for durability and ease of maintenance. The turnarounds would also have a concrete surface.

Table 7.5 provides the estimated annual maintenance cost for removing silt build-up at the end of the ramp and allowances for repairs to the appurtenances of the ramp.

Table 7.4: Bulldog Creek – New Boat Launch Ramp

Item No.	Item Description	Unit	Quantity	Rate	Total
1	Fill for access road and ramp	m^2	37,800	$ 30	$ 1,134,000
2	Upper water level concrete ramp	m^3	156	$ 275	$ 42,900
3	Intermediate water level concrete ramp	m^3	48	$ 275	$ 13,200
4	Lower water level concrete ramp	m^3	288	$ 275	$ 79,200
5	Upper level turnaround	m^2	1200	$ 44	$ 52,800
6	Intermediate level turnaround	m^2	700	$ 44	$ 30,800
7	Excavation for access channel	m^3	60	$ 18	$ 1,100
				Sub-Total	$ 1,354,000
				Mobilization / Demobilization (5% of Total)	$ 67,700
				Contingencies (10 %)	$ 135,400
				Total	**$ 1,557,100**

Table 7.5: Bulldog Creek – Estimated Annual Maintenance

Item No.	Item Description	Unit	Quantity	Rate	Total
1	Remove sand build-up on ramp	m^3	675	$ 18	$ 12,000
2	Repair scour protection	Sum	-	-	$ 3,000
				Total	**$ 15,000**

7.3 Nixon Creek

Table 7.6 below, provides the estimated cost for provision of a low water level ramp at Nixon Creek. The existing access road to the turnaround would be retained as a gravel surface.

The turnaround and boat launch ramp that would run from El. 733.0 m to El. 712.1 m, would have a reinforced concrete slab for durability and ease of maintenance. Table 7.7 provides the estimated annual maintenance cost for removing silt build-up the end of the ramp and allowances for repairs to the appurtenances of the ramp.

Table 7.6: Nixon Creek – Low Water Level Boat Launch Ramp

Item No.	Item Description	Unit	Quantity	Rate	Total
1	Ramp – reinforced concrete slab including concrete, reinforcement and formwork	m^3	155	$ 275	$ 42,600
2	Turnaround	m^2	700	$ 44	$ 30,800
3	Scour protection	m^3	774	$ 28	$ 21,700
4	Floating breakwaters	m	200	$ 386	$ 77,000
				Sub-Total	$ 172,100
				Mobilization / Demobilization (5% of Total)	$ 8,600
				Contingencies (10 %)	$ 17,200
				Total	**$ 197,900**

Table 7.7: Nixon Creek – Annual Maintenance

Item No.	Item Description	Unit	Quantity	Rate	Total
1	Remove sand built-up on ramp	m^3	98	$ 18	$ 1,800
2	Repairs to floats	Sum	-	-	$ 3,000
3	Repairs to breakwater	Sum	-	-	$ 3,000
4	Repairs to chain anchorages	Sum	-	-	$ 3,000
				Total	**$ 10,800**

7.4 Bush Harbour

Table 7.8 below, provides the estimated cost for a new ramp and turnaround at the Bush Harbour site. A provisional sum is included for the clean-up of the site to remove old logs and derelict tugs. Table 7.9 provides the estimated annual maintenance costs for removing silt build-up at the end of the ramp and allowances for repairs to the appurtenances of the ramp.

Table 7.8: Bush Harbour – New Boat Launch Ramp

Item no.	Item Description	Unit	Quantity	Rate	Total
1	Fill to form upper slope of ramp	m^3	7000	$ 30	$ 210,000
2	Concrete ramp - includes concrete reinforcement and formwork	m^3	312	$ 275	$ 85,800
3	Turnaround	m^2	1225	$ 44	$ 53,900
4	Timber piles for floats	m	594	$ 322	$ 191,300
5	Walkway floats including ramp	m^2	240	$ 453	$ 108,700
6	Clean-up site	Sum			$25,000
				Sub-Total	$ 674,700
				Mobilization / Demobilization (5% of Total)	$ 34,000
				Contingencies (10 %)	$ 67,000
				Total	**$ 775,700**

Table 7.9: Bush Harbour – Estimated Annual Maintenance

Item No.	Item Description	Unit	Quantity	Rate	Total
1	Remove sand built-up on ramp	m^3	234	$ 18	$ 4,200
2	Repair floats	Sum	-	-	$ 3,000
3	Repair scour protection	Sum	-	-	$ 3,000
				Total	**$ 10,200**

7.5 Centennial Park

Table 7.10 below, provides the estimated cost for removal and re-grading the existing ramp slope to 12% and extending the end of the existing ramp to El. 432 m. Estimated construction cost for the rubble mound breakwater assumes land based equipment will build the breakwater using the shore access adjacent to the ramp. Table 7.11 provides the estimated annual maintenance costs for removing silt build-up the end of the ramp and allowances for repairs to the appurtenances of the ramp.

Table 7.10: Centennial Park – Proposed Modification to Existing Ramp

Item No.	Item Description	Unit	Quantity	Rate	Total
1	Demolish existing ramp	m^3	242	$ 17	$ 4,100
2	New ramp concrete slab includes concrete, reinforcement and formwork	m^3	75	$ 275	$ 20,600
3	Floating walkway	m^2	12	$ 453	$ 5,400
4	Steel piling for float anchorage	m	60	$ 480	$ 28,800
5	Gangway	No.	1	$ 25,000	$ 25,000
				Sub-Total	$ 83,900
				Mobilization / Demobilization (5% of Total)	$ 4,200
				Contingencies (10 %)	$ 8,400
				Total	**$ 96,500**

Table 7.11: Centennial Park – Estimated Annual Maintenance Cost

Item No.	Item Description	Unit	Quantity	Rate	Total
1	Remove sand built-up on ramp	m^3	56	$ 18	$ 1,000
2	Repair floats	Sum	-	-	$ 3,000
3	Repair scour protection	Sum	-	-	$ 4,000
				Total	**$ 8,000**

In reviewing the above cost estimates, it is important to note the following:

- The estimates are concept level only and are not intended to be used to establish a project budget. The estimates are intended to provide an indication of the probable costs to determine which boat launch ramp facility alternative(s) warrant further consideration.
- The estimates are based on Moffatt & Nichol's in-house experience and data for projects of a similar nature.
- The estimates are based upon mid-2006 to early 2007 price levels in Canadian dollars, and do not allow for escalation.
- The estimated costs for supplying the walkway floats are based on a quotation from Blue Water Systems Limited for a steel float and frame chassis with timber decking.
- The estimates exclude any archaeological investigation assessment, additional habitat compensation programmes, removal and remediation of contaminated materials and other hazardous waste.
- A contingency allowance of 10% was included in the cost estimates to cover unforeseen construction costs at the feasibility stage of this project.
- The estimates exclude the GST.

Table 7.12: Cost Estimates Summary for Various Improvements and Comparison with the WUP CC Estimated Costs

Location	Capital Costs	Annual Maintenance Cost	WUP CC Cost Estimates	WUP CC Annual Maintenance Cost
Valemount Marina	$ 77,400[2]	$ 17,000	$ 30,000	$ 12,500
Bulldog Creek	$ 1,557,100	$ 15,000	$ 87,000	$ 3,000
Nixon Creek	$ 197,900	$ 10,800	$ 136,000	$ 12,500
Bush Harbour	$ 775,700	$ 10,200	$ 46,290	$ 12,500
Centennial Park	$ 96,500	$ 8,000	$ 200,000	$ 12,500

[2] Not including the dredging option with an associated cost of $139,000

8.0 Conclusions and Recommendations

Our general conclusions and recommendations about the various sites are as follows:

8.1 Valemount Marina

The existing boat launch ramp at Valemount Marina has the potential to be extended further into the lake to improve the low water access and to meet the WUP CC recommended end-of-ramp elevation of El. 729.9 m. At this elevation, access to the reservoir would be 43% and 14% for the months of March and April, a marginal improvement over current access of 19% and 8% respectively for the same months.

It is possible for the existing ramp to be extended further to accommodate boat launches to El. 724 m, which would provide 70% to 65% access during the low water months. In this case, a dredged channel approximately 160 m long at end of the extended ramp would be required.

It is recommended that the existing ramp be extended and fitted with a new turnaround area.

Consideration should be given to a dredged channel at the end of the extended Valemount Marina ramp to meet the WUP CC water level recommended El. 724 m for Bulldog Creek. This option would eliminate the need to develop the Bulldog Creek site. The other advantages with the option include lower water level access at Valemount Marina, closer proximity to the Valemount community, and the site has upland infrastructure already in place. The additional cost for the dredged channel is approximately $139,000.

The dredged option at Valemount Marina would save approximately $1.34 million by not providing a boat launch ramp at Bulldog Creek.

8.2 Bulldog Creek

The Bulldog Creek site is not considered feasible for the following reasons:

- Large capital cost to construct road access to the low water level launch site which is 0.5 km from the FSR.
- Possible safety issues with travelling to the section of the FSR from Valemount Marina to the site including long term road maintenance issues with the forestry company operating in the area.
- The site is located near a fish bearing stream and is not desirable from an environmental perspective.

8.3 Nixon Creek

The Nixon Creek is a desirable site as there is low water level access to the reservoir (El. 713.3 m), and the natural slope for low water level boat launches is available at this site, but is not feasible for the following reasons:

- The access road from the FSR to the launch site is no longer maintained by LP and therefore, there is the concern for public safety to access the boat launch site in the future if the access road is not maintained.

- The long term maintenance of the FSR to Nixon Creek is dependant on the economic viability of logging operations in the area. Consequently, public safety for travel on the FSR road in the long term will become an issue.
- Large volumes of fill would be required to modify the upper section of the ramp to make it usable for high water level launches, so the site is limited to low water level launches.
- Long "(winter)" travel distance to the site.

8.4 Bush Harbour

The Bush Harbour site is feasible for development into a boat launch site. The site has sufficient water depth to meet the recommended WUP CC end of ramp El. 726.9 m. The natural slope of the existing ground allows the construction of a boat launch ramp with minimal filling and grading of the site. There is sufficient upland area for parking and turnaround at this site.

Nearby residences and other commercial interest in the vicinity are responsible for maintaining access to the site.

Also, there are no major environmental or archaeological factors that would deter construction of a boat launch at this site.

8.5 Centennial Park

The existing Centennial Park boat launch site is the most convenient site due to its close proximity to the City of Revelstoke. This site has safety concerns due to strong currents at the end of the ramp during low water months and the rapid fluctuation of water levels due to the nearby power generating station at Revelstoke Dam.

It is possible that a rubble-mound breakwater could be constructed at the end of boat launch ramp to deflect the currents away from the boat launch site, so that better control of the boat movements during launches can be achieved. The high capital costs of providing a rubble mound breakwater is not practical for boat launch protection when the reservoir level is low, i.e. in the winter and spring months when facility use is also low. However, the cost can be reduced using a different layout for use only during the fishing season of mid-June to mid August.

It is recommended that the following improvements are made to the existing ramp:

- Re-grade existing ramp to 12% slope to improve boat launching conditions.
- Provide new walkway access along the existing ramp.

9.0 Closure

This report has been prepared for the sole benefit of BC Hydro and its agents, and may not be used by any third party without the expressed written consent of Moffatt & Nichol and BC Hydro. Any use of this document by a third party is at the sole risk of such third party. The statements and conclusions presented herein are valid as of the date of publication. Future changes in the conditions affecting the underlying assumptions of this report may alter its findings and the conclusions. Moffatt & Nichol does not undertake to revise and update this report should future events reflect changed conditions.

We trust that this report meets BC Hydro's requirements at this time. Should you have any questions, or if we can be of further assistance, please contact the undersigned at any time.

Prepared by:

MOFFATT & NICHOL

[Original signed by: Paul Hoo]

Paul Hoo, P.Eng.
Project Manager

Reviewed by:

MOFFATT & NICHOL

[Original signed by: Ron Byres]

Ron Byres, P.Eng.
Senior Project Manager

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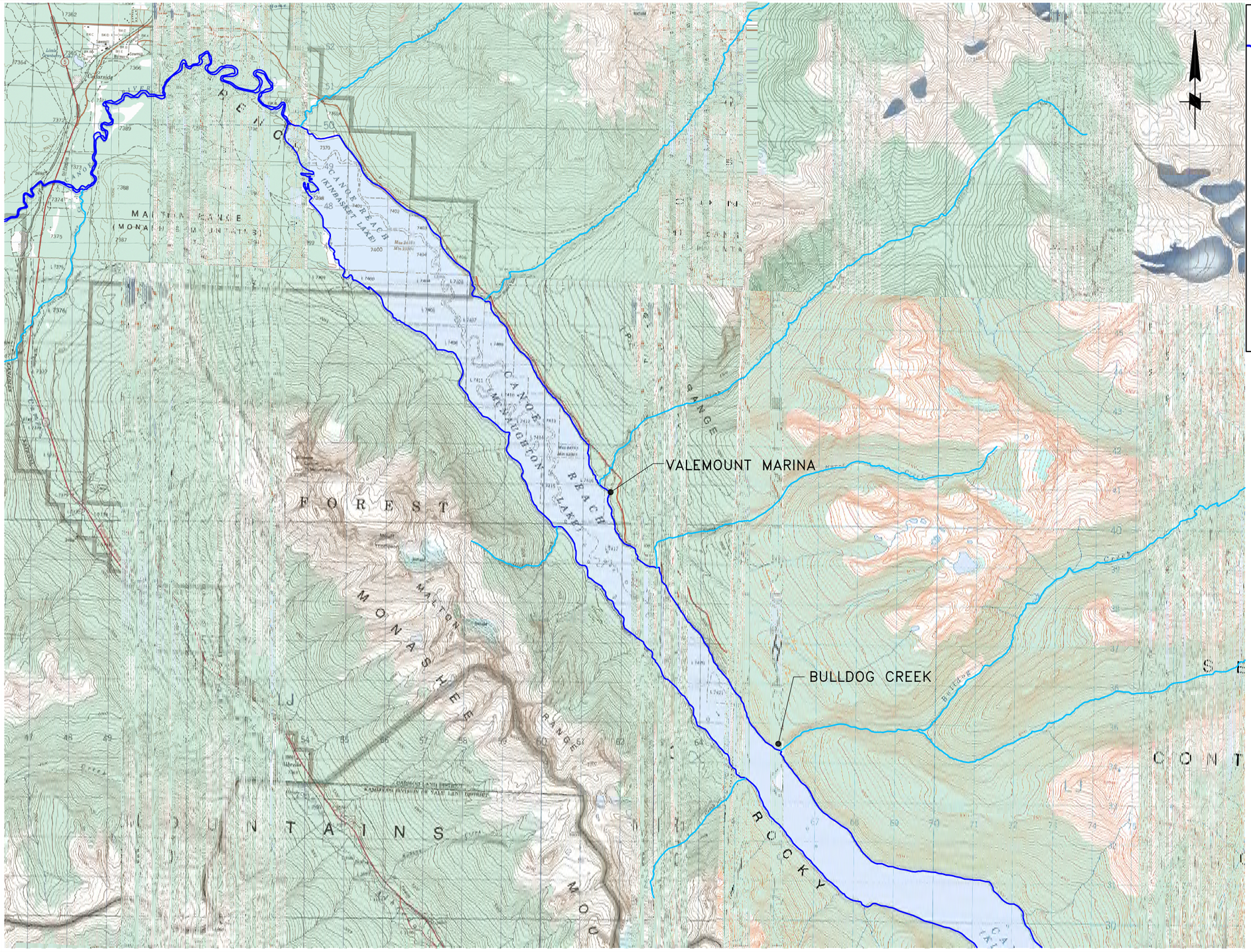
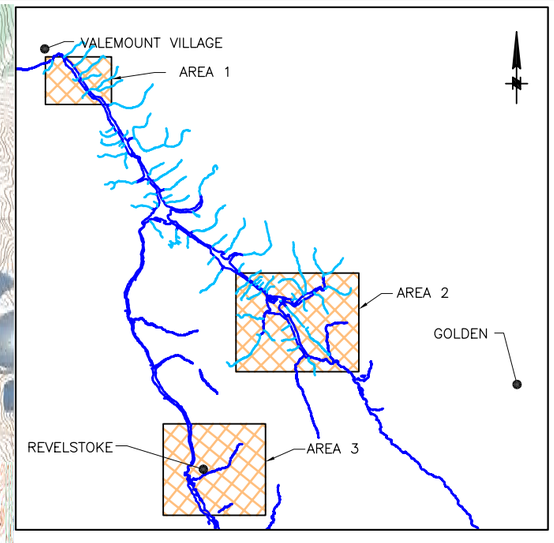
Appendix A:
Drawings





KEY PLAN
N.T.S.

NOTES:

1. MAP ADAPTED FROM TOPOGRAPHIC MAP PRODUCED BY THE CANADA CENTRE FOR MAPPING, NATURAL RESOURCES CANADA, UPDATED FROM LARGE SCALE MAPS. INFORMATION IS CURRANT AS SHOWN IN DIAGRAM, PUBLISHED 1995.
2. SOURCE: BRITISH COLUMBIA WATERSHED AREA ATLAS.

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

1000m 0m 1000m 2000m
SCALE: 1 : 50000

No.	Date	DESCRIPTION	Dr'n	Ch'd
C	OCT5/07	ISSUED FOR FINAL REPORT	JL	PH
B	JULY31/07	ISSUED FOR DRAFT REPORT	JL	PH
A	JULY20/07	ISSUED FOR DISCUSSION	JL	PH

CLIENT:

IN ASSOCIATION WITH:

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DESIGN	DRAWN	CHK'D	APP'D
PH	JL	–	--

DATE: JUNE18/07
DRAWING NUMBER: 6258-100

KINBASKET & ARROW LAKES RESERVOIR BOAT LAUNCH RAMP FEASIBILITY STUDY

SITE LOCATION PLAN AREA 1 – VALEMOUNT

SCALE: AS SHOWN

C

DATE: 2007/10/02 – 10:46am
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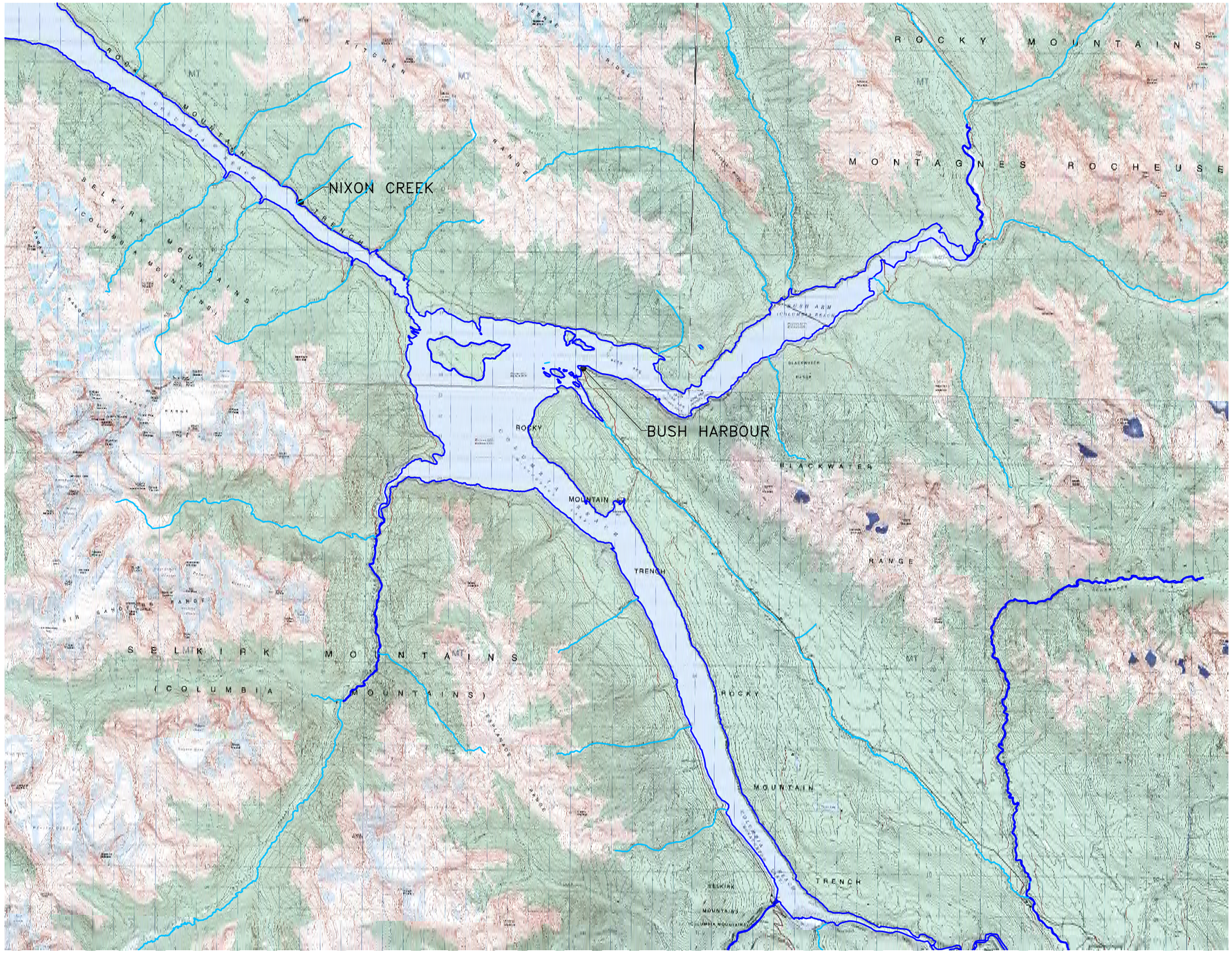
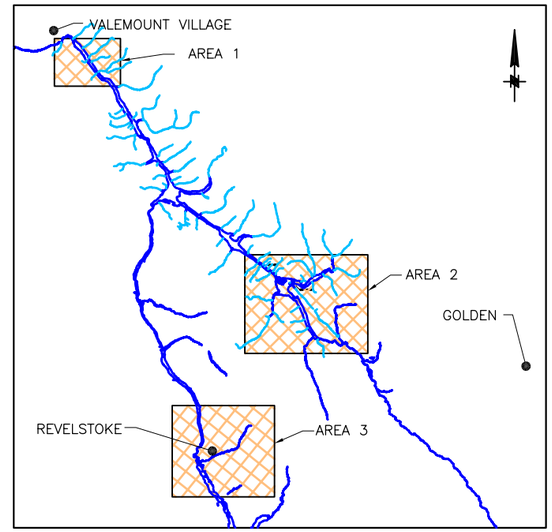




KEY PLAN
N.T.S.

NOTES:

1. MAP ADAPTED FROM TOPOGRAPHIC MAP PRODUCED BY THE CANADA CENTRE FOR MAPPING, NATURAL RESOURCES CANADA, UPDATED FROM LARGE SCALE MAPS. INFORMATION IS CURRANT AS SHOWN IN DIAGRAM, PUBLISHED 1995.
2. SOURCE: BRITISH COLUMBIA WATERSHED AREA ATLAS.

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

2000m 0m 2000m 4000m
SCALE: 1 : 100000

No.	Date	DESCRIPTION	Dr'n	Ch'd
C	OCT5/07	ISSUED FOR FINAL REPORT	JL	PH
B	JULY31/07	ISSUED FOR DRAFT REPORT	JL	PH
A	JULY20/07	ISSUED FOR DISCUSSION	JL	PH

CLIENT: BC hydro

IN ASSOCIATION WITH: Atek HYDROGRAPHIC SURVEYS LTD. 4740 Joyce Avenue Powell River, BC, V8A 3B6 phone 604 485 0205 fax 604 485 0200; TRITON ENVIRONMENTAL CONSULTANTS LTD.; Golder Associates

MOFFATT & NICHOL
777 WEST BROADWAY, SUITE 301
VANCOUVER, BC, CANADA, V5Z 4J7
604-707-9004

DESIGN	DRAWN	CHK'D	APP'D
PH	JL	–	––

DATE: JUNE18/07
DRAWING NUMBER: 6258-101

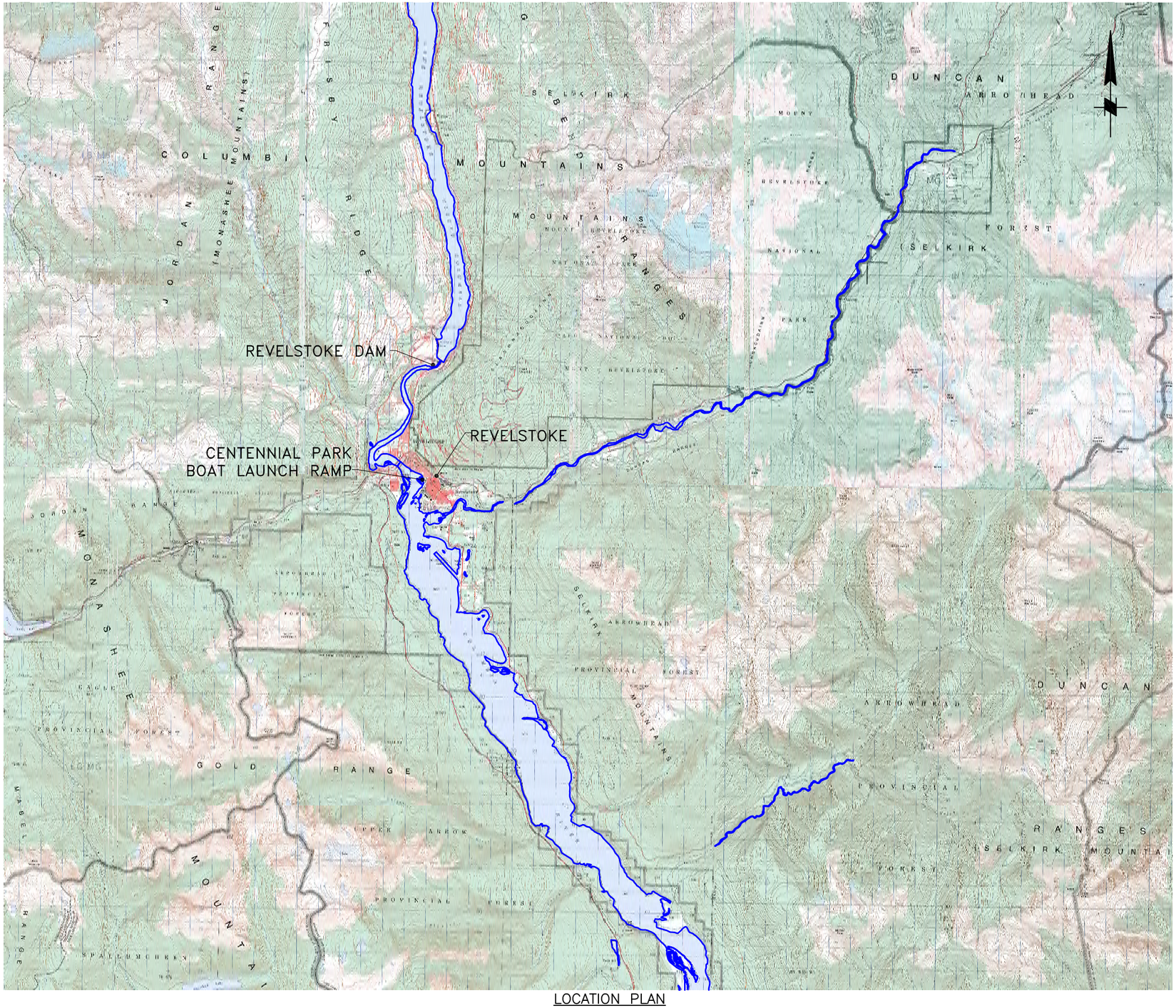
KINBASKET & ARROW LAKES RESERVOIR BOAT LAUNCH RAMP FEASIBILITY STUDY

SITE LOCATION PLAN AREA 2 – GOLDEN

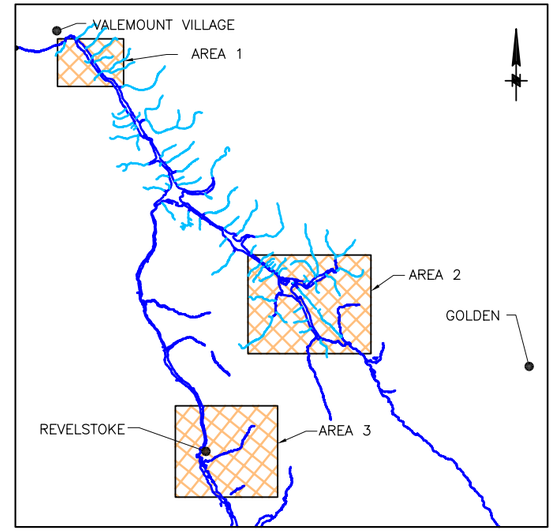
SCALE: AS SHOWN

C

DATE: 2007/10/02 - 11:48am
PATH: P:\6258 Kinbasket & Arrow Lakes Reservoir Recreational Management Plan\CADD\Submittal\ISSUED FILE\2007-10-05_FINAL REPORT\101.dwg



LOCATION PLAN
1:10,000 (SEE NOTE 2)



KEY PLAN
N.T.S.
(SEE NOTE 1)

NOTES:

1. MAP ADAPTED FROM TOPOGRAPHIC MAP PRODUCED BY THE CANADA CENTRE FOR MAPPING, NATURAL RESOURCES CANADA, UPDATED FROM LARGE SCALE MAPS. INFORMATION IS CURRANT AS SHOWN IN DIAGRAM, PUBLISHED 1995.
2. SOURCE: BRITISH COLUMBIA WATERSHED AREA ATLAS.

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

2000m 0m 2000m 4000m

No.	Date	DESCRIPTION	Dr'n	Ch'd
C	OCT5/07	ISSUED FOR FINAL REPORT	JL	PH
B	JULY31/07	ISSUED FOR DRAFT REPORT	JL	PH
A	JULY20/07	ISSUED FOR DISCUSSION	JL	PH

CLIENT: BC hydro

IN ASSOCIATION WITH: Atek HYDROGRAPHIC SURVEYS LTD. 4740 Joyce Avenue Powell River, BC, V8A 3B6 phn 604 485 0205 faxx 604 485 0200; TRITON ENVIRONMENTAL CONSULTANTS LTD. Richmond 604-279-2063 Prince George 250-962-8155 Terrace 250-635-1464 www.triton-env.com; Golder Associates

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777 WEST BROADWAY, SUITE 301
VANCOUVER, BC, CANADA, V5Z 4J7
604-707-9004

DESIGN	DRAWN	CHK'D	APP'D
PH	JL	–	––

DATE: JUNE18/07
DRAWING NUMBER: 6258-102

KINBASKET & ARROW LAKES RESERVOIR
BOAT LAUNCH RAMP FEASIBILITY STUDY
SITE LOCATION PLAN
AREA 3 – REVELSTOKE

SCALE: AS SHOWN

C

DATE: 2007/10/02 – 12:19pm
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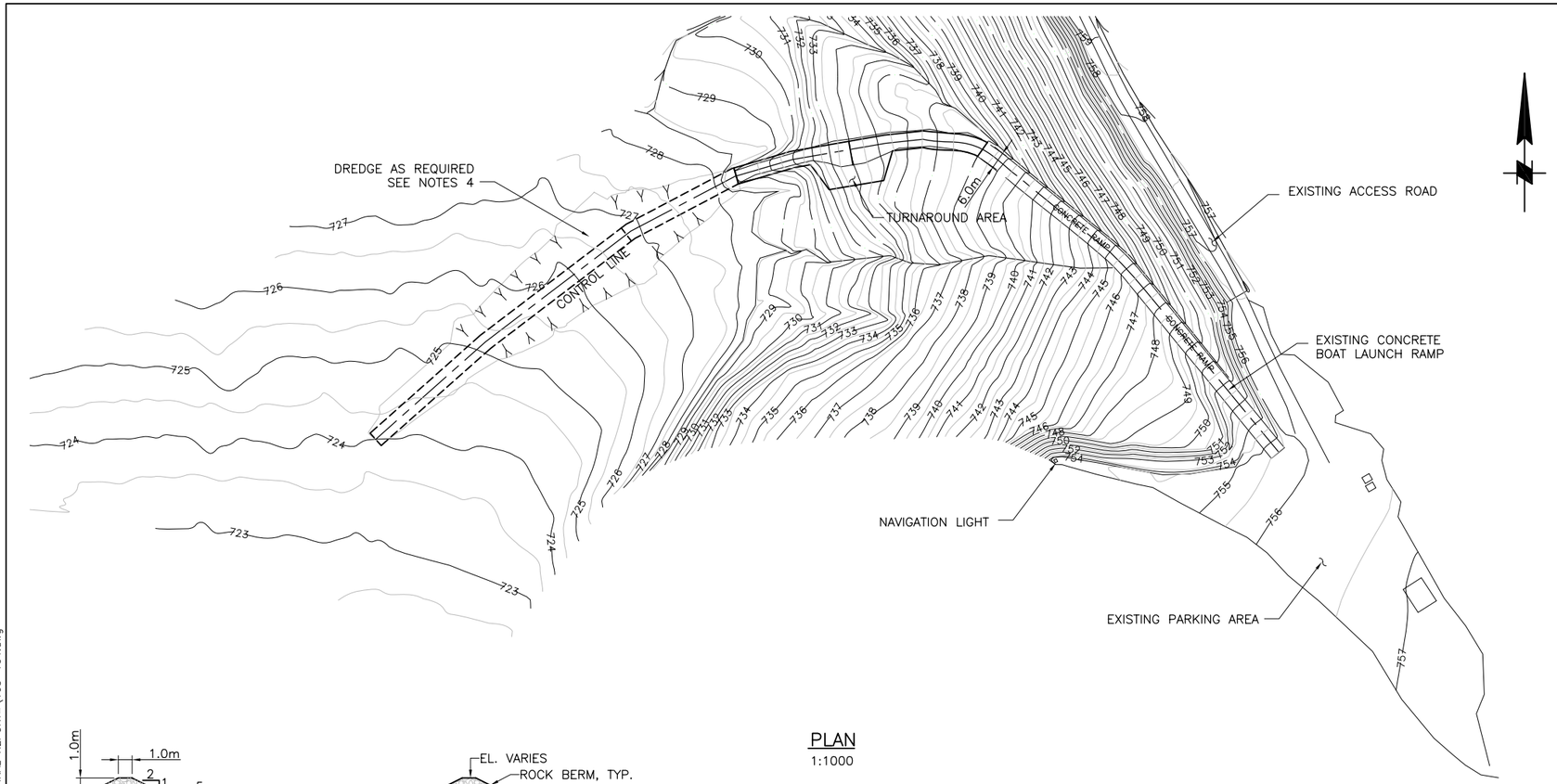
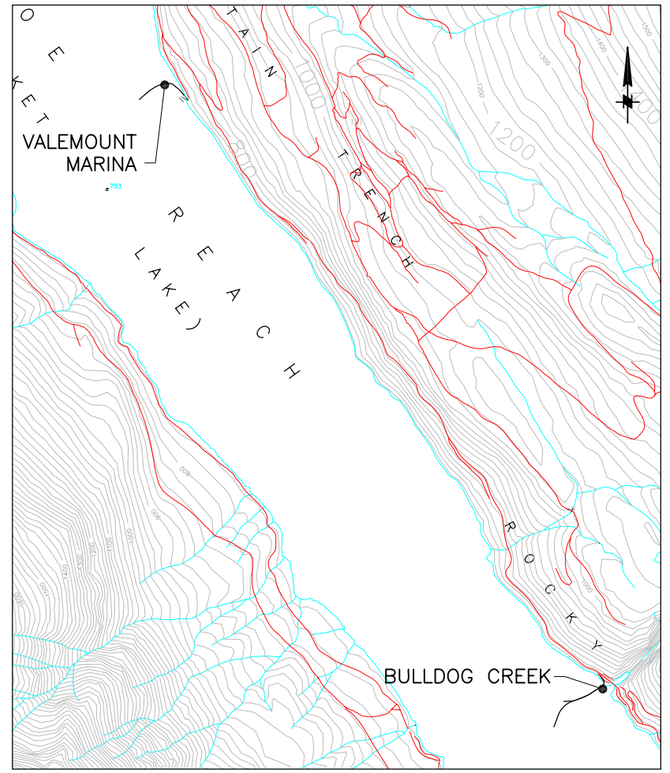
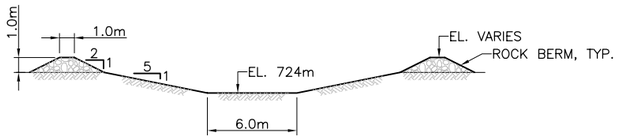


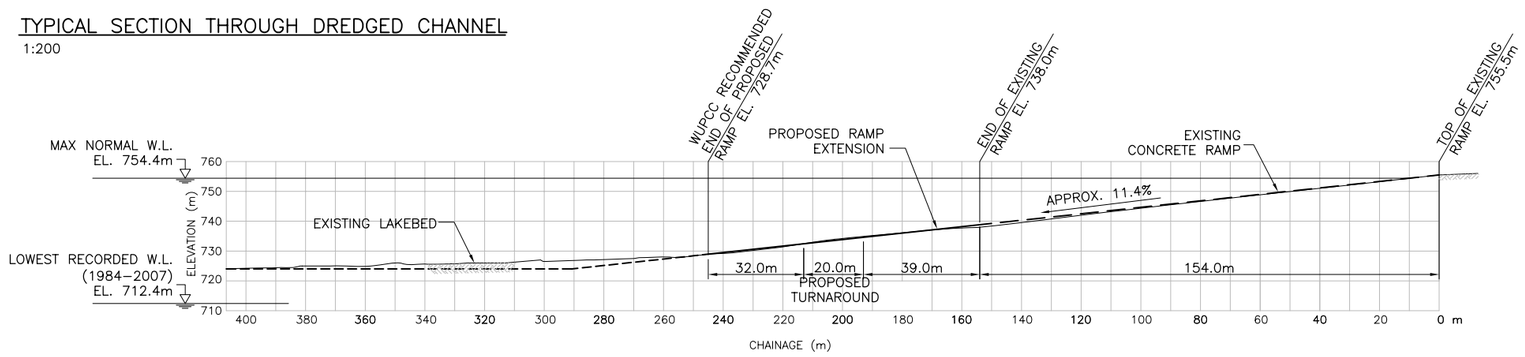
PLAN
1:1000



KEY PLAN
N.T.S.



TYPICAL SECTION THROUGH DREDGED CHANNEL
1:200



PROFILE ALONG CONTROL LINE
1:1000

NOTES:

1. CONTOURS ARE IN METRES TO GEODETIC DATUM AND ARE BASED ON HYDROGRAPHIC SURVEYS CONDUCTED BY ATEK HYDROGRAPHIC SURVEYS LTD ON MAY 25–26, 2007.
2. EXISTING WALKWAY AND MARINA FLOATS ARE NOT SHOWN.
3. END OF PROPOSED BOAT LAUNCH RAMP IS BASED ON THE WUP CC RECOMMENDED ACCESS ELEVATION OF 729.9m (2395 FT) FOR VALEMOUNT MARINA, LESS 1.2m ALLOWANCE FOR ADEQUATE LAUNCHING DEPTH.
4. A DREDGED CHANNEL AT VALEMOUNT MARINA IS POSSIBLE TO ACHIEVE WUP CC RECOMMENDED ACCESS ELEVATION OF 723.9m REQUIRED FOR BULLDOG CREEK.

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

20m 0m 20m 40m

No.	Date	DESCRIPTION	Dr'n	Ch'd
C	OCT5/07	ISSUED FOR FINAL REPORT	JL	PH
B	JULY31/07	ISSUED FOR DRAFT REPORT	JL	PH
A	JULY20/07	ISSUED FOR DISCUSSION	JL	PH

CLIENT: BC hydro

IN ASSOCIATION WITH: Atek HYDROGRAPHIC SURVEYS LTD. 4740 Joyce Avenue Powell River, BC, V8A 3B6 phone 604 485 0205 fax 604 485 0200; TRITON ENVIRONMENTAL CONSULTANTS LTD.; Golder Associates

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604–707–9004

DESIGN	DRAWN	CHK'D	APP'D
PH	JL	–	––

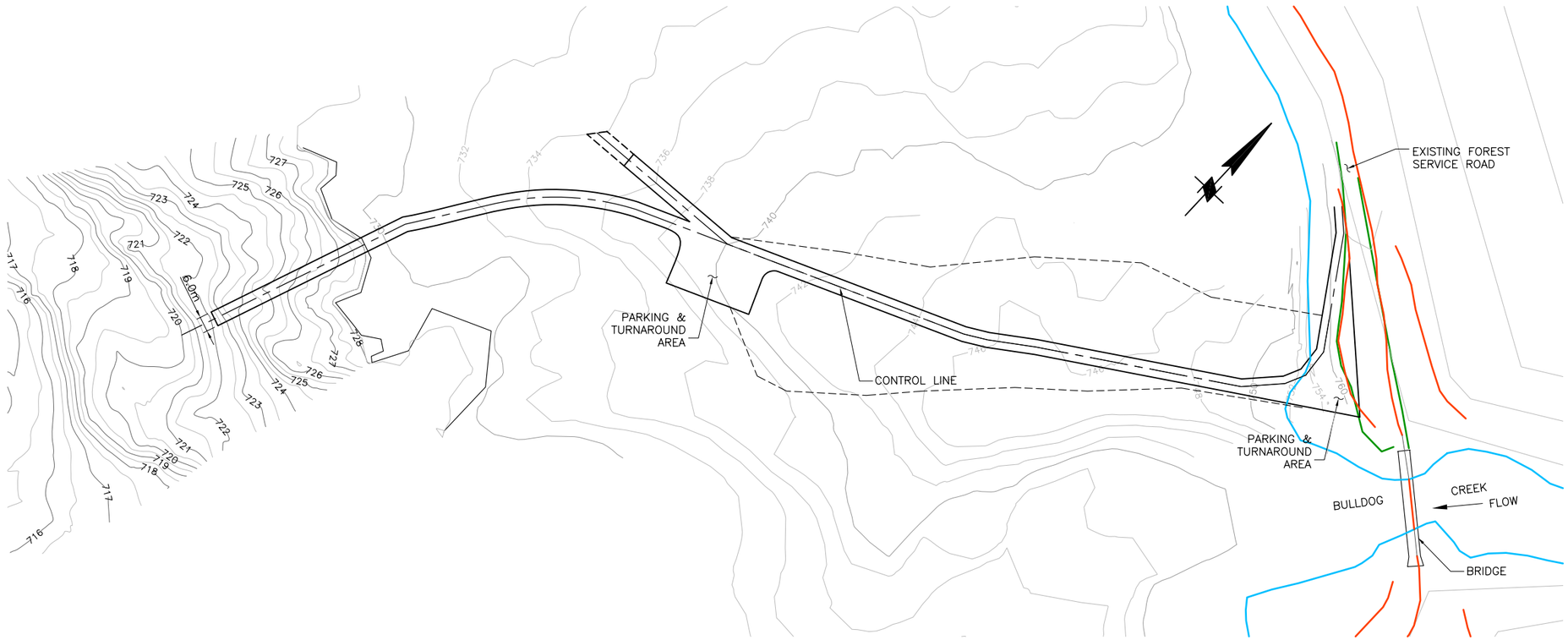
DATE: JUNE18/07
DRAWING NUMBER: 6258–103

KINBASKET & ARROW LAKES RESERVOIR
BOAT LAUNCH RAMP FEASIBILITY STUDY
VALEMOUNT MARINA

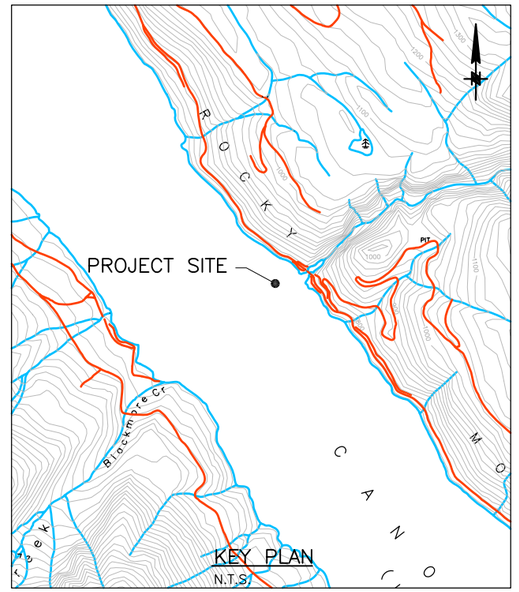
SCALE: AS SHOWN

C

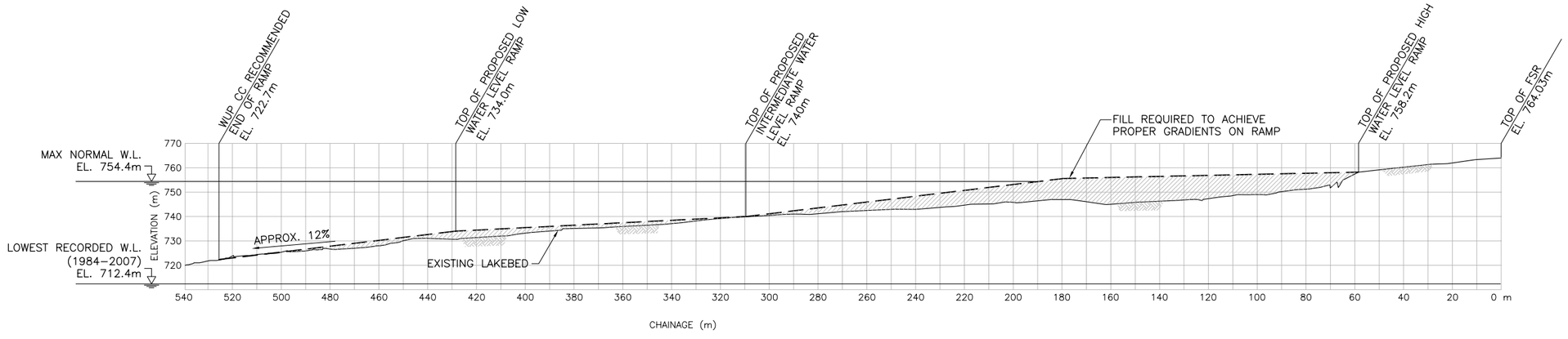
DATE: 2007/10/02 – 11:28am
PATH: P:\6258 Kinbasket & Arrow Lakes Reservoir Recreational Management Plan\CADD\Submittal\ISSUED FILE: 2007-10-05_FINAL REPORT\103–104.dwg



PLAN
1:1000



KEY PLAN
N.T.S.



PROFILE ALONG CONTROL LINE
1:1000

NOTES:

1. CONTOURS ARE IN METRES TO GEODETIC DATUM AND ARE BASED ON HYDROGRAPHIC SURVEY CONDUCTED BY ATEK HYDROGRPAPHIC SURVEYS LTD ON MAY 25, 2007.
2. END OF PROPOSED BOAT LAUNCH RAMP IS BASED THE WUP CC RECOMMENDED ACCESS ELEVATION OF 723.9 (2375.1FT) FOR BULLDOG CREEK, LESS 1.2m ALLOWANCE FOR ADEQUATE LAUNCHING DEPTH.

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

20m 0m 20m 40m

No.	Date	DESCRIPTION	Dr'n	Ch'd
C	OCT5/07	ISSUED FOR FINAL REPORT	JL	PH
B	JULY31/07	ISSUED FOR DRAFT REPORT	JL	PH
A	JULY20/07	ISSUED FOR DISCUSSION	JL	PH

CLIENT: BC hydro

IN ASSOCIATION WITH: Atek HYDROGRAPHIC SURVEYS LTD. 4740 Joyce Avenue Powell River, BC, V8A 3B6 phone 604 485 0205 fax 604 485 0200; TRITON ENVIRONMENTAL CONSULTANTS LTD.; Golder Associates

MOFFATT & NICHOL
777 WEST BROADWAY, SUITE 301
VANCOUVER, BC, CANADA, V5Z 4J7
604–707–9004

DESIGN	DRAWN	CHK'D	APP'D
PH	JL	–	––

DATE: JUNE18/07
DRAWING NUMBER: 6258–104

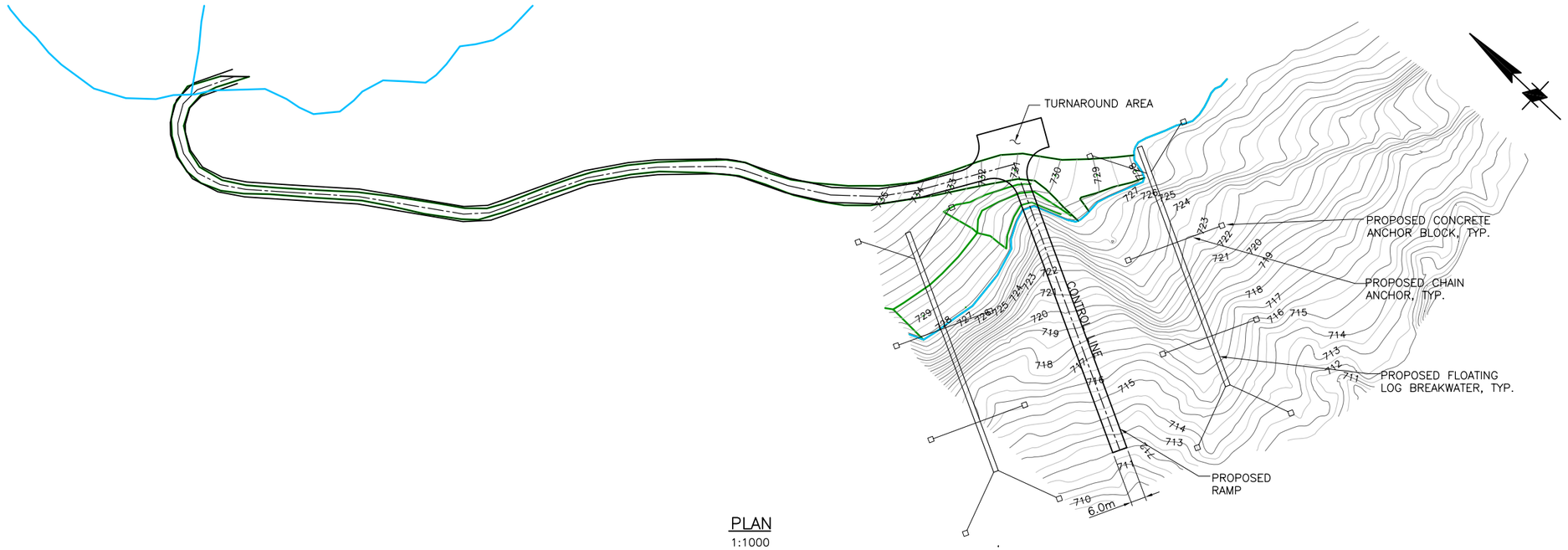
KINBASKET & ARROW LAKES RESERVOIR BOAT LAUNCH RAMP FEASIBILITY STUDY

BULLDOG CREEK

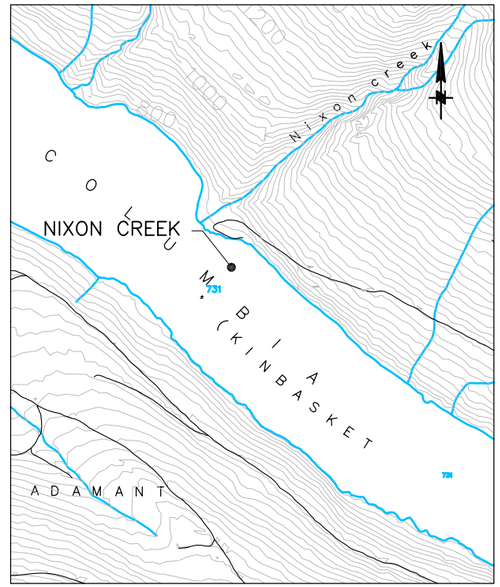
SCALE: AS SHOWN

C

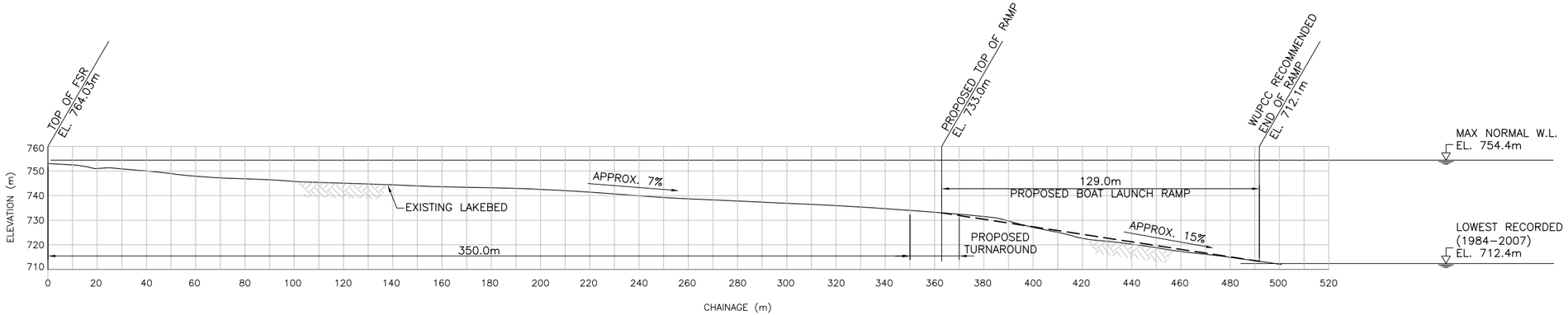
DATE: 2007/10/02 – 11:29am
PATH: P:\6258 Kinbasket & Arrow Lakes Reservoir Recreational Management Plan\CADD\Submittal\ISSUED FILE\2007-10-05_FINAL REPORT\103–104.dwg



PLAN
1:1000



KEY PLAN
N.T.S.



PROFILE ALONG CONTROL LINE
1:1000

NOTES:

1. CONTOURS ARE IN METRES TO GEODETIC DATUM AND ARE BASED ON A HYDROGRAPHIC SURVEY CONDUCTED BY ATEK HYDROGRAPHIC SURVEYS LTD ON MAY 23, 2007.
2. END OF PROPOSED BOAT LAUNCH RAMP IS BASED ON THE WUP CC RECOMMENDED ACCESS ELEVATION OF 713.3m (2340 FT) FOR NIXON CREEK, LESS 1.2m ALLOW FOR ADEQUATE LAUNCHING DEPTH.

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

20m 0m 20m 40m

No.	Date	DESCRIPTION	Dr'n	Ch'd
C	OCT5/07	ISSUED FOR FINAL REPORT	JL	PH
B	JULY31/07	ISSUED FOR DRAFT REPORT	JL	PH
A	JULY19/07	ISSUED FOR DISCUSSION	JL	PH

CLIENT: BC hydro

IN ASSOCIATION WITH: Atek HYDROGRAPHIC SURVEYS LTD. 4740 Joyce Avenue Powell River, BC, V8A 3B6 phc 604 485 0205 fax: 604 485 0200; TRITON ENVIRONMENTAL CONSULTANTS LTD.; Golder Associates

MOFFATT & NICHOL
777 WEST BROADWAY, SUITE 301
VANCOUVER, BC, CANADA, V5Z 4J7
604–707–9004

DESIGN	DRAWN	CHK'D	APP'D
PH	JL	–	––

DATE: JUNE18/07 DRAWING NUMBER: 6258–105

KINBASKET & ARROW LAKES RESERVOIR BOAT LAUNCH RAMP FEASIBILITY STUDY

NIXON CREEK

SCALE: AS SHOWN

C

DATE: 2007/10/02 – 11:31am
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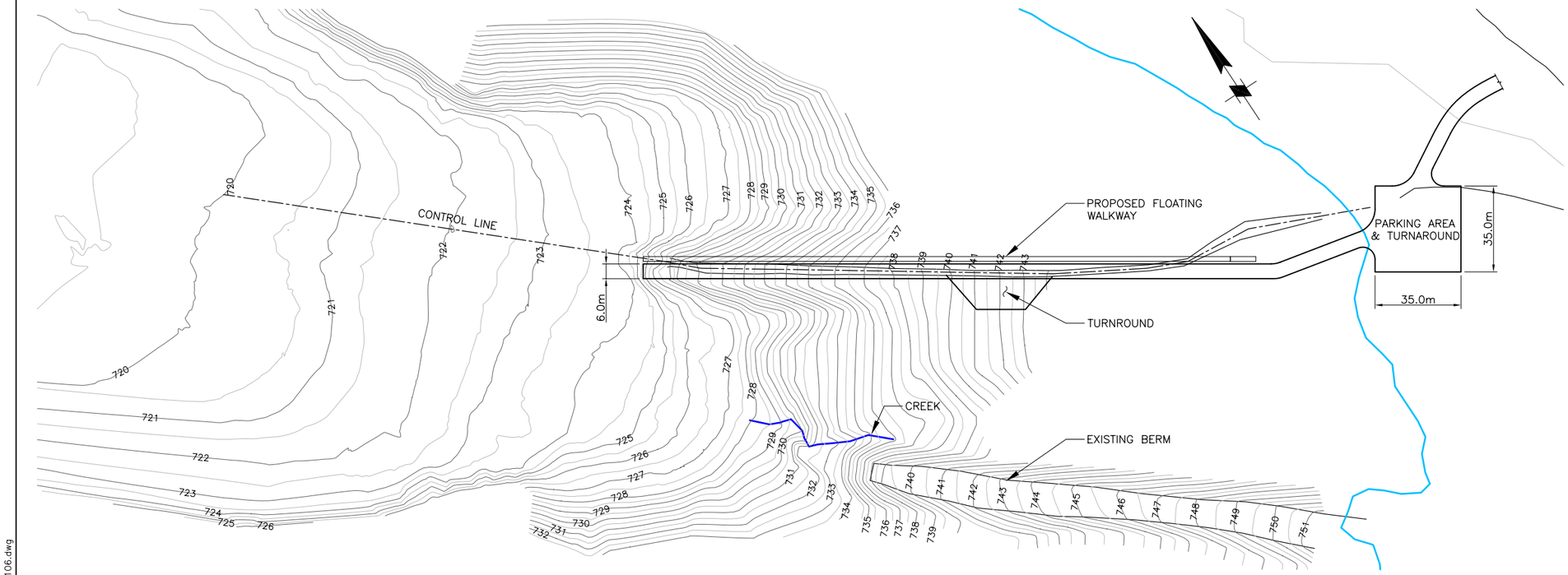
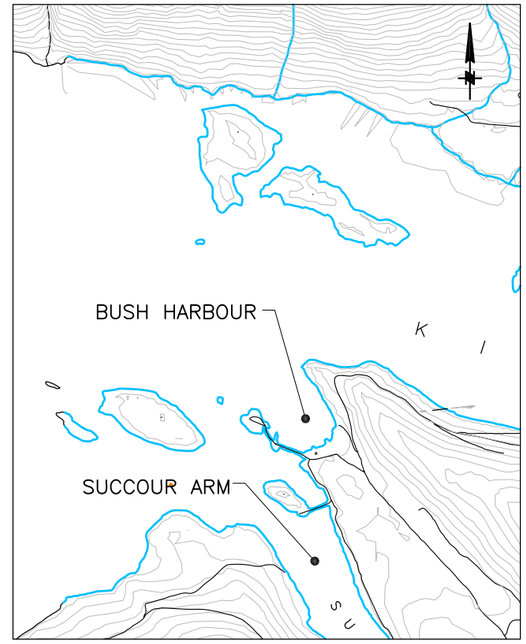


PLAN
1:1000



KEY PLAN
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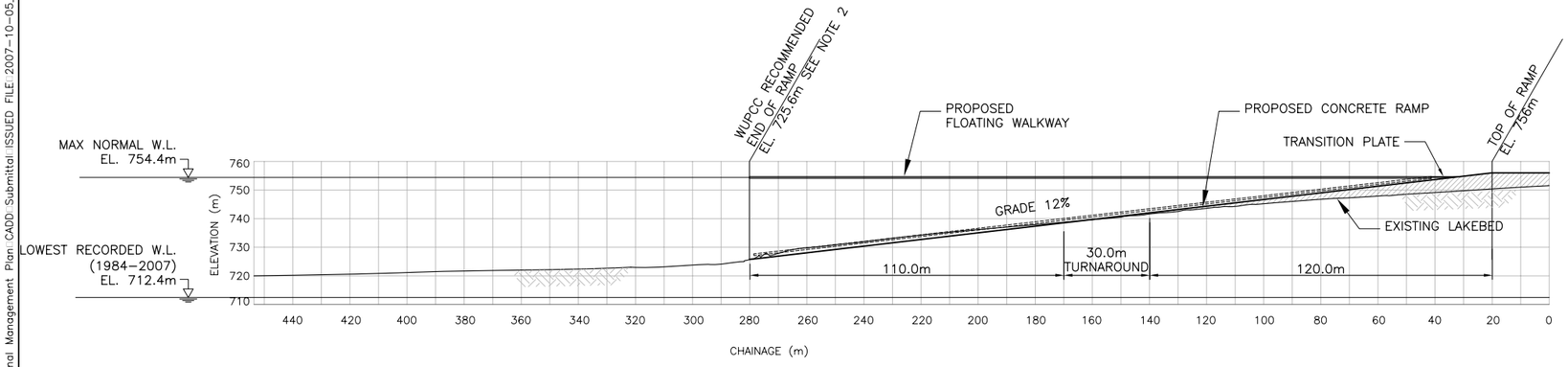


PROFILE ALONG CONTROL LINE
1:1000

NOTES:

1. CONTOURS ARE IN METRES TO GEODETIC DATUM AND ARE BASED ON A HYDROGRAPHIC SURVEY CONDUCTED BY ATEK HYDROGRAPHIC SURVEYS LTD ON MAY 23, 2007.
2. END OF PROPOSED BOAT LAUNCH RAMP IS BASED ON THE WUP CC RECOMMENDED ACCESS ELEVATION OF 726.9m (2385 FT) FOR BUSH HARBOUR, LESS 1.2m ALLOW FOR ADEQUATE LAUNCHING DEPTH.

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

20m 0m 20m 40m
SCALE: 1 : 1000

No.	Date	DESCRIPTION	Dr'n	Ch'd
C	OCT5/07	ISSUED FOR FINAL REPORT	JL	PH
B	JULY31/07	ISSUED FOR DRAFT REPORT	JL	PH
A	JULY20/07	ISSUED FOR DISCUSSION	JL	PH

CLIENT: BC hydro

IN ASSOCIATION WITH:
Atek HYDROGRAPHIC SURVEYS LTD. 4740 Joyce Avenue Powell River, BC, V8A 3B6 phone 604 485 0205 fax 604 485 0200
TRITON ENVIRONMENTAL CONSULTANTS LTD. Richmond 604-279-2063 Prince George 250-562-8155 Terrace 250-635-1464 WWW.TRITON-ENV.COM
Golder Associates

MOFFATT & NICHOL
777 WEST BROADWAY, SUITE 301
VANCOUVER, BC, CANADA, V5Z 4J7
604–707–9004

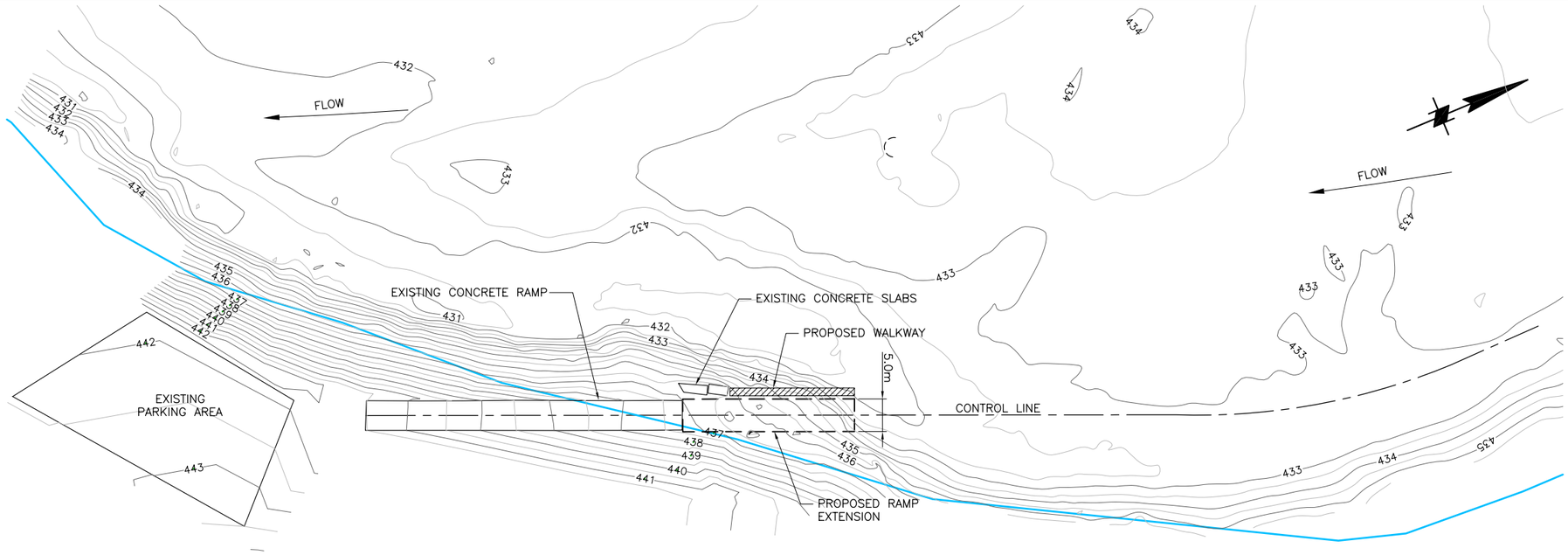
DESIGN	DRAWN	CHK'D	APP'D
PH	JL	–	––

DATE: JUNE18/07
DRAWING NUMBER: 6258–106

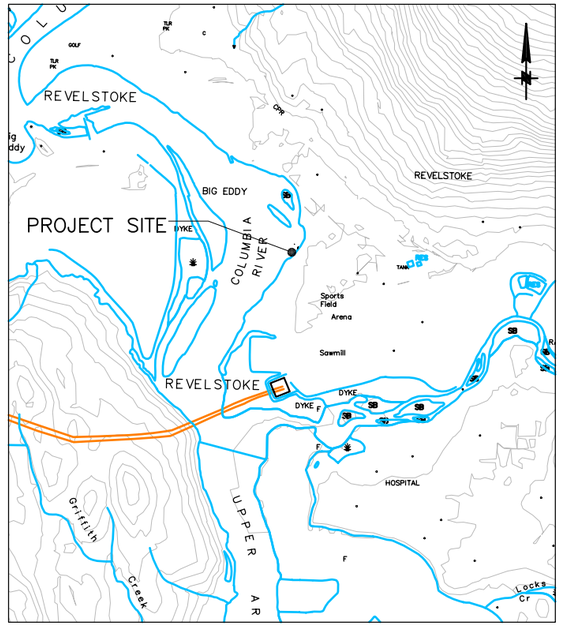
KINBASKET & ARROW LAKES RESERVOIR BOAT LAUNCH RAMP FEASIBILITY STUDY
BUSH HARBOUR

SCALE: AS SHOWN
C

DATE: 2007/10/02 – 11:32am
PATH: P:\6258 Kinbasket & Arrow Lakes Reservoir Recreational Management Plan\CADD\Submittal\ISSUED FILE\2007-10-05_FINAL REPORT\105–106.dwg



PLAN
1:400



KEY PLAN
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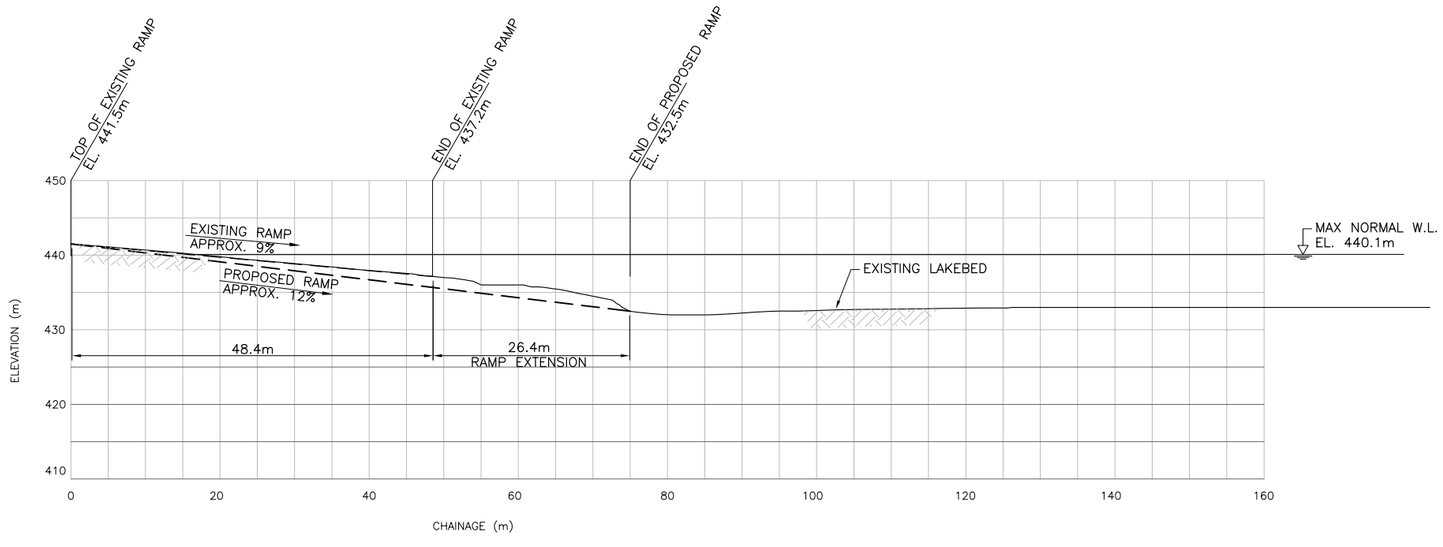


PROFILE ALONG CONTROL LINE
1:400

NOTES:

1. CONTOURS ARE IN METRES TO GEODETIC DATUM AND ARE BASED ON A HYDROGRAPHIC SURVEY CONDUCTED BY ATEK HYDROGRAPHIC SURVEYS LTD ON MAY 24, 2007.

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

8m 0m 8m 16m

No.	Date	DESCRIPTION	Dr'n	Ch'd
C	OCT5/07	ISSUED FOR FINAL REPORT	JL	PH
B	JULY31/07	ISSUED FOR DRAFT REPORT	JL	PH
A	JULY20/07	ISSUED FOR DISCUSSION	JL	PH

CLIENT: BC hydro

IN ASSOCIATION WITH: Atek Hydrographic Surveys Ltd., 4740 Joyce Avenue, Powell River, BC, V8A 3B6, phc 604 485 0205 fax 604 485 0200; TRITON Environmental Consultants Ltd.; Golder Associates

MOFFATT & NICHOL
777 WEST BROADWAY, SUITE 301
VANCOUVER, BC, CANADA, V5Z 4J7
604-707-9004

DESIGN	DRAWN	CHK'D	APP'D
PH	JL	–	--

DATE JUNE18/07 | DRAWING NUMBER 6258-107

KINBASKET & ARROW LAKES RESERVOIR
BOAT LAUNCH RAMP FEASIBILITY STUDY
REVELSTOKE
CENTENNIAL PARK

SCALE AS SHOWN

C

DATE: 2007/10/02 - 11:39am
PATH: P:\6258 Kinbasket & Arrow Lakes Reservoir Recreational Management Plan\CADD\Submittal\ISSUED FILE\2007-10-05_FINAL REPORT\107.dwg

Appendix B:
Photographs Taken on Field Trip at Kinbasket and Arrow Lakes Reservoir, May 23-26, 2007

Photo No. 1: Taken on 2007-05-25 at Valemount Marina
View of the southern fetch on the Kinbasket Reservoir at Valemount Marina.

Photo No. 2: Taken on 2007-05-25 at Valemount Marina
Navigation beacon located at the top the point.

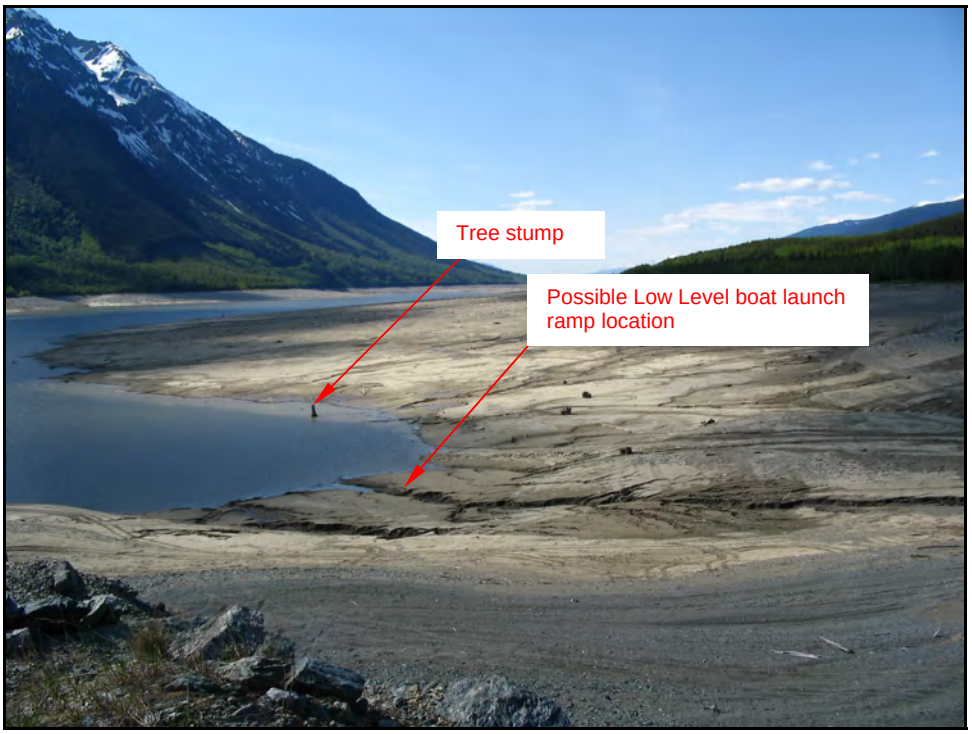


Photo No. 3: Taken on 2007-05-25 at Valemount Marina
View of the northern fetch and bay area at Valemount Marina.
Photo was taken at the point looking north.

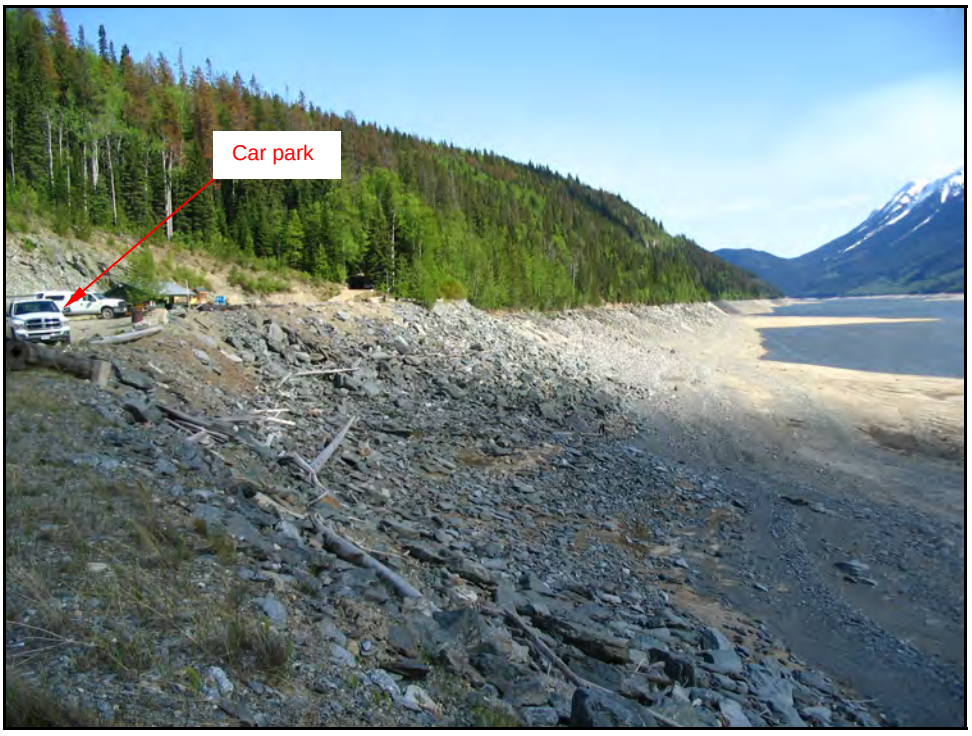


Photo No. 4: Taken on 2007-05-25 at Valemount Marina
Valemount Marina view looking along the southern shoreline at the car park.

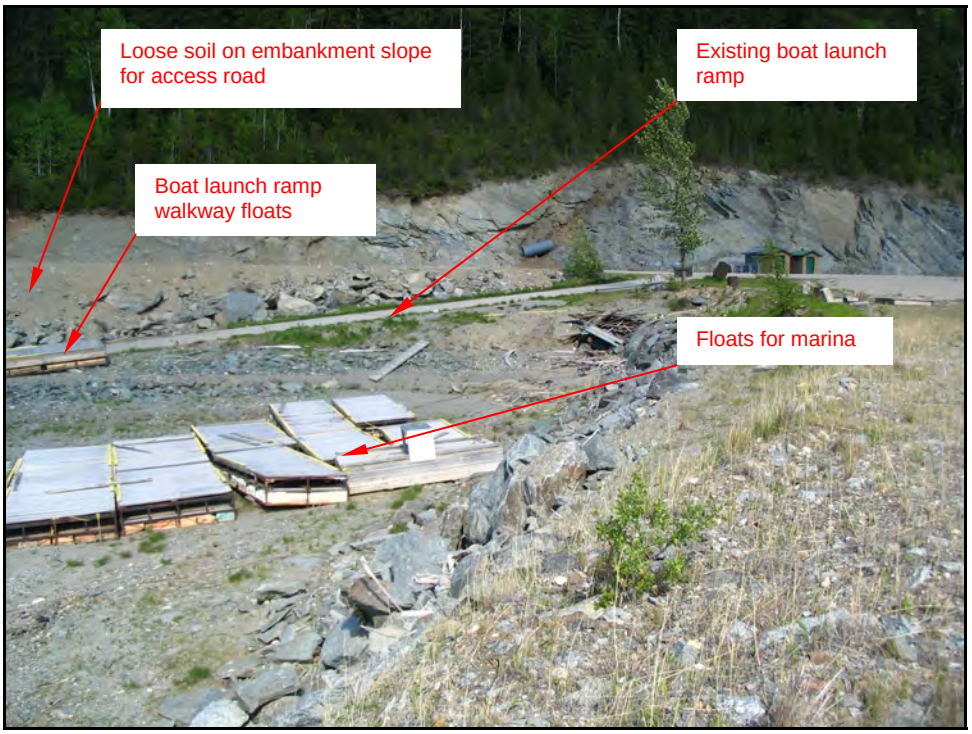


Photo No. 5: Taken on 2007-05-25 at Valemount Marina
View of the boat launch ramp and marina floats from the top of the point.

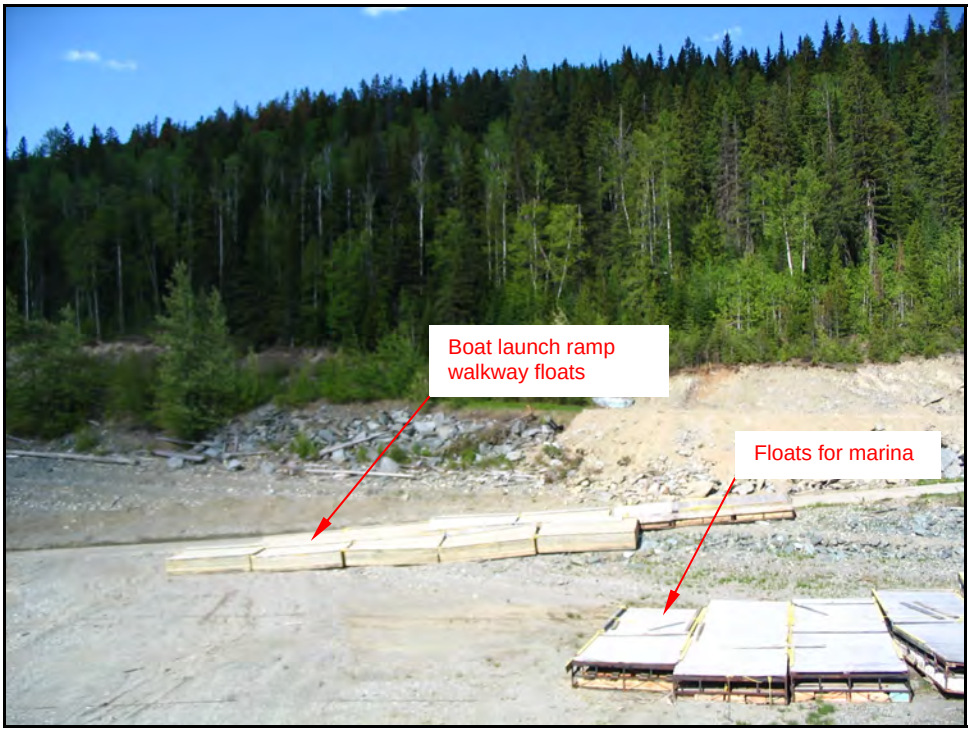


Photo No. 6: Taken on 2007-05-25 at Valemount Marina
View of the walkway and landing floats for marina.

Photo No. 7: Taken on 2007-05-25 at Valemount Marina
View looking down the slope of the existing concrete boat launch ramp.

Photo No. 8: Taken on 2007-05-25 at Valemount Marina
View of the boat launch ramp showing cracks along length of the concrete slabs.

Photo No. 9: Taken on 2007-05-25 at Valemount Marina
More cracks further along the ramp.

Photo No. 10: Taken on 2007-05-25 at Valemount Marina
Boat launch ramp showing debris on the ramp from adjacent sloped area.

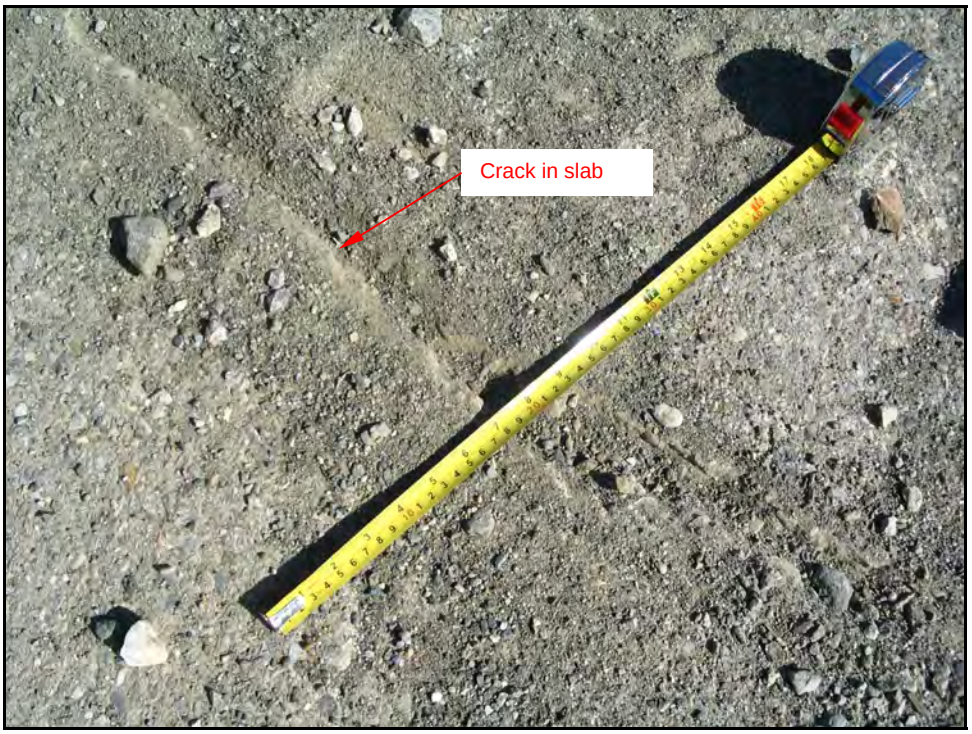


Photo No. 11: Taken on 2007-05-25 at Valemount Marina
Close-up view of crack in slab covered up by debris on the boat launch ramp.

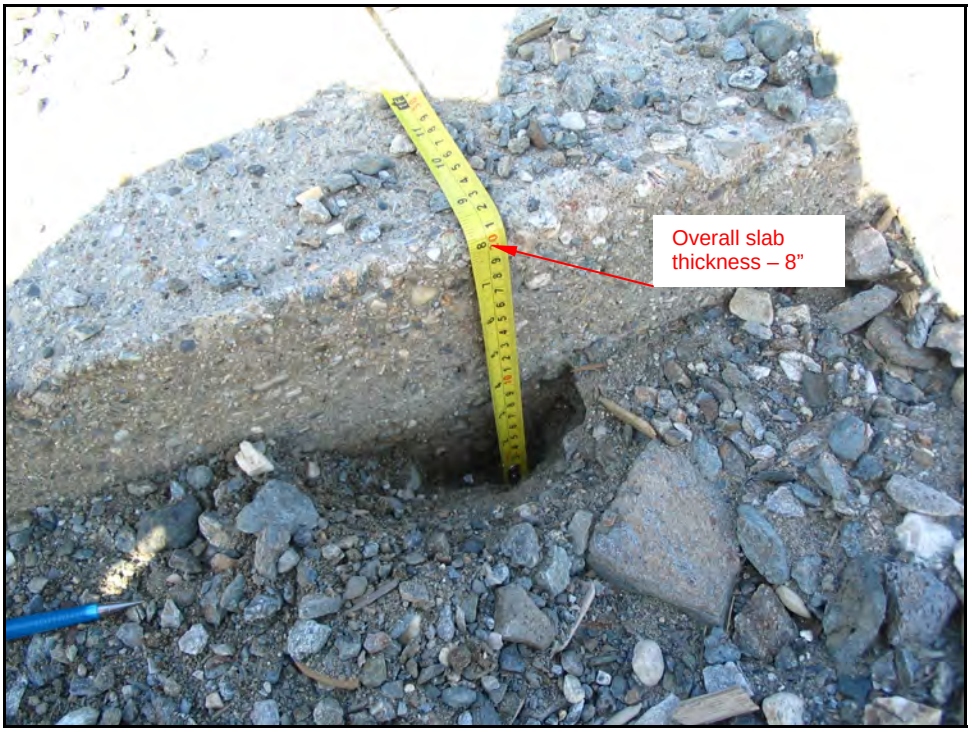


Photo No. 12: Taken on 2007-05-25 at Valemount Marina
Close–up view showing the 8” thickness of the existing concrete slab.

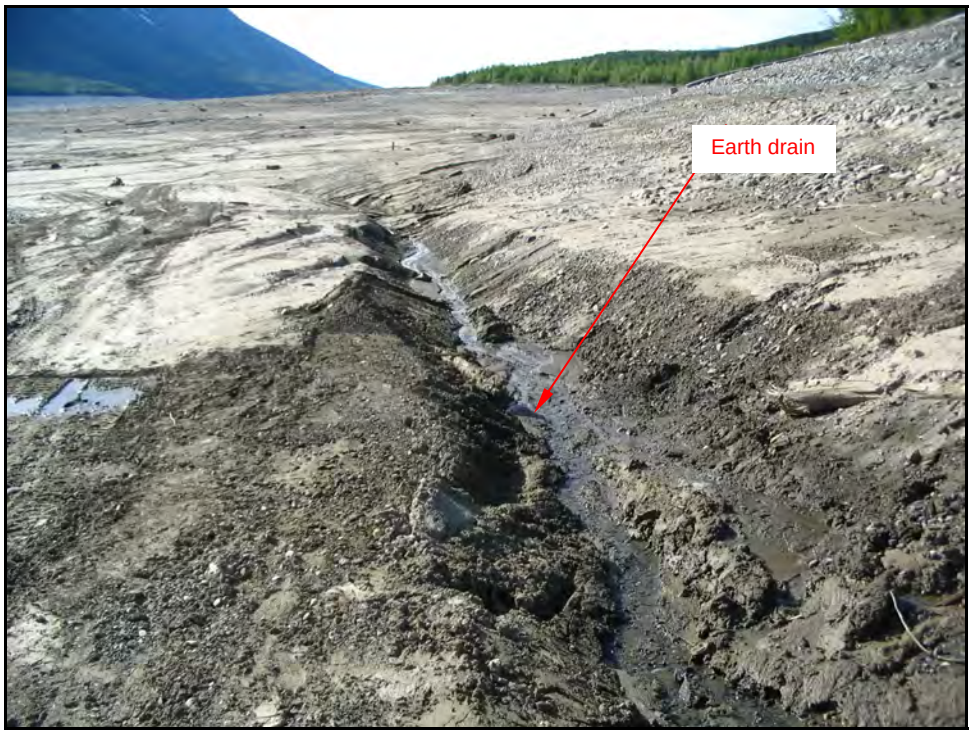
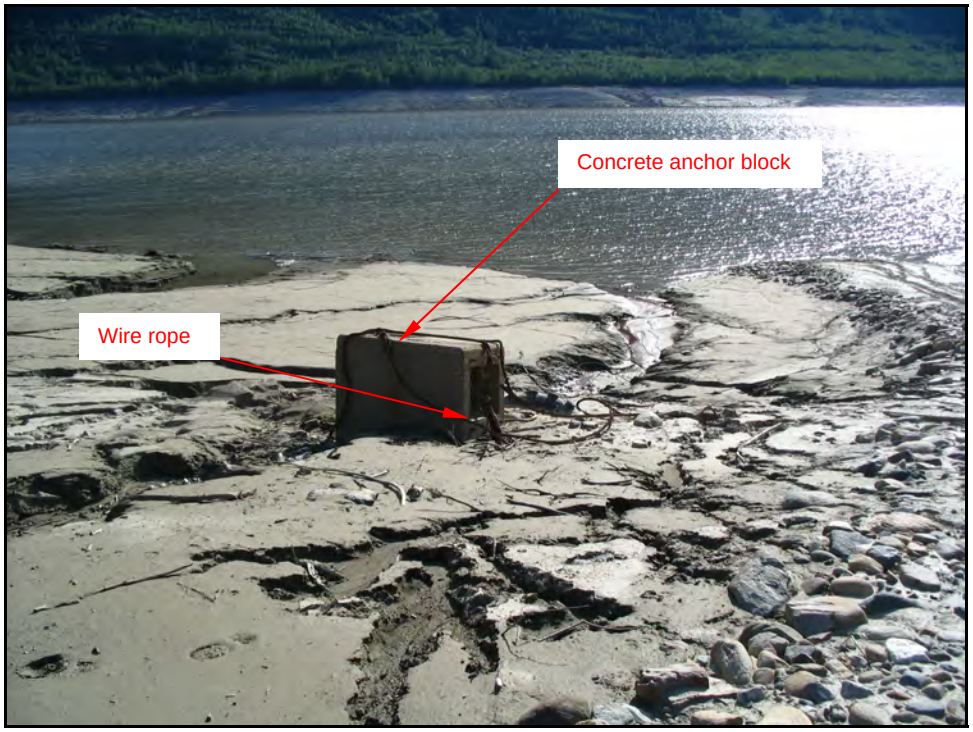


Photo No. 13: Taken on 2007-05-25 at Valemount Marina
View looking downstream showing the earth ditch along side the boat launch ramp.



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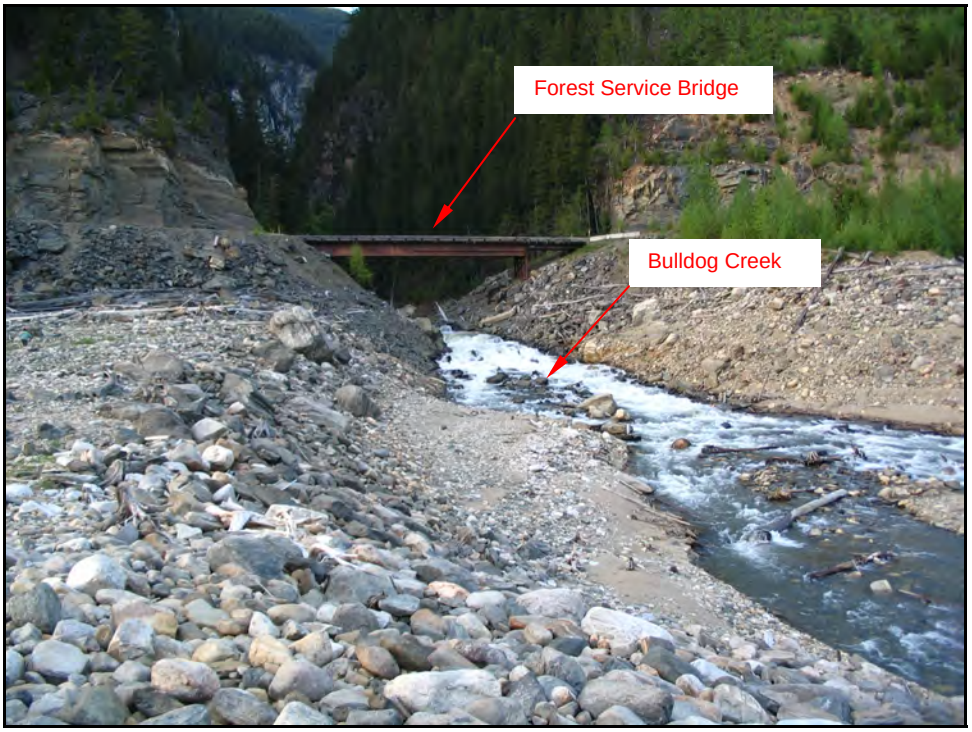

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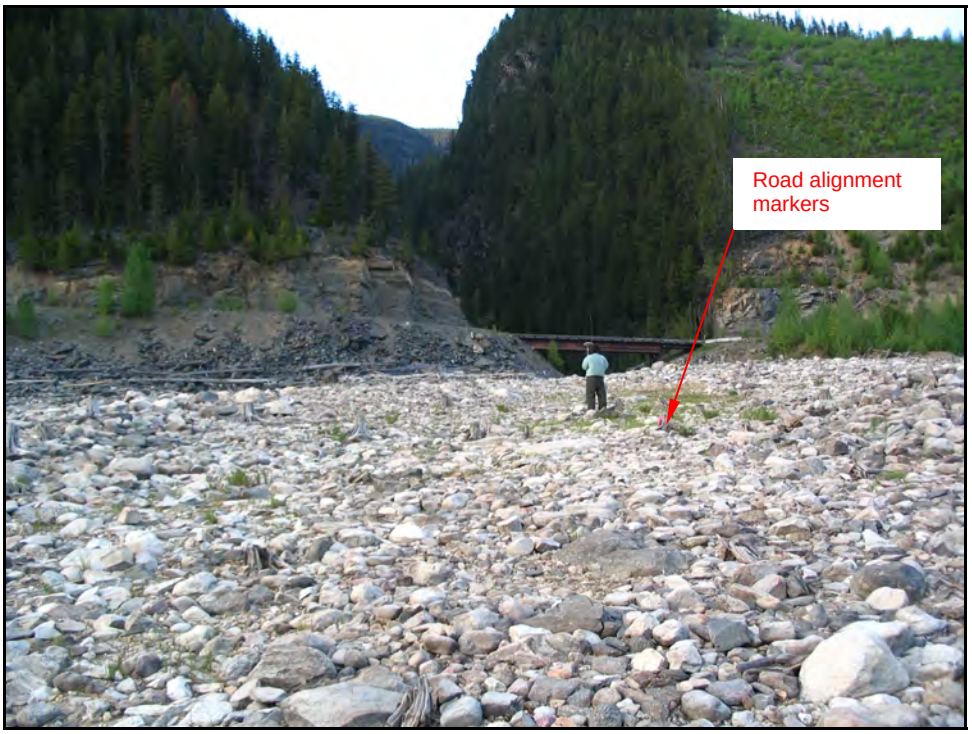

Photo No. 22: Taken on 2007-05-25 at Bulldog Creek
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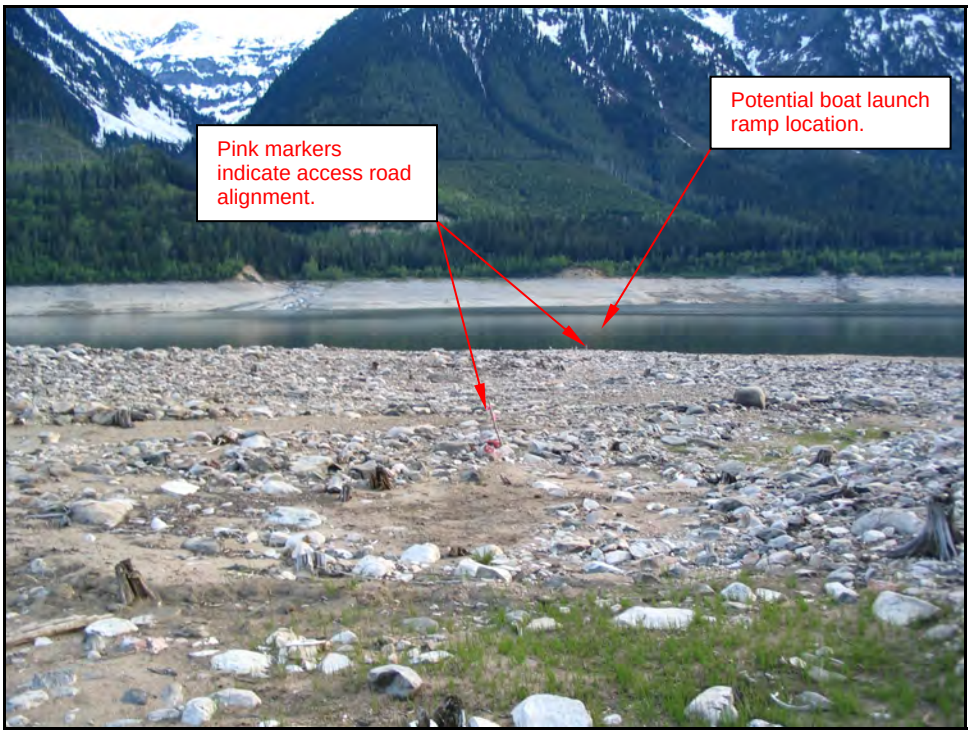

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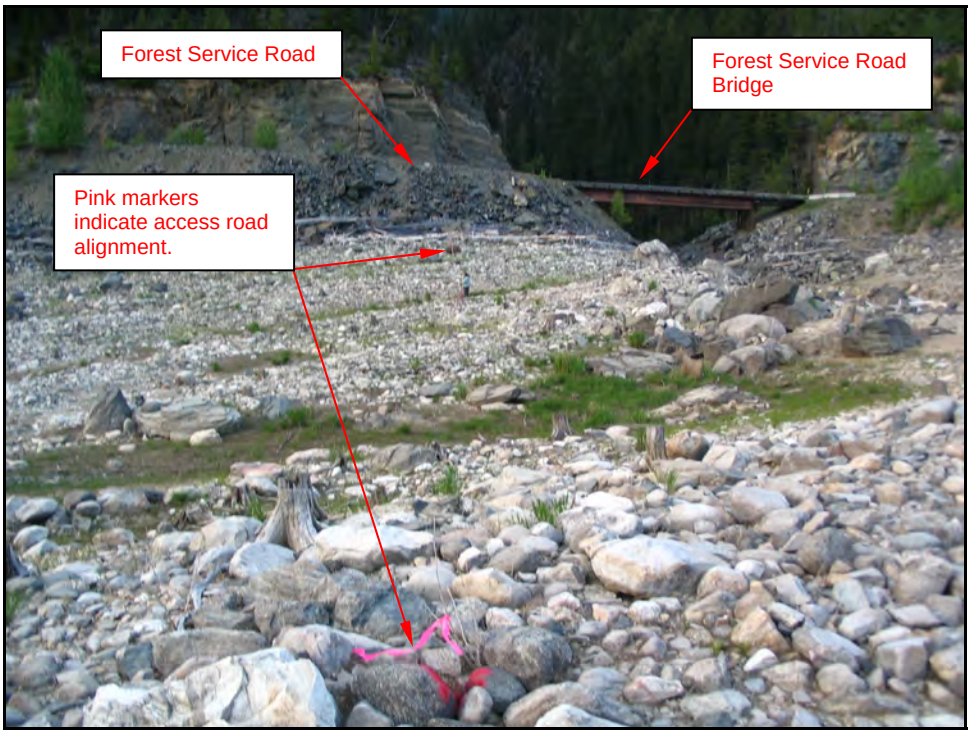

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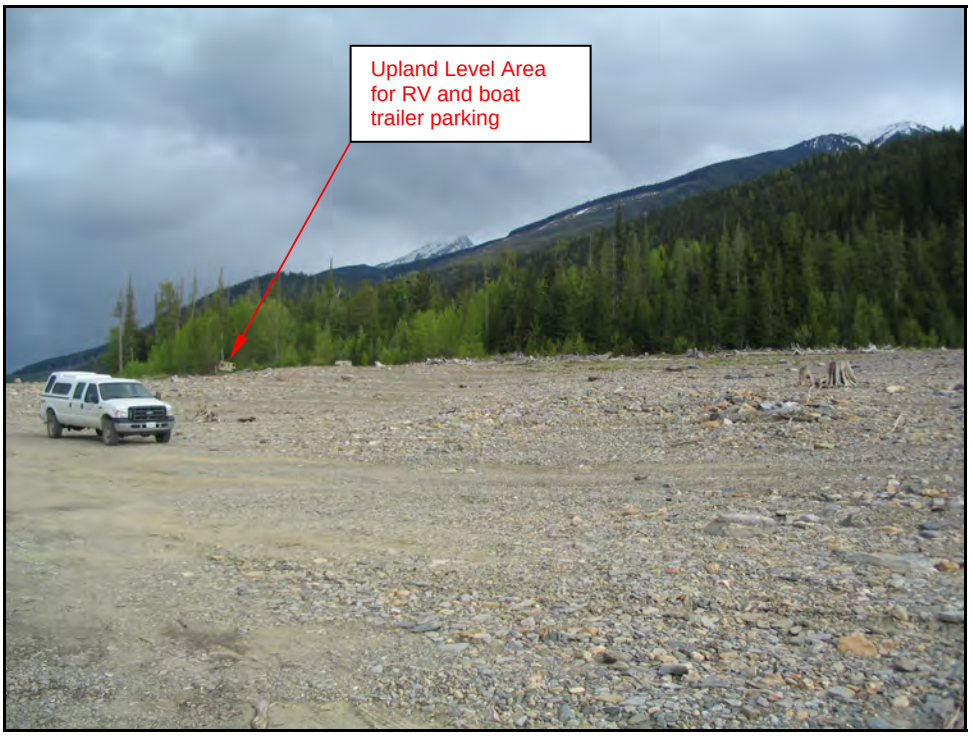

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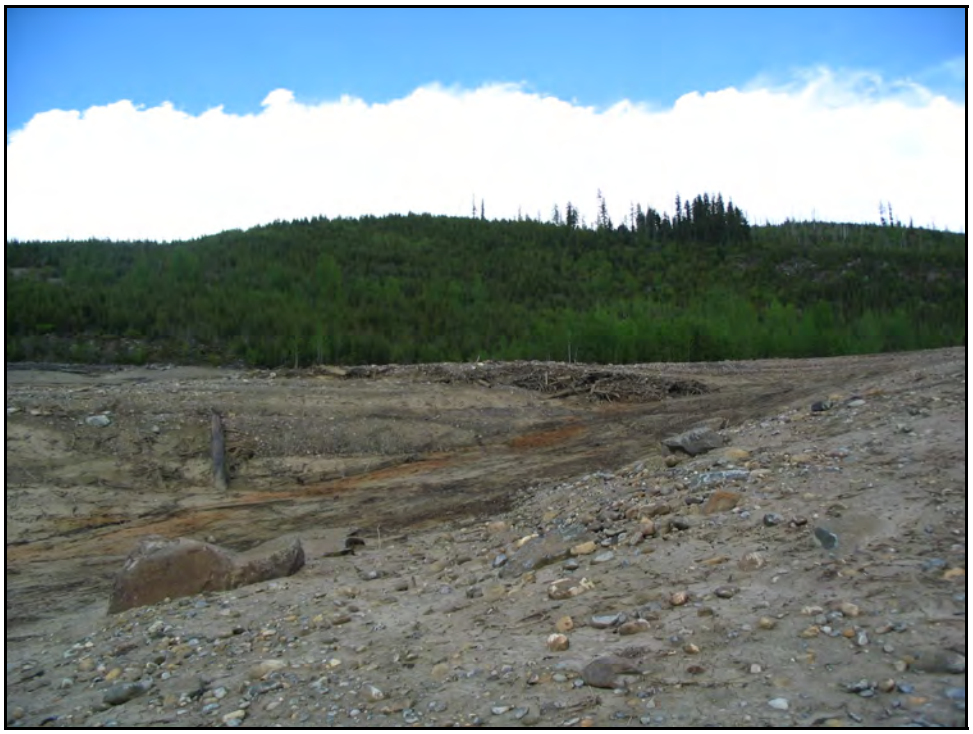

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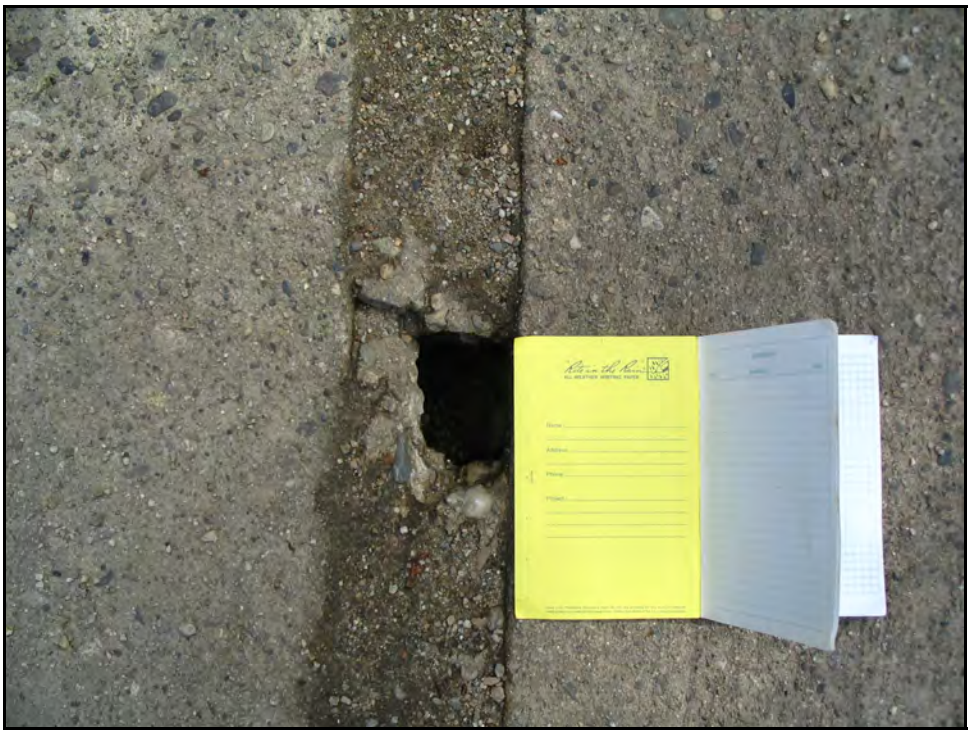

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Kinbasket Reservoir and Mid-Columbia River Boat Ramp Feasiblity Study – Environmental Component.

September 2007

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1.0 INTRODUCTION

1.1 Purpose of Document

The purpose of this document is to identify the environmental sensitivities at each of five proposed boat ramp locations; four on the Kinbasket Reservoir and one on the Mid-Columbia River at Revelstoke. This report is prepared in response to the BC Hydro Columbia River Water Use Plan Feasibility of Boat Ramps Study Terms of Reference. This report will be submitted in conjunction with the associated Engineering Technical and Archaeological Feasibility reports completed by Moffatt & Nichol (M&N) and Golder Associates (Golder).

This report has been prepared to:

- Provide a description of the environmental setting;
- Document baseline environmental conditions based on existing information, field data and observations;
- Identify valued ecosystem components (VEC) at or near each of the proposed sites;
- Provide an assessment of potential impacts of development on the VEC's at each site;
- Provide an Environmental Management Plan (EMP) for each site;
- Identify regulatory permitting and approval requirements necessary to proceed with construction at each site; and
- Identify if any additional environmental investigations may be required.

1.2 Environmental Setting

1.2.1 Kinbasket Reservoir

Four of the boat ramp study sites are located along the Kinbasket Reservoir between the Village of Valemount in the north (Figure 1) and the town of Golden in the south (Figure 2). The boat ramp sites are located at Bush Harbour, Nixon Creek, Bulldog Creek and the Valemount Marina. Access to the Golden end of the reservoir is via the Bush Arm Forest Service Road. This road is accessible from Highway 1 at Donald, 26 km west of Golden. Bush Harbour is located near Km 40 and Nixon Creek is located near Km 100. The northern end of the reservoir is accessible from Cedarside Road off Highway 5 just south of Valemount.

The Kinbasket Reservoir is within the Southern Rocky Mountain Trench Ecoregion between the Rocky Mountains in the east and the Columbia Mountains in the west. The reservoir is bisected by the Headwaters (north) and Columbia (south) Forest Districts. The Interior Cedar Hemlock biogeoclimatic zone (ICH) is characteristic of the lower elevations of this region, with cedar, hemlock, Douglas-fir and western larch predominating (Braumandl and Curran 1992). The climate and vegetation communities of project area are best described by the Golden Moist Warm (mw1) and the Moist Mild (mm) subzones of the ICH zone. The ICHmm subzone occurs at elevations ranging from

750 to 1250 m. The ICHmw1 occurs at elevations ranging from 750 to 1550 m on southern aspects and up to 1500 m on northern aspects. Both occur along the lower valley slopes along the Kinbasket Reservoir.

The climate in the area is best described by warm summers and cool winters. Valemount has maximum temperatures of 24º C in July and daily minimums of -15.2º C in January (Village of Valemount 2007). The mean annual temperature for the Golden area is 4.7º C with daily maximums averaging 24.4º C in July and daily minimums averaging -13.7º C in January (Environment Canada 2007). Precipitation is slightly higher in the ICHmw1 than that of the mm subzone. While no specific data was available for these two subzones, the ICHmw1 is within the moist climatic region and the mm is likely drier (Meidinger *et al* 2007).

Within these two subzones, the dominant tree species include western red cedar (***Thuja plicata***) and western hemlock (***Tsuga heterophylla***) with varying amounts of Douglas-fir (***Pseudotsuga menziesii***), hybrid white spruce (***Larix occidentalis***), and trembling aspen (***Betula papyrifera***). There are more seral stands in the ICHmm than in the ICHmw1 as it is drier and more susceptible to fire disturbances (Meidinger *et al* 2007). Shrub species include falsebox (***Paxistima myrsinites***), false azalea (***Menziesia ferruginea***), thimbleberry (***Rubus parviflorus***) and baldhip rose (***Rosa gymnocarpa***). Herbaceous species include prince's pine (***Chimaphila umbellata***), queen's cup (***Clintonia uniflora***) and foamflowers (***Tiarella sp.***).

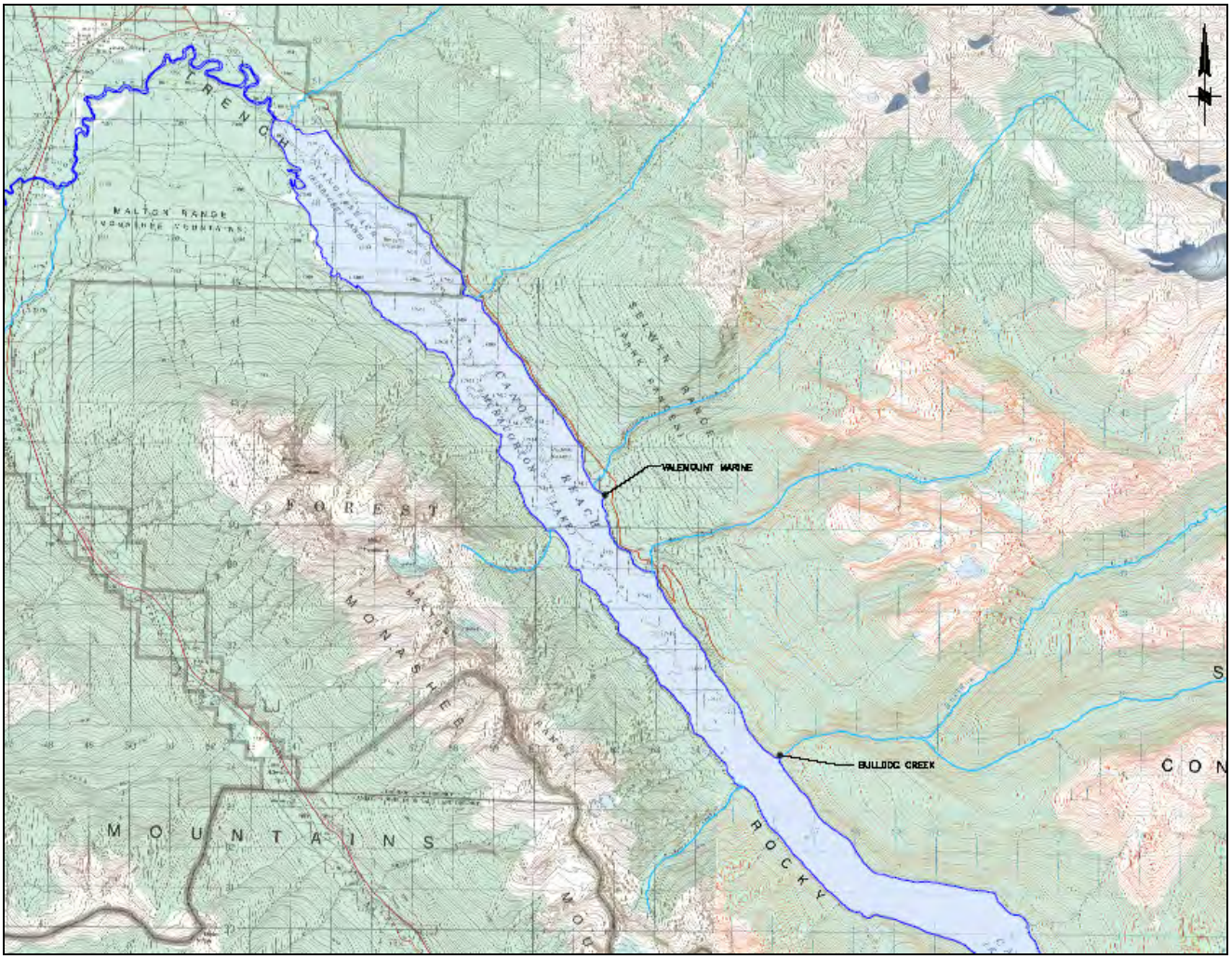

Figure 1. Valemount Site Locations (Moffat & Nichol 2007).

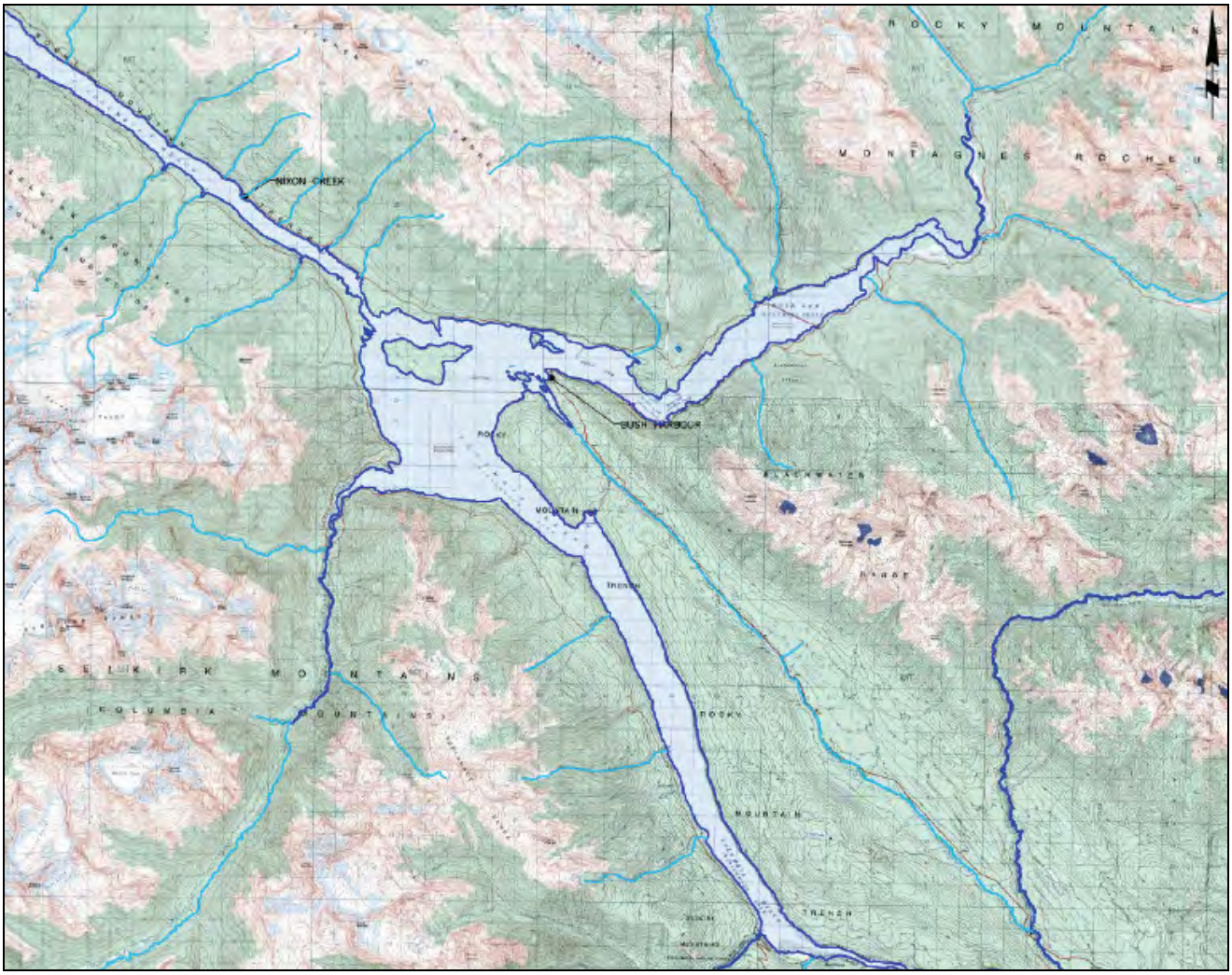

Figure 2. Golden Site Locations (Moffat & Nichol 2007).

1.2.2 Mid-Columbia River

The fifth boat ramp is located along the east bank of the Mid-Columbia River at Centennial Park in downtown Revelstoke (Figure 3). The Mid-Columbia River is within the Selkirk Foothills Ecosection along the valley bottom between the Monashee Mountains in the west and the Selkirk Mountains in the east. The ICH is characteristic of the lower elevations of this region, with cedar, hemlock, Douglas-fir and western larch predominating (Braumandl and Curran 1992). The climate and vegetation communities of project area are described by the Thompson moist warm subzone (mw3) of the ICH zone. The ICHmw3 subzone occurs at elevations ranging from 400 to 1000 m on southerly aspects and 400 to 1350 m on northerly aspects.

The climate of the area is represented by warm, moist, summers and mild winters with moderate snowfall. The daily maximums temperatures average 18.2º C and daily

minimums average -5.3º C (Environment Canada 2007). Precipitation is slightly higher in the ICHmw3 than that of the mw2 but lower than the wk1 and vk1 subzones. The mean annual precipitation recorded in Revelstoke is 1278 mm (Environment Canada 2007).

Within this subzone, the dominant tree species include western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*) with varying amounts of Douglas-fir (*Pseudotsuga menziesii*), western larch (*Larix occidentalis*), and paper birch (*Betula papyrifera*). Late seral and climax stands are limited due to disturbances such as fire and harvesting. Shrub species include falsebox (*Paxistima myrsinites*), mountain alder (*Alnus incana*), and soopollalie (*Shepherdia canadensis*). Herbaceous species include prince's pine (*Chimaphila umbellata*), queen's cup (*Clintonia uniflora*) and bunchberry (*Cornus canadensis*) (Parish *et al* 1996).

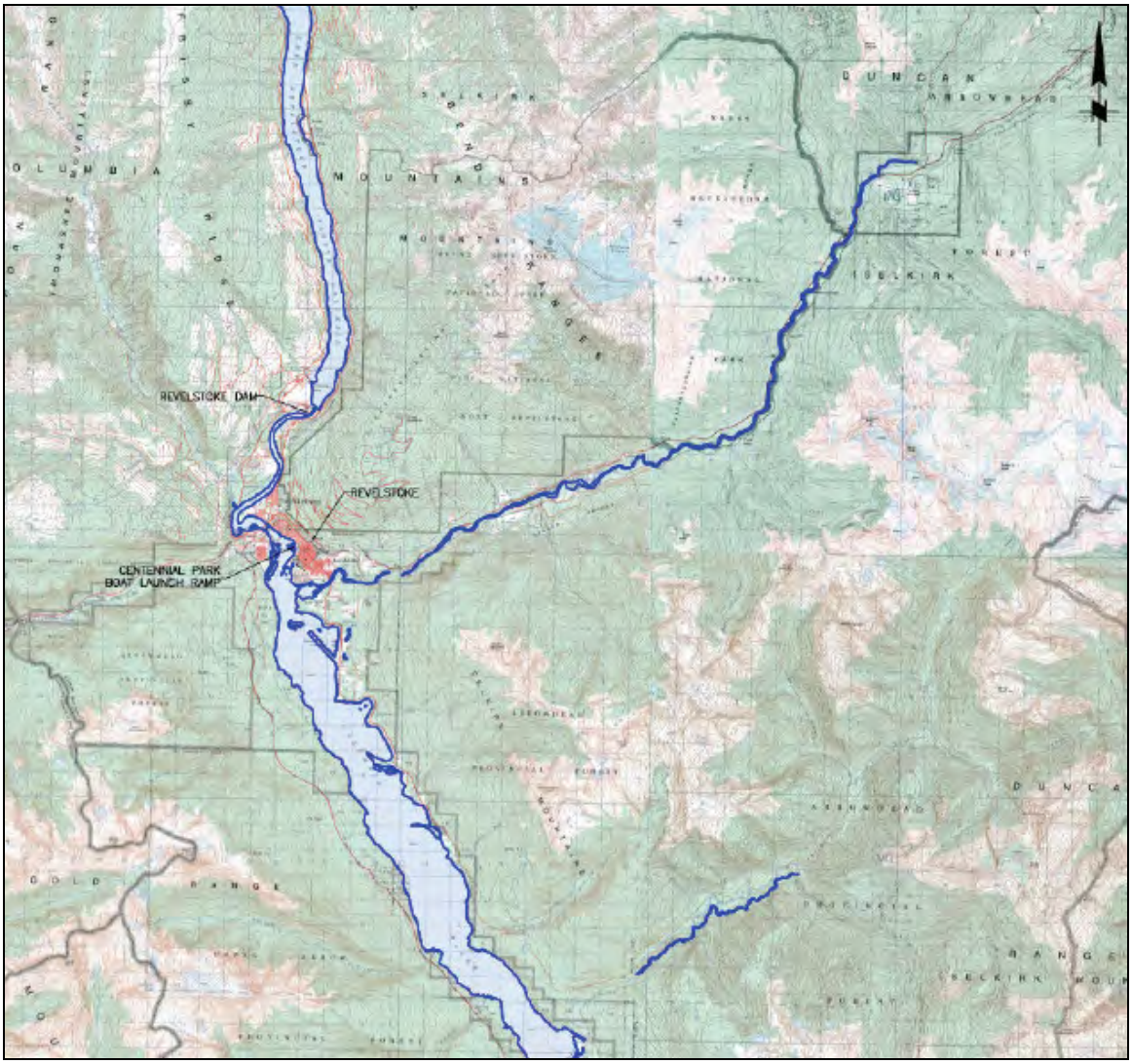

Figure 3. Revelstoke Site Location (Moffat & Nichol 2007).

2.0 METHODOLOGY

Spring field surveys were conducted in conjunction with the engineering and archaeological surveys to document existing conditions in aquatic and terrestrial habitats surrounding the existing and proposed boat ramp locations.

2.1 Fish and Fish Habitat

Aquatic habitats were assessed in terms of substrate, gradients (% slope), and drawdown zone vegetation. No fish sampling was conducted but data on the potential fish species within the project area was reviewed along with the associated habitat requirements of those species for all life stages. Habitat observed at each boat ramp site was described in terms of its suitability to provide habitat for the identified species.

2.2 Wildlife and Wildlife Habitat

In order to determine the local, regional and provincial significance of habitats within the study area, it is necessary to consider the full range of wildlife species known, or with significant potential to occur in the vicinity of each boat ramp. Key references that were utilized to achieve this include:

- Stevens *et a*l. (1994) provide a breakdown of wildlife species by biogeoclimatic zones and subzones with some habitat cross referencing, and habitat preferences;
- The Mammals of British Columbia (Eder and Pattie, 2001);
- The Birds of British Columbia Vol 1, Vol 2, Vol 3, Vol 4 (Campbell *et al*. 1990);
- A field guide to site identification and interpretation for the Nelson Forest Region (Braumandl and Curran 1992);
- A Field Guide for Identification and Interpretation of Ecosystems of the Rocky Mountain Trench, Prince George Forest Region (Meidinger *et al* 1998; 2007);
- BC Conservation Data Centre tracking lists (BC CDC 2007a);
- Bats of British Columbia (Nagorsen and Brigham 1993); and
- The Amphibians and Reptiles of British Columbia (Matsuda *et al.* 2006).

2.2.1 Wildlife Species of Management Concern

The primary warehouse of information on the status of flora and fauna in the province is the BC Conservation Data Centre (CDC). The CDC provides tracking lists for flora, fauna, and plant communities for each Forest District in the province. The District lists identify species that can be expected to occur within the District boundaries, which is often coincident with watershed divides. These areas can include the bulk of some wildlife sub-populations. These status lists use a colour-coding system to rank the status and management priorities for species at risk. Following is a breakdown and brief description of the status and ranking criteria used in developing these lists:

Red-listed Species:

- candidates for legal designation as threatened or endangered under Federal legislation;
- include threatened species - any indigenous species of fauna or flora that is likely to become endangered in British Columbia if the factors affecting its vulnerability do not become reversed; and
- include endangered species - any indigenous species of fauna or flora that is threatened with imminent extinction or extirpation throughout all or a significant portion of its British Columbia range.

Blue-listed Species:

- considered to be vulnerable or sensitive and are candidates for upgrade to the red-list or downgrade to yellow; and
- include vulnerable species - any indigenous species of fauna or flora that is particularly at risk in British Columbia because of low or declining populations.

Yellow-listed Species

- the yellow-listed species are those considered not at risk in British Columbia and are considered for management emphasis for various reasons including recent declines in population numbers, restricted distribution, losses of habitat, public interest, species that are maintained by ecosystem management and species for which the Province has a global responsibility.

In addition to red, blue, and yellow-listed species, numerous other species are of management concern within the province due to:

- populations that are actively managed;
- species that are of commercial value;
- species with specific habitat requirements (e.g. nest cavities);
- species found at low densities; and
- colony nesters.

In order to identify species of management concern that potentially occur in the study area, the full list of wildlife species known to occur, or with significant potential to occur within the ICHmm, ICHmw1, and ICHmw3 were considered. Based on sub-regional wildlife distribution, abundance, and species sensitivities the CDC has developed tracking lists for individual forest districts. The CDC red, blue and yellow lists for rare vertebrate species within the Headwaters and Columbia Forest Districts were acquired. In addition, the Federal Species at Risk Act Registry (SARA) was also reviewed for the potential of any Schedule 1 listed species to be present within the project area (Appendix 2).

The comprehensive list can be reduced based on known regional distributions, specialized habitat requirements, and extreme rarity to a subset of species that is more reasonable to expect within the project area. This was done using the descriptions of terrestrial habitat observed at each boat ramp site to determine its suitability to provide habitat for

identified wildlife species. Seven SARA species may be found within the vicinity of the project areas (Table 1).

Table 1. SARA species which may occur within the project areas.

Scientific name	Common Name	SARA Category
Taxidea taxus	Badger	Endangered
Megascops kennicottii macfarlanei	Western Screech Owl	Endangered
Cottus confuses	Shorthead Sculpin	Threatened
Eumeces skiltonianus	Western Skink	Special Concern
Rangifer tarandus caribou	Woodland Caribou (Southern Mountain population)	Threatened
Plethodon idahoensis	Couer d'Alene salamander	Special Concern
Bufo boreas	Western Toad	Special Concern

2.3 Vegetation

There are two useful land classification schemes that capture the variation in plant and animal communities at a sub-regional scale. Ecosections (Regional Ecosystem Classification) are contiguous areas with similar climate and physiography, which are large enough to sustain a variety of plant and wildlife communities. Biogeoclimatic subzones and subzone variants (Biogeoclimatic Ecosystem Classification, BEC) are characterized by a particular combination of dominant plant species. Subzones and subzone variants are dispersed within sub-regional areas and often occur within a relatively narrow elevational range and/or in relation to aspect.

The Province has protected representative natural examples of both ecosections and subzones/variants at the landscape level. Site associations or site series units are the fine units of the biogeoclimatic classification system that capture plant community variation at the stand or operational level and these are the ecosystems that are tracked by the Conservation Data Centre (CDC). The CDC red and blue-lists identify ecosystems that are considered rare or at risk. The biogeoclimatic site series unit is also routinely used by forest and wildlife resource managers, and provides an appropriate means to assess the local, regional and provincial significance of potential effects of habitat alteration in the study area. The ecosystems of the study area have been described at the biogeoclimatic site series level.

A review of Species at Risk and the CDC red and blue-lists were completed prior to the field assessments. Plant species that were located in areas that may be impacted by construction relating to the boat ramps were identified. A review of potentially occurring species, their habitat requirements and the likelihood of any being present in the project area was also conducted as a risk assessment rather than an actual inventory.

2.4 Potential Impacts

Valued Ecosystem Components (VECs) are elements of the biophysical and socio-economic environment that are valued by society and of particular relevance in completing the project scoping. They may be landscape level features (ecosystems), or individual fish, wildlife or plant species that are recognized as rare, sensitive or vulnerable to human activity. VEC's were identified by reviewing the fish and fish habitats, wildlife and wildlife habitat and vegetation at each site and assigning an Environmental Sensitivity Rating (ESA) of either low, moderate or high, based on how sensitive that habitat feature would be to the proposed boat ramp construction or modification at each site.

3.0 ENVIRONMENTAL ASSESSMENTS

The Kinbasket Reservoir (KR) and the Mid-Columbia River provides habitat for a variety of fish species including several fish species of management concern within the Columbia and Headwaters Forest Districts (Table 2). Burbot has just recently been added as a red-listed species within the Kootenay Region and is not yet included on the CDC website (BC CDC 2007a).

Table 2. Fish Species of Management Concern within the Kinbasket Reservoir and Mid-Columbia River.

Scientific Name	Common Name
Acrocheilus alutaceus	Chiselmouth
Acipenser transmontanus pop. 2	White sturgeon (Columbia River population)
Cottus hubbsi	Columbia sculpin
Cottus confusus	Shorthead sculpin
Lota lota	Burbot
Oncorhynchus clarkii lewisi	Westslope cutthroat trout
Rhinichthys Umatilla	Umatilla dace
Salvelinus confluentus	Bull trout

The majority of the large tributaries to the Reservoir and Mid-Columbia River are important spawning areas. The Bush, Wood, and Canoe Rivers are the main tributaries to the KR and are important spawning area for bull trout, Kokanee and rainbow trout. The Canoe River is known to support the largest number of Kokanee spawners in the Canoe Reach of the Reservoir (Westslope 2004). Bull trout within these larger tributary systems are adfluvial and return to the reservoir after spawning (Oliver 2001). Some resident populations have also been identified further upstream within the larger tributaries as obstructions such as falls prevent the adfluvial populations from migrating further upstream.

Although not identified in Table 2, another species of regional importance is the "yellowfin" rainbow trout. Before dam construction, the Mid-Columbia River contained yellowfin rainbow trout which were very large and had a distinctive yellow colouration of the belly area and lower fins. These fish were believed to make annual spawning migrations from the Lower Columbia (Arrow Lakes Reservoir) up to Canoe River (and its tributary Camp Creek). However, the construction of the dams is believed to be a major factor in their decline however some are still caught in the Arrow Reservoir and have been noted to spawn near Big Eddy (near Revelstoke). Few are still captured in the Kinbasket Reservoir but they are much smaller (Taylor and Tamkee 2005).

Chiselmouth has not been identified within the Reservoir but is present within the Columbia River drainage. Chiselmouth prefers warmer sections of streams and lakes and the adults are primarily algae feeders while the young feed on aquatic and terrestrial

insects (BC CDC 2007b). They can be found within the littoral zones of some lakes but because it is an algae specialist, it requires rocks or large woody debris (LWD) (wood with diameter > 15 cm and > 1m in length) covered with algae as forage habitat. They spawn in tributary streams during June or July when water temperatures reach 17 ^{o}C and in gravel/cobble substrates (Cannings and Ptolemy 1998). Since the substrate within the reservoir is not covered with algae, it is unlikely that they will be in the vicinity of the boat ramps.

Literature reviews for the habitat requirements of the Umatilla dace, Columbia and shorthead sculpin, and Westslope cutthroat trout predict these species are not likely to occur in the project areas. For example, the Umatilla dace is primarily a riverine species (Ford *et al.* 1993) and no occurrences of Westslope cutthroat trout were found in stream data records for the tributary streams closest to the boat ramp locations. FISS data does not identify the Columbia sculpin as present in the upper Columbia and few occurrences have been documented in the lower Columbia. The Columbia sculpin is a subspecies of the mottled sculpin and prefers clear, cool rivers and lakes with gravel and rocky substrates (Troffe 1999). Shorthead sculpin is usually found in fast riffles in colder streams with gravel and cobble substrates. Occurrences have been limited to tributaries of the lower Columbia and Slocan Rivers (Troffe 1999).

Prior to dam construction, the white sturgeon was found throughout the Columbia River system. It is believed that a small remnant population may have been retained upstream of the Mica and Revelstoke Dams, but that they are functionally extirpated from the Kinbasket Reservoir (UCWSRT 2002). Recent sampling did not reveal any white sturgeon within the Reservoir, however, sampling was limited and does not eliminate the possibility of an existing population (RL&L 1996). Local knowledge suggests that white sturgeon are in the KR and further more detailed studies would be required to confirm these sightings.

The first documented white sturgeon spawning events occurred approximately 6 km downstream of Revelstoke Dam in 1999 (Tiley 2006). Recently, there are studies including sturgeon tracking and egg mat monitoring being conducted in the Mid-Columbia River, with some occurring this year just upstream of the Centennial Park boat ramp (Bray 2007). So far, data has shown that the adults move up the river from Arrow Reservoir in early summer to the Jordan River area and return in early fall. Other results have shown a specific concentration of sturgeon in the Big Eddy area (UCWSRT 2002). They may be holding in this eddy prior to moving upstream to Jordan River for spawning.

3.1 Kinbasket Reservoir: Valemount Marina

3.1.1 Fish and Fish Habitat

Located 0.8 km to the north of the proposed boat ramp extension at Valemount Marina is Horse Creek (WSC: 200-833000) which is known to support populations of both rainbow trout and bull trout (FISS 2007). A small unmapped and unnamed drainage was observed just to the north of the existing ramp. A culvert is present to allow flows from upslope of the road however, it is not fish bearing and would be considered a non-classified drainage given the conditions. The drainage was mapped during the hydrographic survey and some ditching has been completed to divert the flows from the culvert outlet along the eastern side of the existing ramp (Appendix 1; Plates 7 and 10). Although non-fish bearing, considerations for sediment and erosion control will be required in the Environmental Management Plan for the construction process. Given the large distance between the existing ramp site and Horse Creek, fish habitat in Horse Creek will not be affected.

The lakebed substrates in the area of the proposed boat ramp extension were observed to be primarily composed of silt and sands with a smaller component of cobbles and gravels (Appendix 1; Plate 4). The fine substrates do not provide adequate rearing or spawning habitat for most species in the lake. While the cobbles and gravels may provide some interstitial space and potential spawning substrate, they are surrounded by fines and are highly compacted (Appendix 1; Plate 5). Fines and silt eroded during spring flows are transported to this area from the drainage upslope. There was little aquatic vegetation and LWD found surrounding the boat launch, therefore little shelter or forage opportunities are available to fish. There are more cobbles and gravels and some vegetation present closer to the high water mark which already contains the concrete panels of the existing boat ramp (Appendix 1; Plates 1 and 2). These substrates are likely insitu materials that have had the fines eroded by wave action along the reservoir.

The area that will be used for the ramp extension may provide some habitat for prickly sculpin as they have shown some affinity for shallow muddy inlets and bays (Northcote undated). In addition, burbot are not usually found where the bottom substrate is predominantly sand or silt and rainbow trout, bull trout and Kokanee would be found in deeper cooler waters and more closely associated with some form of cover.

The extension of the boat ramp is to be 91 m in length with an average width of 6 m. The lower sections will be completed using pre-cast concrete but the upper sections may be cast-in-place. Given the size of the turnaround, the overall disturbance footprint below the high water mark is expected to be approximately 700 m^2. Some dredging will be required to obtain the proper elevation of the ramp. This dredging will occur in the dry and is required to remove mostly silt and fine substrates from the lakebed prior to its conversion to concrete planks. Rock berms will also be placed on both sides of the ramp to protect it from erosion. These will be constructed from larger riprap and will provide cover and interstitial space which is currently lacking in the immediate area. Based on the size of the disturbance footprint associated with the proposed extension of this ramp,

no significant immitigable impacts to fish or fish habitat are expected. Based on recent communications with the Department of Fisheries and Oceans and the Ministry of Environment, neither have issues regarding the proposed extension (Thorton 2007; Panko 2007).

3.1.2 Wildlife and Wildlife Habitat

The ecosystems on the east side of the Kinbasket Reservoir are known to support black bears, moderate to high numbers of grizzly bears, and scattered mountain goats (LRMP 1999). The ICHmm provides medium habitat for moose, low winter range habitat for mule deer, high value habitat for grizzly, and medium for other furbearers (Meidinger *et al* 2007). Although the ICHmm can provide medium habitat for caribou, there have been no caribou observed along the east side of the upper Kinbasket Reservoir (Seip 2003). The Camp and Canoe systems have had occurrences of caribou but it is not considered a core area of habitat. Caribou have been observed on both sides of the Reservoir further south in the ICHwk (McLellan and Flaa 2003).

During the field assessment, deer tracks were observed in the fine substrates below the high water mark near a small seepage (Appendix 1; Plate 6). Cliff swallows and kinglets were observed around the upland area where there are likely suitable nesting sites provided by the rock wall and exposed soils. Although not observed, it is likely that other songbirds, small mammals, amphibians, reptiles, and ungulates utilize this area.

The CDC red, blue and yellow list for rare vertebrate species within the ICH subzone of the Headwaters Forest District was acquired and a total of 1 red-listed and 11 blue-listed species were identified (Table 3). Six bird and 6 mammal species were identified.

Table 3. Red and blue-listed species in the ICH zone of the Headwaters Forest District.

Scientific Name	English Name	BC Status
Ardea herodias herodias	Great Blue heron, *herodias* subspecies	Blue
Botaurus lentiginosus	American Bittern	Blue
Grus canadensis	Sandhill Crane	Blue
Gulo gulo luscus	Wolverine, *luscus* subspecies	Blue
Hirundo rustica	Barn Swallow	Blue
Martes pennanti	Fisher	Blue
Myotis septentrionalis	Northern Myotis	Blue
Numenius americanus	Long-billed Curlew	Blue
Ovis canadensis	Bighorn Sheep	Blue
Patagioenas fasciata	Band-tailed Pigeon	Blue
Rangifer tarandus pop. 1	Caribou (southern population)	Red
Ursus arctos	Grizzly Bear	Blue

Extension of the existing boat ramp would not affect the already developed upland area unless additional blasting of the rock wall is required. Blasting may temporarily displace wildlife from this area and therefore, critical periods such as nesting should be avoided.

Overall, it is unlikely that any wildlife habitat including nesting and migratory bird habitat would be affected. In addition, the habitat requirements for birds such as American Bitterns and short-eared owls are not found at this project site. High value suitable nesting habitat for bitterns is present at the Cranberry Marsh located in Valemount (Cooper and Beauchesne 2003). The grassland areas and cattail marshes that these species require are not usually associated with dam controlled wetland areas but rather those controlled by beavers.

While this area may be used by a variety of species, the habitat is not deemed critical and is not limited upon the landscape. A further review of these listed wildlife species and their habitat requirements are not required. In addition, of the SARA species listed in Table 1, none of them are likely to be affected by the construction at the Valemount Marina.

3.1.3 Vegetation

3.1.3.1 Rare Plant Communities

The CDC Rare Natural Plant Community Tracking List for the Headwaters Forest District identifies one red-listed, two blue-listed and four yellow-listed plant communities (site series unit) in the ICHmm biogeoclimatic subzone (Table 4). Where there is poor representation of mature natural examples of SBS subzones in protected areas and there has been substantial modification of existing areas, most or all site series units in a subzone often appear on the CDC lists (Coupe 2005). Red-listed communities in this subzone are typically rare on the landscape and are often sensitive to disturbance.

Table 4. Red-listed, blue-listed, and yellow-listed plant communities in the ICHmm.

Scientific Name	English Name	BC Status	BGC
Picea mariana - Pinus contorta / Kalmia spp. */ Sphagnum* spp.	black spruce - lodgepole pine / kalmias / peat-mosses	Blue	ICHmm/07
Thuja plicata / Gymnocarpium dryopteris	western red cedar / oak fern	Yellow	ICHmm/04
Thuja plicata / Lysichiton americanus / Sphagnum spp.	western red cedar / skunk cabbage / peat-mosses	Red	ICHmm/08
Thuja plicata / Oplopanax horridus / Athyrium filix-femina	western red cedar / devil's club / lady fern	Yellow	ICHmm/05
Thuja plicata / Oplopanax horridus / Equisetum arvense	western red cedar / devil's club / common horsetail	Yellow	ICHmm/06
Thuja plicata / Paxistima myrsinites	western red cedar / falsebox	Blue	ICHmm/02
Tsuga heterophylla - Picea engelmannii x glauca / Hylocomium splendens	western hemlock - hybrid white spruce / step moss	Yellow	ICHmm/01;ICHmm/03

The upland area is located along the mid-slope of a western aspect and contains a rock face with shallow soils (Appendix 1; Plates 3 and 8). This upslope area has been historically harvested and the tree species include black cottonwood, trembling aspen, western cedar, lodgepole pine and paper birch. The understory is comprised of a mixture of red-osier dogwood, thimbleberry, paintbrush, willows, and mountain alder. Since this area has been very disturbed, it is difficult to determine the plant community that best represents this area. However, it is possible to determine that no red or blue-listed communities are present on the basis that the soils are sub-xeric, western cedar was not dominating and little falsebox was present. The ICHmw1/01 or 04 plant community's best describe this upland area.

Other vegetation communities of particular importance and sensitivity include riparian communities, which are not described in the site identification field guide, but typically have high wildlife values and are sensitive to disturbance. The riparian vegetation along the drainage adjacent to the boat ramp is non-existent, therefore, will not be affected during extension of this boat ramp.

3.1.3.2 Rare Plant Species

Plant species can be identified using several keys. Generally the nomenclature follows Hitchcock ***et al.*** (1973), however The Vascular Plants of British Columbia (Ministry of Forests 1989, 1990, 1991 & 1994) was used where there were discrepancies in the species names used. There are 3 plant species that appear on the CDC red-list and 13 that occur on the blue-list of rare vascular plant species within the ICH subzone of the Headwaters Forest District (BC CDC 2007a, Appendix 3).

This list was further examined to determine if the listed plant species have the potential to occur within the ICHmm subzone. The examination revealed that none of the listed species or genera of the listed species have significant potential to occur within the study area, based on their distribution and habitat requirements. For example, there have been occurrences of Crawe's sedge within the Kinbasket Reservoir however, it is limited to swampy and riverine areas that were not found in the vicinity of this boat ramp (BC CDC 2007a).

3.1.3.3 First Nations Traditional Plant Use

A variety of plants have been identified as providing value to First Nations people. Indigenous peoples throughout BC have used plants for food, medicine, tools, transportation, and shelter (Davies 1993). Foods such as berries, roots, fruits, bark, shoots, leaves and lichens have been included in their diets for centuries. Plants also provide forage for the animals on which they hunted and relied on for meat. Table 5 outlines those species of importance that were observed or are likely to occur in the upland areas of these sites.

Table 5. Plant species found within the project area with traditional uses.

Common Name	Scientific Name	Use
Douglas-fir	*Pseudotsuga menziesii*	Medicinal tea, gum.
Saskatoon	*Amelanchier alnifolia*	Berries.
Paper birch	*Betlua papyrifera*	Sap used for medicine, bark used for baskets, cradles and canoes.
Trembling aspen	*Populus tremuloides*	Tent poles, deodorizer, absorbent material.
Hazelnut	*Corylus cornuta*	Food source - nuts.
Black cottonwood	*Populus balsamifira*	Canoes and fire sets.
Hookers thistles	*Cirsium hookerianum*	Vegetable.
Oregon grape	*Mahonia aquifolium*	Berries, flavour, jelly, beneficial to blood.
Red osier dogwood	*Cornus sericea*	Smoked for lung disease
False solomons seal	*Smilacina racemosa*	Berries, sweetener or flavouring.
High bush cranberry	*Viburnum edule*	Berries.
Wild raspberry	*Rubus idaeus*	Popular berry.
Soapberry	*Sherperdia canadensis*	Confection, ailments, trade item.
Wild strawberry	*Fragaria virginiana*	Berries.
Thimbleberry	*Rubus parviflorus*	Berries.
Chokecherry	*Prunus virginiana*	Berries.
Common juniper	*Juniperus communis*	Medicinal tea, cleaner, deodorizer.

Since the vegetated upland areas surrounding boat ramp should not be affected by the extension of the boat ramp, no rare plant or plant communities or plants used by First Nations people would be affected. However, it is possible that some species such as willow, thimbleberry, and red-osier dogwood may be displaced depending upon if and where any rock blasting occurs and if the roadway requires widening.

3.1.4 Potential Environmental Effects

While fish habitat, wildlife habitat and terrestrial habitat do exist within the vicinity of the boat launch, no critical habitats are present and the habitat present is not limited upon the landscape. Thus these habitats are assigned a low ESA rating.

Based on the conceptual plans for the proposed extension of the existing ramp, no significant impacts to these ecosystem components are expected, provided that an Environmental Management Plan for this site is implemented for the construction. (Section 4.1).

3.2 Kinbasket Reservoir: Bulldog Creek

3.2.1 Fish and Fish Habitat

The proposed boat ramp site is located 7 km south of the Valemount Marina and adjacent to the right bank of Bulldog Creek (WSC: 300-833100) (Appendix 1; Plate 12). Populations of bull trout and rainbow trout are known to exist in Bulldog Creek but a canyon section in Reach 2 has been identified as a barrier to fish (ARL 1992). Underneath the bridge, a set of falls may also be a barrier to upstream migration at low reservoir levels. The mouth of this stream may be an important feeding site for fish within the KR as it provides foraging habitat. Bull trout have been angled near the mouth of this stream (Bennett 2007) and tagged adfluvial bull trout have been sampled between Bulldog and Yellowjacket Creeks near the shoreline (Oliver 2001). At full pool levels fish can access just upstream of the bridge.

During the time of the assessment, Bulldog Creek was flowing south towards the reservoir and was contained within channel banks. However, as the pool levels increase, the stream is known to disperse over its right bank and flow through lower elevation areas. These areas were noted as swales and depressions in the lakebed which contained finer substrates and some vegetation (Appendix 1; Plate 16).

In the area designated for the proposed road and ramp, lake bed substrates are a mix of fine substrates, gravels, cobbles, and some boulders (Appendix 1; Plates 17 and 18). The larger size of substrate provides interstitial space provides greater refuge and foraging opportunities for fish. Juvenile rainbow trout, Kokanee, and bull trout show a preference for the coarser substrates, while prickly sculpin prefer the finer substrates. In addition some vegetation and LWD was observed below the high water mark, which benefits the structural complexity of fish habitat.

From the high water mark, 1440 m^2 of lakebed substrates will be covered by fill to obtain the correct slope and elevation for the access road. An addition 1200 m^2 of lakebed will be converted to the low and intermediate water ramps and will require minor amount of fill to achieve the correct slope. In addition a parking and turnaround area is proposed for at the top of the slope and mid-way down the access road (Appendix 1; Plates 14 and 15).

In addition to the total disturbance footprint of 2640 m^2, the edge of the roadway is close to the top of the Bulldog Creek right bank. Given the approximate centreline observed in the field, it appeared that the roadway would be within the 20 m of the stream. While there is no riparian vegetation along this section, the environmental management plan would need to ensure the stability of the bank is maintained and no sediment is mobilized into Bulldog Creek. The design would also have to allow for the transport of overflow water from the stream through to the lower elevation areas as the pool level increases (culverts or swales).

3.2.2 Wildlife and Wildlife Habitat

Given the close proximity, the wildlife and wildlife habitat in the vicinity of Bulldog Creek are similar to those described at the Valemount Marina. Specifically, the middle and upper Bulldog Creek watershed has been identified as high grizzly bear habitat and as sensitive mountain goat habitat (ILMB 1999). A bear (species undetermined) was observed on the road edge approximately 500 m north of the proposed site.

Two spruce snags were observed along the road fill slope and would provide good perching habitat. No nests were observed in trees which may be affected by the road construction. The rock cliffs above may provide habitat for variety of songbird species and small mammals. The forested area adjacent to the high water level of the reservoir may provide a transitional area for reptiles and amphibian which may use the lakeshore during higher water levels. Wildlife use of the LWD deposited at the high water levels was observed (Appendix 1; Plate 20).

The red-listed and blue-listed species in the ICH zone of the Headwaters Forest District have already been identified (Table 3; Section 3.1.2). The Grizzly bear is the only species that has the potential to be found in the vicinity of this site. The blasting to obtain the 1600 m^3 of rock necessary for construction may temporarily displace some species (Bennett 2003). It will not directly affect the high value grizzly habitat known to occur in the mid to upper sections of the Bulldog Creek drainage, however, the potential for increased human-bear interaction may occur given the site's close proximity to grizzly bear habitat.

Construction of this boat ramp should not negatively affect any critical wildlife habitat including nesting and migratory bird habitat. The habitats present are not limited upon the landscape in this area of the reservoir. A further review of the listed species and their habitat requirements is not required.

3.2.3 Vegetation

3.2.3.1 Rare Plant Communities

The CDC Rare Natural Plant Community Tracking List for the Headwaters Forest District identifies one red-listed, two blue-listed and four yellow-listed plant communities (site series unit) in the ICHmm □iogeoclimatic subzone (Table 4).

The upland area is located along the mid-slope of a western aspect and contains a rock face with shallow soils. The upslope area has been historically harvested and the tree species include black cottonwood, trembling aspen, western cedar, and hybrid spruce. The understory is comprised of a mixture of red-osier dogwood, thimbleberry, paintbrush, willows, and mountain alder. Since this area has been disturbed, it is difficult to determine the plant community that best represents this area.

If blasting of rock is required to construct the roadway and ramp, a minor amount of vegetation would be affected. Two snags and one cottonwood may be removed during construction of the fill slope at the beginning of the road. Overall, no red or blue-listed plant communities will be affected by this construction.

3.2.3.2 Rare Plant Species

The CDC list previously mentioned in Section 3.1.3.2 (Appendix 3) was examined and none of the listed species or genera of the listed species were observed or have significant potential to occur within the study area, based on their distribution and habitat requirements.

3.2.3.3 First Nations Traditional Plant Use

A list of plants that have been identified as providing value to First Nations people was mentioned previously (Table 5; Section 3.1.3.3). The area intended for construction has little vegetation, with the exception of a few snags, young willows, and black cottonwood beside the road. Construction of a boat ramp would not affect many plants that are used for traditional purposes by First Nations people.

3.2.4 Potential Environmental Effects

While wildlife and terrestrial habitat exist within the vicinity of the boat launch, no critical habitats are present and the habitat is not limited upon the landscape. Thus these habitats are assigned a low ESA rating.

The fish habitat surrounding the Bulldog Creek boat ramp site is structurally complex and provides refuge and foraging opportunities for a variety of species of fish. Thus the habitat is assigned a medium ESA rating.

Provided that an Environmental Management Plan for this site is implemented for all phases of the construction (Section 4.1), no significant immitigable impacts to fish or fish habitat are expected. However, given that the fish habitat in this area was assigned a medium ESA rating and that this ramp would only be used from April 1st to mid-June (Bennett 2007), an alternative such as extending the existing ramp at the Valemount Marina would be recommended.

3.3 Kinbasket Reservoir: Nixon Creek

3.3.1 Fish and Fish Habitat

There is no available data on fish species or their distributions in Nixon Creek (WSC: 300-864500). No barriers to upstream migration were observed during low reservoir levels so there is potential for a variety of fish species to utilize this stream. An accumulation of both LWD and small woody debris (SWD) was observed along the banks of Nixon Creek near the high water mark (Appendix 1; Plate 26). Since the upper section of the access road is outside of the riparian area and the end of the boat ramp is 700 m from the mouth of Nixon Creek, no environmental impacts to the stream are expected. No other unnamed or unmapped drainages were observed near the existing ramp.

During the field assessment the lakebed substrates near the end of the existing gravel ramp were estimated to be 60% gravels, 30% cobbles, and 10% fines (Appendix 1; Plate 24). The larger size of substrate provides interstitial space that can be used as refuge and for foraging for fish. A majority of the gravel and cobbles were comprised of shale and not well rounded. Compaction seemed moderate and these substrates could be used to spawning. A few larger boulders and LWD were present just above the current water level and sedges and horsetails were closer to the high water mark. An abundance of LWD has been deposited along the high water mark at this location. The majority of the rootwads had evidence of being cut which occurred during underwater harvesting conducted in 1995 (Bluewater 1997).

The existing gravel road will remain as is (Appendix 1; Plate 21) and a ramp extension with turnaround area will be constructed using pre-cast concrete panels. The total disturbance footprint for the ramp is 780 m^2. A floating breakwater is also proposed and will use concrete anchor blocks and chains to maintain the breakwater's position. The disturbance footprint of the anchors blocks will be minimal.

While the lakebed substrates are likely used by some fish species, they are not limited in this area. Based on the size of the disturbance footprint associated with the proposed extension of this ramp, no significant immitigable impacts to fish or fish habitat are expected.

3.3.2 Wildlife and Wildlife Habitat

The upland area at Nixon Creek currently provides habitat for a variety of songbird species, ungulates, bears, and small furbearers (Appendix 1; Plate 22). Evidence of black bear was observed along the roadway leading to the site and deer tracks were observed in the finer substrates near the end of the existing boat ramp (Appendix 1; Plate 25). Evidence of caribou further up in the Nixon Creek drainage has been recorded (McLellan and Flaa 2003). The upland area has not been designated as ungulate winter range but an enhanced resource development zone (Govt. of BC 1995).

Older western red cedar and black cottonwood were found above the high water mark and while no nests were observed, these provide good perching habitat and may be used for nests in the future. This forested area may also provide transitional area for reptiles and amphibians which may use Nixon Creek or the lakeshore during higher water levels.

The CDC red, blue and yellow list for rare vertebrate species within the ICH subzone of the Columbia Forest District was acquired and a total of 2 red-listed and 12 blue-listed species were identified (Table 6). Six bird, 2 invertebrate, and 6 mammal species were identified.

Table 6. Red and blue-listed species in the ICH zone of the Columbia Forest District.

Scientific Name	English Name	BC Status
Ardea herodias herodias	Great Blue heron, *herodias* subspecies	Blue
Asio flammeus	Short-eared Owl	Blue
Botaurus lentiginosus	American Bittern	Blue
Grus canadensis	Sandhill Crane	Blue
Gulo gulo luscus	Wolverine, *luscus* subspecies	Blue
Hirundo rustica	Barn Swallow	Blue
Martes pennanti	Fisher	Blue
Myotis septentrionalis	Northern Myotis	Blue
Ovis canadensis	Bighorn Sheep	Blue
Patagioenas fasciata	Band-tailed Pigeon	Blue
Plethodon idahoensis	Coeur d'Alene Salamander	Blue
Rana pipiens	Northern Leopard Frog	Red
Rangifer tarandus pop. 1	Caribou (southern population)	Red
Ursus arctos	Grizzly Bear	Blue

Since parking will be limited to 3 or 4 vehicles to discourage overnight camping (Boyd 2007), the extension of this boat ramp would not greatly affect the upland area. Therefore, it is unlikely that any wildlife habitat including nesting and migratory bird habitat would be altered. While this area may be used by a variety of species, the habitat is not deemed critical and is not limited upon the landscape. A further review of these listed species and their habitat requirements are not required.

3.3.3 Vegetation

3.3.3.1 Rare Plant Communities

The CDC Rare Natural Plant Community Tracking List for the Columbia Forest District identifies three blue-listed and five yellow-listed plant communities (site series unit) in

the ICHmw1 biogeoclimatic subzone (Table 7). Where there is poor representation of mature natural examples of SBS subzones in protected areas and there has been substantial modification of existing areas, most or all site series units in a subzone often appear on the CDC lists (Coupe 2005). There are no occurrences of red-listed communities in this subzone which are typically rare on the landscape and are often sensitive to disturbance.

Table 7. Red-listed, blue-listed and yellow-listed plant communities in the ICHmw1.

Scientific Name	English Name	BC Status	Site Series
Carex lasiocarpa / Drepanocladus aduncus	slender sedge / common hook-moss	Blue	ICHmw1/Wf05
Pinus contorta / Juniperus communis / Arctostaphylos uva-ursi	lodgepole pine / common juniper / kinnikinnick	Yellow	ICHmw1/02
Thuja plicata / Oplopanax horridus / Athyrium filix-femina	western red cedar / devil's club / lady fern	Yellow	ICHmw1/05
Thuja plicata - Tsuga heterophylla / Equisetum arvense	western red cedar - western hemlock / common horsetail	Blue	ICHmw1/07
Thuja plicata / Vaccinium ovalifolium / Gymnocarpium dryopteris	western red cedar / oval-leaved blueberry / oak fern	Yellow	ICHmw1/06
Trichophorum cespitosum / Campylium stellatum	tufted clubrush / golden star-moss	Blue	ICHmw1/Wf11
Tsuga heterophylla / Paxistima myrsinites	western hemlock / falsebox	Yellow	ICHmw1/03;ICHmw1/04
Tsuga heterophylla - Thuja plicata / Paxistima myrsinites / Pleurozium schreberi	western hemlock - western red cedar / falsebox / red-stemmed feathermoss	Yellow	ICHmw1/01

The upland area is located at the toe of the western slope and has been slightly disturbed through clearing and older roadways. It is dominated by trembling aspen with some older western cedars scattered throughout. The understory is comprised of a mixture of saskatoon, kinnikinnick, thimbleberry, wild sarsaparillia and red-osier dogwood. The ICHmw1/01 or 04 plant community's best describe this upland area. Both are classified as yellow-listed, which is likely due to similar plant species assemblages occurring in other subzones and variants around the province (Coupe 2005).

Other vegetation communities of particular importance and sensitivity include riparian communities, which are not described in the site identification field guide, but typically have high wildlife values and are sensitive to disturbance. The riparian vegetation along Nixon Creek will not be affected during extension of this boat ramp.

3.3.3.2 Rare Plant Species

Plant species can be identified using several keys. Generally the nomenclature follows Hitchcock *et al.* (1973), however The Vascular Plants of British Columbia (Ministry of Forests 1989, 1990, 1991 & 1994) was used where there were discrepancies in the species names used. There are 10 plant species that appear on the CDC red-list and 23 that occur on the blue-list of rare vascular plant species within the ICH subzone of the Columbia Forest Districts (BC CDC 2007a, Appendix 3).

This list was further examined to determine if the listed plant species have the potential to occur within the ICHmw1 subzone. The examination revealed that none of the listed species or genera of the listed species have significant potential to occur within the study area, based on their distribution and habitat requirements.

3.3.3.3 First Nations Traditional Plant Use

A list of plants that have been identified as providing value to First Nations people was mentioned previously (Table 5; Section 3.1.3.3). The area intended for construction is largely unvegetated, therefore, construction of a boat ramp would not affect any plants that are used for traditional purposes by First Nations people. The upland area across the road from the proposed boat ramp has black cottonwood, wild strawberry, thimbleberry, and saskatoon.

3.3.4 Potential Environmental Effects

While fish habitat, wildlife habitat and terrestrial habitat do exist within the vicinity of the boat launch, no critical habitats are present and the habitat is not limited upon the landscape. Thus these habitats are assigned a low ESA rating.

Based on the conceptual plans for the proposed extension of the existing boat ramp, no significant impacts to these ecosystem components are expected, provided that an Environmental Management Plan for this site is implemented for the construction (Section 4.1).

3.4 Kinbasket Reservoir: Bush Harbour

3.4.1 Fish and Fish Habitat

Succour Creek (WSC: 300-871400), is the closest named stream to Bush Harbour and is located 3.8 km southwest of the boat ramp at the mouth of Succour Arm. It is known to support populations of brook trout, Kokanee, mountain whitefish, longnose dace, longnose sucker, torrent sculpin, and rainbow trout (FISS 2007). The mouth of the creek and lower reaches are one of the dominant spawning grounds for Kokanee while rainbow trout and brook trout are found further upstream. Succour Creek is one of the few tributaries that are lake fed rather than glacial fed. Its overall gradients are much less (1.5%) and its water temperatures greater (12-14.5^{o}C in summer) than the majorities of the tributaries to the Reservoir (ARL 1992). Succour Arm is an important transportation corridor for mature bull trout and Kokanee traveling to spawn in Bush River. There may be congregations of mature fish aggregating in this area at certain times of year.

An unnamed tributary to the reservoir was observed in the vicinity of the boat ramp (Appendix 1; Plate 28). It currently flows north along the eastern edge of the existing berm likely created as a high water level ramp. At the current reservoir levels, some minor falls over LWD were observed which may be barriers to upstream migration (Appendix 1; Plate 31). In addition, a 100 m long culvert was found that transports the flows from the stream upslope of the parking area to the start of the berm. During the assessment, this stream was greater than 20 m away from the existing ramp and should therefore not be affected by the construction.

A non-classified drainage was observed immediately east of the ramp proposed for extension (Appendix 1; Plate 29). There was a defined channel through the lower sections of the drainage where the flows were scouring out some of the fine lakebed substrate but upslope of the high water mark, it flowed over the vegetation. During the summer, this drainage is likely dry but if flows are present during construction, isolation measures will be required to prevent sediment mobilization (Section 4.2.4).

The lakebed substrates at the end and along the existing boat ramp are cobbles and gravels which appear to have been deposited during the creation of this gravel ramp (Appendix 1; Plates 33 and 34). The surrounding lakebed substrates are dominantly fines and silts. The fine substrates in this area do not provide adequate rearing or spawning habitat for most species in the waterbody. There was an absence of aquatic vegetation and LWD surrounding the boat ramp.

The existing gravel ramp will be converted to a 280 m long concrete ramp with parking and turnaround area at the top and a turnaround area 140 m down the ramp. These areas will be constructed using pre-cast concrete panels. The total disturbance footprint below the high water mark is approximately 1900 m^2. A floating breakwater is also proposed and will use steel piles to maintain the breakwater's position. The disturbance footprint of the piles will be minimal.

While the lakebed substrates are likely used by some fish species, they are not limited in this area. Based on the size of the disturbance footprint associated with the proposed extension and the amount of fine substrate naturally occurring in the area, no significant unmitigable impacts to fish or fish habitat are expected.

3.4.2 Wildlife and Wildlife Habitat

Although the upland area has been significantly disturbed, it does provide habitat for a variety of songbird species, ungulates, grizzly bears, black bears, and small mammals (Appendix 1; Plate 27). American robin, northern flicker, killdeer and kinglet were some of the bird species observed in the area. A bear carcass was observed near the upland area and had likely been poached since the feet and head had been removed. Grizzly bear tracks were observed along the lakeshore between the gravel ramp and the berm and ungulate tracks were observed in the upland area (Appendix 1; Plate 32). A red-tailed hawk was observed flying overhead.

The red-listed and blue-listed species in the ICH zone of the Columbia Forest District have been previous mentioned (Table 6; Section 3.3.2). Since the upland area on the east side of Bush FSR will not be directly affected, wildlife habitat will be impacted.

The extension of this ramp and the construction of the parking area should not affect the already disturbed upland area. Therefore, it is unlikely that any wildlife habitat including nesting and migratory bird habitat would be altered. While this area may be used by a variety of species, the habitat is not deemed critical and is not limited upon the landscape. A further review of these listed species and their habitat requirements are not required.

3.4.3 Vegetation

3.4.3.1 Rare Plant Communities

The CDC Rare Natural Plant Community Tracking List for the Columbia Forest District identifies three blue-listed and five yellow-listed plant communities (site series unit) in the ICHmw1 biogeoclimatic subzone (Table 7).

The upland area is located at the toe of the western slope and has been largely disturbed through clearing and older roadways. The vegetation was dominated by trembling aspen with some lodgepole pine, paper birch scattered throughout. The understory is comprised of a mixture of saskatoon, kinnikinnick, thimbleberry, wild sarsaparillia and red-osier dogwood. A small rocky outcropping with shallow soils also contained common juniper. The ICHmw1/02 plant community's best describe this upland area. It is classified as yellow-listed, which is likely due to similar plant species assemblages occurring in other subzones and variants around the province (Coupe 2005).

Other vegetation communities of particular importance and sensitivity include riparian communities, which are not described in the site identification field guide, but typically have high wildlife values and are sensitive to disturbance. The riparian vegetation along the unnamed stream will not be affected during extension of this boat ramp.

3.4.3.2 Rare Plant Species

Plant species can be identified using several keys. Generally the nomenclature follows Hitchcock *et al.* (1973), however The Vascular Plants of British Columbia (Ministry of Forests 1989, 1990, 1991 & 1994) was used where there were discrepancies in the species names used. There are 10 plant species that appear on the CDC red-list and 23 that occur on the blue-list of rare vascular plant species within the ICH subzone of the Columbia Forest Districts (BC CDC 2007a, Appendix 3).

This list was further examined to determine if the listed plant species have the potential to occur within the ICHmw1 subzone. The examination revealed that none of the listed species or genera of the listed species have significant potential to occur within the study area, based on their distribution and habitat requirements.

3.4.3.3 First Nations Traditional Plant Use

A list of plants that have been identified as providing value to First Nations people was mentioned previously (Table 5; Section 3.1.3.3). The area intended for construction is largely unvegetated, therefore, there should be no effect on any plants that are used for traditional purposes by First Nations people.

3.4.4 Potential Environmental Effects

The fish habitat, wildlife habitat and terrestrial habitat existing at the Bush Harbour boat ramp are not deemed critical, are not limited upon the landscape, and have already experienced some degree of disturbance. These ecosystem components are assigned a low ESA rating.

Based on the conceptual plans for the proposed extension of this boat ramp, no significant impacts to these ecosystem components are expected, provided that an Environmental Management Plan for this site is implemented for the construction (Section 4.1).

3.5 Mid-Columbia Reach: Centennial Park, Revelstoke

3.5.1 Fish and Fish Habitat

The closest streams, excluding the Mid-Columbia River, to the existing boat ramp at Centennial Park is the Tonkawatla River (WSC: 300-752700) (1.7 km south) and the Illecillewaet River (WSC: 300-675200) (2.1 km south). These streams are known to support populations of torrent sculpins, brook trout, bull trout, Kokanee, Westslope cutthroat trout, and rainbow trout (FISS 2007). The area known as the Big Eddy is located 2.6 km upstream along the right bank and is known to be a holding area for adult white sturgeon prior to spawning in nearby Jordan River and below the Revelstoke Dam (Appendix 1; Plate 40) (UCWSRT 2002).

There is one minor seepage located 50 m downstream from the existing boat ramp but is classified as a non-classified drainage (Appendix 1; Plate 41). Although a small gully was present, no defined channel was observed and water flows over the riprap protecting the bank prior to entering the river.

The Mid-Columbia River in the vicinity of the boat ramp provides deep run habitat along the bend with suitable spawning gravels and cobbles along the channel margin (Appendix 1; Plate 38). This habitat has been considered transitional habitat for a number of species found within the Columbia River such as white sturgeon, Kokanee, bull trout and rainbow trout. The gravels and cobbles at the end of the existing ramp and further upstream along the channel margin have been used by Kokanee for spawning (Gadbois 2007). Kokanee usually spawn in gravel/cobble substrate and areas with flow velocities between 0.15 and 0.72 m/s (Ford *et al.* 1993). Close proximity to cover such as deep pools or large woody debris, is also important for the protection of adults while spawning and for emerging fry. Overall, the extreme fluctuations in water levels in this area may reduce the likelihood of channel margins being using as spawning areas if they become dewatered. The water levels during the field assessment were 2 - 3 m above low water levels (Gadbois 2007).

The existing concrete plank ramp (Appendix 1; Plate 36) will be extended by 24 m with no changes to the upper part of the ramp or the existing parking area. A floating walkway attached to steel piles will be constructed. A total disturbance footprint area of 120 m^2 will be required to extend this ramp and the disturbance footprint of the piles will be minimal. A rumble mound breakwater may also be proposed 40 m upstream of the end of the ramp to provide decreased water velocities for boaters during deployment. This breakwater would be approximately 90 m long and have a base of 35 m wide creating a disturbance footprint on the channel bottom of 3150 m^2.

Near the end of the existing ramp, the substrate composition is approximately small cobbles 50% gravels 30% and fines 20%. There may also be a few larger boulders but as the water depths increased, the substrates could not be accurately classified. The area proposed for the rubble breakwater appears to be fairly flat. Since the substrates at this location are not known, it is difficult to determine the potential affect building a rubble

breakwater would have on the available fish habitat. If the bottom is comprised of fines and silt, then the rocks used on the breakwater may provide additional habitat in the form of interstitial space and cover. However, if the substrates are gravels and cobbles, which are potential spawning areas (white sturgeon prefer deeper water for spawning), the conversion to rock may produce a loss in habitat value.

The Big Eddy as an alternative site was briefly discussed, however, given the private property surrounding the site, it was not deemed feasible. In addition, this area is known to be utilized by pre-spawning white sturgeon and construction may have affected this habitat.

3.5.2 Wildlife and Wildlife Habitat

In the areas surrounding Revelstoke, there is potential habitat for a variety of bird species. For example, Machete Island located south of the Illecillewaet River is a known habitat area for yellow warblers (Green and Quinlan 2007). Old cottonwoods, old willows and other shrub species create good nesting and foraging habitat for these and other birds such as osprey. The grassland areas also provide nesting areas for short-eared owls, Canada geese, and other waterfowl. Active great blue heron nest have been recorded around Revelstoke (Machmer and Steeger 2003) but none were observed in the vicinity of the project site. During the field assessment Canada geese were observed on the river and along the bank just upstream of the ramp. Osprey were flying overhead and northern flicker, American robin, dark eyed junco, and western garter snake were observed around the site (Appendix 1; Plate 39).

The lower valley slopes adjacent to the Mid-Columbia River and the Upper Arrow Reservoir have been identified as mule deer ungulate winter range. Deer and elk have been the targets of several ungulate winter range projects in the surrounding areas (D'Eon *et al* 2002). Given that the project site is in the town of Revelstoke, no impact to ungulate winter range is expected.

The upland area surrounding the existing boat ramp location is developed and used as local park. There are adequate parking areas and the access road is paved (Appendix 1; Plate 35). It is likely that the vegetated areas nearby provide habitat for songbirds, small mammals, amphibians and reptiles.

The red-listed and blue-listed species in the ICH zone of the Columbia Forest District have been previous mentioned (Table 7; Section 3.3.2). Further development of the upland area is not proposed, therefore the existing habitat and riparian area of the Mid-Columbia River at this location will not be impacted.

3.5.3 Vegetation

3.5.3.1 Rare Plant Communities

The CDC Rare Natural Plant Community Tracking List for the Columbia Forest District identifies three blue-listed and six yellow-listed plant communities (site series unit) in the ICHmw3 biogeoclimatic subzone (Table 8). Where there is poor representation of mature natural examples of SBS subzones in protected areas and there has been substantial modification of existing areas, most or all site series units in a subzone often appear on the CDC lists (Coupe 2005). There are no occurrences of red-listed communities in this subzone which are typically rare on the landscape and are often sensitive to disturbance.

Table 8. Red-listed, blue-listed and yellow-listed plant communities in the ICHmw3.

Scientific Name	English Name	BC Status	Site Series
Carex lasiocarpa / Drepanocladus aduncus	slender sedge / common hook-moss	Blue	ICHmw3/Wf05
Carex spp. - *Potentilla* spp.	sedges - cinquefoils	Yellow	ICHmw3/09
Equisetum fluviatile - Carex utriculata	swamp horsetail - beaked sedge	Blue	ICHmw3/Wm02
Pseudotsuga menziesii / Juniperus communis / Cladina spp.	Douglas-fir / common juniper / reindeer lichens	Yellow	ICHmw3/02
Pseudotsuga menziesii - Pinus contorta / Calamagrostis rubescens / Pleurozium schreberi	Douglas-fir - lodgepole pine / pinegrass / red-stemmed feathermoss	Yellow	ICHmw3/03
Thuja plicata / Oplopanax horridus / Athyrium filix-femina	western redcedar / devil's club / lady fern	Yellow	ICHmk3/06
Thuja plicata - Picea engelmannii x *glauca / Lysichiton americanus*	western redcedar - hybrid white spruce / skunk cabbage	Yellow	ICHmw3/08
Trichophorum cespitosum / Campylium stellatum	tufted clubrush / golden star-moss	Blue	ICHmw3/Wf11
Tsuga heterophylla / Paxistima myrsinites	western hemlock / falsebox	Yellow	ICHmw3/04;ICHmw3/05
Tsuga heterophylla - Thuja plicata / Paxistima myrsinites / Pleurozium schreberi	western hemlock - western redcedar / falsebox / red-stemmed feathermoss	Yellow	ICHmw3/01

The upland area has been previous developed as a parking lot, paved roads, and playing fields. The vegetation along the riparian area of the river was dominated by black cottonwood with a few scattered paper birch and spruce. The understory is comprised of a mixture of mountain ash, thimbleberry, red-osier dogwood and Douglas maple. Since this area has been disturbed, it is difficult to select a site series that best represents this area.

Riparian communities, which are not described in the site identification field guide, typically have high wildlife values and are sensitive to disturbance. The riparian vegetation along the river should not be affected, however, if some clearing is required for machinery to lift the concrete planks in place, the shrubs can be replanted at the discretion of the agencies.

3.5.3.2 Rare Plant Species

Plant species can be identified using several keys. Generally the nomenclature follows Hitchcock *et al.* (1973), however The Vascular Plants of British Columbia (Ministry of Forests 1989, 1990, 1991 & 1994) was used where there were discrepancies in the species names used. There are 10 plant species that appear on the CDC red-list and 23 that occur on the blue-list of rare vascular plant species within the ICH subzone of the Columbia Forest Districts (BC CDC 2007, Appendix 3).

This list was further examined to determine if the listed plant species have the potential to occur within the ICHmw3 subzone. The examination revealed that none of the listed species or genera of the listed species have significant potential to occur within the study area, based on their distribution and habitat requirements.

3.5.3.3 First Nations Traditional Plant Use

A list of plants that have been identified as providing value to First Nations people was mentioned previously (Table 5; Section 3.1.3.2). Since no alterations to the park area is proposed, there will be no negative impacts to the surrounding vegetation including traditional plants used by First Nations.

3.5.4 Potential Environmental Effects

The wildlife habitat and terrestrial habitat existing at the Centennial Park boat ramp are not deemed critical and are not limited upon the landscape. These ecosystem components are assigned a low ESA rating.

However, the fish habitat value in the area of the extension may be assigned a medium ESA rating given that Kokanee have been observed spawning in the cobbles and gravels along the channel margin upstream of the ramp. The exact substrates on the bottom that will be converted to concrete are not yet known. It is recommended to gather additional information pertaining to the substrate composition at lower water levels at the end of the proposed extension and the area which may be covered by the rubble breakwater.

Based on the conceptual plans for the proposed extension of this boat ramp, no significant immitigable impacts to these ecosystem components are expected, provided that an Environmental Management Plan for this site is implemented for the construction (Section 4.1). The construction of the breakwater may require further review and would need approval from the agencies.

4.0 MITIGATIVE MEASURES, GUIDELINES AND RECOMMENDATIONS

4.1 General Environmental Management Plan

The purpose of an Environmental Management Plan (EMP) is to identify the components of a project with may impact identified ecosystem components (see previous sections). It shall be used as a guide by all parties associated with the construction process to ensure best management practices are followed and negative impacts to the environment are nil.

Potential impacts from the extension of an existing boat ramp or the construction of a new ramp are expected to be minimal and should be easily avoided and/or mitigated. The primary potential impact is the introduction and/or mobilization of deleterious substances into the lake habitat during construction. This may include the following:

- sediment mobilization during excavation of the lakebed in preparation for the installation of the concrete slab;
- oil/fuel spills to occur both on the soils surrounding the work area and into the water;
- disturbance to fish during pile driving operations;
- leaching of grouting materials, waste water or concrete slurry into the water if concrete poured on site; and
- erosion of exposed soils and transport into waterways.

The intent of this EMP is to limit the suspended sediment discharged from the site to within 25 mg/l under normal conditions and 75 mg/l during storm events, which is consistent with the recommendations in the *Land Development Guidelines for the Protection of Aquatic Habitat* (Chilibeck 1993). The general approach to meet the criteria will be to ensure construction works occur in the dry, isolate any sediment-laden water from the lake, minimize surface erosion, and minimize the size of disturbed areas.

4.1.1 Mitigative Measures

Specific mitigative measures that will be used during the course of construction at all of the boat ramp locations include the following:

1. Construction should be completed within the lowest reservoir water levels, which usually occur between late-April and early May. The lowest water levels in the Mid-Columbia reach also occur in early May but the operators at the Revelstoke Dam may be contacted to determine the best time for construction. This will help ensure that the work is completed in the "dry". If water levels begin to increase during the construction, an isolation fence or berm must be constructed to keep water out of the work site.

2. Isolation fences can be installed using a variety of materials. Concrete lock blocks can be placed and will provide a level of isolation. Also, a section of filter fabric

with a sheet of heavy gauge polyethylene plastic, as a liner would be laid on the lakebed, the sandbags placed on top, and the fabric wrapped over the sandbags to create an impermeable barrier. Other materials such as rebar, hay bales and silt fencing can be combined to create an isolation fence. The availability of materials, site conditions, and access to the site will determine the type of fence constructed. Disturbed sediment within the construction site will be allowed to settle out prior to removal of the enclosure.

3. With most isolation features, some degree of seepage should be expected. If this does occur, any sediment-laden water that is created should be retained in the isolation area. If necessary, the turbid water can be pumped out of the area by a vacuum truck. If water is present within the work area, a fish salvage using an electrofisher should be completed prior to the beginning of works to prevent potential injury to fish.

4. Pre-cast concrete slabs are to be used in remote areas and in areas near the water. If a cast-in place concrete slabs are to be used (such as at the upper portion of the ramp at Valemount Marina), it is very important that no concrete or grouts enter the water as the leachate is toxic and is considered a deleterious substance. To prevent this, the work area should be isolated from the water with a waterproof barrier such as polyethylene sheets or sealed coffer dams. These should remain in place during the curing period (at least 72 hours) (MOT 2004). Monitoring of the pH frequently in the watercourse immediately downstream of the isolated worksite will be required until completion of the works. Emergency measures will be implemented if downstream pH has changed more than 1.0 pH unit from the background level, or is below 6.0 or above 9.0 pH units (MWLAP 2004). Keep a carbon dioxide (CO_2) tank with regulator, hose and gas diffuser readily available during concrete work as it can be used to neutralize pH levels if a spill occurs.

5. Pile driving will be required for construction of the floating docks. Pile driving does not usually cause enough disturbance to the stream/lake bed to cause the mobilization of any significant amount of sediment. It is recommended that pre-cast concrete or steel piles are used instead of treated wooden pilings. Untreated wooden piling may also be used however, they will require more maintenance than steel piles (MOE 2006). Steel piles should be used instead of treated timber piles as DFO does not recommended the used of treated lumber due to the potential for leaching of contaminants into the water (DFO 2007).

6. Each steel pile will be driven into the stream bed using a drop hammer. While pile driving may have as some impact on the fish in the immediate vicinity, a 3000 lb drop hammer will not produce a large concussive force, therefore the effects will be localized. A 10 m^2 zone around each pier can be isolated by seine nets to reduce any potential impacts to fish within the zone of influence. It is unlikely that fish will be present within the pile driving area as this should be completed in the dry.

7. If there is surface flow at the time of construction, it will be necessary to dewater the work area. To facilitate pumping, a sump would need to be excavated in the drainage upstream of the work area as there is no well defined channel to dam, and the flow pumped out of the sump and into the bush for natural filtration. Once the water in the sump has clarified, the flows should be pumped around the work area and discharged directly back into the lake.

8. As heavy equipment activity will occur in close proximity to the stream, the equipment should be inspected to ensure it is clean, in good working order and free of any fluid leaks or excess grease. Equipment that uses synthetic biodegradable hydraulic fluid oil would be preferred. The environmental monitor should inspect the equipment for leaks and the operator should be asked to comment on the condition of the hydraulic lines. A spill kit should be present on any machinery working on this project.

9. Excavated material should be placed on level ground, away from any concentrated flows. Stockpiled materials can be covered with polyethylene tarps, or silt fences may be placed around the perimeter of the pile if excessive erosion occurs that results in sediment laden water being transported off the site.

10. In order to minimize tracking dirt onto the access roads, gravel pads should be maintained at access points. If necessary these pads can be modified to function as active (pressure wash) or passive (wet trench) wash stations. This may only apply to the Centennial Park site to prevent the tracking of dirt onto the City's streets.

Other general mitigative measures may include but not be limited to:

- Flagging or otherwise delineating the limits of disturbance prior to initiating construction;
- A daily tailgate meeting to review environmental objectives and procedures with the construction supervisor and crew;
- If rocks, stumps or logs need to be moved from the lakebed to build the ramp, they should be relocated to an area of similar depth and not removed from the site;
- Ensuring that a spill kit is present on-site;
- Ensuring there are no fuel or fluid leaks from equipment;
- Prohibiting refueling or fuel storage within 20 m of waterbodies;
- Minimize unnecessary clearing; and
- Avoid working during heavy or prolonged rains

4.1.2 Monitoring Requirements

A suitably qualified professional should be retained as an environmental monitor during the construction process. The monitor should be on site prior to the start of the project to ensure all parties are aware and familiar with the EMP, during all phases of the construction that are in the wetted area, during significant weather events, and at completion to ensure site is left stable and environmentally sound.

Activities with associated environmental monitoring responsibilities can include:

- Installation of isolation structures at site to prevent mobilization of any sediment-laden water;
- Thoroughly monitoring machinery before and during works to ensure no hydraulic fluid leaks;
- Fish salvage within isolation area;
- Monitoring of water quality to ensure no sediment is mobilized during construction;
- Ensuring no concrete leachate or slurry enters the water and monitoring of water pH levels;
- Construction and decommissioning of any isolation structures; and
- Mitigation activities (*e.g.* erosion and sediment control measures).

Additional monitoring requirements may be outlined in the Letter of Advice or Authorization issued by DFO. The monitor will complete daily environmental monitoring reports which will accurately document the daily activities and any problems/solutions that were managed on site. A post-construction monitoring will be completed and submitted to both BC Hydro and the appropriate agencies.

4.1.3 Timing Windows

In addition to the low water levels required, the timing of construction is also potentially limited by the Periods of Least Risk for Instream Works (MOE 2007c). Based on the presence of bull trout, rainbow trout, Kokanee, and burbot in the KR and Mid-Columbia River, the instream work window is July 15th to August 31st. Since this timeframe corresponds with higher water levels not suitable for construction, a variance must be obtained from MOE prior to construction (Section 4.1.2).

It is advised that if clearing of the upland area is required, operations such as brushing and mowing, should not be conducted in the spring or early summer when birds are nesting. Work areas should be thoroughly inspected for occupied bird nests, eggs or nests of species protected under the Wildlife Act and Migratory Bird Convention Act (MOT 2004).

4.1.4 Permitting Requirements

If during construction, an isolation fence is required, fish salvage should be conducted. A fish collection permit for fish salvage must be obtained from MOE.

Since all construction must occur during low water levels, the timing of these works will be outside of the instream work window and a variance from MOE will be required. In order to satisfy MOE requirements for granting a variance, the basic requirements include:

1. Justification for why the works need to be conducted outside of the default instream work window;
2. Demonstration that fish passage will be maintained to accommodate fish migration to or from spawning areas; and
3. A sediment management plan that minimizes the potential for sediment release.

This feasibility study and associated EMP's should provide MOE with the required information to grant a variance.

4.2 Specific Site Requirements

4.2.1 Kinbasket Reservoir: Valemount Marina

Since there may be flow within the drainage adjacent to the boat ramp during the construction window, a buffer between the work area and this flow should be installed to ensure substances and/or sediment is not mobilized into this drainage and transported into the lake. A silt fence may be installed between the ramp and the drainage to not only act as a barrier to sediment transport but to outline the work area and prevent equipment and people from entering the drainage.

Prior to the extension of the ramp at the Valemount Marina, a Section 9 Water Act *Notification* form must be submitted to the local Ministry of Environment office (Nelson, BC). This form will notify MOE as to the location of the works, nature of the change, and contact information for the construction works.

This feasibility study along with the *Notification* form should be forwarded to the local DFO office (Nelson, BC) for their review prior to construction. While DFO have provided preliminary comments, they should still be notified of the final construction approach. Normally the conversion of lakebed habitat to a hard surface (*i.e.* concrete) would constitute a HADD under section 35(2) of the Federal Fisheries Act. DFO will determine if the project can proceed under a Letter of Advice (which approves the project without legal requirements for reporting or monitoring) or an Authorization (which may require legal compensation, post-construction monitoring, and reporting requirements).

Since this is an extension of an existing boat ramp, Transport Canada does not require further regulatory interest in this project and it can proceed as necessary (Mackie 2007).

4.2.2 Kinbasket Reservoir: Bulldog Creek

Since the Bulldog Creek ramp is a new construction, it will require a Section 9 Water Act *Approval* form be submitted to the local Ministry of Environment office (Nelson, BC). This project would need to be approved by the MOE prior to construction given that it is a new ramp and not an extension.

This feasibility study along with the *Approval* form will also be forwarded to the local DFO office (Nelson, BC) for their review prior to construction. Normally the conversion of lakebed habitat to a hard surface (*i.e*. Concrete) would constitute a HADD under section 35(2) of the Federal Fisheries Act. DFO will determine if the project can proceed under a Letter of Advice (which approves the project without legal requirements for reporting or monitoring) or an Authorization (which may require legal compensation, post-construction monitoring, and reporting requirements).

Since this will involve the construction of a new ramp, which may be a potential navigational hazard, Transport Canada will require the submission of an application for works approval pursuant to the Navigable Waters Protection Act (Mackie 2007).

4.2.3 Kinbasket Reservoir: Nixon Creek

Although the Nixon Creek ramp is not new, it is currently gravel based and not concrete based, therefore upgrades to this ramp would require a Section 9 Water Act *Approval* form must be submitted to the local Ministry of Environment office (Nelson, BC). This form will notify MOE as to the location of the works, nature of the change, and contact information for the construction works.

This feasibility study along with the *Approval* form should be forwarded to the local DFO office (Nelson, BC) for their review prior to construction. Normally the conversion of lakebed habitat to a hard surface (*i.e*. concrete) would constitute a HADD under section 35(2) of the Federal Fisheries Act. DFO will determine if the project can proceed under a Letter of Advice (which approves the project without legal requirements for reporting or monitoring) or an Authorization (which may require legal compensation, post-construction monitoring, and reporting requirements).

Although this is an extension of an existing boat ramp, currently there are no breakwaters and Transport Canada may require the submission of an application for works approval pursuant to the Navigable Waters Protection Act.

4.2.4 Kinbasket Reservoir: Bush Harbour

Since there maybe flow within the drainage adjacent to the boat ramp during the construction window, a buffer between the work area and this flow should be installed to ensure substances and/or sediment is not mobilized into this drainage and transported into the lake. A silt fence may be installed between the ramp and the drainage to not only act as a barrier to sediment transport but to outline the work area and prevent equipment and people from entering the drainage.

Prior to the extension of the ramp at the Valemount Marina, a Section 9 Water Act *Notification* form must be submitted to the local Ministry of Environment office (Nelson, BC). This form will notify MOE as to the location of the works, nature of the change, and contact information for the construction works.

This feasibility study along with the *Notification* form should be forwarded to the local DFO office (Nelson, BC) for their review prior to construction. While DFO have provided preliminary comments, they should still be notified of the final construction approach. Normally the conversion of lakebed habitat to a hard surface (*i.e.* concrete) would constitute a HADD under section 35(2) of the Federal Fisheries Act. DFO will determine if the project can proceed under a Letter of Advice (which approves the project without legal requirements for reporting or monitoring) or an Authorization (which may require legal compensation, post-construction monitoring, and reporting requirements).

Since this is an extension of an existing boat ramp, Transport Canada may not require further regulatory interest in this project and it can proceed as necessary.

4.2.5 Mid-Columbia Reach: Centennial Park, Revelstoke

Based on the assumption that the proposed breakwater will be a part of the construction process at this site, a Section 9 Water Act *Approval* form must be submitted to the local Ministry of Environment office (Nelson, BC). This project would need to be approved by the MOE prior to construction given that it is a new feature and would require review and approval from the MOE to ensure the location of the works, nature of the change, and contact information for the construction works.

This feasibility study along with the *Approval* form will also be forwarded to the local DFO office (Nelson, BC) for their review prior to construction. Normally the conversion of lakebed habitat to a hard surface (*i.e.* concrete) and the placement of a large amount of riprap within the channel would constitute a HADD under section 35(2) of the Federal Fisheries Act. DFO will determine if the project can proceed under a Letter of Advice (which approves the project without legal requirements for reporting or monitoring) or an Authorization (which may require legal compensation, post-construction monitoring, and reporting requirements).

If however, the breakwater is not requirement and the extension is all that is proposed, then a Section 9 Water Act Notification form will be submitted to MOE. DFO should also be forwarded a copy of the EMP and they will decide if the project can proceed under a Letter of Advice or an Authorization.

The ramp extension would likely not require approval from Transport Canada but if the breakwater is to be constructed, Transport Canada will require the submission of an application for works approval pursuant to the Navigable Waters Protection Act.

5.0 SUMMARY

No significant environmental impacts are predicted for the majority of the proposed works on the existing boat ramps. The extension of the Valemount Marina ramp, Nixon Creek, and Bush Habour will not negatively impact the ecosystem components observed at that location and the extension of the boat ramp can proceed following its EMP. DFO, MOE and Transport Canada should be contacted but do not object to the extension of these ramps.

The construction of a new ramp at Bulldog Creek is not recommended based on the fish habitat available in the footprint area and its close proximity to Bulldog Creek. Since it is a new construction project Transport Canada would need to review an application for works approval pursuant to the Navigable Water Protection Act. This site would require a Federal Fisheries Act Authorization and further review by DFO.

The extension of the Centennial Park ramp can proceed provided that an environmental management plan is followed. DFO and MOE may have concerns regarding the potential conversion of suitable spawning gravels to concrete planks and may request further information. In addition, should the breakwater be proposed, it would require review by MOE, DFO and Transport Canada.

While possible alternative sites to the Centennial Park ramp were discussed, no other sites were assessed. Give the flow levels in the Mid-Columbia River during which time the extension would be required, navigation through this section of river is difficult and ramps, if constructed, would not be usable at other sites. The Big Eddy was briefly visited but given that private property surrounds the area, it was not considered a feasible option.

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APPENDIX 1

REPORT PHOTOGRAPHS

Plate 1. Looking north along the existing boat ramp at Valemount Marina.

Plate 2. View of the area designated for extension of the existing ramp at Valemount Marina.

Plate 3. Looking east towards the upland area at Valemount Marina. Forested area has been previously harvested.

Plate 4. Lakebed substrate located at the end of the proposed extension of the ramp at Valemount Marina.

Plate 5. Lakebed substrate indicating abundant sediment is deposited at this location. Typical of area designated for ramp extension.

Plate 6. Showing the extent of ungulate usage near water seepage areas upslope of the proposed extension.

Plate 7. View of current ramp, ditchline and culvert conveying surface flow during spring freshet. Will need to incorporate these features into EMP.

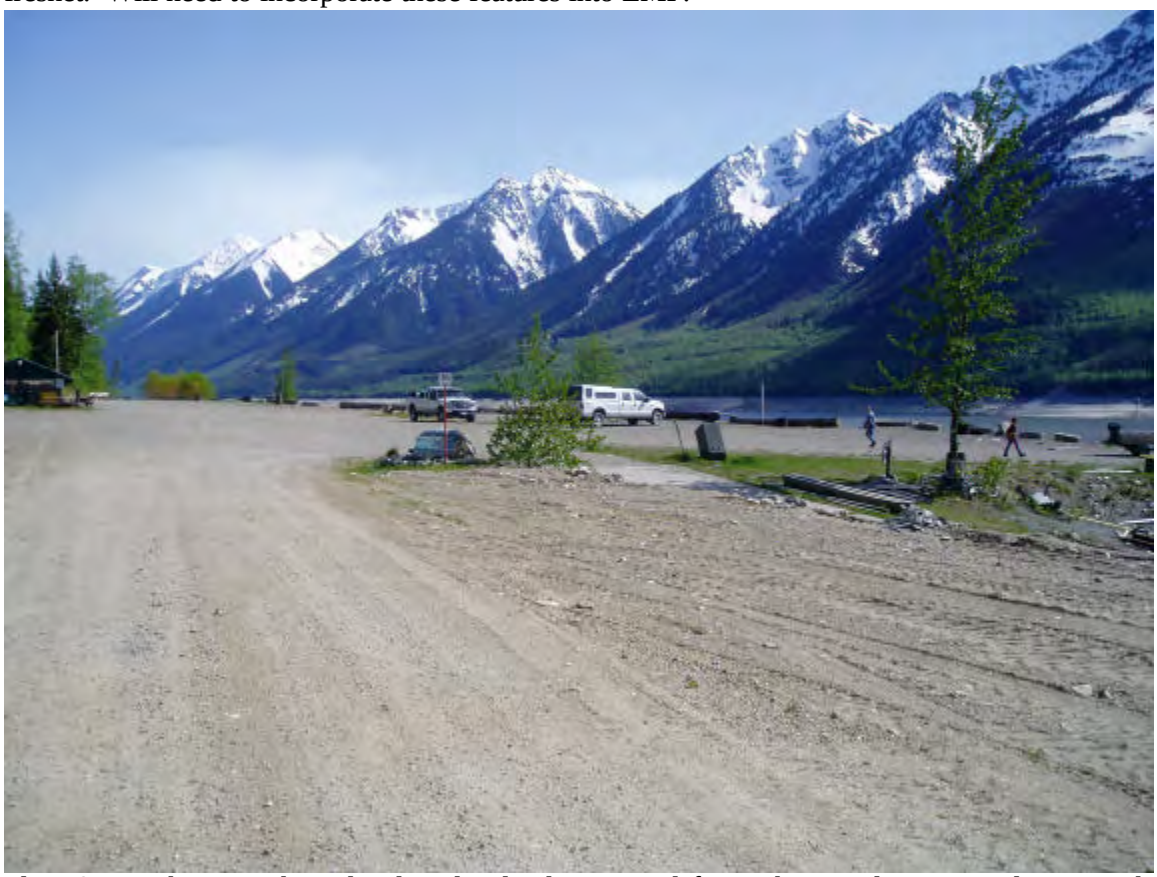

Plate 8. Looking south at developed upland area used for parking and camping during peak season.

Plate 9. Looking east towards constructed spit designed to protect existing boat ramp.

Plate 10. Looking north along ditchline and boat ramp. Ditchline conveys flows during spring freshet and jumps the ramp and moves downslope.

Plate 11. Looking east at extensive erosion caused by ditchline flows jumping the ramp.

Plate 12. Looking west at mouth of Bulldog Creek at current reservoir levels.

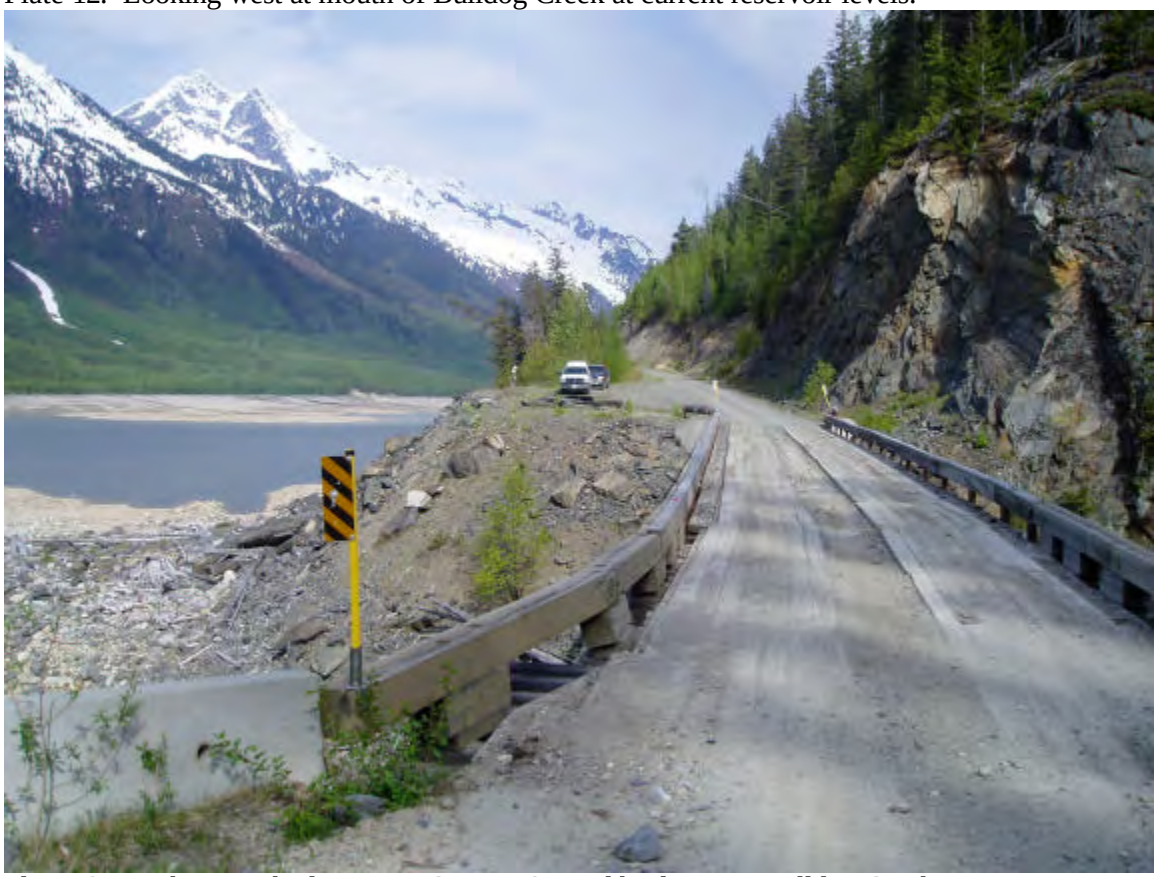

Plate 13. Looking north along East Canoe FSR and bridge over Bulldog Creek.

Plate 14. Pink flags indicate possible point of access for construction of new ramp at Bulldog Creek.

Plate 15. View of the slope below road at Bulldog Creek. Pink flag indicates possible road centerline.

Plate 16. View of the sediment and vegetation in low elevation area that Bulldog Creek uses very temporarily as reservoir levels rise.

Plate 17. View of the proposed boat ramp location at Bulldog Creek.

Plate 18. View of the substrates which would be impacted during construction of road at Bulldog Creek.

Plate 19. View of the lakebed at the proposed Bulldog Creek site.

Plate 20. Wildlife usage of large woody debris deposited at high reservoir levels near Bulldog Creek.

Plate 21. Looking south towards access road and existing boat ramp at Nixon Creek.

Plate 22. Current upland area located by Nixon Creek boat ramp.

Plate 23. Gravel boat ramp currently used at Nixon Creek.

Plate 24. Lakebed substrates at location of possible extension of ramp at Nixon Creek.

Plate 25. View of ungulate (deer) tracks upslope of the existing ramp at Nixon Creek.


Plate 26. View of confluence of Nixon Creek with Kinbasket Reservoir. Located 700 m north of boat ramp.

KINBASKET RESERVOIR: BUSH HARBOUR

Plate 27. Looking north at upland area at Bush Harbour.

Plate 28. Looking downslope along the unnamed stream.

Plate 29. View of existing ramp at Bush Harbour.

Plate 30. Channel conditions of stream which parallel the berm at Bush Harbour.

Plate 31. Upstream view of potential barriers to fish use at low reservoir levels. Note end of current high water ramp at upper left of frame.

Plate 32. View of the grizzly tracks observed near stream and just upslope of the current reservoir level.

Plate 33. Looking north at substrate at end of existing ramp at Bush Harbour.

Plate 34. Looking west towards end of existing berm and stream location from end of existing ramp.

MID-COLUMBIA RIVER: CENTENNTIAL PARK

Plate 35. Looking east towards the existing upland areas at Centennial park boat ramp

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Plate 36. View of the current ramp and upslope vegetation at Centennial Park in Revelstoke.

Plate 37. Looking southwest at current ramp conditions at Centennial Park. Note riprap bank protection downstream of ramp.

Plate 38. Riverbed substrate that would be converted to concrete if ramp extended.

Plate 39. Western garter snake observed just downstream of ramp in vegetated upslope area.


Plate 40. Downstream view of Big Eddy; dismissed possible site location. Located 8 km downstream of Revelstoke Dam and a known area for white sturgeon.

Plate 41. View of non-classified drainage located downstream from existing ramp.

APPENDIX 2

SARA SPECIES LIST
(not including marine species)

Table 9. Schedule 1 species listed as extirpated, previously known to occur within British Columbia, and their accepted range within British Columbia.

Species	Category	Historical range within British Columbia[1]	Potential for habitat to occur in vicinity of project
Sage grouse (BC population)	Bird	Occurred in Okanagan and Similkameen valleys.	No
Pacific gopher snake	Reptile	Two historical (over 50 years ago) sightings in grasslands (southern BC).	No
Pygmy short-horned lizard (BC population)	Reptile	Two historical records from Okanagan Valley.	No
Pacific pond turtle	Reptile	Common in ponds and lakes of southern BC and Vancouver Island in the mid-1800s (no sightings Canada since 1959).	No
Island marble	Arthropod	Historically found on Gabriola and Vancouver islands.	No
Puget Oregonian snail	Molluscs	Extreme southwestern BC. Most recent record in Canada from 1905.	No

[1] Species range taken from Environment Canada (2007), except where otherwise noted.

Table 10. Schedule 1 species listed as endangered that are known to occur within British Columbia, and their accepted range within British Columbia.

Species	Category	Range within British Columbia[1]	Potential for species to occur in vicinity of project
American badger (*jeffersonii* subspecies)	Mammal	Southeastern BC (south of Quesnel).	**YES**
Vancouver Island marmot	Mammal	Vancouver Island.	No
Townsend's mole	Mammal	Restricted to about 20 km^2 in the central Fraser Valley.	No
Horned Lark	Bird	Coastal BC and lower Fraser Valley	No
Williamson's Sapsucker	Bird	Lytton, Cache Creek area south to Manning Park.	No
Yellow breasted chat (*auricollis* subspecies)	Bird	Okanagan.	No
Western Screech Owl	Bird	Coastal BC and Okanagan Valley.	**YES**
Spotted owl (*caurina* subspecies)	Bird	Southwestern British Columbia.	No
Burrowing owl	Bird	A few in south-central BC. Requires treeless plains.	No
Sage thrasher	Bird	Extreme south-central BC.	No
White-headed woodpecker	Bird	Extreme south-central BC.	No
Nightsnake	Reptile	Extreme south-central BC.	No
Sharp-tailed snake	Reptile	Gulf Islands and southeastern Vancouver Island.	No
Oregon spotted frog	Amphibian	Lower Fraser River Valley[2]	No
Northern leopard frog (southern mountain population)	Amphibian	Extreme southeastern BC.	No
Tiger salamander	Amphibian	Extreme south-central BC.	No
Rocky Mountain tailed frog (southern mountain population)	Amphibian	East Kootenays of extreme southern British Columbia.	No
Nooksack dace	Fish	4 small streams tributary to the Nooksack River in the Abbotsford, Aldergrove and Clearbrook areas of the lower Fraser Valley.	No
Morrison Creek lamprey	Fish	Morrison Creek watershed (Vancouver Island).	No
White Sturgeon	Fish	Nechako River Population	No
Stickleback (Enos and Paxton Lakes, and Vananda Creek populations)	Fish	Vancouver Island (Enos Lake), Texada Island (Paxton Lake and Vananda Creek).	No
Salish sucker	Fish	Nine populations in four creek drainages in the lower Fraser Valley.	No
Island blue	Arthropod	Vancouver Island.	No
Taylor's checkerspot	Arthropod	Vancouver Island.	No
Sand verbera moth	Arthropod	Coastal areas – Strait of Georgia.	No
Mormon metalmark (southern mountain	Arthropod	Okanagan.	No

Species	Category	Range within British Columbia[1]	Potential for species to occur in vicinity of project
population)			
Oregon forestsnail	Mollusc	Extreme southwestern BC.	No
Hotwater physa	Mollusc	Liard River hotsprings.	No
Scarlet ammannia	Vascular Plant	Osoyoos Lake area of south-central BC.	No
Spadling's campion	Vascular Plant	Southeastern BC.	No
Slender collomia	Vascular Plant	Single site near Princeton BC.	No
Deltoid balsamroot	Vascular Plant	Vancouver Island.	No
Tall bugbane	Vascular Plant	Chilliwack River Valley.	No
Water-plantain buttercup	Vascular Plant	Vancouver Island.	No
Coastal Scouler's catchfly	Vascular Plant	Limited to three small islands close to Victoria on Vancouver Island.	No
Southern maidenhair fern	Vascular Plant	Fairmont Hot Springs (southeastern British Columbia).	No
Small-flowered lipocarpha	Vascular Plant	BC southern border is the northern limit.	No
Seaside birds-foot lotus	Vascular Plant	Southern tip of Vancouver Island.	No
Prairie lupine	Vascular Plant	Southern tip of Vancouver Island.	No
Streambank lupine	Vascular Plant	Southwestern corner of BC (lower Fraser Valley and Vancouver Island).	No
Bearded owl-clover	Vascular Plant	Southern tip of Vancouver Island.	No
Golden paintbrush	Vascular Plant	Southern tip of Vancouver Island.	No
Kellogg's rush	Vascular Plant	Southeastern Vancouver Island.	No
Bear's-foot sanicle	Vascular Plant	Southern tip of Vancouver Island.	No
Toothcup	Vascular Plant	Along Kamloops and Osoyoos lakes.	No
Howell's triteleia	Vascular Plant	Southeastern Vancouver Island.	No
Tall woolly-heads	Vascular Plant	Southern Vancouver Island.	No
Margined streamside moss	Moss	Kootenay region, along southern border.	No
Poor pocket moss	Moss	North Vancouver.	No
Rigid apple moss	Moss	Eastern Vancouver Island and on some of the adjacent Gulf Islands.	No
Rusty cord moss	Moss	Four sites- closest is North-east of Kamloops. Alkaline wetlands.	No
Silver hair moss	Moss	Sumas Mountain (east of Abbotsford).	No
Seaside centipede	Lichen	Two locations on the west coast of Vancouver Island (Ucluth Peninsula and Schooner Cove).	No

[1] Species range taken from Environment Canada (2007), except where otherwise noted.

[2] Species range taken from Matsuda *et al.* (2006)

Table 11. Schedule 1 species listed as threatened that are known to occur within British Columbia, and their accepted range within British Columbia.

Species	Category	Range within British Columbia[1]	Potential for species to occur in vicinity of project
Pallid bat	Mammal	Okanagan Valley.	No
Wood bison	Mammal	Northeastern BC.	No
Woodland caribou (boreal population)	Mammal	Northeastern BC.	No
Woodland Caribou (Southern Mountain population)	Mammal	CENTRAL BC.	**YES**
Ermine (*haidarum* subspecies)	Mammal	Queen Charlotte Islands	No
Pacific water shrew	Mammal	Lower Mainland of southwestern BC.	No
Peregrine falcon (*anatum* subspecies)	Bird	Southwestern and west-central BC.	No
Northern goshawk (*laingi* subspecies)	Bird	Queen Charlotte Islands	No
Marbled murrelet	Bird	Coastal BC (up to 75 km inland).	No
Great Basin gophersnake	Reptile	Southern BC. Okanagan primarily.	No
Western rattlesnake	Reptile	Southern BC, north to Cache Creek.	No
Coastal giant salamander	Amphibian	Chilliwack River Valley.	No
Great Basin spadefoot	Amphibian	Dry valleys of southern interior BC (especially the Okanagan Valley).	No
Vancouver Lamprey	Fish	Southern Vancouver Island.[2]	No
Cultus pygmy sculpin	Fish	Cultus Lake (Lower Mainland)	No
Shorthead sculpin	Fish	Southeast BC (Columbia River Basin).	**YES**
Behr's hairstreak	Arthropod	Southern Okanagan Valley.	No
Dun skipper	Arthropod	Southwestern BC including Vancouver Island.	No
Dromedary jumping-slug	Molluscs	Southern and western Vancouver Island.	No
White-top aster	Vascular Plant	Southern Vancouver Island.	No
Scouler's corydalis	Vascular Plant	Western Vancouver Island.	No
Lemmon's holly fern	Vascular Plant	Eastern side of the Okanagan Valley.	No
Lyall's mariposa lily	Vascular Plant	Between the Similkameen River and the Okanagan Valley (limited to a single height of land adjacent to the U.S. border).	No
Mexican mosquito-fern	Vascular Plant	South central BC.	No
Macoun's meadowfoam	Vascular Plant	Vancouver Island, not on mainland of BC.	No
Showy phlox	Vascular Plant	Most northern occurrence in BC is Summerland.	No
Cliff paintbrush	Vascular Plant	Southwest BC around Chilliwack and Skagit Rivers.	No

Species	Category	Range within British Columbia[1]	Potential for species to occur in vicinity of project
Phantom orchid	Vascular Plant	Extreme southwest of BC.	No
Purple sanicle	Vascular Plant	Southeastern Vancouver Island and the adjacent Gulf Islands.	No
Yellow montane violet	Vascular Plant	East coast of Vancouver Island and on Saltspring Island.	No
Alkaline wing-nerved moss	Moss	Southwest of Williams Lake, wet alkaline areas.	No
Haller's apple moss	Moss	East central BC (close proximity to Alberta border).	No

[1] Species range taken from Environment Canada (2007), except where otherwise noted.

[2] Species range taken from Froese and Pauly (2005).

Table 12. Schedule 1 species listed as special concern that are known to occur within British Columbia, and their accepted range within British Columbia.

Species	Category	Range within British Columbia[1]	Potential for species to occur in vicinity of project
Mountain beaver	Mammal	Extreme southwestern BC.	No
Woodland caribou (Northern Mountain population)	Mammal	Northern BC (north of Mackenzie).	No
Spotted Bat	Mammal	Okanagan, Chilcotin River and Williams Lake.	No
Long-billed curlew	Bird	South central British Columbia, but extending range into McBride, Prince George, and known to breed in the vicinity of Vanderhoof.[2]	No
Ancient murrelet	Bird	Coastal areas only.	No
Peregrine falcon (*pealei* subspecies)	Bird	Queen Charlotte Islands, northern Vancouver Island.	No
Barn owl	Bird	Extreme southern BC and west coast of southern Vancouver Island.	No
Flammulated owl	Bird	South central BC (south of Quesnel).	No
Yellow rail	Bird	Eastern BC.	No
Western screech owl (*kennicotti* subspecies)	Bird	Coast of BC, including Vancouver Island but excluding Queen Charlotte Islands.	No
Lewis's woodpecker	Bird	Most common in the Okanagan Valley and Thompson Basin areas.	No
Rubber boa	Reptile	Patchy distribution through major river basins in southern third of BC.	No
Western yellow-belly racer	Reptile	Hot and dry areas of the Okanagan and Similkameen.	No
Western skink	Reptile	Extreme southern portion of mainland BC.	**YES**
Coast tailed frog	Amphibian	Coastal mountain ranges in BC.	No

Red-legged frog	Amphibian	Vancouver Island, the Gulf Islands, the mainland adjacent to the Strait of Georgia, and through the Fraser Valley to Hope.	No
Couer d'Alene salamander	Amphibian	Southeastern edge of Kootenay Lake in Creston Valley, the Moyie River drainage and in the Columbia River drainage	**YES**
Western toad	Amphibian	Widespread across BC.[3]	**YES**
Columbia mottled sculpin	Fish	Columbia, Flathead, Similkameen and Kettle rivers.	No
Monarch	Arthropod	Southern BC.	No
Rocky Mountain ridged mussel	Arthropod	Southern BC, Columbia River System.	No
Warty jumping-slug	Mollusc	Southern Vancouver Island.	No
Vancouver Island beggarticks	Vascular Plant	Lower Fraser Valley and on southern Vancouver Island, with one additional record on the mainland coast of BC just north of Vancouver Island	No
Coastal wood fern	Vascular Plant	Southeastern Vancouver Island.	No
Columbia carpet moss	Moss	Bunchgrass BioGeozone of narrow valley in south-central part of BC.	No
Twisted oak moss	Moss	Coastal BC, Vancouver Island.	No
Banded cord moss	Moss	Southwestern coastal BC.	No

[1] Species range taken from Environment Canada (2007), except where otherwise noted.

[2] Species range taken from De Smet (1992). [3] Species range taken from Wind and Dupuis (2002).

APPENDIX 3

RARE PLANT SPECIES LIST

Columbia Forest District; ICH Biogeoclimatic zone.

Scientific Name	English Name	BC Status	BGC
Agoseris lackschewitzii	pink agoseris	Blue	BAFA;CMA;ESSFmw;ESSFwc;ESSFwcp;ESSFxc;ICHmw;ICHwk;IDFdk;IMA;MSdm
Anemone canadensis	Canada anemone	Blue	BWBSmw;ICHdw;ICHmc;IDFdm;MSdk;SBSdh
Arabis hirsuta var. *hirsuta*	hairy rockcress	Red	ICHvk
Botrychium crenulatum	dainty moonwort	Blue	BWBSmw;ESSFdk;ICHwk
Botrychium hesperium	western moonwort	Blue	ESSFwc;ESSFxc;ICHmw
Botrychium montanum	mountain moonwort	Red	ICHmc;ICHmw;ICHwk
Carex crawei	Crawe's sedge	Red	ICHmk;ICHwk;IDFdm
Carex lenticularis var. *dolia*	Enander's sedge	Blue	ESSFmc;ESSFmk;ESSFvc;ESSFwk;ESSFwv;ICHwc;MHmm;SBSmc
Carex lenticularis var. *lenticularis*	lakeshore sedge	Red	CWHms;ESSFdk;ICHmk;ICHmw;IDFmw
Carex pedunculata	peduncled sedge	Blue	ICHmw;IDFmw;PPdh
Carex tenera	tender sedge	Blue	ESSFmv;ESSFwm;ICHmk;ICHwk;SBSmh
Castilleja gracillima	slender paintbrush	Blue	BWBSdk;ESSFdk;ESSFmm;ICHmk;ICHmw;IDFdm;IDFmw;IDFxk;MSdk;SBSdh;SWBmk
Chenopodium atrovirens	dark lamb's-quarters	Red	ICHmk;IDFdm;IDFxh;IDFxw;MSxk;SBSdw
Delphinium bicolor ssp. *bicolor*	Montana larkspur	Blue	ESSFdk;ESSFdkp;ICHdw;ICHmw;IDFdm;MSdk
Dryopteris cristata	crested wood fern	Blue	ICHdw;ICHmc;ICHmw;ICHvk;ICHwk;ICHxw;IDFmw;IDFxh;SBSmk
Eleocharis elliptica	Slender spike-rush	Blue	BAFA;ESSFdk;ESSFwc;ICHmw;ICHvk;ICHwk;IDFmw;IMA
Epilobium leptocarpum	small-fruited willowherb	Blue	BAFA;CMA;CWHdm;CWHds;CWHvm;CWHwh;CWHxm;ESSFmw;ESSFwc;ESSFwk;ESSFxv;ICHmc;ICHmw;ICHwk;IMA;MSdk;SBSwk;SWBmk
Galium trifidum ssp. *trifidum*	small bedstraw	Blue	CWHxm;ICHmk;ICHmw
Gentianopsis macounii	Macoun's fringed gentian	Red	ICHmk;MSdk
Hypericum scouleri ssp. *nortoniae*	western St. John's-wort	Blue	CWHvh;CWHvm;CWHxm;ESSFdk;ESSFwc;ESSFwcp;ESSFwm;ICHdw;IDFdm;IDFxh;PPdh
Megalodonta beckii var. *beckii*	water marigold	Blue	CDFmm;ICHdw;ICHmw;ICHxw;IDFdm;IDFun;SBSmk
Melica smithii	Smith's melic	Blue	CDFmm;CWHdm;CWHxm;ESSFdk;ICHdw;ICHmw;ICHwk;IDFdm;IDFmw;IDFxh;SBSdk;SBSdw;SBSmk;SBSwk
Muhlenbergia glomerata	marsh muhly	Blue	BGxh;BWBSdk;BWBSmw;ESSFwc;ICHdw;ICHmw;ICHwk;IDFdk;IDFdm;IDFmw;IDFun;MSdk;MSdm;SBPSxc
Nephroma occultum	Cryptic Paw	Blue	CWH;ICH
Scrophularia lanceolata	lance-leaved figwort	Blue	CWHms;ICHmw;IDFxh
Sidalcea oregana var. *procera*	Oregon checker-mallow	Red	BGxh;ICHmw;PPxh
Solidago gigantea ssp. *serotina*	smooth goldenrod	Red	ICHdw;ICHmk;ICHmw;IDFdk;IDFdm;IDFxh
Solidago nemoralis ssp. *longipetiolata*	field goldenrod	Blue	ICHmk;ICHmw
Stellaria obtusa	blunt-sepaled starwort	Blue	ESSFdk;ESSFwc;ESSFwcp;ESSFwk;ICHdw;ICHwk;IDFdm;IDFww;IDFxh
Thalictrum dasycarpum	purple meadowrue	Blue	ESSFdk;ICHdw;ICHxw;IDFdm
Thermopsis rhombifolia	prairie golden bean	Red	BWBSdk;ESSFdk;ICHdw;ICHmk;IDFdm;MSdk;PPdh
Trichophorum pumilum	dwarf clubrush	Blue	BWBSdk;BWBSmw;ICHmw;IDFdk;SBPSxc;SBSdh
Trifolium cyathiferum	cup clover	Red	BGxh;CDFmm;CWHmm;CWHxm;ICHdw;ICHmw;IDFdm;IDFxh;PPdh

Headwaters Forest District; ICH Biogeoclimatic zone.

Scientific Name	English Name	BC Status	BGC
Agoseris lackschewitzii	pink agoseris	Blue	BAFA;CMA;ESSFmw;ESSFwc;ESSFwcp;ESSFxc;ICHmw;ICHwk;IDFdk;IMA;MSdm
Anemone canadensis	Canada anemone	Blue	BWBSmw;ICHdw;ICHmc;IDFdm;MSdk;SBSdh
Azolla mexicana	Mexican mosquito fern	Red	ICHmw;IDFxh
Carex comosa	bearded sedge	Red	BGxh;CWHdm;CWHds;ICHmw;ICHxw;IDFmw;IDFxh
Carex heleonastes	Hudson Bay sedge	Blue	BWBSdk;ESSFwk;ICHdw;ICHmw;IDFdk;SBPSxc
Carex rostrata	swollen beaked sedge	Blue	CWHvm;ESSFdk;IDFdm;SBPSxc;SBSdw
Dryopteris cristata	crested wood fern	Blue	ICHdw;ICHmc;ICHmw;ICHvk;ICHwk;ICHxw;IDFmw;IDFxh;SBSmk
Eleocharis elliptica	Slender spike-rush	Blue	BAFA;ESSFdk;ESSFwc;ICHmw;ICHvk;ICHwk;IDFmw;IMA
Epilobium ciliatum ssp. *watsonii*	purple-leaved willowherb	Blue	CDFmm;CWHvh;CWHvm;CWHwh;CWHxm;ICHmw;IDFxm;SBSdh
Epilobium oregonense	Oregon willowherb	Blue	ESSFxc;ICHmw;IDFxh;MHmm
Glyceria pulchella	slender mannagrass	Blue	BGxh;BWBSmw;IDFdk;IDFun;SBSdk;SWBun
Muhlenbergia glomerata	marsh muhly	Blue	BGxh;BWBSdk;BWBSmw;ESSFwc;ICHdw;ICHmw;ICHwk;IDFdk;IDFdm;IDFmw;IDFun;MSdk;MSdm;SBPSxc
Ophioglossum pusillum	northern adder's-tongue	Blue	CDFmm;CWHvm;CWHxm;ICHmw;IDFxh
Senecio plattensis	plains butterweed	Blue	BGxh;BWBSmw;IDFdk;SBPSxc;SBSdh;SBSdk;SBSdw;SBSmh
Solidago gigantea ssp. *serotina*	smooth goldenrod	Red	ICHdw;ICHmk;ICHmw;IDFdk;IDFdm;IDFxh
Trichophorum pumilum	dwarf clubrush	Blue	BWBSdk;BWBSmw;ICHmw;IDFdk;SBPSxc;SBSdh