March 24, 2016

BURNCO AGGREGATE PROJECT

Surface Water Hydrological Baseline

Submitted to:
Derek Holmes
Regional Manager BC Aggregate Operations
BURNCO Rock Products Ltd.
1A, 2760 Emerson Street
Abbotsford, BC V2T 3J6

REPORT

Report Number: 1114220046-551-R-Rev1

Distribution:

2 copies - BURNCO Rock Products Ltd.
1 copy - Golder Associates Ltd.

Golder Associates

Executive Summary

BURNCO Rock Products Ltd. proposes development and operation of an aggregate facility within the lower McNab Valley, approximately 22 kilometres (km) southwest of Squamish and 35 km northwest of Vancouver. The proposed project is located on the western part of the lower McNab valley, on the western shore of Howe Sound's Thornbrough Channel, north of Gambier Island. The proposed project consists of an aggregate pit mine, aggregate extraction system, processing plant, and barge loading facility.

The proposed aggregate pit is situated on a flat area of the glacial fan-delta near the mouth of McNab Creek. A constructed groundwater-fed habitat compensation watercourse (WC 2) flows from the centre of the proposed aggregate pit area into Howe Sound. The construction and operation of the proposed aggregate pit will have direct effects on the surface water (freshwater) quantity and quality of the area. The project's Local Study Area (LSA) encompasses the area within which the Project is expected to interact with, and potentially change the conditions of Surface Water quantity and quality. For the Surface Water component of this project, the LSA was defined as an area bounded to the north and east by McNab Creek, to the south by Howe sound, and to the west by a line approximately 10 metres (m) beyond (i.e., west of) the access road that runs in the north-south direction. The Regional Study area (RSA) was established to provide a regional context for the consideration of changes to the surface water quantity and quality that could cause adverse Project effects to a VC. For the Surface Water component of this project, the RSA was defined as all watersheds that flow into McNab Creek and the LSA.

The main objective of the surface water baseline report is to characterize the climatic and streamflow conditions of the Project area, to support the Project's environmental impact assessment and the design of water management infrastructure. The baseline studies involved review of available regional climate and streamflow records, and results from the project's hydrogeological assessment (Golder 2014a).

The Port Mellon Climate Station (EC #1046330, #1046332) was identified as the regional station that was the most representative of the conditions near the project site. This station has long-term temperature and precipitation records between 1942 and 2012. The station's temperature and precipitation records were compared to short term measurements recorded at the Fire Weather Station (TS_MCNABB) located adjacent to the Project area, and were found to have similar trends. The Port Mellon Climate Station records were used to establish the project climate baseline as follows:

- Average, mean maximum and mean minimum monthly temperature;
- Annual, seasonal (wet/dry) and monthly precipitation;
- 200-year return period extreme high precipitation for various durations; and
- Average monthly and annual evapotranspiration and evaporation.

WSC hydrometric station Chapman Creek above Sechelt Diversion (#08GB060) was identified as the regional station that was the most representative of the McNab Creek flows upstream the project site. This station has streamflow records between 1970 and 1988. The station's streamflow records were compared to that of MC-US-01, a flow monitoring station on McNab Creek approximately 1,000 m upstream from the Project site, and were found to have similar trends. The Chapman Creek records were used to establish the McNab Creek streamflow baseline as follows:

- McNab Creek mean annual and monthly flows;
- McNab Creek extreme low flow with a return period of five years and 10 years; and
- McNab Creek extreme high daily flow with a return period of 200-years.

There were no records of flow in the constructed groundwater-fed watercourse (WC 2) prior this project. A flow monitoring station was installed in the upper segment of WC 2. Water levels and flow records were used to characterize flows in the watercourse's upper segment and were used to support the hydrogeological assessment (Golder 2014a).

There were no records of flow in the foreshore minor streams prior this project. The flows in these streams were estimated using the results from hydrogeological assessment (Golder 2014a).

Water licenses within the project LSA were compiled using the MoE BC Water Resources Atlas (MoE 2014a). A PoD search conducted was limited to those with any reasonable possibility of being impacted by the project. One water license was identified within the project LSA.

Surface water quality baseline conditions are presented in a separate baseline data report (Golder 2014c).

Table of Contents

TABLES

CHARTS

FIGURES

Glossary and Abbreviations

Baseline	A surveyed or predicted condition that serves as a reference point to which later surveys are coordinated or correlated.
Basin	A geographic area drained by a single major stream; consists of a drainage system comprised of streams and often natural or man-made lakes.
Catchment	The entire surface drainage area that contributes to water to a lake or river.
Channel	The bed of a stream or river.
Evaporation	The process by which water is changed from a liquid to a vapour.
Evaporation, Lake	Evaporation that occurs from a lake surface.
Evapotranspiration	A measure of the ability of the atmosphere to remove water from a location through the processes of evaporation and water loss from plants (transpiration).
Frequency Analysis	A statistical procedure involved in interpreting the past record of a hydrological event to occurrences of that event in the future.
Groundwater	That part of the subsurface water that occurs beneath the water table, in soils and geologic formations that are fully saturated.
Hydrology	The science of waters of the earth, their occurrence, distribution and circulation; their physical and chemical properties; and their reaction with the environment, including living beings.
Hydrometric	Adjective that typically refers to the quantification of water level, velocity or discharge of flowing water. In this document, this definition is expanded in the context of the term “hydrometric program” to include the quantification of rainfall depth.
Hydrometric Station	A station where measurement of hydrological parameters is performed.
Intensity-Duration-Frequency (IDF) Curve	A relationship between the intensity, duration and the frequency of rainfall amounts.

Rating Curve	A curve showing the relation between the discharge of a gauge, meter or other hydraulic structure or instrument and the pertinent hydraulic conditions affecting the discharge, such as pressure, hydrostatic head and velocity of approach. In hydrology, this typically refers to a curve showing the relationship between the discharge of a river or stream and the water level in the stream.
Reach	A comparatively short length of river, stream channel or shore. The length of the reach is defined by the purpose of the study
Relative Humidity	The ratio of the amount of water vapour in the atmosphere to the amount necessary for saturation at the same temperature. Relative humidity is expressed in terms of percent and measures the percentage of saturation.
Runoff	The portion of water from rain and snow that flows over land to streams, ponds or other surface waterbodies. It is the portion of water from precipitation that does not infiltrate into the ground or evaporate.
Sediment	Solid material that is transported by, suspended in, or deposited from water. It originates mostly from disintegrated rocks and also includes chemical and biochemical precipitates and decomposed organic material, such as humus. The quantity, characteristics and cause of the occurrence of sediment in streams are influenced by environmental factors. Some major factors affecting the amount of sediment in a water bodies are degree of slope, length of slope soil characteristics, land usage and quantity and intensity of precipitation.
Stream Flow	The volume of surface water movement in a stream channel per unit of time, usually measured in cubic metres per second (m^3/s).
Transpiration	Transpiration is the process through which water is transferred from soil and plant surfaces to the atmosphere.
Watercourse	A general term that refers to riverine systems such as creeks, brooks, streams and rivers.

1.0 INTRODUCTION

BURNCO Rock Products Ltd. (BURNCO) proposes development and operation of an aggregate facility (the Project) within the lower McNab Valley, approximately 22 kilometres (km) southwest of Squamish and 35 km northwest of Vancouver. The proposed project location is shown in Figure 1 and Figure 1, on the western shore of Howe Sound's Thornbrough Channel, north of Gambier Island. The proposed project is located in the western part of the lower McNab valley (the Project Site), and will consist of an aggregate pit mine, aggregate extraction system, processing plant, and barge loading facility.

The proposed project covers an area of 320 hectare (ha), privately-owned since 2008 by 0819042 BC Ltd and BURNCO Rock Products Ltd. The land based activities for the proposed project are entirely contained within the owned land. The marine barge loading are limited within the privately held water lot leases, and barge shipping will be conducted within public marine waters. The property is accessible only by water, air or all-terrain vehicle (via a deactivated logging road network).

The proposed aggregate pit mine is situated on a flat area of the glacial fan-delta near the mouth of McNab Creek, inside the project boundary shown in Figure 2. A constructed groundwater-fed habitat compensation watercourse (hereafter referred to the upper and lower segment of WC 2) flows from the centre of the proposed aggregate pit area into Howe Sound, as shown in Figure 3.

1.1 Objectives

The main objective of this report is to characterize the hydrologically relevant baseline conditions of the Project area, to support the Project's environmental impact assessment and the design of water management infrastructure.

2.0 BASELINE ASSESSMENT METHODS

This section discusses information and methods used in baseline characterisation of surface water resources in the Project area.

2.1 Hydrological Setting

The Project Site hydrological setting was characterized by completing the following tasks:

- Review of general hydrological setting based on hydrological zones defined by Coulson (1998) and Ecosections in Ministry of Environment (MoE) *Coastal and Mountain Ecoprovince* website (MoE 2014b).
- Review of site topographical information, including the Terrain Resource Information Management (TRIM) dataset, the BC Water Resources Atlas (MoE 2013a), and contours generated from Laser Imaging, Detection and Ranging (LIDAR) surveys. The topographical information was used to characterize the land relief, slope and elevation of the project site and the local McNab Creek watershed.
- Review of aerial images provided in the BC Water Resources Atlas (2014a) and Google Earth. Aerial images were used to estimate the general land cover of the project site and the McNab Creek watershed; and, used to verify the location of surface water features identified from the topographical information.
- Multiple site reconnaissance trips were carried out to characterize surface water features not readily visible from topographical data or aerial photos, such as local drainage patterns, stream cross-sections, bed material composition and size.

2.2 Climate

Climate variables evaluated in this baseline study, were selected based on their influence on surface water flows. These variables are air temperature, precipitation, evaporation and evapotranspiration. Air temperature has direct influence over evaporation and evapotranspiration, and is related to runoff rates during times of snowmelt. The amount of precipitation influences the potential amount of surface runoff. Evaporation and evapotranspiration are loss-related climatic variables that affect the fraction of precipitation that appears as runoff. These climate variables play a significant role in a watershed's surface runoff rates and the seasonal variability of flow. Data used to characterize these variables was collected and analysed using the methodology detailed in the following sections.

2.2.1 Climate Data Collection

Due to the limited climate records available near the Project Site, the project baseline conditions were established using regional climatic stations with long-term records. To verify that the regional records were representative of the site conditions, concurrent records were compared to the available shorter-term local climate records. The collection of the regional and local climate data are detailed in the following sections.

2.2.1.1 Regional Climate Data Collection

Data available from Environment Canada (EC) regional climate stations around the Project Site were collected and reviewed to identify which station would better represent local climate conditions. The climate station at Port Mellon (#1046330 and #1046332) was selected to represent the temperature and precipitation conditions of the project site. This station is located approximately 9 km southwest from the site, as shown in Figure 1. As shown in Table 1, the Port Mellon climate station initially recorded temperature from 1982 to 1989, and precipitation data from 1942 to 1989. In 2006, the station was relocated to a higher elevation, at a location nearby. As the old and new station elevations fall within the Project Site elevation range, both sets of climate data were used as one dataset, without further adjustment.

Table 1: Inventory of Available Regional Climate Data

Station Name (status)	Source	Location (Lat/Long)	Elev. [m]	Period of Record	Data Available**
Port Mellon (discontinued)	EC No. 1046330	49.31º N 123.29º W	7.6	1942 to 1989	Daily precipitation (1942 to 1989) Daily temperature (1983 to 1989)
Port Mellon (active)	EC No.1046332	49.31º N 123.29º W	122.6	2006 to 2012*	Hourly precipitation, temperature, relative humidity, and barometric pressure

* records available up to the time of the reporting

** finest temporal resolution

2.2.1.2 Local Climate Data Collection

One local climate station, Fire Weather Station (TS_MCNABB), was identified near the project area. This local climate station is located approximately 1.8 km northeast of the proposed aggregate pit, and had approximately two years of record available at the time of this report's writing, shown in Table 2. The data from this station was used to verify that the regional climate data from Port Mellon was representative of project site conditions.

Table 2: Inventory of Available Local Climate Data

Station Name (status)	Source	Location (Lat/Long)	Elev. [m]	Period of Record	Data Available**
Fire Weather Station (active)	BCFS (TS_MCNABB)	49.58º N 123.38º W	154	2010 to 2012*	Hourly precipitation, temperature, relative humidity, and wind direction/speed

* records available up to the time of the reporting

** finest temporal resolution available

In addition to the climate data from the Fire Weather Station (TS_MCNABB), barometric pressure records were collected near the Project Site between November 2011 and November 2012 using an atmospheric pressure logger. Local barometric pressure records were used to verify that the regional climate records from Port Mellon Station were similar to that of the recorded Project Site conditions, and used to compensate for the atmospheric pressure variations in the recorded water levels in McNab Creek and WC 2.

2.2.2 Climate Data Analysis

To establish the Project Site climate baseline conditions, the climate data identified in the previous section (Section 2.2.1) was used to estimate the following:

- Average, mean maximum and mean minimum monthly temperature;
- Annual, seasonal (Wet/Dry), and monthly precipitation;
- 200-year return period extreme precipitation; and
- Average monthly evapotranspiration and evaporation.

Average temperature, mean maximum temperature and mean minimum monthly temperatures for the Project Site were estimated using the regional temperature records from Port Mellon Station. The local monthly temperature records from Fire Weather Station (TS_MCNABB) were compared to verify that the Port Mellon station's regional record is representative of the site conditions.

Annual precipitation, seasonal (Wet/Dry) precipitation, and monthly precipitation were estimated from regional precipitation records from Port Mellon Station. The local monthly precipitation records from Fire Weather Station (TS_MCNABB) were compared to verify that the Port Mellon station's regional record is representative of the site conditions.

The 200-year return period extreme precipitation events for different short storm durations (up to 24 hours) were estimated through extrapolation using Intensity-Duration-Frequency (IDF) data from Port Mellon Station. Longer storms with durations ranging from two to 14 days were also evaluated. The largest storm for each period during a year within at the Port Mellon Station was extracted from the data. These populations of data were analysed and compared to several common statistical distributions. A best fit analysis was completed to determine which distribution provided the closest representation of the recorded data, selected from extreme value distributions including three Parameter Log-normal, Log Pearson III, Extreme Value, and Weibull (Gumbel III). The selected distributions were then used to estimate the 200-year design storm depths. The alternate block method was applied onto the design storm depths to create hyetographs distributions for the corresponding storm duration.

Evapotranspiration and evaporation were estimated using several other climatic variables recorded at Port Mellon Station. Evapotranspiration is a measure of the ability of the atmosphere to remove water from a location through the processes of water loss from plants (transpiration) and evaporation, and evaporation is the process by which water is changed from a liquid to a vapour. Potential evapotranspiration was estimated using the Food and Agricultural Organization of the United Nations (FAO) Penman Monteith equation (FAO 1998), which uses average monthly minimum and maximum temperatures and assumes a grass reference crop. Potential evaporation was estimated using the Lugeon Formula (FAO 1968), based average monthly maximum temperature, saturation and actual vapour pressure, relative humidity and barometric pressure estimated from Port Mellon Station.

2.3 Streamflow

Available regional and local streamflow records were used to establish the streamflow baseline conditions for the Project Site. Long-term regional hydrometric records were compared to the short-term hydrometric records collected near the Project Site. Data collection and analysis methodologies used to establish the streamflow baseline are detailed in the following sections.

2.3.1 Streamflow Data Collection

Due to the absence of long-term McNab Creek streamflow records, the streamflow baseline conditions were established using long-term regional records from Water Survey of Canada (WSC) hydrometric stations (refer to Section 2.3.1.1, below).

2.3.1.1 Regional Streamflow Data Collection

Regional hydrologic characteristics combined with hydrometric data, were used to estimate hydrologic conditions in McNab Creek. After reviewing available regional Water Survey of Canada (WSC) hydrometric stations near the Project Site, two long-term stations that were most likely to represent McNab Creek flow conditions were selected, as shown in Table 3**.**

Of the two stations in Table 3, Chapman Creek above Sechelt Diversion Station (#08GB060) was identified as the hydrometric station that was the most representative of the streamflow conditions in McNab Creek and selected for this study. This station is within the same hydrologic zone as the project area, in the Hydrologic Subzone 9B: “Southern Coastal Mountain“ (Coulson 1998), and is located approximately 25 km southwest from the Project Site, as shown in Figure 1. Compared to Clowhom River near Clowhom Lake Station (#08GB013), Chapman Creek station has a watershed size that is more similar to that of McNab Creek (i.e., 67.3 km^2), with 19 years of hydrometric records. It also has a mean basin elevation (MBE) that is closer that of McNab Creek MBE (i.e., 740 m). Clowhom River near Clowhom Lake Station was used in this baseline study as a secondary check on the reasonable range of the estimated McNab Creek extreme high flows.

Table 3: Inventory of Available Regional Streamflow Data

Station Name	Station Number	Location (Lat/Long)	Catchment Area (km^2)	Mean Basin Elevation (m)	Period of Record	Type of Data
Chapman Creek above Sechelt Diversion	08GB060	49.28º N 123.42º E	64.5	958	1970 to 1988	Average daily, average monthly, and peak (daily and instantaneous) flows
Clowhom River near Clowhom Lake	08GB013	49° 47'N 123° 25'W	147	1,120	1993 to 2011	Average daily, average monthly, and peak (daily and instantaneous) flows

2.3.1.2 Local Streamflow Data Collection

Flow monitoring stations were installed at McNab Creek and the upper segment of WC 2. Station locations were selected based on access, conditions conducive to manual measurement (i.e., depth suitable for wading), suitability for the flow measurement (i.e., straight section of river, stable river banks, free of large boulders and other obstructions, and relatively even distribution of flow across the width); and confined and uniform creek cross section.

Station installation works included installation of local benchmark(s) and staff gauge(s) driven into the stream bank. Pressure transducer probes were inserted below the water surface to measure water level. Barologgers were secured nearby above the high water mark to measure the atmospheric pressure so it could be used to compensate for the total pressure readings recorded by the transducers installed below the water surface. The pressure transducers were set to record at 15-minute intervals, and the barometric loggers were set to record at hourly intervals.

During subsequent site visits, the water level and atmospheric pressure records from the pressure transducers were downloaded and checked, and equipment maintenance was performed. At each visit, the water surface was measured relative to the local benchmark, and manual flow measurements were carried out using methodologies derrived from Coulson (1991).

The local flow monitoring stations relevant to the surface water EA assessment are presented in Table 4 and Figure 3.

Table 4: Flow Monitoring Stations

Watercourse	Location	Station Name	Period of Record
McNab Creek	Approximately 2.5 km north of the mouth of McNab Creek, and 400 m upstream of the confluence of McNab Creek and Box Canyon Creek	MC-US-01	Nov 2011 – Nov 2012
WC 2 – upper segment	In the upper segment of WC 2, approximately 500 m upstream of the access road culvert crossing	GC-US	Sep 2010 – Nov 2012

Stage-discharge rating curves were developed for each of the flow monitoring stations using channel cross-section survey and manual flow measurements carried out during the site visits. These rating curves were used to estimate flows from recorded water levels.

2.3.2 Streamflow Data Analysis

To establish the streamflow baseline conditions in the project area, the following characteristics were derived:

- McNab Creek mean annual and monthly flows;
- McNab Creek extreme low flow with return periods of five years and 10 years;
- McNab Creek extreme high daily flow with a return period of 200-years, and
- Average monthly flows of WC 2.

Mean annual and monthly flows at McNab Creek were estimated using areal transfer on the regional hydrometric data from the WSC Chapman Creek above Sechelt Diversion Station (#08GB060).

The five and 10 year return period extreme low flows were also estimated using data from the WSC Station Chapman Creek above Sechelt Diversion. The average flows over durations of one to 25 days were estimated for the month of August and September, when the lowest flows in McNab Creek are expected. The lowest flows were selected, and the five-year and 10-year extreme low flows were estimated using extreme frequency analysis. Extreme value distributions including three Parameter Log-normal, Log Pearson III, Extreme Value, and Weibull (Gumbel III) were evaluated against the data, and the most suitable distribution was selected.

The 200-year extreme high flow in McNab Creek was estimated based on the 200-year precipitation event described in 3.2.2.2. A numerical rainfall-runoff model, HEC-HMS[1] (Version 3.5) was used to estimate the 200-year McNab Creek peak flows, based on the estimated watershed characteristics discussed in Section 3.1.1. The HEC-HMS model was configured using the parameters and assumptions below:

- Ground conditions were assumed to be saturated with Antecedent Moisture Condition III (AMC III).
- The McNab Creek watershed was assumed to have good forest cover. A Curve Number (CN) of 79 was considered representative of the McNab Creek watershed, i.e., woods protected from grazing, and litter and brush adequately covers the soil (USDA 1986); to reflect AMC III (saturated conditions), the CN for the McNab Creek watershed was raised to 88 (USDA 1986).
- The watershed was assumed to have an impervious fraction of 8% based on review of aerial photos.

The estimated 200-year peak McNab Creek flow was checked against the extreme high flows from nearby regional hydrometric stations with similar watershed characteristics, Chapman Creek above Sechelt Diversion Station (#08GA060) and Clowhom River near Clowhom Lake Station (#08GB013).

The flow records from flow monitoring station GS-US located in the upper segment of WC 2 were summarized into average monthly flow. Approximately two years of flow records, between September 2010 and November 2012 were presented in the assessment. These flow records were used to establish input data for the hydrogeological model of the project area (Golder 2014a).

[1] The Hydrologic Engineering Center's Hydrologic Modelling System

3.0 BASELINE CONDITIONS

3.1 Hydrological Setting

Based on the BC Streamflow Inventory, the proposed project is located in hydrologic subzone 9B, Southern Coastal Mountains, within Zone 9, Coastal Mountains (Coulson 1998). The McNab Creek watershed is further classified as part of the Southern Pacific Ranges Ecosection (MoE 2013b). The Southern Pacific Ranges Ecosection is characterized by glaciated U-shape valleys. Upper valley slopes are generally steep, with a mantle of till glacial material or exposed bedrock, and the lower valley slopes are generally flatter with predominantly coarse substrate in the valley bottoms along the mainstream watercourses (MoE 2013b). Based on available aerial imagery, much of the McNab Creek watershed is covered by thick forest, while the upper slope areas have limited vegetative cover, consistent with steep slopes nearing the alpine limit of forests.

The project's Local Study Area (LSA) is the immediate area surrounding the proposed pit, as shown in Figure 2. The LSA encompass the area within which the Project is expected to interact with, and potentially change the conditions of Surface Water quantity and quality. In determining LSA boundaries, consideration was given to the nature and characteristics of Surface water quantity and quality, its potential exposure to various influences such as water diversion and changes to the creeks watershed areas that may impact runoff into the creeks, and the maximum extent of potential changes on Surface Water quantity and quality. For the Surface Water component of this project, the LSA was defined as an area bounded to the north and east by McNab Creek, to the south by Howe sound, and to the west by a line approximately 10 m beyond (i.e., west of) the access road that runs in the north-south direction.

The Regional Study area (RSA) was established to provide a regional context for the consideration of changes to the surface water quantity and quality that could cause adverse Project effects to a VC. The RSA was also established to encompass the area within which the residual effects of the Project are likely to overlap with the residual effects of other existing or reasonably foreseeable projects and activities. For the Surface Water component of this project, the RSA was defined as all watersheds that flow into McNab Creek and the LSA, as shown in Figure 2.

Several surface water systems have been identified within the project's LSA as shown in Figure 2

The following surface water systems were characterized in the baseline study:

- McNab Creek;
- Watercourse 2 (upper and lower segment); and
- Foreshore minor streams (WC 3, WC 3-E, WC 4-W, WC 4-E, and a portion of WC 5).

McNab Creek, WC 2, and the foreshore minor streams were studied in this surface water resources section of the EA, as they may be potentially impacted by the proposed project.

The following nearby watercourses are not anticipated to have an interaction with the Project and have not been included in the baseline study:

- Harlequin Creek; and
- Several steep ephemeral watercourses on the slope west of the pit (hereafter referred to as West Slope).

The baseline conditions for the surface water systems in the LSA were established as basis of comparison with projected future conditions, to estimate the project's impact.

3.1.1 McNab Creek

McNab Creek is the main watercourse of the McNab Valley, and has a total length of approximately 12.7 km, flowing southeast into the north end of Thornborough Channel in Howe Sound. The watershed elevation ranges from the sea level to 1,600 m. The mean basin elevation was estimated to be approximately 740 m. The total watershed area for McNab Creek (i.e., at the mouth) is approximately 67.3 km^2. A watershed area of 63.3 km^2 has been used in this study to establish the baseline conditions for McNab Creek at the Project Site, located about 1.4 km upstream of the mouth, where McNab Creek turns sharply to the east.

High flow in McNab Creek occurs during the spring freshet (i.e., between May and June), during the months with heavy precipitation (i.e., between October and November). Low flows typically occur during August and September and Golder field staff observed that McNab Creek loses water to the groundwater system in the area of the proposed pit. Further details are presented in Section 3.3.1.3.

Within the watershed, there are no glaciers and only a few alpine areas of late-persisting snow, and there are no significant lake systems or water storage. The creek's main stem typically has channel widths between 10 m and 20 m and a gradient from 4% to 9%, with predominantly boulder and cobble substrates (Whelan 1999). The Creek has the typical longitudinal profile of an alluvial channel with a decreasing gradient in the downstream direction. The lower section of the creek is characterized a relatively short section (<2 km) with a low gradient of 2%. In this section, the creek flows through a meandering, incised, but unconfined with gravel and cobble bars, and off-channels.

McNab Creek watershed has been heavily logged along both sides of the McNab Creek main stem for most of its length. A power line right-of-way (ROW) crosses the McNab valley and the Project area near the mouth of McNab Creek. A Terasen gas pipeline ROW extends along the main road on the west side of the valley to Box Canyon. A small strata-lot residential housing development is present on the east bank of McNab Creek near its mouth.

There are several large third and fourth order tributaries in the McNab Creek watershed. The tributaries include Box Canyon Creek, Marty Creek, and Cascara Creek located on the western slopes and Lost Lake Creek located on the eastern slope, as well as several unnamed creeks.

3.1.2 Watercourse 2

Watercourse 2 is fed by losses from McNab Creek as well as contributions from the broader ground water system. The upper segment of WC 2 would be removed by the project. The proposed pit will fill with groundwater, potentially influencing the local groundwater table and the groundwater flows into the lower segment of WC 2and the foreshore minor streams.

Watercourse 2 extends from the foreshore to the centre of the BURNCO property. The watercourse is approximately 1,225 m long, running from the centre of the proposed aggregate pit area to the foreshore located approximately 100 to 150 m west of the McNab Creek estuary. The watercourse comprises distinct upper and lower segments, crossed by the power line ROW and a parallel access road located on the south side of the ROW. The watercourse flows through the property and outlets to the foreshore approximately 100 to 150 m west of the McNab Creek estuary. This watercourse was constructed to provide spawning habitat for Chum Salmon with the additional function of providing spawning and rearing habitat for Coho Salmon. It was constructed in in three phases over the 18 year period from 1985 to 2003 (DFO 1997):

- The first (and furthest downstream) phase of this watercourse is a 230 m long tidal watercourse that was constructed in 1985 by DFO's Resource Restoration Division (Hatfull 1998).
- The second phase was constructed in 1998. It extends the 1985 watercourse by approximately 470 m. Hatfull Consultants Limited undertook this work with funding from DFO and in-kind contributions from Canfor Ltd (Hatfull 1998).
- The third phase of the watercourse was constructed from 2001 to 2003 above the BC Hydro ROW, by Howe Sound Pulp and Paper Limited Partnership (HSLP), previous owner of the property. The watercourse in this phase is approximately 4 to 12 m wide and 523 m long, extending northward from the ROW.

In this report, phases one and two of this watercourse will collectively be referred to as "the lower segment". The third phase of the watercourse is herein referred to as "the upper segment". Upper and lower segments of WC 2 are described in more detail below.

Upper Segment

The upper segment of WC 2 consisted of a large, straight, excavated channel flowing from north to south through the area of the proposed aggregate pit. The north end of the watercourse consisted of steeply excavated slopes. The south end of the watercourse was directly upstream of an access road located on the south side of the ROW. Flows in the watercourse passed under the access road to the watercourse's lower segment via a 1.0-m high semi-circular culvert.

The watercourse consisted of primarily a low gradient (<1%), slow moving pool or run for its entire length with the exception of an approximately 150 m of riffle-pool near its upper (north) extent. The banks of this watercourse were very steep (up to 45^{o} slope). Throughout much of the watercourse, the height to the top of bank was approximately 10 m, with a top of bank width reaching up to 30 m. Wetted width ranged between 4 to 12 m with an average wetted depth of 0.4 m.

Lower Segment

The lower segment of WC 2 is located downstream (i.e., to the south) of the semi-circular culvert that crosses under the access road. The watercourse turns east and flows for approximately 400 m before turning south and flowing into Howe Sound at a location approximately 150 m west of the mouth of McNab Creek. The portion of this lower segment was aligned west to east consisted primarily of a straight, slow flowing watercourse with constructed glide and pool areas. Downstream, the remainder of the watercourse flows south to Howe Sound. The lowest portions of WC 2 are tidally influenced with saltwater intrusion reaching approximately 100 m inland.

The height from the watercourse bed to the top of the excavated banks in the lower segment was typically less than 5 m. The average watercourse width was approximately 10 m, with an average wetted width of 5.6 m and average wetted depth of 0.4 m.

3.1.3 Foreshore Minor Streams

The foreshore minor streams are located within the marine foreshore, west of the mouth of McNab Creek, and between the proposed aggregate pit and the shoreline. The groundwater-dominated streams are primarily composed of freshwater when they are exposed at low tide and inundated with seawater. As shown in Figure 3, the foreshore minor streams include watercourses WC3, WC3-E, WC4-E, WC4-W, and WC5.

WC3 was the only watercourse that is directly connected to the lower segment of WC 2, and it received intermittent flows from WC 2 during periods of higher flow. WC3 had an average watercourse width of 7.5 m, average wetted width of 4.6 m, and average wetted depth of 0.5 m.

WC3-E was a dead-end wetland watercourse which joins with WC3 before flowing into Howe Sound.

WC4-E and WC4-W were dead-end and slow-moving, swamp or wetland watercourses disconnected from other tributaries or watercourses, and drained groundwater into the intertidal flats along the coastline of the LSA. Average watercourse width and wetted width for these groundwater-fed watercourses were 7.7 m and 3.0 m for WC4-E and WC4-W, respectively. Their average wetted depth was approximately 0.2 m, and subjected to tidal influence.

WC5 is located in the southwest corner of the BURNCO property in the vicinity of the hydro ROW, near the proposed aggregate processing plant area. The watercourse began from the slopes west of the existing access road that runs in the east-west direction. The lower portion of WC5 is located in the foreshore area east of the main access road. This section flowed in a south-east direction towards the foreshore. The watercourse characteristics and dimensions of WC5 vary substantially along the length of watercourse. The average watercourse width was 5.8 m, average wetted width was 2.9 m, and the average wetted depth was 0.2 m with a low gradient (approx. 1%).

3.2 Climate Baseline Conditions

The climate of the McNab valley is characterized by heavy precipitation from late-fall to winter and the dry, warm summers with occasional rainy periods. In the winter, most of the precipitation falls as rain at the lower altitudes, with some falling as snow at higher elevations. The climate baseline setting of the project area, including the characterization of temperature, precipitation, evapotranspiration and evaporation is described in the following sections.

3.2.1 Temperature

Table 5 summarizes the average monthly temperature estimated from the regional and local climate stations selected for the baseline study. The location of these stations is shown in Figure 1. For regional data, as discussed in Section 2.2.1.1, two sets of historical temperature records from EC Port Mellon climate stations (#1046330, #1046332) were used. This station is located approximately 9 km to the southwest of the project site. Local temperature data was obtained from the Fire Weather Station (TS_MCNABB) located approximately 1.8 km northwest of the Project Site.

Table 5: Average Monthly Temperature

Month	Average Monthly Temperature (°C)		
	Port Mellon (#1046330, #1046332) 1982-1989, 2006-2012	**Port Mellon (#1046330, #1046332) May 2010 – Oct 2012**	**Fire Weather Station (TS_MCNABB) May 2010 – Oct 2012**
January	3.7	3.5	2.2
February	4.5	n/a	2.9
March	6.4	5.7	4.2
April	8.6	8.8	6.8
May	12.2	12.0	10.5
June	15.0	14.6	14.0
July	18.1	18.4	17.9
August	18.4	19.6	19.2
September	15.0	16.5	16.3
October	10.4	10.9	10.2
November	5.4	5.0	3.6
December	2.9	4.3	2.7

The average monthly temperature at the Port Mellon Station were compared to the Fire Weather Station (TS_MCNABB) between May 2010 and October 2012, based on the data availability at the Fire Weather Station at the time of this report's writing. As shown in Table 5 and Chart 1, the average monthly temperature at the Port Mellon Station showed similar trend with that of the Fire Weather Station (TS_MCNABB).

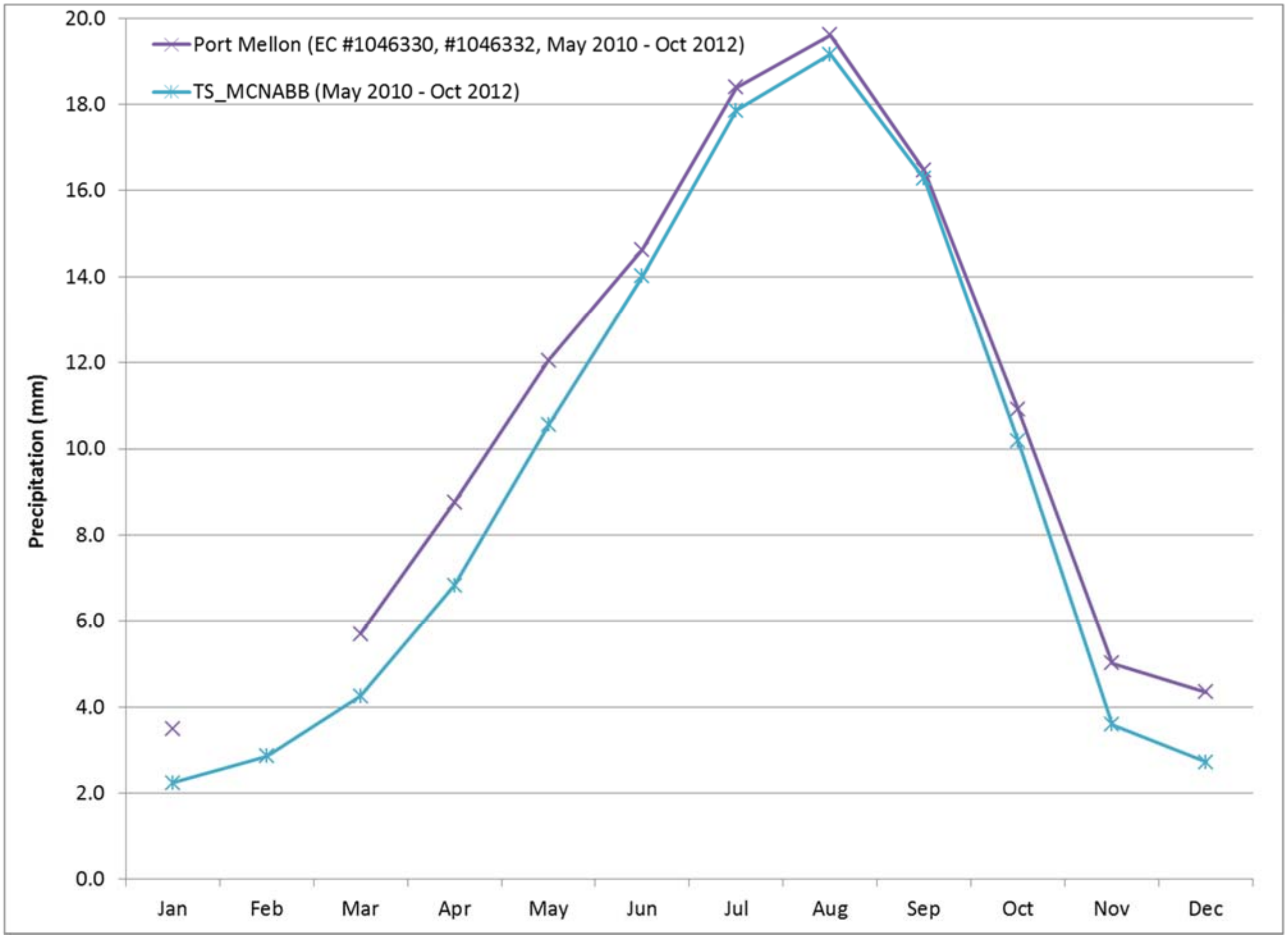


Chart 1: Average Monthly Temperature at Port Mellon and TS_MCNABB Stations, May 2010 to Oct 2012

As there were only two years of temperature recorded at the Fire Weather Station (TS_MCNABB), the longer term record at the Port Mellon Station was considered to provide a better representation of the long-term conditions at the Project Site. The annual average, mean minimum and mean maximum temperature of the project site estimated from the Port Mellon Station are presented in Table 6.

Table 6: Estimated Project Baseline Temperature (ºC)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	3.7	4.5	6.4	8.6	12.2	15.0	18.1	18.4	15.0	10.4	5.4	2.9
Mean Max	5.8	7.2	9.8	12.5	16.4	18.9	22.7	23.0	19.1	13.5	7.6	5.1
Mean Min	1.4	1.8	3.1	4.7	7.9	11.0	13.5	13.7	10.9	7.3	3.1	0.7

3.2.2 Precipitation

3.2.2.1 Annual, Seasonal, and Monthly Precipitation

The region receives on average approximately 3,200 mm of precipitation per year. Typically, July and August are the driest months, with the heaviest precipitation occurring between October and March.

The precipitation records from the regional and local climate stations studied are presented in Table 7. The regional data was based on the precipitation records from EC Port Mellon climate station (#1046330, #1046332), located approximately 9 km to the southwest of the Project Site. As discussed in Section 2.2.1.1, two sets of historical precipitation records from this station were used. The local precipitation record was obtained from the Fire Weather Station (TS_MCNABB), located approximately 1.8 km northwest of the Project Site. Table 7 and Chart 2 compared the precipitation records between the regional station at Port Mellon and the local Fire Weather Stations.

Table 7: Average Annual, Seasonal, and Monthly Precipitation

Month	Precipitation (mm)				
	Port Mellon (#1046330, #1046332)			Fire Weather Station TS_MCNABB May 2010 – Oct 2012	
	1942-1989, 2006-2012		May 2010 – Oct 2012		
January	398	Wet Season	384	437	Wet Season
February	344		n/a	285	
March	336		412	420	
April	205	Dry Season (790)	237	226	Dry Season (872)
May	150		155	170	
June	102		133	169	
July	91		39	64	
August	80		39	49	
September	162		204	194	
October	352	Wet Season (2347)	347	385	Wet Season (2337)
November	461		348	408	
December	456		443	402	
Annual	**3,137**		**n/a**	**3,209**	

As shown in Table 7 and Chart 2, the average monthly total precipitation at the Port Mellon Station were compared to the Fire Weather Station (TS_MCNABB) between May 2010 and October 2012, based on the data availability at the Fire Weather Station at the time of this report's writing. The precipitation pattern at the Port Mellon Station and the Fire Weather Station showed similar trends.

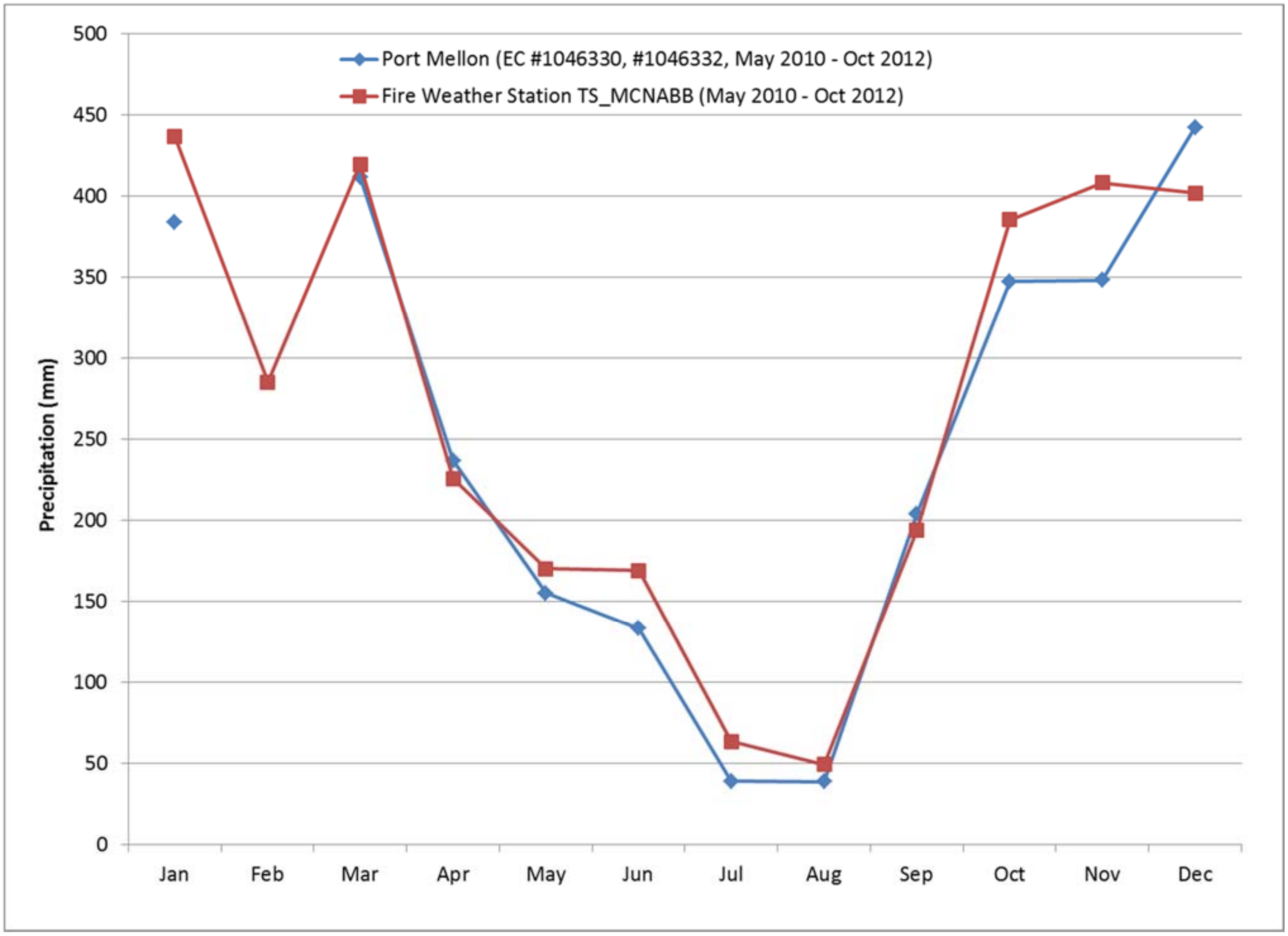


Chart 2: Average Monthly Precipitation at Port Mellon and Fire Weather (TS_MCNABB) Stations

As there were only two years of precipitation record at the local TS_MCNABB station, the longer term record at the Port Mellon Station was considered to provide a better representation of the long-term conditions at the Project Site. Therefore the Port Mellon Station average monthly total precipitation in Table 7 was used to represent the project's baseline condition.

3.2.2.2 Extreme High Precipitation

The 200-year recurrence interval was selected as the flooding design criteria for this assessment. For durations ranging from 5 minutes to 24 hours, the rainfall intensities were extrapolated from the IDF curves from the Port Mellon climate station. Table 8 shows the estimated rainfall depth for the 200-year precipitation event with durations ranging from five minutes to 24 hours.

Table 8: Estimated 200-Year Rainfall Depth at Port Mellon Station (duration 5 minutes to 24 hours)

Storm Duration	5 min	15 min	1h	2h	3h	4h	6h	12h	24h
Depth (mm)	5.43	11.66	31.11	50.0	65.65	79.0	103.6	172.08	278.4

The 200-year rainfall depths for multi-day duration were estimated using daily rainfall data from the Port Mellon climate station. The results in Table 9 were based on the result of the extreme value analysis discussed in Section 2.2.2.

Table 9: Estimated 200-Year High Rainfall Depth at Port Mellon Station (multi-day)

Storm Duration	2-day	3-day	4-day	5-day	6-day	7-day	14-day
Depth (mm)	440.9	514.1	573.2	623.8	668.3	708.5	921.1

3.2.3 Evapotranspiration and Evaporation

3.2.3.1 Evapotranspiration

Evapotranspiration is the combination of evaporation of water from water bodies and surficial soils and transpiration of water from plants. In general, evapotranspiration is the greatest in the summer when the days are the longest and solar radiation is the strongest. As the Port Mellon Station did not have evapotranspiration measurement or estimates, evapotranspiration was estimated based on the FAO Penman Monteith equation (FAO 1998), as discussed in Section 2.2.2.

The estimated monthly and annual evapotranspiration for the project site is presented in Table 10.

Table 10: Estimated Monthly and Annual Evapotranspiration

Month	Evapotranspiration [mm/month]
January	12
February	20
March	41
April	65
May	97
June	106
July	125
August	109
September	67
October	34
November	14
December	10
Annual	**700**

The annual evapotranspiration value of 700 mm was compared to the 2011 and 2012 evapotranspiration estimates from the Squamish (748 mm) and Sechelt (660 mm) locations available from the Pacific Field Corn Association (Pacific Field Corn Association 2013). The Project Site is located between these two stations, with Squamish to its northeast and Sechelt to its southwest. The annual evapotranspiration estimate of 700 mm for the Project Site is considered to be reasonable, compared to the estimates for these two stations.

3.2.3.2 Evaporation

The evaporation for the proposed aggregate pit lake was estimated using the Lugeon Formula (FAO 1968), using climate data from the Port Mellon Station, including average monthly maximum temperature, saturation and actual vapour pressure, relative humidity, and barometric pressure. Table 11 presents the estimated average monthly and annual evaporation.

Table 11: Average Monthly and Annual Pit Evaporation

Month	Evaporation (mm/month)
January	14
February	21
March	27
April	47
May	70
June	72
July	106
August	110
September	69
October	31
November	13
December	13
Annual	**594**

3.3 Streamflow Baseline Conditions

The streamflow baseline setting for McNab Creek, WC 2, and minor foreshow streams were analysed and described in the following sections.

3.3.1 McNab Creek Flows

3.3.1.1 Mean Annual and Monthly Flows

The WSC hydrometric station Chapman Creek above Sechelt Diversion station (#08GB060) was used to estimate the flow conditions in McNab Creek. Chapman Creek above Sechelt Diversion station (#08GB060) has a watershed area of 64.5 km^2, similar to the McNab Creek watershed area of 63.3 km^2 by the Project Site that was used in this study to establish the baseline conditions.

Using area transfer in Equation 1, the average monthly streamflow records from Station #08GB060 were used to estimate flows for McNab Creek:

$$Q_{A_1} = Q_{A_2} \times \left(\frac{A_1}{A_2} \right) \qquad \text{Equation [1]}$$

Where:

Q_{A1} = Flow at McNab Creek;

Q_{A2} = Flow at Chapman Creek;

A_1 = Catchment area contributing to McNab Creek; and,

A_2 = Catchment area contributing to Chapman Creek.

The estimated McNab Creek mean annual and monthly flows are shown in Table 12.

Table 12: Estimated McNab Creek Average Monthly Flow

Month	Flow (m^3/s)
January	3.6
February	4.4
March	4.1
April	4.3
May	8.0
June	6.6
July	3.5
August	1.1
September	1.8
October	4.1
November	5.3
December	5.4
Annual	4.4

3.3.1.2 Extreme High Flow

The 200-year extreme high flow in McNab Creek was selected as the design flood for the proposed flood protection works. The 200-year high flows in McNab Creek were estimated using the precipitation estimates and a rainfall-runoff model (HEC-HMS[2]).

The 200-year peak flow was estimated to be 289 m^3/s. This flow was compared with the extreme high flows estimated from nearby regional WSC hydrometric stations with similar watershed characteristics, Chapman Creek above Sechelt Diversion (#08GA060) and Clowhom River near Clowhom Lake (#08GB013). The flow was found to be within a reasonable range, as the estimated 200-year McNab Creek extreme high flows falls between the areal-transferred 200-year extreme high flows of these two hydrometric stations.

3.3.1.3 Extreme Low Flow

Typically, a natural stream gains flow as it flows downstream towards the mouth. However, McNab Creek loses flow to the groundwater system in the project area, due to alignment of the watercourse, the nature of the surficial soils, and the presence of WC 2. The section of the creek losing water to the groundwater system is north of the proposed aggregate pit area, where the creek sharply turns east. As a result of this groundwater loss, the creek was observed by Golder field staff between 2011 and 2014 to periodically have no surface flow in isolated segments during dry periods of the year. The project's impact on low flow was quantitatively evaluated by assessing the duration and frequency of periods when the creek has no surface flow in this segment.

Based on the result of the hydrogeological assessment (Golder, 2014a), the annual average baseline flow loss of flow in McNab Creek to groundwater is 0.206 m^3/s. The drought analysis was carried out by estimating the rate of surface flow loss to the groundwater system in this segment of the creek, and comparing this rate to the estimated extreme low flows based on a regional analysis. When the rate of groundwater loss was greater than the low flow rate, the creek was considered to be in drought with no surficial flow within the affected segment. Extreme low flow rates for various durations were estimated. As expected, the extreme low flow rate increase with duration. By comparing the estimated rate of loss to the low flow rates of various durations, the anticipated duration of a drought of a given recurrence interval was estimated.

An extreme low flow analysis was carried out using the methodology described in Section 2.3.2.

[2] HEC-HMS Version 3.5, US Army Corps of Engineers

Streamflow records from WSC Station Chapman Creek above Sechelt Diversion were used to estimate extreme low flows in McNab Creek immediately upstream from the watercourse segment which is losing flows to the groundwater system. The five-year and 10-year extreme low flows between one and 20 days duration, selected from the lower of the August and September flows, are shown in Table 13.

Table 13: Estimated McNab Creek 5-Year and 10-Year Low Flow

Duration (days)	5-Year Low Flow (m^3/s)	10-Year Low Flow (m^3/s)
1	0.196	0.153
2	0.199	0.155
3	0.201	0.158
4	0.204	0.160
5	0.207	0.162
6	0.210	0.164
7	0.213	0.167
8	0.217	0.171
9	0.221	0.174
10	0.224	0.177
11	0.228	0.180
12	0.231	0.183
13	0.234	0.186
14	0.238	0.190
15	0.243	0.195
16	0.248	0.200
17	0.249	0.203
18	0.255	0.209
19	0.260	0.214
20	0.265	0.219

The annual-average groundwater loss projected by the hydrologic assessment (Golder 2014a) was compared to the estimated five-year and 10-year McNab Creek low flow. This comparison indicated that the five-year and the 10-year low flows would result in drought conditions with durations in the range of four days and 17 days respectively. Significant uncertainty exists in the prediction of low flow conditions at the site and the rate of loss of flow from McNab Creek to the groundwater system. These results should be considered as indicative of the overall system and the flow patterns with an appreciation that there is the potential for variability in the absolute values.

3.3.2 Watercourse 2 Flows

Flows in WC 2 generally come from the local water table which is recharged by McNab Creek and the groundwater from the west side slope. WC 2 flows were observed to be relatively responsive to rainfall. Flow monitoring station GC-US was installed in the upper segment of WC 2, approximately 400 m upstream of the existing culvert crossing as shown in Figure 3. The pressure transducers at this station recorded water levels at 15 minute intervals. At the time of this report's writing, water level records between September 2010 and November 2012 were converted into flows using estimated discharge rating curves established for GC-US. The estimate flows are summarized in Table 14 and Chart 4. Based on the observed records, the period of the highest flow was between November and December, and the period of the lowest flow was between August and September. The average total annual flow was approximately 1,892,200 m^3 per year.

Table 14: Recorded Average Monthly WC 2 Flow at GC-US (Sep 2010 to Nov 2012)

Month	Average Monthly WC 2 Flow (m^3/s)
January	0.097
February	0.061
March	0.071
April	0.042
May	0.035
June	0.032
July	0.024
August	0.014
September	0.017
October	0.051
November	0.138
December	0.141
Annual	**0.060**

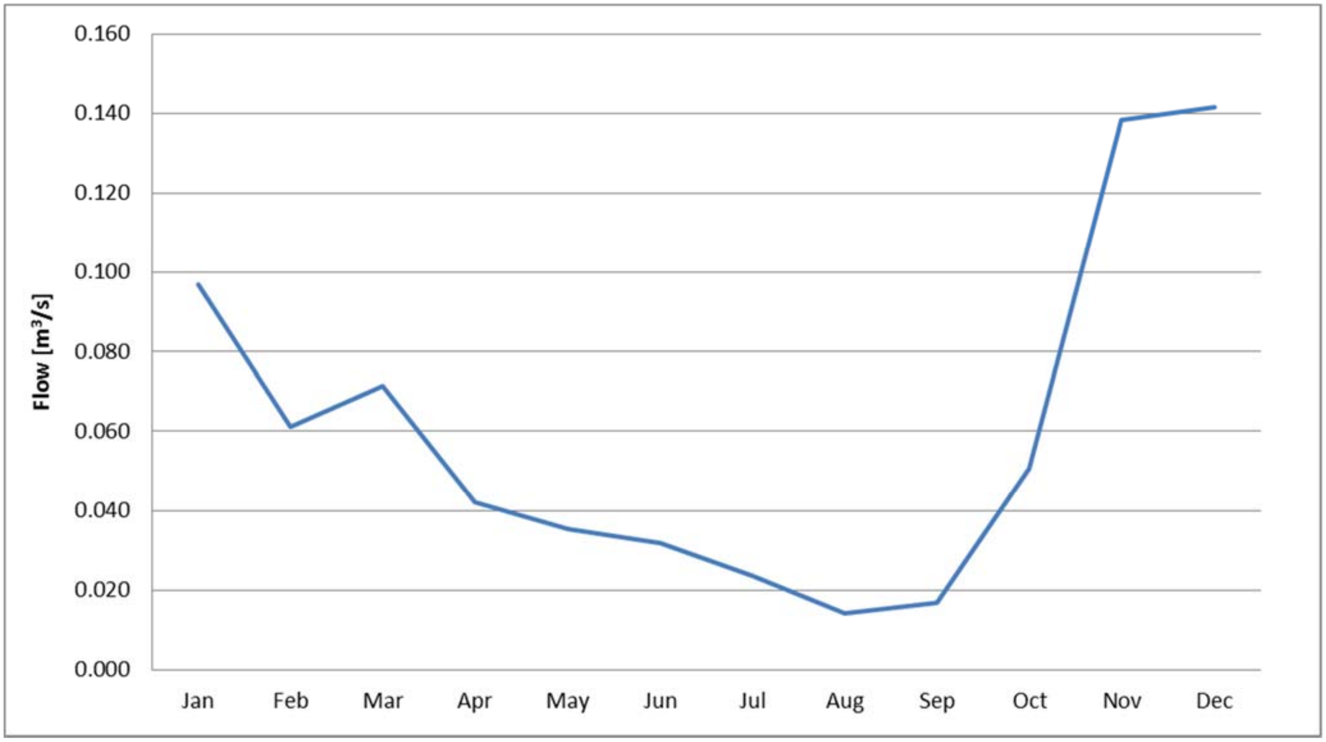


Chart 3: Watercourse 2 Average Monthly Streamflow Records from GC-US station

Based on the results of the hydrogeological assessment (Golder 2014a), the estimated baseline annual average flow at the mouth of WC 2 is 36,500 m^3/day (0.422 m^3/s). This flow includes the groundwater contribution from both the upper and lower segment of WC 2 in pre-project conditions.

3.3.3 Foreshore Minor Streams

Based on the results of the hydrogeological assessment (Golder 2014a), the estimated baseline total annual average flow for the foreshore minor streams is 5,900 m^3/day (0.068 m^3/s). This flow includes contributions from WC3, WC3-E, WC4-E, WC-4W, and WC5. The flows in each foreshore minor stream were pro-rated from the total flow, based on the channel length, shown in Table 15.

Table 15: Estimated Foreshore Minor Stream Annual Average Flows

Minor Stream	Channel Length (m)	Flow (m^3/day)	Flow (m^3/s)
WC3	210	1,229	0.014
WC3-E	153	896	0.010
WC4-E	118	691	0.008
WC4-W	179	1,048	0.012
WC-5	348	2,037	0.024

3.3.4 Water Licenses

A review of existing water licenses and Points of Diversion (PoD) around the Project area was completed using the MoE BC Water Resources Atlas (MOE 2013a). A water license may have one or more PoD, and a PoD may have one or more water licenses (e.g., a shared intake).

The PoD search was limited to the area with reasonable possibility of being impacted by the project, specifically, within the LSA of the Project Site. Based on the Water Resources Atlas, there is one current water licence at a location approximately 200 m upstream of the mouth of McNab Creek, shown in Table 16:

Table 16: Point of Diversion/Water License

Point of Diversion Number	License #	License Status	Stream Name	Purpose	Quantity	Licensee
PD44460	C063713	Current	McNab Creek	Waterworks (other)	36.369 m^3/day	Strata Corporation VR 850 C/O Dennis MacPherson BOX 431 Garibaldi Highlands BC V0N1T0

Outside of the LSA, and within the RSA, there are additional water licenses on Harlequin Creek, Lost Lake Creek, Box Canyon Creek and its tributaries, Marty Creek and its tributaries, and Cascara Creek and its tributaries. The project is not expected to have impact on the water usage in these systems, and these water licenses were not included in the baseline study.

3.3.5 Water Quality

The McNab Creek watershed is mostly forested, and aside from previous and ongoing logging activities and infrastructures associated with independent power production, the watershed is largely undeveloped. Therefore, the surface water quality baseline condition within the Project's LSA is expected to be relatively free of chemical contaminants, and would have suspended sediment loading typical of other similar undeveloped creek systems.

Surface water quality baseline conditions are presented in a separate baseline data report (Golder 2014c).

4.0 SUMMARY

The surface water baseline reports are summarized in this section.

The Port Mellon Climate Station (EC #1046330, #1046332) was identified as the regional station that was the most representative of the conditions near the project site. This station has long-term temperature and precipitation records between 1942 and 2012. The station's temperature and precipitation records were compared to short term measurements recorded at the Fire Weather Station (TS_MCNABB) located adjacent to the Project area, and were found to have similar trends. The Port Mellon Climate Station records were used to establish the project climate baseline as follows:

- Average, mean maximum and mean minimum monthly temperature;
- Annual, seasonal (wet/dry) and monthly precipitation;
- 200-year return period extreme high precipitation for various durations; and
- Average monthly and annual evapotranspiration and evaporation.

WSC hydrometric station Chapman Creek above Sechelt Diversion (#08GB060) was identified as the regional station that was the most representative of the McNab Creek flows upstream the project site. This station has streamflow records between 1970 and 1988. The station's streamflow records were compared to that of MC-US-01, a flow monitoring station on McNab Creek approximately 1000 m upstream from the Project site, and were found to have similar trends. The Chapman Creek records were used to establish the McNab Creek streamflow baseline as follows:

- McNab Creek mean annual and monthly flows;
- McNab Creek extreme low flow with a return period of five years and 10 years; and
- McNab Creek extreme high daily flow with a return period of 200-years.

There were no records of flow in WC 2 prior this project. A flow monitoring station was installed in the upper segment of WC 2. Water levels and flow records were used to characterize flows in the watercourse's upper segment and were used to support the hydrogeological assessment (Golder 2014a).

There were no records of flow in the foreshore minor streams prior this project. The flows in these streams were estimated using the results from hydrogeological assessment (Golder 2014a).

Water licenses within the project LSA were compiled using the MoE BC Water Resources Atlas (MoE 2014a). A PoD search conducted was limited to those with any reasonable possibility of being impacted by the project. One water license was identified within the project LSA.

Surface water quality baseline conditions are presented in a separate baseline data report (Golder 2014c).

5.0 CLOSING

We trust this information is sufficient for your needs at this time. Should you have any questions or concerns, please do not hesitate to contact the undersigned at 604-296-4200.

GOLDER ASSOCIATES LTD.

Christopher T. Coles, M.A.Sc., P.Eng.
Associate, Senior Water Resources Engineer

RS/CTC/asd

\\golder.gds\gal\burnaby\final\2011\1422\11-1422-0046\1114220046-551-r-rev1\1114220046-551-r-rev1-burnco surface water baseline report.docx

6.0 REFERENCES

Coulson, C.H. 1991. Manual of Operational Hydrology in British Columbia. Ministry of Environment, Water Management Division, Hydrology Section. February 1991.

Coulson, C.H. and W. Obedkoff. 1998. British Columbia Streamflow Inventory.

FAO. 1968. Volume II: Water Resources. Agricultural and Water Surveys, Somalia, Final Report. Food and Agricultural Organization of the United Nations.

FAO. 1998. Crop Evapotranspiration, Guidelines for Computing Crop Water Requirements, Paper 56, 1998, Food and Agricultural Organization of the Unite Nations.

Fisheries and Oceans Canada (DFO). 1997. Memorandum: McNab Ground Water Channel: juvenile salmonid densities and incubation box removal – July 8th and 9th 1997. From: Mel Sheng To: Lana Miller. December 5, 1997.

Golder Associated Ltd. (Golder). 2014a. Hydrogeological Modelling to Assess Proposed Mine Plan – McNab Valley Aggregate Project (Revision 1). January 16, 2014.

Golder. 2014b. Water Quality Modelling of McNab Valley Aggregate Project, BC.

Golder. 2014c. Baseline Data Report: McNab Valley Surface Water Quality, 2009-2014 (Draft). September 9, 2014.

Hatfull. 1998. Hatfull and Associates Forestry Management Consultants. McNab Salmonid Enhancement Project: Groundwater Channel Extension and Completing (Phase I) Report. Prepared for: Department of Fisheries and Oceans Habitat and Enhancement Branch.

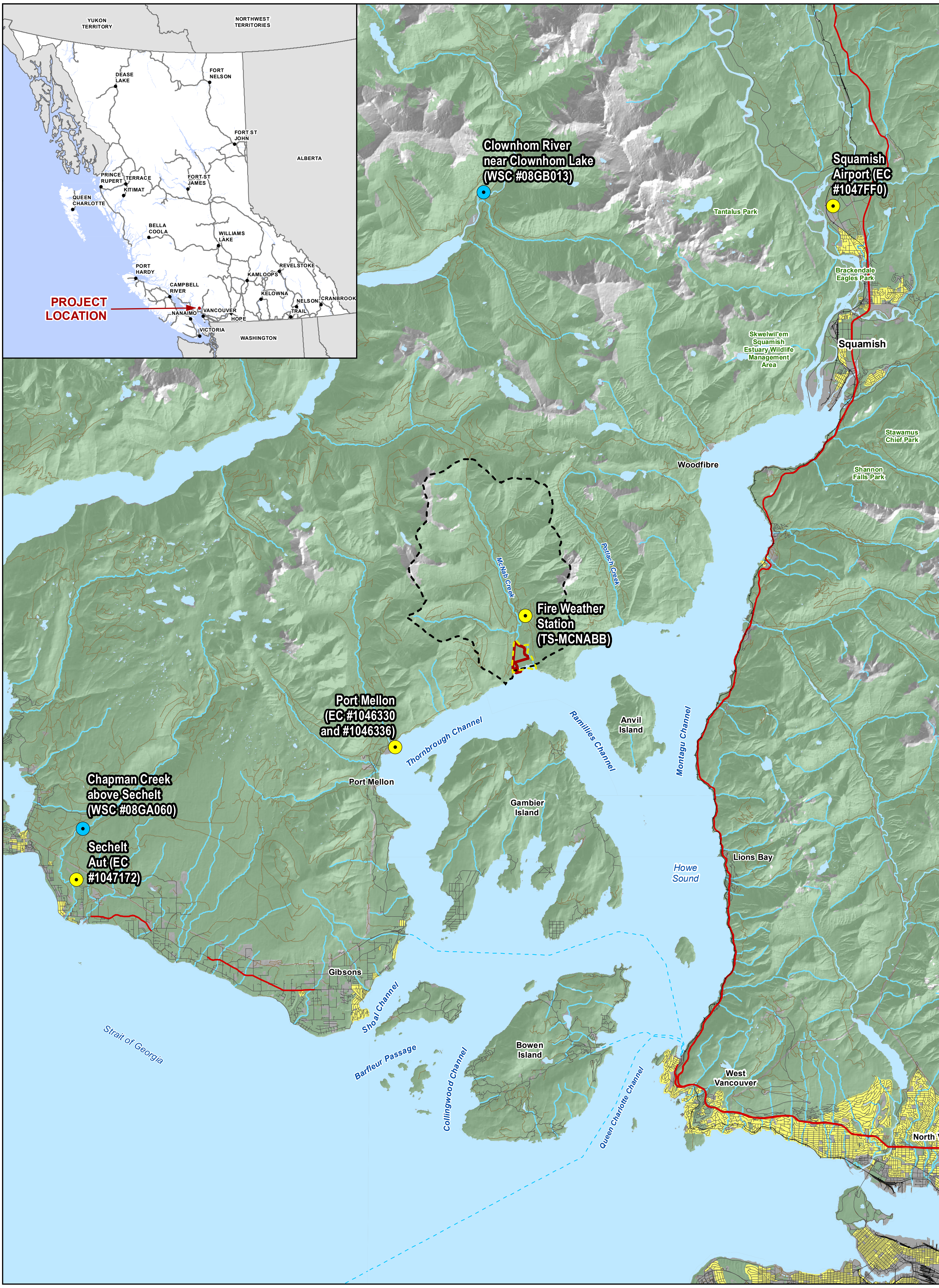
Ministry of Environment (MoE). 2013a. Water Resources Atlas. Available at: http://www.env.gov.bc.ca/wsd/data_searches/wrbc/. Accessed February 2015.

Ministry of Environment (MoE). 2013b. Coastal and Mountain Ecoprovince. Available at: http://www.env.gov.bc.ca/ecology/ecoregions/humidtemp.html. Accessed February 2015.

Pacific Field Corn Association. 2013. Available at: http://farmwest.com/climate/et. Accessed February 2015.

USDA. 1986. Urban Hydrology for Small Watersheds, TR-55.

Whelen, M.A. & Associates Ltd. 1999. Port Mellon Reconnaissance (1:20,000) Fish and Fish Habitat Inventory. McNab Creek: 900-106300. Potlatch Creek : 900-104300. Prepared for Canadian Forest Products Ltd.



LEGEND

- Hydrometric Station
- Climate Station
- Project Area
- Surface Water Resources Local Study Area
- Surface Water Resources Regional Study Area
- Vegetation
- Residential Area
- Waterbody
- Highway
- Road
- Resource Road
- Railway
- Ferry
- Watercourse

REFERENCE

Contours and hillshade derived from GeoBase DEM data. Base data from CanVec.
Projection: UTM Zone 10 Datum: NAD 83

5,000 0 5,000

SCALE 1:200,000 METRES

PROJECT

BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

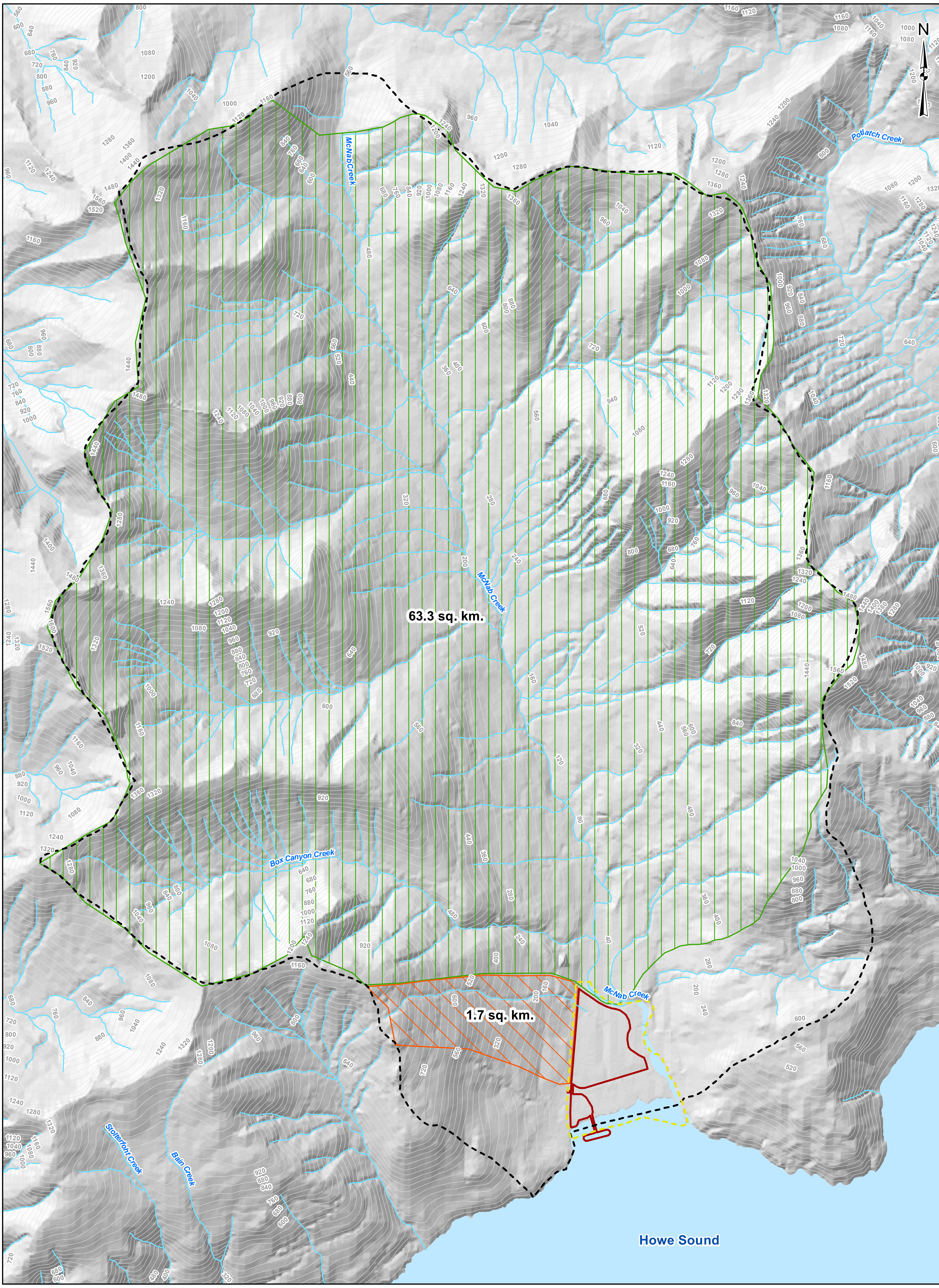
TITLE

KEY PLAN AND REGIONAL CLIMATE AND HYDROMETRIC STATIONS

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No.
DESIGN	RS	6 May. 2013	SCALE AS SHOWN REV. 0
GIS	DL	10 Mar. 2016	
CHECK	CC	10 Mar. 2016	FIGURE 01
REVIEW	CC	10 Mar. 2016	

Path: X:\Project Data\BC\McNab\Figures\MXD\Surface Water\Appendices\5.5-A\BURNCO_HYDROLOGY_Figure_01_Key_Plan_Regional_Climate_and_Hydrometric_Stations.mxd



LEGEND

- West Slope Watershed
- McNab Creek Watershed Upstream from the Site
- Project Area
- Surface Water Resources Local Study Area
- Surface Water Resources Regional Study Area
- Waterbody
- Watercourse
- Contour (20m)

1,200 0 1,200

SCALE 1:40,000 METRES

REFERENCE

Hillshade derived from GeoBase DEM data. Contours from TRIM positional data. Base data from the Canvec.
Projection: UTM Zone 10 Datum: NAD 83

PROJECT

BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

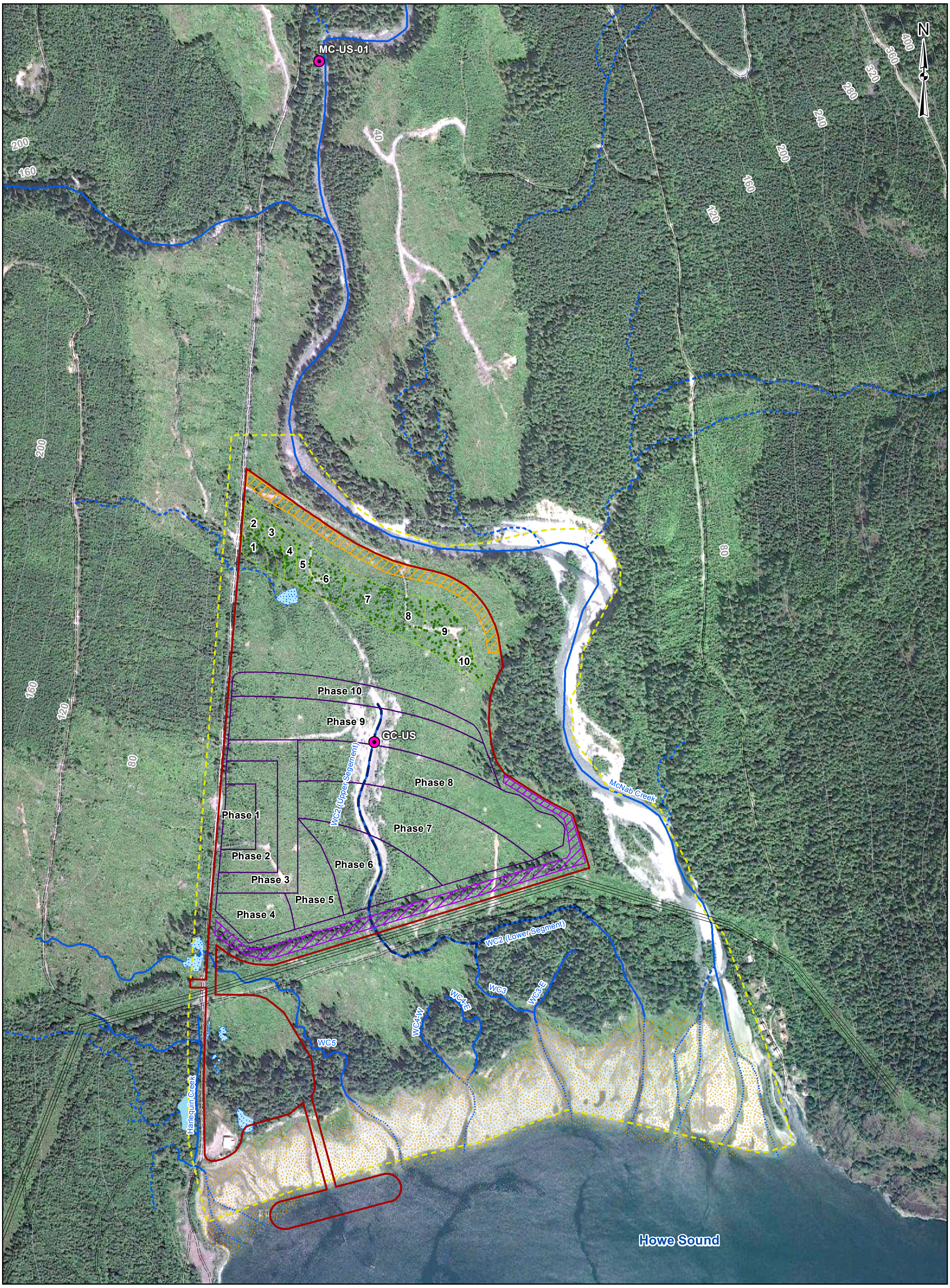
TITLE

WATERSHEDS

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No.
DESIGN	RS	6 May. 2013	SCALE AS SHOWN — REV. 0
GIS	DL	10 Mar. 2016	
CHECK	CC	10 Mar. 2016	FIGURE 02
REVIEW	CC	10 Mar. 2016	

Path: X:\Project Data\BC\McNab\Figures\MXD\Surface Water\Appendices\5.5-A\BURNCO_HYDROLOGY_Figure_02_Watersheds.mxd



LEGEND

- Station Locations (ID)
- Project Area
- Surface Water Resources Local Study Area
- Proposed Aggregate Pit Phase
- Fines Storage Area
- McNab Creek Flood Protection Dyke
- Pit Lake Containment Berm
- Low Lying Wetted Area
- Waterbody
- Intertidal Zone
- Transmission Line
- Road (Existing)
- Contour (20m)
- Permanent / Perennial Watercourse
- Intermittent Watercourse
- Intertidal Watercourse

Constructed Watercourse

- Phase 1 (1985)
- Phase 2 (1998)
- Phase 3 (2001 - 2003)

REFERENCE

Watercourses from the Province of British Columbia and field data. Base data from the Province of British Columbia. Contours from TRIM positional data. Base Imagery from Google Maps 20100807. Projection: UTM Zone 10 Datum: NAD 83

200 0 200

SCALE 1:8,000 METRES

PROJECT

BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

TITLE

SITE HYDROMETRIC, RAINFALL, AND BAROMETRIC STATIONS

Golder Associates	PROJECT NO. 11-1422-0046			PHASE No.	
	DESIGN	RH	6 May. 2013	SCALE AS SHOWN	REV. 0
	GIS	DL	10 Mar. 2016	**FIGURE 03**	
	CHECK	CC	10 Mar. 2016		
	REVIEW	CC	10 Mar. 2016		

Path: X:\Project Data\BC\McNab\Figures\MXD\Surface Water\Appendices\5.5-A\BURNCO_HYDROLOGY_Figure_03_Site_Hydrometric_Rainfall_and_Barometric_Stations.mxd

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 44 1628 851851
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

solutions@golder.com
www.golder.com

Golder Associates Ltd.
Suite 200 - 2920 Virtual Way
Vancouver, BC, V5M 0C4
Canada
T: +1 (604) 296 4200