

DATE 19 June 2017**REFERENCE No.** 1114220046-675-TM-Rev1**TO** Derek Holmes
BURNCO Rock Products Ltd.**FROM** David Carter**EMAIL** David_Carter@golder.com**BURNCO AGGREGATE PROJECT: HARLEQUIN CREEK CONTINGENCY OPTION FOR HABITAT
OFFSET PLAN TO SUPPORT FISHERIES ACT AUTHORIZATION****1.0 INTRODUCTION**

BURNCO Rock Products Ltd. (BURNCO) and 0819042 BC Ltd. are proposing to construct and operate a sand and gravel operation, the BURNCO Aggregate Project (“the Proposed Project”), on private property (“the Site”) in the lower portion of the McNab Creek watershed (BC Watershed Code 900-106300) on the western shore of Howe Sound’s Thornbrough Channel. The Proposed Project will be situated on a glacial fan-delta between the mouths of Harlequin Creek and McNab Creek. A number of fish-bearing watercourses exist on the Site including McNab Creek, Harlequin Creek, Watercourse 2 (WC 2), and several natural groundwater-fed watercourses that occur downslope (south) of the proposed pit area (Figure 1).

Most of the Site has been previously logged during the last century, the latest logging activity occurred from 2001 to 2006. The area has been used over the past 100 years for industrial forest harvesting and log sorting. Canfor Ltd. (Canfor) began large-scale logging operations in the valley in the 1970s and established a logging camp, warehouse and maintenance facilities near the beach. Canfor also established a water licence on Harlequin Creek (now held by BURNCO) and ran a log dump and storage area in proximity to the camp until the late 1990s. A series of logging roads in the watershed have been deactivated and only a single mainline road (access road) remains open in the lower portion of the valley.

2.0 BACKGROUND ON HABITAT OFFSETTING PLAN

As part of the *Fisheries Act* Authorization for the Proposed Project, a Habitat Offsetting Plan (EAC Application/EIS Appendix 5.1-B) was developed that includes a 770 m extension to WC 2 with extensive meandering over relatively uniform terrain to where it will connect to the outlet of the future pit lake. The extension will have an average wetted width of five meters (m) and an average depth of approximately 30 centimetres (cm). The extension will also incorporate three off-channel pond structures that will provide additional rearing and overwintering habitat for salmonids. The Habitat Offsetting Plan provides more new and notably improved fish habitat (23,382 m²) than will be lost or disrupted by the Proposed Project (5,098 m²).



The potential for success of the created habitat is expected to be high as the creation of similar groundwater-fed watercourse habitat in the lower segment of WC 2 has been successful at the site already. Monitoring of the effectiveness of the constructed habitat will focus on physical stability, functionality and utilization of the habitat. The monitoring program will assess qualitative and quantitative habitat metrics such as stem density for riparian planting, percent cover for instream habitat features, and fish relative abundance and distribution through spawner and juvenile salmonid surveys. In the event that the constructed habitat does not function as intended, adaptive management will dictate adjustments to the channel design and operation such that stability, function and fish usage will be re-assessed and modifications to the Habitat Offsetting Plan will be implemented. Adaptive management techniques include physical adjustments to the channel configuration (e.g., increase/decrease gradient, modify water depth and velocity) and modification of the flow regime through management of the low-level outlet of the pit lake. If monitoring identifies that the adaptive management measures have not addresses the issue and the offset habitat is still not functioning as intended then a contingency Habitat Offset Plan for Harlequin Creek will be initiated.

3.0 CONTINGENCY HABITAT OFFSETTING PLAN – HARLEQUIN CREEK

Harlequin Creek is a modified watercourse situated in the south-west corner of the Property (Figure 2). It flows east off Mount Varley at a steep gradient (average gradient: 9%), and turns south along the west side of the main access road on the Property, flowing parallel to the road at a lower gradient (average gradient: 2%). The creek continues south, connects to a wetland area and flows through a road culvert (I) to the McNab intertidal area near the existing dock. Prior to the access road construction, Harlequin Creek appears to have flowed southeast across the glacial fan where it likely formed a braided channel where bedload was deposited due to the lower gradient. With the access road in place and the channel forced to the west side of the road, the steep gradient change from 10% to 2% coupled with the sharp turn south along the access road promotes bedload deposition and periodic flooding onto the roadway during high precipitation events.

Given that Harlequin Creek is a modified watercourse, there is opportunity for enhancement of the channel. Using the space available a wider and longer channel could support bedload transport and increase the amount of potential spawning habitat in the system.

3.1 Description of Harlequin Creek

Harlequin Creek changes from steep cascade-pool and step-pool habitats along the western mountain slopes, to riffle-pool and wetland habitats (Photograph 1) adjacent to the access road. The substrate within Harlequin is predominately cobbles and gravel. The channel width of Harlequin ranges from 1.6 to 5.7 m, with an average of 3.4 m. Harlequin is wetted year-round, with flashy flows observed in the fall and spring. Wetted width during surveys ranged from 0.6 to 5.1 m with an average of 2.8 m and average depth of 0.10 m.

The Harlequin Creek wetland area (Pond 1) is associated with beaver dam construction and subsequent backwatering and flooding. It is a perennial feature that is located within the lower reach of Harlequin Creek adjacent to the access road and is roughly 75 m long and 30 m wide. Substrates in this segment are composed primarily of fines and organics.

Harlequin Creek's riparian vegetation is a mix of western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), big leaf maple (*Acer macrophyllum*) and vine maple (*Acer circinatum*) with shrubs such as salmon berry (*Rubus spectabilis*) and thimble berry (*Rubus parviflorus*). Shrub species present include skunk cabbage (*Symplocarpus foetidus*) and various equisetum species in the wetland area of Harlequin Creek.

Harlequin Creek provides abundant cover for fish in the form of instream and overhanging vegetation and woody debris. Excellent substrates for spawning are present throughout Harlequin Creek, particularly in lower gradient segments, and in pool outlets in higher gradient segments. Slow flowing, deep pool areas in the wetland of Harlequin Creek provide suitable overwintering habitats for salmonids including Coho Salmon (*Oncorhynchus kisutch*), Cutthroat Trout (*Oncorhynchus mykiss*) and sculpin species (*Cottus* sp.). No physical fish passage barriers to salmonids were noted along the length of Harlequin Creek within the BURNCO Property area. The fish distribution and passage obstructions identified within Harlequin Creek are shown in Figure 7 of Fish and Fish Habitat Baseline Report (EAC Application/EIS Appendix 5.1-A).

Several watercourses flow into Harlequin Creek from the high gradient slopes along the west side of the property. These watercourses are largely ephemeral with year-round base flows present in lower reaches near Harlequin Creek. Watercourses 25 and 25-N flow into the Harlequin Creek wetland; Watercourses 22-24 converge into a single watercourse (WC 22) that drains into the lower segment of Harlequin Creek (Photograph 2) near the road bridge crossing, and outlet to the foreshore. A ditch along the access road (WC 26a) collects rainwater and conveys flows overland across the access road south, where it combines with collecting seepage and overflow from Harlequin Creek and drains (WC 26b) southeast. Seepage and overland flow collects and continues southeast toward the foreshore flowing through a lowland area and multiple watercourses that are often indistinct and flows infiltrate to ground with no surface connection to the foreshore. The volume of seepage, overland flows, and subsequent watercourse flow in this area appears to be resulting from seepage from Harlequin Creek to the adjacent main access road and has resulted in substantial flow and pooling of water throughout the forest in this area.

Southwest watercourses tributary to Harlequin Creek have suitable seasonal habitats for rearing and overwintering salmonids. Pockets of suitable spawning gravels are found in many areas. Distribution of salmonids is limited to lower reaches where gradients and water velocities are passable to fish and adequate depth and flows are present. Coho Salmon were captured in WC 22 downstream of a 1.0 m high log-step that may limit anadromous fish access, located approximately 30 m upstream of the confluence with Harlequin Creek. Cutthroat Trout were the only salmonid species collected upstream of the log step on the same watercourse. Upstream reaches are intermittent with numerous gradient and drop barriers to fish passage.

3.2 Harlequin Creek Contingency Option

There are a number of different habitat offset options that could be incorporated into the Harlequin Creek watercourse, these are:

- Adding width to the corridor to allow bends and provide more sinuosity that would extend the mainstem channel.
- Increasing width to the mainstem channel to allow a braided channel in the area of bedload deposition.
- Creating a side-channel.

The preferred contingency option for Harlequin Creek is adding width to the mainstem channel to increase the space within the floodplain corridor and allow the creek to meander back and forth between the banks. There is adequate space to allow for this to occur as 325 m of the creek corridor can be widened up to 10 m width allowing the channel to move within an area of a total area of 2,744 m² (Figure 2). Initially a longer and more sinuous 3 to 4 m wide channel could be designed to meander within the wider corridor. This will allow the creek to deposit bedload and braid naturally within the widened channel corridor and manage further flooding across the roadway. The creek bed and adjacent riparian areas contain adequate space for widening the creek, suitable water flow and a preferred gradient (1-2%). Implementing this option would also include restoring areas with suitable spawning substrate and gravels and planting native riparian vegetation. The implementation of this option is expected to be successful; however, the system will be dynamic and experience regular perturbations associated with variable flow and bedload.

Effectiveness monitoring of Harlequin Creek would be carried out to ensure that the construction of the offset habitat is functioning as intended. A Habitat Monitoring Plan will be developed for Harlequin Creek prior to implementing the enhancement activities and will focus on the physical stability, functionality and fish use of habitat features. The components of the Habitat Monitoring Plan will include assessment of the following:

- Qualitative and quantitative habitat features such as stem density for riparian planting and percent cover for instream habitat features.
- Habitat metrics (e.g., dissolved oxygen, velocity, temperature, depth).
- Fish density and distribution:
 - Salmonid spawner survey (e.g., spawner returns).
 - Juvenile Coho Salmon rearing and utilization (e.g., fyke nets to assess out-migration of juvenile salmonids and minnow nets to assess juvenile presence).
- Turbidity testing and bedload assessment.

If monitoring results indicate that the habitat is not functioning as intended, adaptive management would involve adjusting and modifying the plan, these adjustments could include assessing physical parameters of the watercourse such as gradient, flow regime, water depth and water velocity.

4.0 CLOSURE

We trust this memorandum describing the Habitat Offsetting Plan contingency option at Harlequin Creek meets your present needs. If you have any questions, please do not hesitate to contact the undersigned at 604-296-4200.

Yours truly,

GOLDER ASSOCIATES LTD.

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Attachments: Photographs 1 and 2
Figure 1: Overview of Watercourses
Figure 2: Harlequin Creek

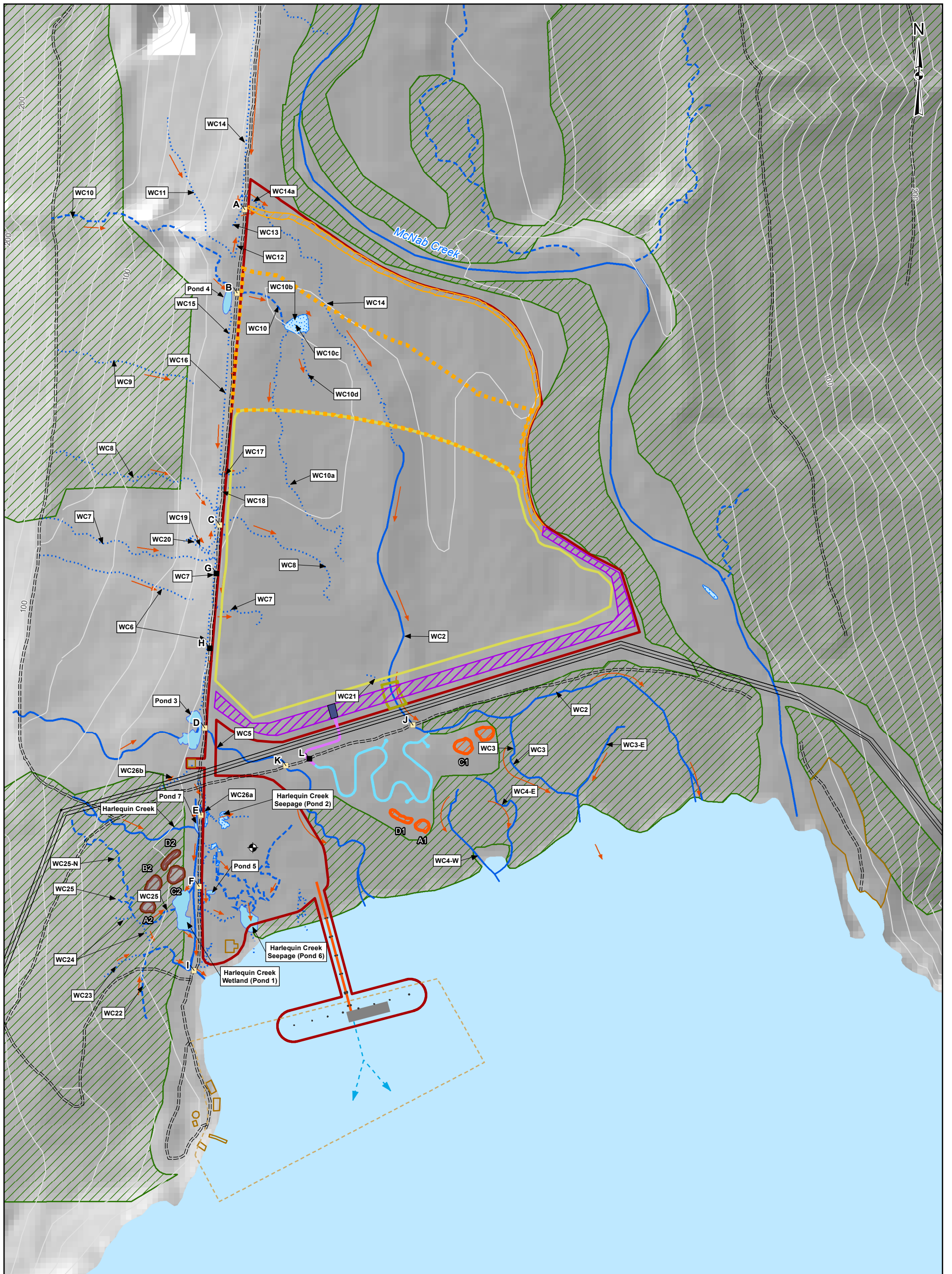
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Photograph 1: Harlequin Creek riffle habitat, view looking north upstream, located immediately north of confluence with WC 22. Photograph taken on 28 June 2011.



Photograph 2: Log-plunge-pool on WC 22, upstream of confluence with Harlequin Creek, outside the southern boundary of the Proposed Project Area. Photograph taken on 26 July 2011.



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PROJECT COMPONENTS

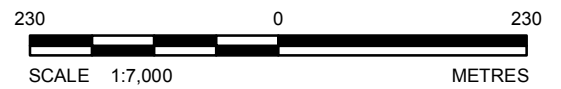
- Project Area
- McNab Creek Flood Protection Dyke
- Pit Lake Containment Berm
- Soil Deposit Area (Salvaged Soil Stockpiles)
- Elevated Conveyor
- Barge Route
- Proposed Groundwater Use Well
- Existing Culvert
- Proposed Culvert
- Existing Feature
- Chanel Infill (WC 2 Plug) Riprap and Filter Zone

- WC 2 Extension - Year 1 Construction
 - WC 2 Extension - Closure Construction
 - Outlet Structure with Spillway and Low-level Outlet
 - Final Pit Lake Boundary
 - Amphibian Compensation Ponds (Combined Area ~1613 m²)
 - Alternate Amphibian Compensation Pond (Combined Area ~1613 m²)
- BASEMAP DATA (TRIM / McElhanney)**
- Mature Forest
 - Existing Road
 - Existing Log Tenure Area
 - Existing Transmission Lines

- Contour (20m)
- Permanent / Perennial Watercourse
- Intermittent Watercourse
- Intertidal Watercourse
- Ephemeral Watercourse

REFERENCE

DEM from Geobas. Base data from the Province of British Columbia. Contours from TRIM positional data. Additional detailed site features provided by McElhanney. Projection: UTM Zone 10 Datum: NAD 83



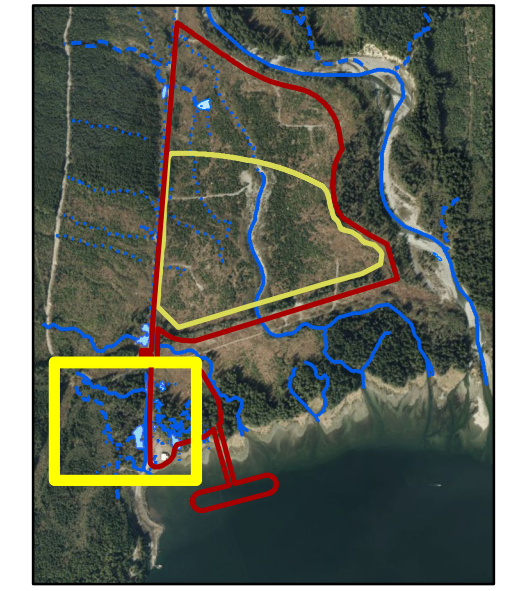
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TITLE		OVERVIEW OF WATERCOURSES																					
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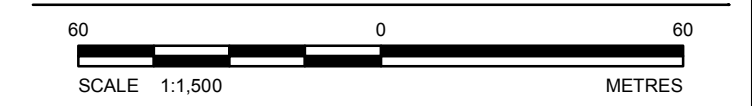
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Proposed Project Sites & Infrastructure

- Project Area
- Existing Road (5m wide)
- Existing Transmission Lines
- Contour (20m)
- Permanent /Perennial Watercourse
- Intermittent Watercourse
- Intertidal Watercourse
- Ephemeral Watercourse
- Anadromous/Resident Fish Presence
- Resident Fish Presence
- Gradient greater than 25% *
- Field Observed
- Alternate Amphibian Compensation Pond (Combined Area ~1613 m²)
- Potential Harlequin Creek Compensation Area
- Lake/Ocean



REFERENCE
 WC2 Extension and outlet structure from Golder Associates Ltd. Base data from the Province of British Columbia. Contours from TRIM positional data. Watercourses from the Province of British Columbia and field data. Additional detailed site features provided by McElhanney.
 Projection: UTM Zone 10 Datum: NAD 83



PROJECT				
BURNCO ROCK PRODUCTS LTD. BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.				
TITLE				
HARLEQUIN CREEK				
	PROJECT NO. 11-1422-0046		PHASE No.	
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	GIS	JP	26 May 2017	REV. 0
	CHECK	AC	12 Jun. 2017	FIGURE 2
	REVIEW	AC	12 Jun. 2017	