



# 2019 Operations and Monitoring Report

Tahsis Landfill  
Tahsis, British Columbia

Comox Strathcona  
Waste Management





## Executive Summary

GHD Limited (GHD) was retained by Comox Strathcona Waste Management (CSWM), a function of the Comox Valley Regional District (CVRD), to complete the 2019 water quality monitoring and prepare this Annual Operations and Monitoring Report for the Tahsis Waste Management Centre (Site) located on North Maquinna Drive, approximately 2.0 kilometres (km) north of the Village of Tahsis (VoT), British Columbia (BC).

The objective of this annual report is to summarize the development and environmental monitoring results for the Site for the 2019 calendar year (Reporting Period). The annual report contains the information required to fulfill monitoring and reporting requirements in accordance with Section 25.3 of the 2012 Comox Strathcona Solid Waste Management Plan (SWMP) (AECOM, 2012) and Operational Permit (PR) PR-4278.

### *Site Operations and Development*

The Site consists of approximately 7.5 hectares (ha) of Crown land subleased from Pacific Forest Products and is occupied and operated by the VoT as per agreement with the CVRD under license of occupation number 112889. The Site is currently authorized by PR-4278, issued in 1976, to accept municipal waste including refuse, ashes and digested sewage sludge. The Site has historically accepted municipal solid waste (MSW) and grit from septage screening in the VoT (EBA, 2013). The authorized works include the sanitary landfill (Landfill) whose waste footprint occupies an estimated 1.9 ha and related appurtenances.

The Landfill currently accepts municipal solid waste from the VoT, Conuma Fish Hatchery, the Moutcha Bay Resort, Esperanza and floating lodges (Tetra Tech, 2014). The Landfill is currently authorized to accept municipal waste for discharge in the Landfill until 2025 or until capacity is reached providing no environmental impacts occur.

The 2019 airspace consumption rate was determined based on the filling in the active area of the landfill, which was analyzed from the topographical surveys conducted in October 21, 2018 and October 30, 2019. Based on the calculated fill rate and CVRD wide average apparent waste density, an estimated 1,475 cubic meters (m<sup>3</sup>) of material was placed at the Landfill in 2019. As of December 31, 2019, approximately 4,912 m<sup>3</sup> of airspace remained at the Site based on the airspace capacity in the Fill Plan Update (GHD, 2018). Based on the 2019 airspace consumption rate of 4.0 m<sup>3</sup>/day, approximately 3.4 years of airspace remain at the Landfill. Using a three year annual airspace consumption average to estimate the remaining site life, it is estimated approximately 4.5 years of site life remains.

### *Water Quality Compliance Assessment*

Two water quality sampling events were completed at the Site during 2019: May (spring) and November (fall). Analytical results for groundwater samples collected in 2019 were assessed relative to the BC Contaminated Sites Regulations (CSR) (BC Reg. 375/96 Schedule 3.2 Column 6 (Drinking Water) and Schedule 3.2 Column 3 (Aquatic Life) (ENV, 2017).

All parameters analyzed at all sampled groundwater monitoring wells were below applicable the Contaminated Sites Regulation (CSR) water quality standards in 2019.



Based on the groundwater assessment presented in Section 5.3, negligible Landfill influences are present in the local groundwater at the Site.

### ***Recommendations***

Based on the landfill development and results of the water quality monitoring program carried out as outlined in this report, GHD recommends the following:

- Continue landfilling as described in the Updated Fill Plan (GHD, 2018).
- Record the waste loads landfilled at the Site and approximate quantities of daily cover applied to the Landfill to assist in tracking the Site's airspace consumption rate.
- Continue with groundwater quality monitoring at the Site on a semi-annual basis.
- As limited impacts to groundwater quality are observed at the Site, surface water monitoring is not identified as being required at this time.



## Table of Contents

1.	Introduction.....	1
1.1	Objective and Scope.....	1
1.2	Regulatory Setting .....	2
1.3	Annual Report Organization .....	2
2.	Site Background .....	2
2.1	Site Location .....	2
2.2	Landfill Development .....	3
2.3	Geological Setting.....	3
2.4	Hydrogeological Setting .....	3
3.	Site Operations and Development .....	4
3.1	Site Operations .....	4
3.1.1	Site Inspections .....	4
3.1.2	Leachate Collection .....	4
3.2	Changes from Approved Reports, Plans, and Specifications.....	5
3.3	Site Development and Closure Works.....	5
3.3.1	Site Development .....	5
3.3.2	Closure Works .....	5
3.4	Volume Survey.....	5
3.4.1	Airspace Consumption and Remaining Capacity .....	5
3.5	Population Forecast and Waste Disposal Rates .....	6
3.5.1	2019 Waste Disposal.....	6
3.5.2	Population Forecast.....	6
3.5.3	Per Capita MSW Disposal Rate .....	7
3.6	Closure and Post-Closure Fund .....	7
3.7	Operational Plan for the Next 12 Months.....	8
3.8	Public Complaints .....	8
3.9	Non-Compliance Items .....	8
4.	Environmental Monitoring Program.....	8
4.1	Groundwater Monitoring Program .....	8
4.2	Surface Water Monitoring Program .....	9
4.3	Sampling Methodology .....	9
4.4	Quality Assurance/Quality Control.....	9
5.	Environmental Monitoring Results and Interpretation .....	10
5.1	Data Quality Assessment and Validation.....	10
5.2	Hydraulic Monitoring Results .....	10





5.3	Groundwater Quality Monitoring Results .....	11
5.3.1	Leachate Indicators .....	11
5.3.2	Groundwater Results .....	12
5.4	Summary .....	13
6.	Recommendations .....	14
7.	References .....	16

## Figure Index

Figure 2.1	Site Location
Figure 2.2	Site Plan
Figure 5.1	Hydraulic Monitoring Results
Figure 5.2	Groundwater Contours - Spring 2019

## Table Index

Table 5.1	Typical Leachate Parameter Concentrations .....	12
Table 5.2	Leachate Parameter Data Summary .....	12

## Table Index (following text)

Table 3.1	Waste Area Population and Projected Population
Table 4.1	Monitoring Locations and Sampling Frequency
Table 4.2	Well Completion Details and Hydraulic Monitoring Results
Table 5.3	Vertical Gradients
Table 5.4	Groundwater Analytical Results
Table 5.5	Analytical Table Notes

## Appendix Index

Appendix A	Tahsis Landfill Permit # PR-4278
Appendix B	Borehole Logs
Appendix C	2018 and 2019 Topographic Surveys
Appendix D	2019 Closure and Post-Closure Fund Estimates Memorandum Excerpt
Appendix E	Environmental Monitoring Specifications
Appendix F	Field Sample Keys and Laboratory Reports
Appendix G	Data Quality Assessment and Validation Memoranda
Appendix H	Historical Groundwater/Surface Water Chemistry Trend Plots



# 1. Introduction

GHD Limited (GHD) was retained by Comox Strathcona Waste Management (CSWM) – a function of the Comox Valley Regional District (CVRD) – to carry out the 2019 water quality monitoring program and to prepare the 2019 Operations and Monitoring Report (Annual Report) for the Tahsis Waste Management Centre (Site). The Annual Report provides a summary of Site operations, landfill development, water quality monitoring activities, and assessment of the monitoring program results for 2019 calendar year (Reporting Period).

## 1.1 Objective and Scope

The objective of this Annual Report is to summarize the development and environmental water quality monitoring program results for the Reporting Period. The Annual Report contains the following information in accordance with Section 25.3 of the Comox Strathcona Solid Waste Management Plan (SWMP) (AECOM, 2012), Section 10.6 of the Landfill Criteria for Municipal Solid Waste, Second Edition (Landfill Criteria) (BC MOE, 2016), and Section 15 of Permit PR-4278 (Permit) (MOE, 1988):

- Landfill gas quantities collected, flared and utilized (Section 2.2).
- A summary of the landfill operation equipment (Section 3.1).
- Results of regular inspections for cover integrity, health of vegetation, undesirable plant species, burrowing animals, erosion, settlement (Section 3.1.1).
- Leachate quantities collected, treated, discharged (Section 3.1.2).
- A review of the preceding year of operation plans for the next year and any new information or proposed changes relating to the facility (Sections 3.2, 3.3, 3.7).
- Changes from the approved reports, plans, and specifications (Section 3.2).
- Closure works completed (Section 3.3.2).
- A review of certified survey including volume changes (Section 3.4).
- The remaining Site life and capacity update (Section 3.4).
- Estimated tonnage and categories of waste landfilled and waste diverted from the landfill (Section 3.5).
- An updated estimate of the municipal solid waste (MSW) disposal per capita (Section 3.5.3).
- A waste area population table including projected population for the estimated facility life (Table 3.2).
- Certified updates to the landfill financial assurance report (Section 3.6).
- Operational plan for the next 12 months (Section 3.7).
- Any complaints received and actions taken as a result of the complaint (Section 3.8).
- Non-compliance items identified and an action plan to reach compliance (Section 3.9).



- Comparison of the environmental monitoring data to applicable regulatory standards, interpretation of the monitoring data, identification and interpretation of irregularities and trends, recommendations, and any proposed changes to the monitoring program (Section 5).

## **1.2 Regulatory Setting**

Landfilling at the Site is authorized under British Columbia (BC) Ministry of Environment (MOE) permit number PR-4278 (Permit) (MOE, 1988), initially issued on June 11, 1976, and last amended on March 8, 1988 (Appendix A). The Permit authorizes the disposal of up to 10,000 cubic metres (m<sup>3</sup>) of municipal waste annually. No monitoring or reporting requirements are specified under the Permit.

Analytical results for groundwater samples collected during the Reporting Period were compared to the BC Contaminated Sites Regulations (CSR) (BC Reg. 375/96 Schedule 3.2 Column 6 (Drinking Water) and Column 3 (Aquatic Life) (BC Ministry of Environment and Climate Change Strategy [ENV], 2017).

Based on GHD's experience on similar landfill projects throughout the province, GHD has concluded that the above CSR standards are appropriate for assessing groundwater quality at this Site.

CSR Schedule 3.2 also provides water quality standards for the protection of water used for irrigation and livestock watering, however, these standards are intended for lands within a 500 metres (m) radius of a water well or surface water intake used for irrigation or livestock watering. The Site does not fall within these conditions, therefore, irrigation and livestock standards have not been applied to the collected analytical data.

## **1.3 Annual Report Organization**

The Annual Report is organized into the following sections:

- Section 1 Introduction
- Section 2 Site Background
- Section 3 Site Operations and Development
- Section 4 Environmental Monitoring Program
- Section 5 Environmental Monitoring Results and Interpretation
- Section 6 Recommendations
- Section 7 References

# **2. Site Background**

## **2.1 Site Location**

The Site is located approximately 2.0 kilometres (km) north of the Village of Tahsis (VoT), BC, on North Maquinna Drive. A Site location map is presented on Figure 2.1. A Site plan is presented on Figure 2.2. At this time, there is no legal lot area available so the property boundary is unknown.



The surrounding region is mountainous, second growth coniferous forest. The nearest surface water body is the Tahsis River, which flows from north to south approximately 200 m east of the Site and drains into the Tahsis Inlet located approximately 3.0 km to the south of the Site.

A closed wood waste landfill formerly operated by Pacific Forest Products is located immediately southeast of the landfill footprint. The Pacific Forest Products landfill historically provided disposal facilities for wood waste, metal and process wastes from the Doman Western Lumber Limited lumber mill. The closure date and landfill authorization permit number for the wood waste landfill were not available to GHD at the time of preparing this report.

## **2.2 Landfill Development**

The Site is situated on Crown land subleased from Pacific Forest Products and is occupied and operated by the VoT as per agreement with the CVRD under license of occupation number 112889. The Site covers a total of approximately 7.5 hectares (ha) of which an estimated 1.9 ha is used for municipal landfilling. The landfill at the Site (Landfill) is authorized to accept municipal waste including refuse, ashes and digested sewage sludge and has historically accepted municipal solid waste (MSW) and grit from septage screening in the VoT (EBA, 2013).

There is currently no active leachate management system in place at the Site and, as the Landfill was developed without a liner, leachate removal is considered impractical. Consequently, no leachate collection system is planned (EBA, 2013).

There is currently no active landfill gas (LFG) recovery system at the Site. As of December 31, 2019, an estimated 61,309 tonnes of waste has been landfilled at the Site. As indicated in Section 3.5.1 of this report, it is estimated approximately 885 tonnes of waste was landfilled at the Site in 2019. As per the BC Landfill Gas Management Regulation, a LFG generation assessment report is not required at this time as the Site has landfilled less than 100,000 tonnes of waste during its lifetime and receives less than 10,000 tonnes of waste per year.

## **2.3 Geological Setting**

Regional surficial geology in the vicinity of the Site is composed of fluvial sediments containing primarily sands and gravels (Guthrie and Penner, 1993).

Based on borehole logs, overburden geology at the Site is primarily composed of sands and gravels with occasional discontinuous silt layers. Site borehole logs are included in Appendix B.

Regional bedrock geology in the vicinity of the Site is composed of the Vancouver Group of mid to late Triassic age (Guthrie, 2003). The Vancouver Group is composed of undivided sedimentary rock and marine sedimentary rocks, with some siltstones and mudstones.

Bedrock was not encountered in any Site boreholes and, therefore, the thickness of local overburden and nature of the bedrock underlying the Site is unknown.

## **2.4 Hydrogeological Setting**

Based on a review of the borehole logs, the Site overlies an unconfined aquifer primarily composed of sands and gravels with discontinuous silts. The Tahsis River, located approximately 200 m to the



east and 300 m south of the Site, receives groundwater from the sand and gravel aquifer underlying the Site. The Tahsis River drains into the Tahsis Inlet approximately 3 km south of the Site.

The water table is generally encountered at depths ranging approximately 1.5 to 13.5 m below ground surface (bgs) with seasonal water table fluctuations in the range of 1 m.

Based on historical groundwater elevation data, groundwater is inferred to flow predominantly to the southeast across the Site.

## **3. Site Operations and Development**

### **3.1 Site Operations**

The Site currently receives waste from the VoT, Conuma Fish Hatchery, the Moutcha Bay Resort, Esperanza and floating lodges (Tetra Tech, 2014) and is open Wednesdays from 8:00 a.m. to 3:30 p.m. and Saturdays from 10:00 a.m. to 3:30 p.m., during which time it is attended by a site operator. Non-hazardous wastes, which may not be landfilled (e.g. metals, white goods, tires and clean wood), are stockpiled in marked areas to the north and east of the active landfill area and are periodically picked up and transported to an appropriate recycling facility off-Site. Staff use a 1991 CAT 518 compactor to conduct operations.

Site facilities consist of surface water management infrastructure, electric fencing, and the Landfill. Waste volumes and mass are not currently measured or recorded by Site staff.

#### ***Entrance Facility***

The Site entrance is equipped with a lockable gate located south of the Landfill. There is also an electrified fence system around the Landfill, posted signs, and power. The Site is attended by a Site operator who directs waste drop off during operational hours. The Site does not have a weigh scale.

#### ***Sanitary Landfill***

The landfill footprint occupies an estimated 1.9 ha of the Site based on the limit of waste provided in the Tahsis Landfill Surface Water Management Upgrade – Phase 1 Closure Report (EBA, 2014). Waste is deposited in a defined area by commercial vehicles operated by the VoT and by smaller pick-up trucks servicing the Conuma Hatchery, Moutcha Bay, and floating lodges (Tetra Tech, 2014). Daily cover is accomplished with movable metal plates as well as soil stockpiles located on Site. Intermediate cover consists of a combination of yard and wood waste grindings and gravel sourced from an on-Site gravel pit.

#### **3.1.1 Site Inspections**

There were no issues regarding cover integrity, settlement, burrowing animals, or health of vegetation noted in 2019.

#### **3.1.2 Leachate Collection**

The Landfill operates as a natural attenuation landfill. As such, leachate was not collected or treated in 2019.



## **3.2 Changes from Approved Reports, Plans, and Specifications**

No changes from approved reports, plans, or specifications occurred in 2019 for the Site.

## **3.3 Site Development and Closure Works**

### **3.3.1 Site Development**

Outside of normal Site operations and landfilling activities, the following Site activities were undertaken in 2019:

- Soil stockpiles were delivered to Site in 2019 from construction projects in the area. The soil stockpiles will be used as daily cover material.

### **3.3.2 Closure Works**

No closure works were completed in 2019.

## **3.4 Volume Survey**

The most recent topographic surveys for the Site were conducted October 21, 2018 and October 30, 2019 by McElhanney Associates Land Surveying Ltd, based out of Campbell River, BC.

Topographic surveys are typically conducted annually near the end of each calendar year in order to estimate the volume of airspace consumed between the two survey events. A copy of the 2018 and 2019 topographic surveys is provided in Appendix C.

The next volume survey is scheduled for fall 2020 to provide an update of the remaining airspace and fill rates.

### **3.4.1 Airspace Consumption and Remaining Capacity**

GHD developed airspace consumption and remaining capacity estimates for the Site from 2019 to 2025 based on a review of the two most recent topographical surveys conducted at the Site on October 21, 2018 and October 30, 2019 by McElhanney Associates Land Surveying Ltd. and the following assumptions:

- Approximately 1,512 m<sup>3</sup> of airspace was consumed between the October 2018 and October 2019 surveys.
- Total remaining landfill design volume as of December 31, 2019, was estimated to be 4,912 m<sup>3</sup>. This is an estimated airspace reduction of approximately 66% compared to the 2018 estimate (14,284 m<sup>3</sup>). However, unlike the 2019 estimate, the 2018 value did not account for the 0.75 m of final cover materials.
- Airspace consumption rate will remain constant at 2019 rate until closure (except for three-year average calculation).
- No filling to occur after 2025.

Based on the above noted assumptions, the 2019 annual airspace consumption rate for the Site was calculated at 1,475 m<sup>3</sup>, or 4.0 m<sup>3</sup> per day. The remaining airspace available at the Site as of December 31, 2019, is estimated at 4,912 m<sup>3</sup> representing 3.4 years' worth of airspace at the 2019





airspace consumption rate. Using the 2019 airspace consumption rate, landfill capacity will be reached at the Site in mid-2023, which is 2 years earlier than the planned closure.

The calculated remaining airspace volume estimate for 2019 accounted for the 0.75 m of final cover materials, which was not included in the 2018 remaining airspace volume.

The calculated airspace consumption rate for 2019 is approximately 53 percent higher than the 2018 calculated airspace consumption rate (974 m<sup>3</sup>). The 2019 consumption rate is likely greater due to additional construction waste received at the Site in 2019 and potentially inefficiencies in filling (i.e., use of more daily cover than is required, lower waste compaction).

Due to the variable fill rates at the Site over the last three years, GHD also calculated the three-year average airspace consumption rate. Using the 2017, 2018, and 2019 annual airspace consumption rate estimates, the average annual airspace consumption rate over the last three years is approximately 1,103 m<sup>3</sup> per year, or 3.03 m<sup>3</sup> per day. With the remaining airspace available at the Site as of December 31, 2019, of 4,912 m<sup>3</sup>, there is approximately 4.5 years' worth of airspace remaining at the three-year average consumption rate. Using this average rate, landfill capacity will be reached at the Site in mid 2024, which is half a year earlier than the planned closure.

Recording the waste loads landfilled at the Site and approximate quantities of daily cover material applied to the Landfill, may assist in determining the potential cause of the higher than expected airspace consumption rates at the Site.

### **3.5 Population Forecast and Waste Disposal Rates**

#### **3.5.1 2019 Waste Disposal**

GHD calculated the 2019 and three-year average Site waste disposal based on the following inputs:

- 2019 annual airspace consumption rate of 1,475 m<sup>3</sup> and three-year average annual airspace consumption rate of 1,103 m<sup>3</sup>.
- Apparent density of 0.6 tonnes of waste per m<sup>3</sup> based on CVRD wide average (AECOM, 2012).

Based on the above noted assumptions, GHD calculated the 2019 waste disposal at 885 tonnes and the three-year average waste disposal at 662 tonnes.

#### **3.5.2 Population Forecast**

In past reports, GHD developed population forecasts for the VoT from the reporting year until the planned year of Landfill closure in 2025. Forecasts were based on population data from the 2016 federal census (Statistics Canada, 2018) and the change in population from the two most recent censuses (2011 and 2016). The British Columbia Ministry of Jobs, Economic Development and Competitiveness (MoJ) provides more recent population data, therefore, it will be used to estimate the population for VoT and will provide the basis for GHD's population forecasts in this report. GHD notes that there remains uncertainty in population estimates as VoT population varies significantly between seasons (Tetra Tech, 2014).

According to the latest BC Municipal Population Estimates, the VoT saw its population grow approximately 8.6 percent between 2018 and 2019 to a total of 303. Population forecast results up



until 2025 are presented in Table 3.1 and are based on a rolling three-year average of estimated yearly population change.

### **3.5.3 Per Capita MSW Disposal Rate**

GHD calculated the 2019 and the 2016–2019 three-year average VoT per capita waste disposal rates based on the following inputs:

- 2019 airspace consumption rate of 1,475 m<sup>3</sup> and three-year average consumption rate of 1,103 m<sup>3</sup> per year.
- 2019 waste disposal of 885 tonnes and three-year average waste disposal of 662 tonnes, both calculated assuming an apparent waste density of 0.6 tonnes/m<sup>3</sup>.
- VoT population of 303.

Based on the above noted assumptions, GHD calculated the 2019 per capita disposal rate of 2,920 kilograms (kg) (2.92 tonnes) per capita per year and the three-year average disposal rate of 2,185 kg (2.18 tonnes) per capita per year.

The waste generation rate calculated in 2019 is almost six times greater and the three-year average rate over four times greater than the most recent available estimate for average per capita waste disposal rate in BC of 506 kg (0.506 tonnes) (BC Environmental Reporting, 2019).

Based on GHD's experience with sites of similar size and discussions with CVRD staff, it is likely that waste compaction at the Site is less efficient than the average CVRD rate of 0.6 tonnes per m<sup>3</sup> used in calculating the 2019 and three-year waste disposals of 885 and 662 tonnes, respectively. The estimated disposal rates likely overestimate the actual tonnage of waste disposed.

As population in the area is seasonally variable and available population data likely excludes some temporary population from local resorts and fishing lodges (e.g., Moutcha Bay Resort, Esperanza and floating lodges) it is likely that the available census population data underestimates the actual population contributing to filling at the Site.

Based on the above noted sources of error in the per capita waste generation rate estimate (overestimated waste generation rate and underestimated population), it appears VoT residents are likely generating more waste than the BC average of 0.506 tonnes/capita, but the calculated MSW disposal rate for 2019 of 2.92 tonnes/capita and three-year average rate of 2.18 tonnes/capita are higher than the actual disposal rate at the Site. This observation cannot be confirmed as the Site does not have a weigh scale to provide tonnage data.

## **3.6 Closure and Post-Closure Fund**

Closure and post-closure (CPC) fund estimates for the Site are prepared under a separate cover. 2019 forecast CPC costs were submitted to the CVRD in a memorandum, which included forecast estimates for the Comox Valley Waste Management Centre, the Campbell River Waste Management Centre, the Tahsis Landfill, the Zeballos Landfill and the Gold River Landfill and details of the forecast calculation method. A copy of the memorandum with the sections relevant to the Site is included in Appendix D.



### **3.7 Operational Plan for the Next 12 Months**

The operational plan for the next 12 months (2020 calendar year) is to continue landfilling as prescribed in the Fill Plan Update (GHD, 2018).

### **3.8 Public Complaints**

No complaints were received from the public for the Site in 2019.

### **3.9 Non-Compliance Items**

No non-compliance items occurred in at the Site in 2019.

## **4. Environmental Monitoring Program**

The water quality monitoring program for the Site was developed with consideration of the Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills (BC MOE, 1996) based on previous water quality monitoring reports with the goal of determining what impacts (if any) the Landfill has on the receiving groundwater.

Two water quality monitoring events (May and November) were conducted during the 2019 Reporting Period. Water quality monitoring was conducted by GHD personnel with analytical services provided by ALS Environmental, in Burnaby, BC.

Water quality monitoring locations are presented on Figure 2.2. Monitoring specifications including analytical parameters and the monitoring frequency for 2019 are included in Appendix E.

### **4.1 Groundwater Monitoring Program**

The objective of the groundwater monitoring program is to detect the extent and magnitude of groundwater alteration (if any) associated with landfilling activities, predict potential migration of leachate derived contaminants in groundwater, and identify the need to mitigate potential environmental risk.

Groundwater monitoring wells (monitoring wells) are generally located along the perimeter of the landfill footprint and further downgradient from the Landfill for the purpose of monitoring groundwater quality at the property boundary as shown in Figure 2.2. A list of the wells and frequency of sampling are presented in Table 4.1. Well completion details, including the depths of screened intervals for each groundwater monitoring well are included in Table 4.2. The 2019 groundwater monitoring program included hydraulic monitoring at the following monitoring wells:

- One nested overburden background monitoring well (PFP#4A/B).
- Two downgradient overburden monitoring wells adjacent to the limit of waste (MW-1, MW-2).
- Three nested downgradient overburden monitoring wells on the adjacent Pacific Forest Products property (PFP#1A/B/C/D, PFP#2A/B/C, and PFP#3A/B/C).

In addition to hydraulic monitoring, groundwater samples were collected for chemical analysis at MW-1, MW-2, PFP#1A, PFP#2A, PFP#3A and PFP#4A. As recommended in the 2018 Operations



and Monitoring Report (GHD, 2019) the monitoring program was adjusted for 2019 to collect groundwater samples from the “A” wells of the “PFP” wells instead of the “B” wells as the “A” wells are screened at a similar elevation as MW-1 and MW-2.

Groundwater samples were collected semi-annually as outlined in Table 4.1. Groundwater samples collected were analyzed for various general chemistry parameters, nutrients, and dissolved metals. A more detailed description of analyzed parameters can be found in the Monitoring Specifications in Appendix E.

## **4.2 Surface Water Monitoring Program**

At this time, no surface water monitoring program is undertaken at the Site.

## **4.3 Sampling Methodology**

The following section provides a general description of the field sampling methods used at the Site's groundwater monitoring program.

For groundwater sample collection, the following sampling methodology was generally used:

- Daily equipment inspection and calibration.
- Well identification and inspection.
- Water level monitoring followed by well volume calculation.
- Well purging and stabilization monitoring. Purging was completed using a dedicated bailer or dedicated Waterra™ tubing fitted with a foot valve. A minimum of three well volumes were purged at wells with good recovery. Well water quality stabilization was monitored via the collection of field parameter measurements after the purging of each well volume including pH, specific conductance, temperature, turbidity, and oxidation-reduction potential.
- Sample collection using dedicated Waterra™ tubing.
- Equipment decontamination.

All samples were collected in the appropriate laboratory-supplied sample containers, preserved as required, packaged in an ice-chilled cooler, and delivered to the laboratory under chain-of-custody protocol. Groundwater samples designated for dissolved metals analysis were field filtered.

## **4.4 Quality Assurance/Quality Control**

In order to ensure adequate quality control for water quality samples, the following quality assurance/quality control (QA/QC) practices were employed during the reporting period:

- Activities performed by qualified and trained personnel.
- Field QA/QC included field duplicate and field blank analysis.
- Data validation was completed by a qualified GHD chemist to assess laboratory and field QA/QC, and to determine if the data exhibited acceptable levels of accuracy and precision.



## 5. Environmental Monitoring Results and Interpretation

This section presents the hydraulic monitoring results, water quality monitoring results, and provides a review of QA/QC to ensure available field and analytical data are suitable for their intended use. Appendix F presents field data, field parameters, field sample keys (FSKs), and laboratory reports collected in 2019.

### 5.1 Data Quality Assessment and Validation

Analytical data generated during the Reporting Period was reviewed by a qualified GHD chemist to assess laboratory and field QA/QC. Data quality assessment and validation results are presented in Appendix G.

Laboratory QA/QC was evaluated by assessing the final results and supporting quality QA/QC data. Evaluation of the data was based on information obtained from the chain of custody forms, finished report forms, method blank data, duplicate data, recovery data from surrogate spikes, laboratory control samples (LCS), matrix spikes (MS), and field QC samples.

The QA/QC criteria by which these data have been assessed are outlined in the analytical methods referenced and applicable guidance from the documents entitled:

- i. "USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review", USEPA 540-R-08-01, June 2008.
- ii. "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review", USEPA 540-R-10-011, January 2010.
- iii. "British Columbia Environmental Laboratory Manual", 2015 Edition, Environmental Monitoring, Reporting & Economics Knowledge Management Branch, Ministry of Environment, Province of British Columbia.

Field QA/QC was monitored by analyzing field duplicate samples. The maximum criterion used to assess overall precision for field duplicates is a relative percent difference (RPD) of 20 percent.

Qualifications were made to the analytical data presented in the following sections based on the quality assessment and validation results. Details of the qualifications are presented in Table 5.4 with explanatory notes contained on Table 5.5. Overall, the data were found to exhibit acceptable levels of accuracy and precision and are suitable for their intended use with noted qualifiers presented in Appendix G.

### 5.2 Hydraulic Monitoring Results

Groundwater elevations were measured semi-annually during the May and November 2019 monitoring events. Based on observed static water levels and calculated groundwater contours, groundwater at the Site flows to the southeast through a sand and gravel aquifer and through the adjacent Pacific Forest Products closed landfill before reaching the downgradient overburden monitoring wells (presented on Figure 5.2). As the Pacific Forest Products landfill historically



accepted wood waste, metal, and process wastes, this could influence groundwater geochemistry in the area and is considered when interpreting results.

Table 4.2 presents hydraulic monitoring results collected during the monitoring events. A hydrograph presenting historical hydraulic monitoring results is presented in Figure 5.1. Due to a field sampling error, groundwater elevations were only measured at the “A” series of the “PFP” wells, MW-1, and MW-2.

From Figure 5.1, groundwater elevations at the Site in 2019 appear to be consistent with historical results and appear to fluctuate seasonally. Groundwater elevations at MW-1 were notably higher than groundwater elevations at the other monitoring wells on Site during the fall 2019 monitoring event. Further monitoring is required to determine if this is indicative of a change in groundwater elevations at this location or anomalous.

Calculated vertical gradients are presented in Table 5.3 for selected nested wells. Well pairs were chosen based on historical data to allow consistent comparison of data. Vertical gradients near the landfill were estimated using data collected from nested wells PFP#1, PFP#2, PFP#3 and PFP#4. Examination of the vertical gradients indicated the following:

- Calculated vertical gradients ranged from -0.020 m/m to 0.052 m/m.
- Generally slightly positive (downward) gradients were observed in the upper portions of the monitored aquifer becoming increasingly negative (upward) with depth.
- Vertical gradients were generally of small magnitude and showed variation in direction between well nests indicating there is no dominant trend in vertical gradients across the Site.
- No clear seasonal trend in vertical gradients was observed during 2019.
- Vertical gradients within the unconfined aquifer are relatively weak.

### **5.3 Groundwater Quality Monitoring Results**

Groundwater samples were collected from groundwater monitoring wells during the spring and fall monitoring events. Groundwater analytical results are summarized in Table 5.4. Detailed laboratory reports are included in Appendix F. Historical groundwater data trend plots for select parameters are included in Appendix H.

#### **5.3.1 Leachate Indicators**

The following section presents an examination of selected leachate indicator parameters in groundwater. Parameters were selected to identify indications of leachate impact (if any) in Site groundwater. Due to the lack of site-specific leachate chemistry data, typical leachate indicator parameters and their respective ranges were identified based on literature values (Mulamootil, et al., 1999) which have been used to represent groundwater impacted by MSW leachate. Based on the age of the landfill, GHD compared the concentrations of typical leachate parameters to typical values for older landfill leachate (10 to 15 years post closure).

Typical leachate indicators for older leachate are TDS, chloride, sodium, potassium, sulphate, calcium, iron, and manganese. Typical concentration ranges for the aforementioned parameters are presented in the table below.





**Table 5.1 Typical Leachate Parameter Concentrations**

Parameter	Old Leachate
TDS (mg/L)	2,000
Chloride (mg/L)	500
Sulphate (mg/L)	50
Calcium (mg/L)	300
Sodium + Potassium (mg/L)	100
Iron (mg/L)	100 - 500
Manganese (mg/L)	0.03 - 79
Source: Mulamootil, et al, 1999	

GHD considers the values of older landfill leachate to represent a realistic estimate of potential parameter concentrations in leachate at the Site. However, leachate characteristics vary widely between landfills as well as over each individual landfills' lifetime, therefore, the example values are for comparison purposes only and cannot be used to definitively determine whether leachate impacts are present or not.

### 5.3.2 Groundwater Results

Groundwater analytical results were assessed against BC CSR water quality standards as discussed in Section 1.2. Concentrations for all parameters tested at all wells were below applicable standards in 2019.

Based on historical and current hydrogeological data, background water quality was inferred based on analytical data from one upgradient well (PFP#4A) screened in the gravel aquifer. Downgradient groundwater quality was assessed from wells MW-1, MW-2, PFP#1A, PFP#2A, and PFP#3A in order to maintain consistency with historical environmental monitoring programs and historical analytical data. The following table presents a summary of analytical data for typical leachate parameters from the 2019 monitoring events including background, Landfill and downgradient wells along with the most stringent applicable CSR standard:

**Table 5.2 Leachate Parameter Data Summary**

Parameter <sup>(1)(3)</sup>	CSR <sup>(5)</sup>	Leachate <sup>(4)</sup>	Upgradient Well (PFP#4A)	Landfill Well (MW-1)	Landfill Well (MW-2)	Downgradient (PFP#1A, PFP#2A, PFP#3A)
Calcium	-	300	27.8 – 36	43.7 – 55.0	31.7 – 42.5	19.9 – 126
Chloride	250 <sup>(6)</sup>	500	1.12 – 1.72	1.27 – 2.04	1.87 – 2.38	1.36 – 2.03
Iron	6.5 <sup>(6)</sup>	100 – 500	ND	ND	ND	ND – 0.056
Manganese	1.5 <sup>(6)</sup>	0.03 – 79	0.00032 – 0.00089	ND	ND	0.00013 – 0.00752
Potassium	-	100 <sup>(7)</sup>	ND	0.126 – 0.317	0.099 – 0.151	0.118 – 4.76
Sodium	200 <sup>(6)</sup>	100 <sup>(7)</sup>	0.838 – 1.04	1.15 – 1.35	0.985 – 1.63	0.820 – 10
Sulphate	500 <sup>(6)</sup>	50	1.68 – 1.69	1.93 – 3.80	2.51 – 3.20	1.46 – 3.57
TDS	-	2000	99 – 155	178 – 199	114 – 172	120 – 440



Parameter <sup>(1)(3)</sup>	CSR <sup>(5)</sup>	Leachate <sup>(4)</sup>	Upgradient Well	Landfill Well	Landfill Well	Downgradient (PFP#1A, PFP#2A, PFP#3A)
			(PFP#4A)	(MW-1)	(MW-2)	

**Notes:**

- (1) Parameter concentrations in Site groundwater wells represent observed range values detected during 2018.
- (2) ND Non-detect: parameter concentrations below laboratory reportable limit.
- (3) Units in mg/L.
- (4) Concentrations represent estimated mean or range values for wastes of approximately 10 year old waste for all parameters except manganese which is based on 15 year old waste (Mulamootil, et al, 1999).
- (5) Concentrations represent the most stringent applicable standard with the exception of sulphate. CSR Schedule 3.2 Column 3 (FAW) criteria for sulphide is dependent on hardness and was not included in the table.
- (6) CSR, Schedule 3.2, Column 6 (Drinking Water Standard).
- (7) Example concentration represents the combined concentration of potassium and sodium.

Leachate indicator parameter concentrations in Site groundwater samples collected in 2019 are well below typical leachate ranges and applicable CSR standards. Examination of 2019 analytical results and historical trends of groundwater parameters indicate that:

- Leachate indicator parameter concentrations are within historical ranges for all parameters analyzed in Site groundwater quality at MW-1 and MW-2.
- Leachate indicator parameter concentrations in groundwater of the “A” series of the PFP wells is generally similar to the “B” series of the PFP wells.
- Concentrations of most leachate indicator parameters in groundwater collected from the landfill and downgradient monitoring wells were marginally above or similar to background groundwater quality indicating no significant leachate derived impacts to groundwater at the sampled monitoring locations.
- Groundwater quality at PFP#1A demonstrated elevated concentrations of alkalinity, hardness and conductivity during the spring 2019 monitoring event compared to the historical range for PFP#1B and to concentrations in samples collected from PFP#1A during the fall 2019 monitoring event. The spring 2019 monitoring event was the first time PFP#1A has been sampled in recent years by GHD, and the well was not re-developed before sampling, which may account for these elevated concentrations. Elevated turbidity and total dissolved solids samples collected from PFP#1A support this assertion.

Based on the results of the 2019 groundwater monitoring program, no notable groundwater quality impacts are resulting from landfilling at the Site.

## 5.4 Summary

- No major landfill developments occurred at the Site in 2019, with the exception of receiving soil from nearby construction activities. The soil will be used as daily cover material.
- Based on survey results collected on October 21, 2018 and October 31, 2019 by McElhanney Associates Land Surveying Ltd., approximately 1,512 m<sup>3</sup> of airspace was consumed at the Site between the two surveys.
- An estimated 4,912 m<sup>3</sup> of airspace remained at the Landfill as of December 31, 2019. Based on the 2019 airspace consumption rate approximately 3.4 years’ worth of Site life remains.



- An estimated 885 tonnes of waste was deposited at the Landfill during 2019 resulting in a calculated waste area waste disposal rate of 4,400 kg per capita per year. The estimated tonnage and waste disposal per capita rates for 2019 are both likely inaccurate potentially due to the Site receiving a large volume of construction waste in 2019, inefficient waste compaction, and seasonal population fluctuation in the Site's wasteshed.
- The monitoring activities for 2019 included semi-annual groundwater sampling, semi-annual hydraulic monitoring, analysis of groundwater water samples, and interpretation of data. The following summarizes the results of environmental monitoring at the Site for 2019:
  - Groundwater at the Site generally flows southeast.
  - All parameters analyzed in all groundwater locations sampled were less than the applicable CSR standards.
  - Negligible leachate impacts were identified in the groundwater at any of the monitoring locations.
- Based on an examination of current and historical data and trends, it appears that the Landfill has no significant impact on the surrounding receiving groundwater. Sufficient natural attenuation mechanisms are mitigating adverse potential impacts from the Landfill to the surrounding groundwater.

## **6. Recommendations**

Based on the landfill development and results of the water quality monitoring program carried out as outlined in this report, GHD recommends the following:

- Continue landfilling as prescribed in the Fill Plan Update (GHD, 2018).
- Record the waste loads landfilled at the Site and approximate quantities of daily cover applied to the Landfill to assist in tracking the Site's airspace consumption rate. (e.g., X truckloads of waste, Y truckloads of cover material on DDMMYYYY).
- Continue with groundwater quality monitoring at the Site on a semi-annual basis.
- As limited impacts to groundwater quality are observed at the Site, surface water monitoring is not identified as being required at this time.



All of Which is Respectfully Submitted,

GHD

A handwritten signature in black ink, appearing to read "Chris Thorne", with a long horizontal flourish extending to the right.

Chris Thorne, B.Sc.

A handwritten signature in black ink, appearing to read "Michaela Dyck", with a long horizontal flourish extending to the right.

Michaela Dyck, G.I.T.

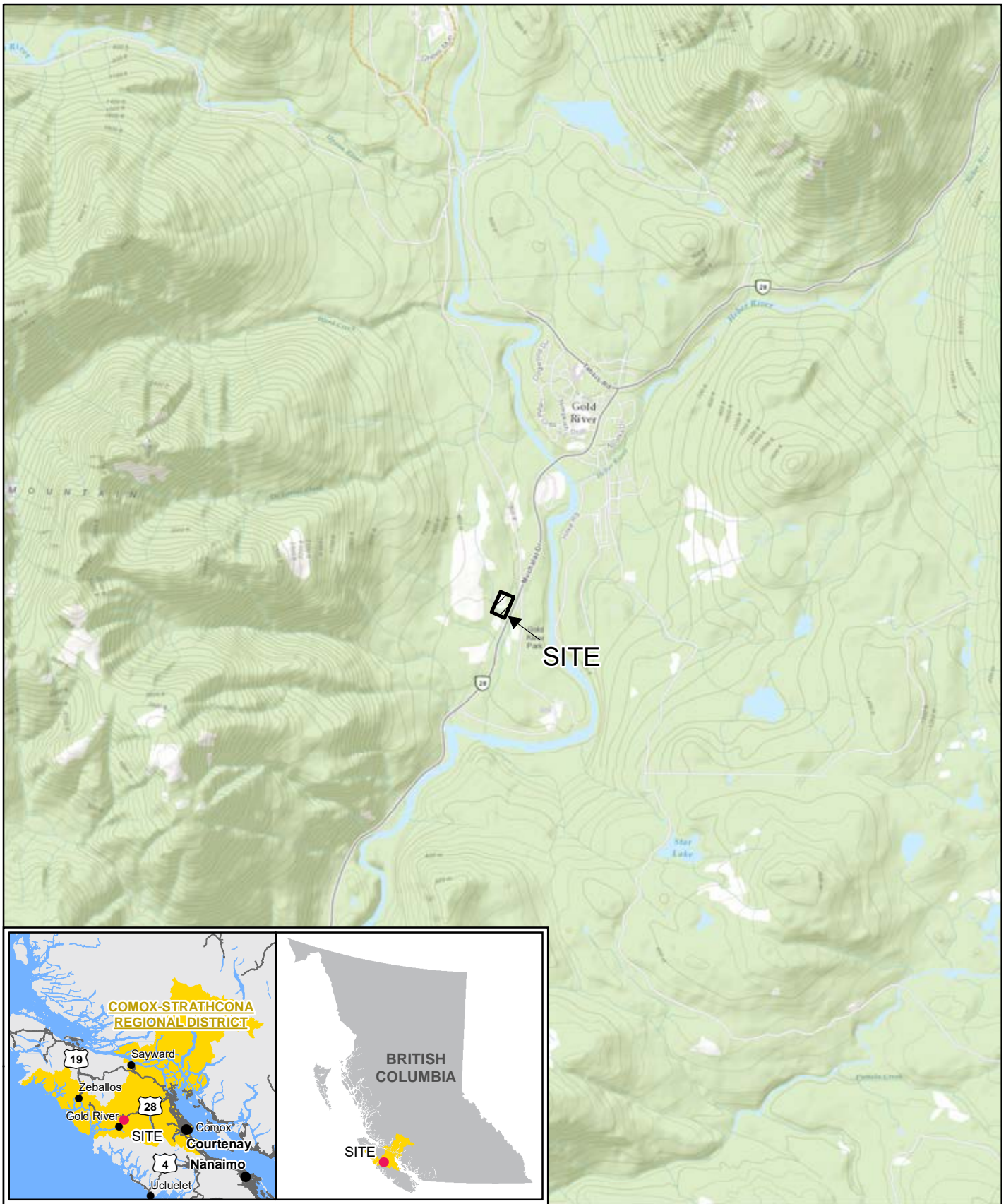
A handwritten signature in blue ink, appearing to read "Gregory D. Ferraro", with a long horizontal flourish extending to the right.

Gregory D. Ferraro, P.Eng.



## 7. References

- AECOM, December 2012. 2012 Comox Strathcona Solid Waste Management Plan.
- British Columbia Environmental Reporting BC, 2019. Municipal Solid Waste Disposal in B.C. (1990-2017). Retrieved from <http://www.env.gov.bc.ca/soe/indicators/sustainability/municipal-solid-waste.html> February 2020
- British Columbia Ministry of Environment, October 4, 1974. Landfill Permit PR-4278
- British Columbia Ministry of Environment, 2014. Municipal Solid Waste Disposal in BC (1990-2014).
- British Columbia Ministry of Environment, June 1996. Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills.
- British Columbia Ministry of Environment and Climate Change Strategy, November 1, 2017. Contaminated Site Regulation B.C. Reg. 375/96, including amendments up to B.C. Reg. 253/2016.
- British Columbia Ministry of Jobs, Economic Development and Competitiveness, 2020. British Columbia Municipal Population Estimates (Sorted by Municipality 2019 Population Size). Retrieved from <https://www2.gov.bc.ca/gov/content/data/statistics/people-population-community/population/population-estimates> March 2020.
- Conestoga-Rovers & Associates Ltd., April, 2015. 2014 Operations and Monitoring Report, Tahsis Landfill, Tahsis, British Columbia
- EBA a Tetra Tech Company, 2013. Updated Closure Plan Tahsis Landfill Vancouver Island, British Columbia.
- GHD Limited, March 2018. 2017 Operations and Monitoring Report, Tahsis Landfill, Tahsis, British Columbia.
- GHD Limited, March 2017. 2016 Operations and Monitoring Report, Tahsis Landfill, Tahsis, British Columbia.
- GHD Limited, April 2016. 2015 Operations and Monitoring Report, Tahsis Landfill, Tahsis, British Columbia.
- GHD Limited, April 2018. Tahsis Landfill – Fill Plan Update, Revision 1.
- GHD Limited, February, 2019. 2018 Closure and Post-Closure Fund Estimates.
- Mulamottil, George, McBean, Edward A., Rovers, Frank, 1999. Constructed Wetlands for the Treatment of Landfill Leachates. United States of America: Lewis Publishers.
- R. H. Guthrie, 2003. Vancouver Island Bedrock Geology.
- R. H. Guthrie and C. R. Penner, 1993. Vancouver Island Surficial Geology.
- Statistics Canada, February 2017. 2016 Canada National Survey.
- Tetra Tech EBA, 2014. Construction and Construction Quality Assurance Report, Tahsis Landfill Surface Water management Upgrade – Phase 1 Closure, Tahsis, BC.



Source: ESRI Topographic Basemap, Accessed 2020

0 500 1,000 1,500  
Meters  
Coordinate System:  
NAD 1983 UTM Zone 10N



COMOX STRATHCONA WASTE MANAGEMEN  
GOLD RIVER LANDFILL  
2019 OPERATIONS AND MONITORING REPORT

056484  
Mar 23, 2020

SITE LOCATION

FIGURE 2.1



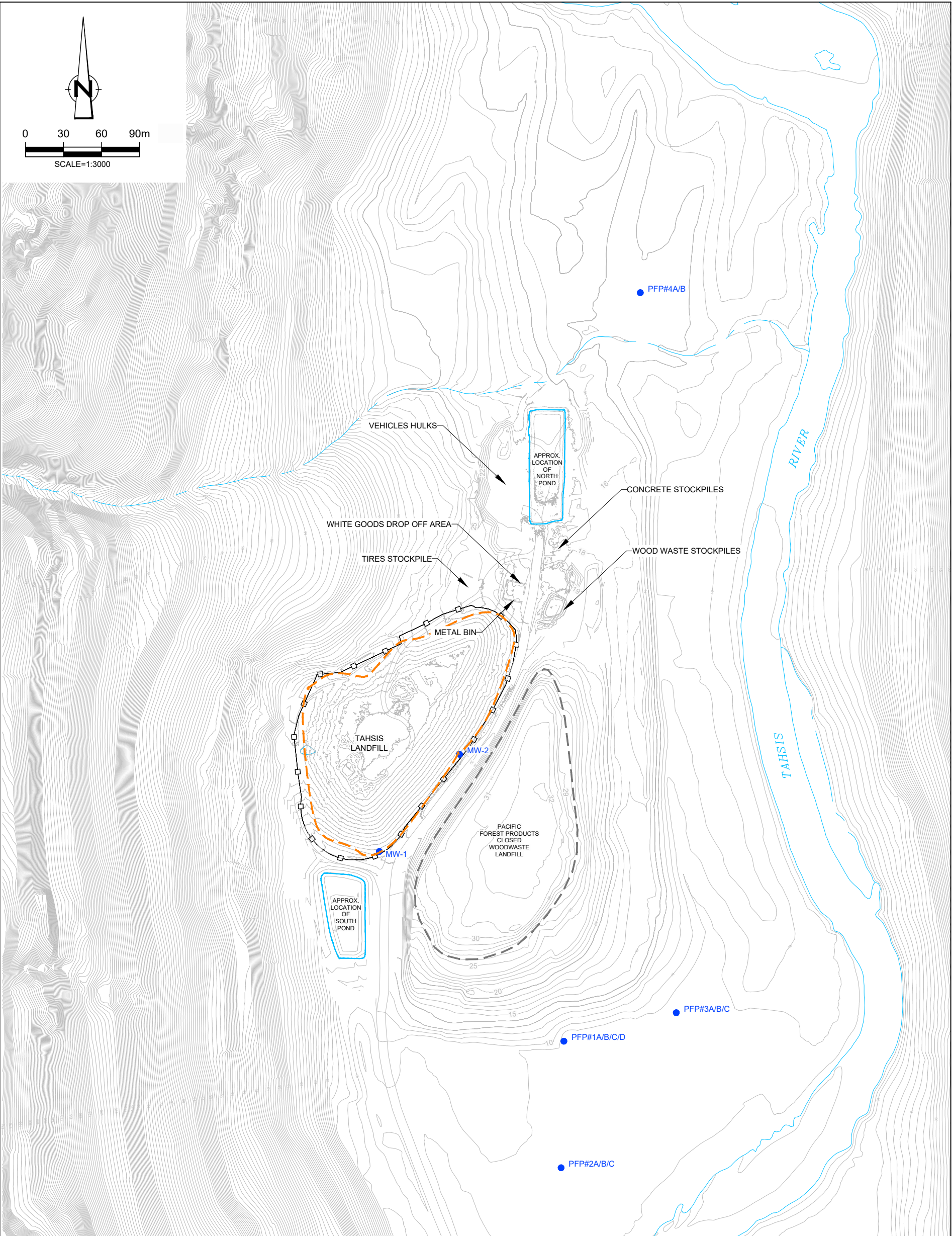


figure 2.2

MONITORING LOCATIONS  
2019 OPERATIONS AND MONITORING REPORT  
TAHSIS LANDFILL  
*Comox Strathcona Waste Management*



SOURCE: TOPOGRAPHICAL INFORMATION BASED ON SURVEY DATED OCTOBER 30, 2019  
COMBINED WITH SURVEY DATED OCTOBER 30, 2018 BY McELHANNEY ASSOCIATES  
CAMPBELL RIVER, B.C. WELL LOCATIONS BASED ON SURVEY DATA PROVIDED BY TETRA  
TECH EBA. WELLS SURVEYED BY QUARMBY LAND SURVEYING, JAN. 20, 2005. LIMIT OF  
WASTE FROM TETRA TECH EBA, PHASE 1 CLOSURE REPORT, 2014.

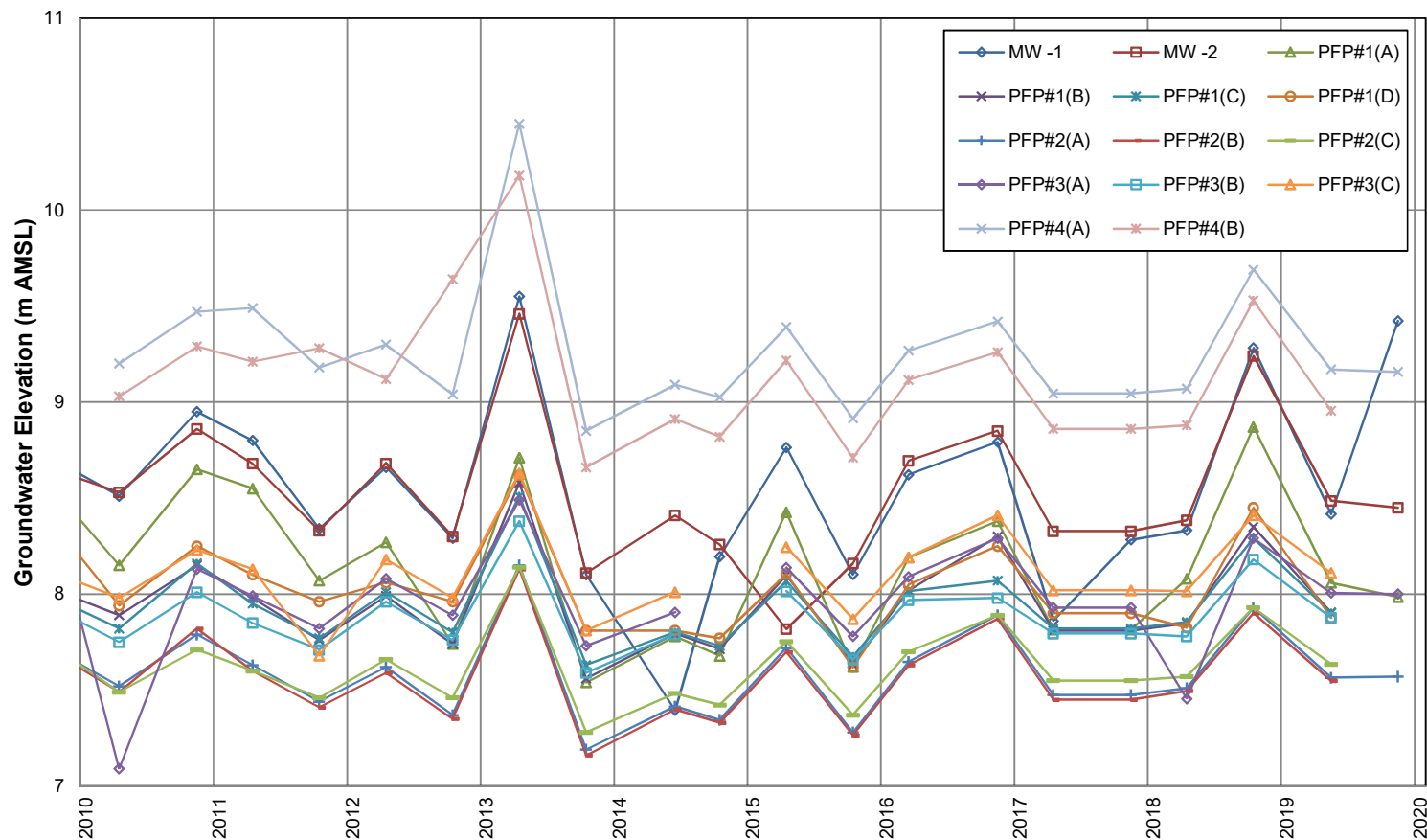
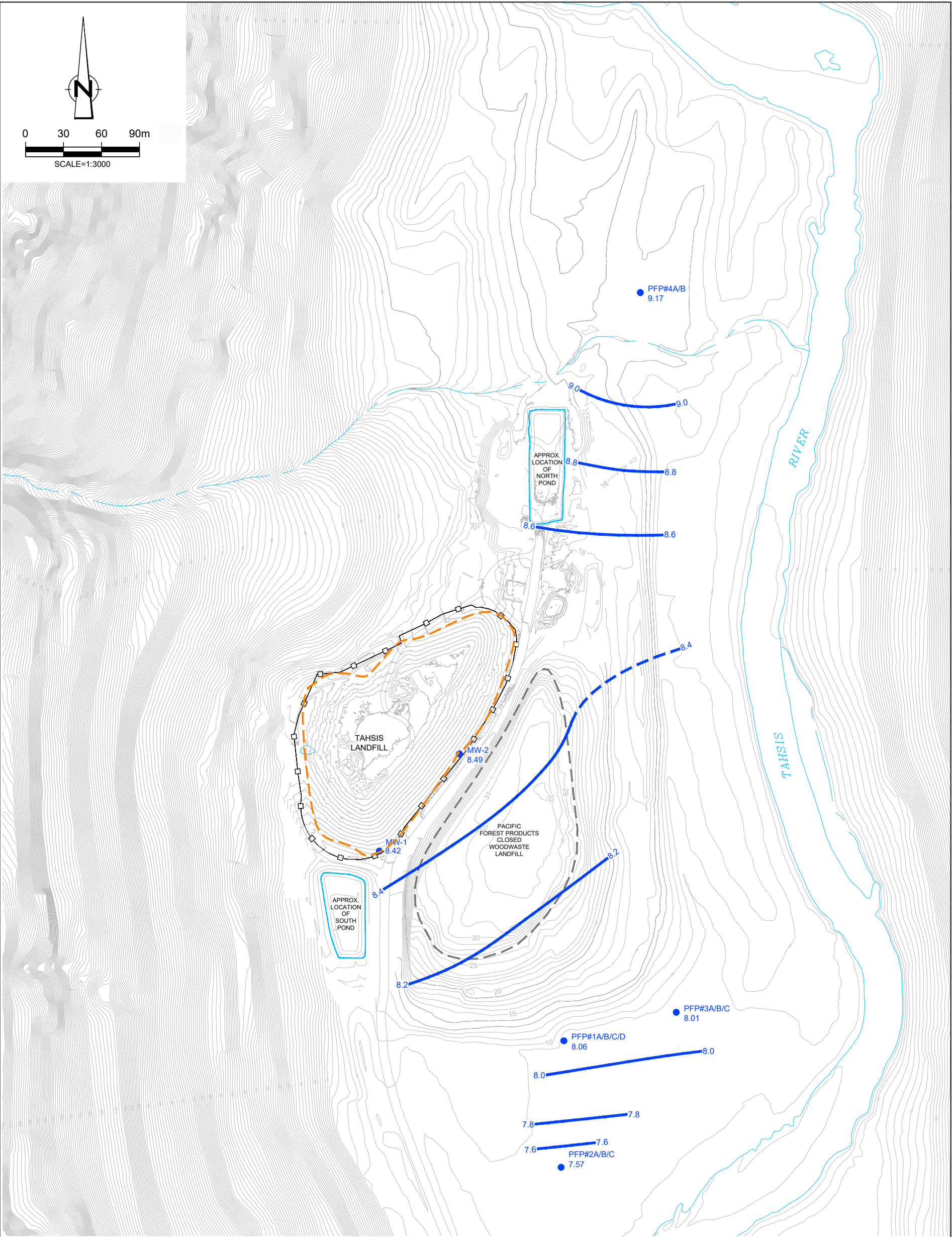


figure 5.1  
HYDRAULIC MONITORING RESULTS  
TAHSIS LANDFILL  
2019 ANNUAL OPERATIONS AND MONITORING REPORT  
*Comox Strathcona Waste Management*







- LEGEND**
- APPROXIMATE LIMIT OF WASTE
  - BEAR FENCE
  - MW-1 APPROXIMATE GROUNDWATER WELL LOCATION
  - 7.6 --- GROUNDWATER CONTOUR
  - INFERRED GROUNDWATER CONTOUR

figure 5.2

**GROUNDWATER CONTOURS - MAY 2019**  
**2019 OPERATIONS AND MONITORING REPORT**  
**TAHSIS LANDFILL**  
*Comox Strathcona Waste Management*

**GHD**

SOURCE: TOPOGRAPHICAL INFORMATION BASED ON SURVEY DATED OCTOBER 30, 2019 COMBINED WITH SURVEY DATED OCTOBER 30, 2018 BY McELHANNEY ASSOCIATES. CAMPBELL RIVER, B.C. WELL LOCATIONS BASED ON SURVEY DATA PROVIDED BY TETRA TECH EBA. WELLS SURVEYED BY QUARMBY LAND SURVEYING, JAN. 20, 2005. LIMIT OF WASTE FROM TETRA TECH EBA, PHASE 1 CLOSURE REPORT, 2014.

**Waste Area Population and Projected Population  
2019 Operations and Monitoring Report  
Tahsis Landfill  
Tahsis, British Columbia**

<b>Year</b>	<b>Estimated Population<sup>(1)(2)</sup></b>
2019	303
2020	321
2021	341
2022	362
2023	384
2024	407
2025	432

- (1) Based on 2019 population estimate sourced from the Government of BC, Ministry of Jobs, Economic Development and Competitiveness.
- (2) Annual population decrease rate of 6.10% based on the 3-year average (2016-2019) of estimated changes in population for the Village of Tahsis sourced from the Government of BC, Ministry of Jobs, Economic Development and Competitiveness.

**Monitoring Locations and Sampling Frequency**  
**2019 Operations and Monitoring Report**  
**Tahsis Landfill**  
**Tahsis, British Columbia**

Monitoring Location	May	November
<b>Groundwater</b>		
MW-1	√	√
MW-2	√	√
PFP#1A	√	√
PFP#1B	WL	-
PFP#1C	WL	-
PFP#1D	WL	-
PFP#2A	√	√
PFP#2B	WL	-
PFP#2C	WL	-
PFP#3A	√	√
PFP#3B	WL	-
PFP#3C	WL	-
PFP#4A	√	√
PFP#4B	WL	-

**Notes**

√ - Sample collected and submitted for laboratory analysis.

WL - Water level measured only.

- - No sample or water level collected.

Table 4.2

**Well Completion Details and Hydraulic Monitoring Results  
2019 Operations and Monitoring Report  
Tahsis Landfill  
Tahsis, British Columbia**

Location	Total Depth	Top of Riser	Screened Interval				Screen Length	Water Levels				Screened Unit
	(m BTOR)	(m AMSL) <sup>(1)</sup>	May-19		Nov-19							
			(m BTOR)	(m AMSL)	(m BTOR)	(m AMSL)		(m BTOR)				
MW-1	20.20	20.18	12.92	15.92	7.26	4.26	3.00	8.42	11.77	9.42	10.76	SILT with gravel
MW-2	20.40	21.28	14.70	17.80	6.58	3.48	3.10	8.49	12.79	8.45	12.83	GRAVEL and SAND with silt
PFP#1A	4.90	9.98	1.90	3.40	8.08	6.58	1.50	8.06	1.92	7.99	2.00	Silty GRAVEL and SAND
PFP#1B	15.60	10.04	12.60	14.10	-2.56	-4.06	1.50	7.90	2.14	-	-	Silty SAND, trace gravel
PFP#1C	29.90	9.90	26.80	28.30	-16.90	-18.40	1.50	7.90	2.00	-	-	Silty GRAVEL and SAND
PFP#1D	52.20	10.10	48.80	50.30	-38.70	-40.20	1.50	7.88	2.22	-	-	Silty SAND
PFP#2A	5.60	9.19	1.90	5.30	7.29	3.89	3.40	7.57	1.63	7.57	1.62	Silty GRAVEL and SAND
PFP#2B	11.70	9.14	9.30	10.20	-0.16	-1.06	0.90	7.55	1.59	-	-	SAND and GRAVEL
PFP#2C	25.00	9.09	22.70	23.60	-13.61	-14.51	0.90	7.64	1.46	-	-	Silty GRAVEL and SAND
PFP#3A	5.80	9.99	2.70	4.30	7.29	5.69	1.60	8.01	1.98	8.00	1.99	Silty GRAVEL and SAND
PFP#3B	13.10	9.78	10.70	11.60	-0.92	-1.82	0.90	7.88	1.90	-	-	GRAVEL
PFP#3C	25.30	9.83	22.20	23.10	-12.37	-13.27	0.90	8.11	1.72	-	-	Silty GRAVEL and SAND
PFP#4A	7.30	14.90	2.70	5.75	12.20	9.15	3.05	9.17	5.73	9.16	5.74	GRAVEL and SAND
PFP#4B	17.6	14.78	14.60	15.50	0.18	-0.72	0.90	8.96	5.83	-	-	Silty GRAVEL

**Notes**

<sup>(1)</sup> Elevation data provided in the Tahsis Landfill 2013 Annual Monitoring Report (Tetra Tech EBA, 2014).

m BTOR metres below top of riser  
m AMSL metres above mean sea level  
- Water level not measured.



Table 5.3

**Vertical Gradients**  
**2019 Operations and Monitoring Report**  
**Tahsis Landfill**  
**Tahsis, British Columbia**

Well ID	Depth of Borehole	Top of Screen Elevation	Vertical Distance Between Well Screens	Groundwater Elevation May 2019	Well Pair	Vertical Gradient May 2019
	(m AMSL) <sup>(1)</sup>	(m AMSL) <sup>(1)</sup>	(m)	(m AMSL)		
PFP#1(A)	4.9	8.08	10.64	8.06	PFP#1(A) & PFP#1(B)	0.015
PFP#1(B)	15.6	-2.56	14.34	7.90	PFP#1(B) & PFP#1(C)	0.0001
PFP#1(C)	29.9	-16.90	21.80	7.90	PFP#1(C) & PFP#1(D)	0.001
PFP#1(D)	52.2	-38.70	46.78	7.88	PFP#1(A) & PFP#1(D)	0.004
PFP#2(A)	5.6	7.29	7.45	7.57	PFP#2(A) & PFP#2(B)	0.002
PFP#2(B)	11.7	-0.16	13.45	7.55	PFP#2(B) & PFP#2(C)	-0.006
PFP#2(C)	25	-13.61	20.90	7.64	PFP#2(A) & PFP#2(C)	-0.003
PFP#3(A)	5.8	7.29	8.21	8.01	PFP#3(A) & PFP#3(B)	0.016
PFP#3(B)	13.1	-0.92	11.45	7.88	PFP#3(B) & PFP#3(C)	-0.020
PFP#3(C)	25.3	-12.37	19.66	8.11	PFP#3(A) & PFP#3(C)	-0.005
PFP#4(A)	7.3	12.20	12.02	9.17	PFP#4(A) & PFP#4(B)	0.018
PFP#4(B)	17.6	0.18	-	8.96	-	-

**Notes**

<sup>(1)</sup> Elevation data provided in the Tahsis Landfill 2013 Annual Monitoring Report (Tetra Tech EBA, 2014) and GHD field survey, March 2016.

<sup>(2)</sup> Downwards gradient (positive), upwards gradient (negative).

<sup>(3)</sup> Hydraulic monitoring not completed for full set of groundwater monitoring wells in November 2019 Monitoring Event.

m AMSL - metres above mean sea level

Table 5.4

Groundwater Analytical Results  
2019 Operations and Monitoring Report  
Tahsis Landfill  
Tahsis, British Columbia

Sample Location:				MW-1	MW-1	MW-2	MW-2	PFP#1A	PFP#1A	PFP#2A	PFP#2A	PFP#3A	PFP#3A	PFP#4A	PFP#4A
Sample ID:				WG-56484-080519-DB-06	WG-56484-271119-CT-13	WG-56484-080519-DB-05	WG-56484-271119-CT-12	WG-56484-080519-DB-03	WG-56484-271119-CT-10	WG-56484-080519-DB-04	WG-56484-271119-CT-11	WG-56484-080519-DB-02	WG-56484-271119-CT-09	WG-56484-080519-DB-01	WG-56484-271119-CT-08
Sample Date:				5/8/2019	11/27/2019	5/8/2019	11/27/2019	5/8/2019	11/27/2019	5/8/2019	11/27/2019	5/8/2019	11/27/2019	5/8/2019	11/27/2019
BC CSR Schedule 3.2															
Parameters	Units	DW a	FAW b												
Field Parameters															
Conductivity, field	uS/cm	--	--	307	274	176	264	684	301	426	491	184	410	152	239
Oxidation reduction potential (ORP), field	millivolts	--	--	235	111	229	80	252	-51	253	58	261	226	234	206
pH, field	s.u.	--	--	7.82	7.61	8.08	7.77	6.93	7.82	7.25	7.07	6.91	7.36	6.94	7.59
Temperature, field	Deg C	--	--	9.59	9.82	7.98	7.59	10.42	6.54	8.87	7.76	7.52	7.84	7.22	8.92
Total dissolved solids, field (TDS)	g/L	--	--	0.199	0.178	0.114	0.172	0.437	0.196	0.277	0.319	0.120	0.267	0.099	0.155
Turbidity, field	NTU	--	--	0.3	0	0.0	0	180	0	37	0	10.7	0	58	14.7
General Chemistry															
Alkalinity, bicarbonate	mg/L	--	--	149	142	92.4	125	288	141	233	273	99.4	217	77.5	115
Alkalinity, carbonate	mg/L	--	--	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5
Alkalinity, hydroxide	mg/L	--	--	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5
Alkalinity, total (as CaCO3)	mg/L	--	--	149	142	92.4	125	288	141	233	273	99.4	217	77.5	115
Chloride	mg/L	250	1500	2.04	1.27	1.87	2.38	2.03	1.36	1.77	1.47	1.63	1.64	1.72	1.12
Conductivity	uS/cm	--	--	283	252	190	240	527	269	396	447	198	376	162	216
Fluoride	mg/L	1.5	[b]	ND 0.010	ND 0.010	ND 0.010	ND 0.010	ND 0.010	0.305	ND 0.010	ND 0.010	ND 0.010	ND 0.010	ND 0.010	ND 0.010
Hardness	mg/L	--	--	156	123	88.4	117	349	100	223	233	86.3	191	79.2	103
pH, lab	s.u.	--	--	8.13 J	8.18 J	8.28 J	8.22 J	7.74 J	8.23 J	8.26 J	7.94 J	8.29 J	8.19 J	8.13 J	8.18 J
Sulfate	mg/L	500	[b]	3.80	1.93	2.51	3.20	1.92	3.57	1.46	1.74	1.83	2.53	1.69	1.68
Nutrients															
Ammonia-N	mg/L	--	[a]	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	3.45	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	0.0073	0.0058
Nitrate (as N)	mg/L	10	400	0.238	0.160	0.0900	0.346	0.129	ND 0.0025	0.175	0.348	0.0837	0.240	0.120	0.0615
Nitrite (as N)	mg/L	1	[c]	ND 0.0005	ND 0.0005	ND 0.0005	ND 0.0005	ND 0.0005	ND 0.0005	ND 0.0005	ND 0.0005	ND 0.0005	ND 0.0005	ND 0.0005	ND 0.0005
Nitrite/Nitrate	mg/L	10	400	-	0.160	-	0.346	-	ND 0.00255	-	0.348	-	0.240	-	0.0615
Dissolved Metals															
Aluminum (dissolved)	ug/L	9500	--	3.5	1.8	10.1	7.5	ND 0.5	2.1	1.5	1.9	4.4	2.2	12.4	5.8
Antimony (dissolved)	ug/L	6	90	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Arsenic (dissolved)	ug/L	10	50	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Barium (dissolved)	ug/L	1000	10000	2.16	1.89	0.87	4.58	5.91	0.16	2.78	3.14	0.93	2.93	0.52	2.48
Beryllium (dissolved)	ug/L	8	1.5	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Bismuth (dissolved)	ug/L	--	--	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025
Boron (dissolved)	ug/L	5000	12000	17	ND 5	ND 5	22	18	310	11	14	ND 5	ND 5	ND 5	ND 5
Cadmium (dissolved)	ug/L	5	[b]	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	0.0087	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025
Caesium (dissolved)	ug/L	--	--	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	0.033	0.015	0.017	ND 0.005	ND 0.005	ND 0.005	ND 0.005
Calcium (dissolved)	ug/L	--	--	55000	43700	31700	42500	126000	19900	80000	84400	31200	69700	27800	36000
Chromium (dissolved)	ug/L	50	10	0.19	0.13	0.13	0.1	ND 0.05	ND 0.05	0.25	0.18	0.22	0.19	ND 0.05	0.16
Cobalt (dissolved)	ug/L	20 (i)	40	ND 0.05	ND 0.05 (i)	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Copper (dissolved)	ug/L	1500	[b]	0.28	0.39	ND 0.1	0.87	0.61	ND 0.1	0.23	0.41	ND 0.1	0.49	ND 0.1	0.66
Iron (dissolved)	ug/L	6500	--	ND 5	ND 5	ND 5	ND 5	ND 5	56	ND 5	ND 5	ND 5	ND 5	ND 5	ND 5
Lead (dissolved)	ug/L	10	[b]	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025	ND 0.025
Lithium (dissolved)	ug/L	8	--	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	3.8	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5
Magnesium (dissolved)	ug/L	--	--	4590	3420	2220	2720	8490	12200	5650	5440	2020	4010	2370	3120
Manganese (dissolved)	ug/L	1500	--	0.47	ND 0.05	ND 0.05	ND 0.05	1.99	7.52	ND 0.05	ND 0.05	0.13	ND 0.05	0.32	0.89
Mercury (dissolved)	ug/L	1	0.25	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	ND 0.0025	0.01 J	ND 0.0025
Molybdenum (dissolved)	ug/L	250	10000	0.073	ND 0.025	0.132	0.171	0.055	ND 0.025	0.071	0.082	0.125	0.089	0.105	0.091
Nickel (dissolved)	ug/L	80	[b]	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25
Phosphorus (dissolved)	ug/L	--	--	ND 25	ND 25	ND 25	ND 25	ND 25	661	ND 25	ND 25	ND 25	ND 25	ND 25	ND 25
Potassium (dissolved)	ug/L	--	--	317	126	99	151	946	4760	491	522	118	164	ND 25	59
Rubidium (dissolved)	ug/L	--	--	ND 0.1	ND 0.1	ND 0.1	ND 0.1	0.38	1.87	0.22	0.21	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Selenium (dissolved)	ug/L	10	20	0.067	0.082	0.076	0.095	0.054	0.155	0.054	0.072	0.08	0.083	0.058	0.09
Silicon (dissolved)	ug/L	--	--	1130	1260	755	1000	2210	10500	2270	2380	1100	1870	827	1280
Silver (dissolved)	ug/L	20	[b]	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005
Sodium (dissolved)	ug/L	200000	--	1350	1150	10000	1630	2230	1470	1610	820	838	1230	838	1040
Strontium (dissolved)	ug/L	2500	--	69.4	49.2	46.8	64.7	154	129	96.9	102	38.1	82.7	40.9	49.9
Sulfur (dissolved)	ug/L	--	--	1280	910	1000	1330	840	2190	510	820	700	1020	ND 250	840
Tellurium (dissolved)	ug/L	--	--	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1	ND 0.1
Thallium (dissolved)	ug/L	--	3	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005	ND 0.005
Thorium (dissolved)	ug/L	--	--	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Tin (dissolved)	ug/L	2500	--	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Titanium (dissolved)	ug/L	--	1000	ND 0.15	ND 0.15	ND 0.15	ND 0.15	ND 0.15	ND 0.15	ND 0.15	ND 0.15	ND 0.15	ND 0.15	ND 0.15	ND 0.15
Tungsten (dissolved)	ug/L	3	--	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	0.1	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05	ND 0.05
Uranium (dissolved)	ug/L	20	85	0.181	0.106	0.249	0.276	0.374	ND 0.005	0.39	0.348	0.184	0.333	0.144	0.17
Vanadium (dissolved)	ug/L	20	--	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25	ND 0.25
Zinc (dissolved)	ug/L	3000	[b]	ND 0.5	ND 0.5	ND 0.5	4.6	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	ND 0.5	1.4
Zirconium (dissolved)	ug/L	--	--	ND 0.03	ND 0.1	ND 0.03	ND 0.1	ND 0.03	ND 0.1	ND 0.03	ND 0.1	ND 0.03	ND 0.1	ND 0.03	ND 0.1

**Analytical Table Notes**  
**2019 Operations and Monitoring Report**  
**Tahsis Landfill**  
**Tahsis, British Columbia**

**Notes:**

ENV	British Columbia Ministry of Environment and Climate Change Strategy
CSR	ENV British Columbia Contaminated Sites Regulation (CSR) Schedule 3.2 Generic Numerical Water Standards (June, 2018)
FAW	Guideline/standard for the protection of freshwater aquatic life
DW	Guideline/standard for the protection of drinking water
a	CSR DW
b	CSR FAW
(*)	Aesthetic objective. Parameters may impair the taste, smell or colour of water or interfere with the supply of good quality water. Parameters do not cause adverse health effects.
ND	Not detected at the associated reporting limit.
J	Estimated concentration.
R	Rejected result
[a]	Limit varies with pH.
[b]	Limit varies with Hardness.
(i)	Cobalt concentrations in groundwater do not exceed the referenced cobalt interim background groundwater concentration estimate. Standard confirmed in email received from ENV, November 7, 2017.
<div style="border: 1px solid red; width: 20px; height: 10px; display: inline-block;"></div>	Exceeds indicated standard or guideline.

# Appendices

# Appendix A

## Tahsis Landfill Permit # PR-4278



Province of  
British Columbia

Ministry of  
Environment  
and Parks

Vancouver Island Region 1  
Regional Headquarters  
2569 Kenworth Road  
Nanaimo  
British Columbia  
V9T 4P7  
Phone: (604) 758-3951

MAR 8 1988

REGISTERED MAIL

File: PR-4278

Village of Tahsis  
P.O. Box 519  
Tahsis, British Columbia  
VOP 1X0

*TAHSIS  
LANDFILL*

Gentlemen:

LETTER OF TRANSMITTAL

Enclosed is a copy of amended Permit No. PR-4278, issued under the provisions of the Waste Management Act, in the name of the Village of Tahsis. Your attention is respectfully directed to the terms and conditions outlined in the Permit.

The administration of this Permit will be carried out by staff from our Regional Office located at 2569 Kenworth Road, Nanaimo, British Columbia, V9T 4P7 (telephone 758-3951). Plans, data and reports pertinent to the Permit are to be submitted to the Regional Waste Manager at this address.

You will note that values have been expressed in the International System of Units (SI). These units are to be used in submitting monitoring results and any other information in connection with this Permit.

This Permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority shall rest with the Permittee.

Yours truly,

G. E. Oldham, P. Eng.  
Regional Waste Manager

Enclosure

*H-33/03/01*

*FD 02.3.88  
RMB 02/03/88*



MINISTRY OF ENVIRONMENT  
AND PARKS


**PERMIT**

*Under the Provisions of the Waste Management Act*

Village of Tahsis  
P.O. Box 519  
Tahsis, British Columbia  
V0P 1X0

is hereby authorized to discharge refuse to the land  
from municipal sources and contaminants to the air from a  
regulated open burning operation  
located at Tahsis, British Columbia.

This permit has been issued under the terms and  
conditions prescribed in the attached Appendices  
01, A-1, B-1, and B-2

  
Regional Waste Manager  
Permit No. PR-4278

Date issued: June 11, 1976  
Date amended: December 2, 1981  
MAR 8 1988

17-33/03/01  
18 02.3.88  
CMB 04/03/88





MINISTRY OF ENVIRONMENT  
and Parks  
WASTE MANAGEMENT BRANCH

APPENDIX 01

to Permit No. PR-4278

(Refuse)

- (a) The discharge of refuse to which this appendix is applicable is from the Village of Tahsis and from a regulated open burning operation as shown on the attached Appendix A-1.
- (b) The rate at which refuse may be discharged is a maximum of 10 000 m<sup>3</sup>/y.
- (c) The type of refuse which may be discharged is municipal.
- (d) The components of the refuse which may be discharged are typical municipal refuse, ashes and digested sewage sludge.
- (e) The works authorized are a landfill and regulated open burning operation approximately located as shown on the attached Appendix A-1.
- (f) The land to which the refuse is to be discharged and the location of the regulated open burning operation to which this appendix is appurtenant is an unsurveyed portion of Lot 98, TL 1460P, Nootka Land District, which is approximately 3 kilometres north of the Village of Tahsis.
- (g) The works authorized must be complete and in operation on and from the date of this appendix.

Date issued: June 11, 1976

Date amended: December 2, 1981

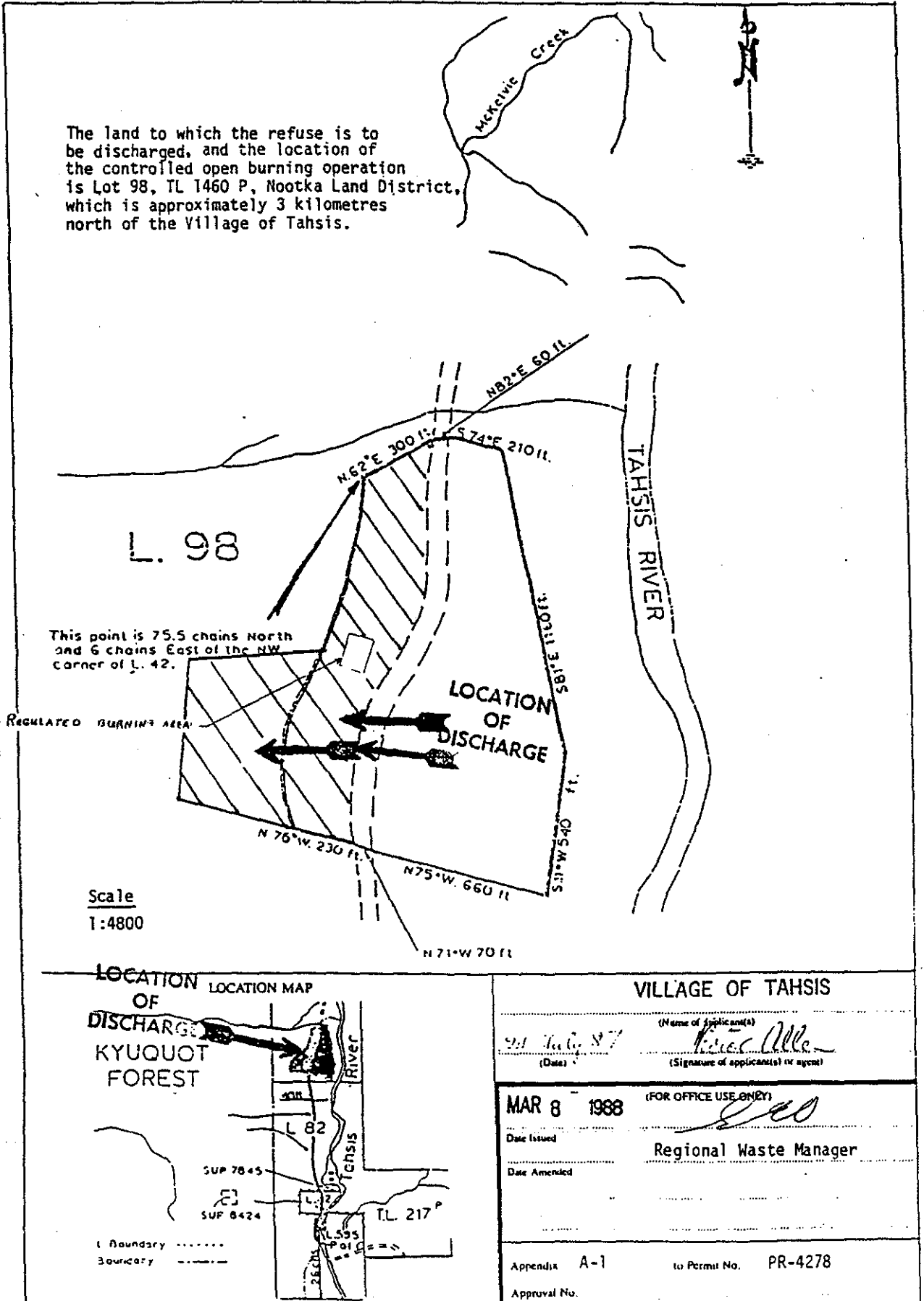
MAR 8 1988

H-88/03/01  
02.3.88

  
Regional Waste Manager



The land to which the refuse is to be discharged, and the location of the controlled open burning operation is Lot 98, TL 1460 P, Nootka Land District, which is approximately 3 kilometres north of the Village of Tahsis.





MINISTRY OF ENVIRONMENT  
and Parks  
WASTE MANAGEMENT BRANCH

APPENDIX B-1

to Permit No. PR-4278

A. LANDFILL OPERATION

The Permittee shall maintain the landfill authorized in Appendix 01 as a Level "A" operation in accordance with the Pollution Control Objectives for Municipal Type Waste Discharges in British Columbia, dated September, 1975, which, in normal conditions, require that cover material be applied daily. The Regional Waste Manager may vary the frequency of covering when freezing conditions affect normal operation.

B. SITE PREPARATION AND RESTORATION

Provision of site access, vehicle safety barriers, surface water diversionary works, firebreaks and site restoration as required, shall be carried out to the satisfaction of the Regional Waste Manager.

C. SEGREGATION OF METALLIC WASTES

Segregate large metallic wastes, such as appliances and auto bodies, etc., for disposal in a separate area of the site.

D. SEGREGATION OF DIGESTED SEWAGE SLUDGE

The Permittee shall dispose of the digested sewage sludge in a separate area of the site and cover immediately after each discharge.

E. WILDLIFE NUISANCE

The subject discharge is one that is of concern because of the possibility of a nuisance or hazard being caused by bears or other animals attracted to the site. Additional works, including, but not limited to, a cleared buffer zone between the trees and the site, fencing around the site, an air curtain incinerator, and moveable bear-proof receptacles will be required, or other operating instructions will be issued by the Regional Waste Manager if such problems arise.

F. GROUNDWATER MONITORING WELLS

The Permittee shall install not more than 2 groundwater monitoring wells. The number, locations and structural details of these facilities are subject to the approval of the Regional Waste Manager.

Date issued: MAR 8 1988

Date amended:

  
Regional Waste Manager

14-32/03/01  
023.88  
AND 02/03/88



MINISTRY OF ENVIRONMENT  
and Parks  
WASTE MANAGEMENT BRANCH

APPENDIX B-2  
to Permit No. PR-4278

G. OPERATIONAL REQUIREMENTS FOR REGULATED OPEN BURNING OF  
SELECTED NON-PUTRESCIBLE MATERIALS FROM MUNICIPAL AND  
INDUSTRIAL SOURCES

(a) Area

The operation shall be restricted to an area on the site which is satisfactory to the Regional Waste Manager. If required, this area shall be fenced to restrict access to the burn area stockpile.

(b) Quantity and Frequency

The maximum quantity of wastes to be treated is 200 m<sup>3</sup> per burn at a frequency not to exceed 5 burns per year. Each burn shall comprise one continuous period necessary to reduce the stockpiled waste to ashes.

(c) Nature of Wastes

Generally, no waste shall be burned which is unacceptable to the Regional Waste Manager. Acceptable materials may include selected demolition refuse, stumps, trees and similar items, but exclude nuisance causing combustibles such as rubber, plastics, tars, insulation, etc. No putrescible waste shall be burned.

(d) Timing

Burning shall take place only when an attendant is on duty and when conditions promote rapid combustion and dispersion of combustion products. Materials shall be charged to the facility in a manner to promote best combustion and restrict the uplift of lighter constituents. No burning shall take place during periods of fire hazard or when burning is prohibited by other government agencies.

(e) Fire Control

Suitable approved devices shall be available for extinguishing fires to prevent them from spreading to surrounding areas. Such devices may include a pressurized water supply, chemical type fire extinguishers, or an earth stockpile. If an earth stockpile is contemplated for fire control, earth moving equipment shall be available at the site during burning. A fireguard shall be cleared and maintained free of combustible materials.

(f) Residue of Combustion

As soon as the residue of combustion has cooled to ambient temperature it shall be incorporated into the adjacent landfill.

Date issued: MAR 8 1988  
Date amended: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

  
Regional Waste Manager

17 / 38 / 03 / 01.  
02.3.88  
100

## Appendix B

### Borehole Logs



PROJECT NUMBER  
VBC25337.00

WELL NUMBER  
WH-1

SHEET 1 OF 1

## WELL COMPLETION LOG

PROJECT Regional District of Comox-Strathcona

LOCATION Tansis Landfill, Tansis, B.C.

ELEVATION

DRILLING CONTRACTOR Drillwell Enterprises LTD., Cowichan, B.C.

DRILLING METHOD AND EQUIPMENT Air Rotary, Drilltech D25K

WATER LEVELS 34.4 feet BGS 17/11/93

START 16/11/93

FINISH 17/11/93

LOGGER B. Ebersold

DEPTH BELOW SURFACE (FT)	SAMPLE			BLOW COUNTS 8" - 8" - 8" - 8" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	WELL COMPLETION DIAGRAM
	INTERVAL	TYPE AND NUMBER	RECOVERY (FT.)			
0					Cobbles and coarse gravel with some sand and silt (GP) reddish-brown poorly graded, loose, dry, some refuse. (GP)	<p>8" protective steel casing with locking lid</p> <p>Cement surface seal</p> <p>Bentonite seal (3/8" Holeplug)</p> <p>2" PVC blank casing</p> <p>2" PVC screen with 0.01 inch slots</p> <p>Stainless steel centralizers 1" above &amp; below screen</p> <p>5' stump with end cap</p>
5					As above, dry	
10					Silt, reddish-brown, with 20% gravel and 5% sand (GM-GP), poorly graded, moist. (ML/GP)	
15					Same as above, wet	
20					Silt with 15% gravel (GM), dark brown, low plasticity, wet. (ML/GP)	
25					Silt, reddish-brown, with gravel (GM-SP), poorly graded, wet. (ML/GP)	
30					Sand, medium to fine, silty, dark gray with sheen, wet, loose. (SM)	
35					Silt, reddish-brown, with gravel (GM-SP), poorly graded, wet. (GM/GP)	<p>Backfill (Bentonite)</p> <p>Granular Grade 8 sand</p>
40					END BORING @ 57.0 FEET	
45						
50						
55						
60						
65						
70						
75						
80						
85						
90						
95						
100						



PROJECT NUMBER  
VBC25337.D0

WELL NUMBER  
MW-2

SHEET 1 OF 1

## WELL COMPLETION LOG

PROJECT Regional District of Comox-Strathcona

LOCATION Tahsis Landfill, Tahsis, B.C.

ELEVATION \_\_\_\_\_ DRILLING CONTRACTOR

Drillwell Enterprises LTD., Cowichan, B.C.

DRILLING METHOD AND EQUIPMENT Air Rotary, Drilltech D25K

WATER LEVELS 40.3 feet BGS 18/11/93

START 17/11/93

FINISH 18/11/93

LOGGER B. Ebersold

DEPTH BELOW SURFACE (FT)	SAMPLE			BLOW COUNTS 6" - 6" - 6" - 6" (2)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	WELL COMPLETION DIAGRAM
	INTERVAL	TYPE AND NUMBER	RECOVERY (FT.)			
0					Gravel, coarse to medium, angular, with some sand (GP) light brown poorly graded, loose, dry, some refuse. (GP)	<p>8" steel protective casing with locking lid</p> <p>Cement air/face seal</p> <p>Bentonite seal (3/8" Holeplug)</p> <p>2" PVC blank casing</p> <p>2" PVC screen with 0.01" slots</p> <p>Stainless steel centralizers 1" above &amp; below screen</p> <p>5' sump with end cap</p> <p>Backfill (Bentonite)</p> <p>Granul Grade 8 sand</p>
5					Coarse gravel (GP), gray, angular, dry, loose (appears to be cobble and/or boulders ground up by drill bit). (GP)	
10					Gravel, coarse (80%) with brown silt (15%) and trace of coarse sand (GP-GM), moist. (GP/GM)	
15					As above with more silt and darker reddish-brown color. (GP-GM)	
20					Gravel, coarse (90%) with some light brown silt, dry. (GP)	
25					As above with more gradation of gravel, a little tan silt, dry. (GW)	
30					Gravel, coarse, angular, with some tan silt. (GP) dry. (GP)	
35					As above, wet.	
40					Gravel, coarse, grading to coarse sand (60 to 70%) with some reddish-brown silt (GW), wet. (GW/SW)	
45					As above with less silt (10%), wet.	
50					END BORING @ 65.0 FEET	

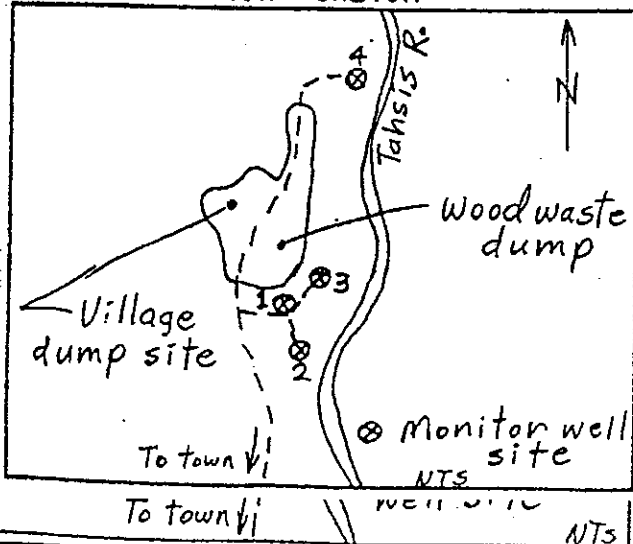


## WATER WELL RECORD

Date 9.0.9.11Descriptive Location Near Tahsis Woodwaste Pump, see sketchOwners Name CPEPL Driller Drillwell Ltd.LAT.            LONG.            WELL No. 1011  
UTM Z            E            N UTM Date 19901. TYPE OF WORK ☒ New Well ☐ Reconditioned ☐ Deepened ☐ Abandoned2. WORK METHOD ☐ Cable tool ☐ Bored ☐ Jetted ☒ Rotary ☐ mud ☒ air ☐ reverse ☐ Other3. WATER WELL USE ☐ Domestic ☐ Municipal ☐ Irrigation ☒ Commercial & Industrial ☐ Other Monitoring4. DRILLING ADDITIVES Nil5. MEASUREMENTS from ☒ ground level ☐ top of casing  
Top of casing to ground level            ft

FROM	TO	6. WELL LOG DESCRIPTION	SWL
0	22	Gravel & sand, very silty, brown	
22	40	Gravel & sand, water bearing	
40	43	Sand, silty, trace gravel	
43	77	Gravel & sand, brown, water	
77	91	Gravel & sand, very silty, grey	
91	106	Grey clay	
106	137	Sand, gravel, silty, brown	
137	148	Gravel, coarse, reddish water	
148	163	Sand, very silty, grey	
163	177	Grey silt	
177	179	Sand, very silty, grey	

## 7. WELL LOCATION SKETCH

8. CASING: ☒ Steel ☐ Galvanized ☐ Wood  
Materials ☒ Plastic ☐ Concrete ☐ Other  
units  
Hole diameter 8 5/8 ins  
Diameter 8 ins  
from 0 ft  
to 179 ft  
Thickness 0.322 ins10. Welded ☐ Cemented ☐ Threaded ☐ New ☐ Used  
Perforations: Four PVC piezometers installed, 8" casing withdrawn  
Open hole, from 179 to 180 ft Diameter 8 5/8 ins  
Grout: Nil9. SCREEN: ☐ Nominal ☒ Pipe Size  
Type ☐ Continuous Slot ☐ Perforated ☐ Louvre  
☒ Other 2" slotted PVC  
Material ☐ Stainless Steel ☐ Plastic ☐ Other PVC  
Set from see below ft below ground level

SCREEN & BLANKS					units
Length	(A) 4.5	(B) 4.5	(C) 4.5	(D) 4.5	ft
Diam. ID	2	2	2	2	ins
Slot Size	.020	.020	.020	.020	ins
from	4	39	86	158	ft
to	9	44	91	163	ft

Fittings, top Threaded, bottom 5' tail pipe  
Gravel Pack Silica sand10. DEVELOPED BY: ☒ Surging ☐ Jetting ☐ Air  
☐ Bailing ☐ Pumping ☐ Other11. TEST ☐ Pump ☐ Ball ☒ Air Date 9.0.9.11  
Rate Below gpm Temp            °C SWL before test see ft  
PWL            ft end of test of            hrs            mins below

TIME in mins & DRAWDOWN in ft			TIME in mins & RECOVERY in ft		
mins	WL	mins	mins	WL	mins
A	0.5 gpm	8.86	D	0.5 gpm	8.76
B	6 gpm	8.79	Note: SWL from		
C	16 gpm	8.92	Top of 8" casing		

12. RECOMMENDED PUMP TYPE 24 monitoring well RECOMMENDED PUMP SETTING 2-3 RECOMMENDED PUMPING RATE gpm13. WATER TYPE: ☒ fresh ☐ salty ☐ clear ☒ cloudy  
colour vt to 9th small Nil gas ☐ yes ☒ no14. WATER ANALYSIS: ☐ Hardness            mg/l  
☐ Iron            mg/l ☐ Chloride            mg/l  
☐ pH            ☐ Cond.             
☐ Temp.            Date           

## 15. FINAL WELL COMPLETION DATA

Well Depth            ft Water Flowing            gpm  
Static Water Level            ft Pressure Head            ft  
Back filled           

A-14, B-49, C-96, D-168 ft.

16. CONSULTANT KPA Engineering Ltd.  
16. CONSULTANT KPA Engineering Ltd.

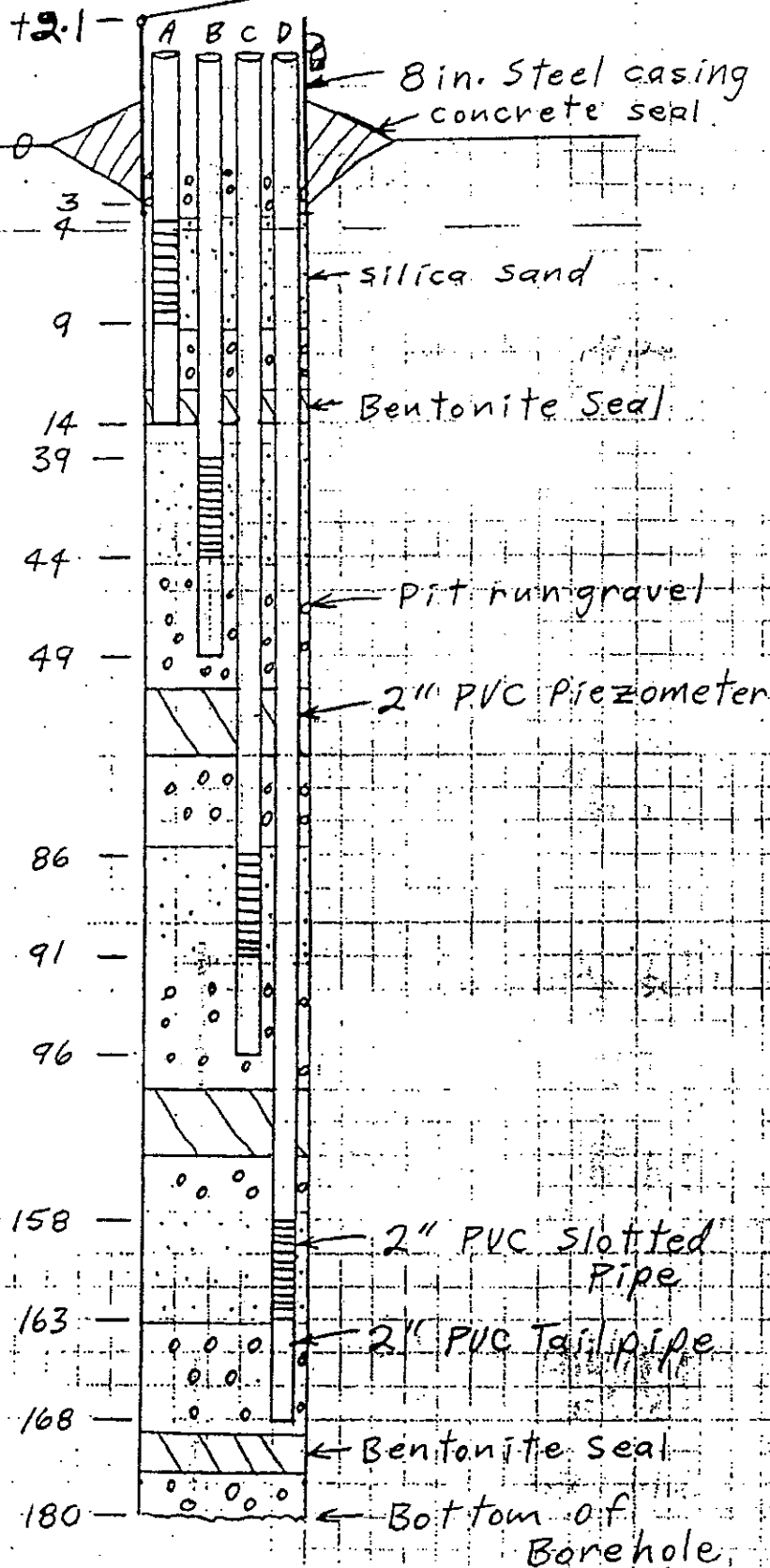
KPA	Project Tahsis	By DL	Date 13/09/90	Page 1 of 4
	Subject Monitor Wells	Ckd. DL	Date "	Job No. 2690

Well #1

Ground Surface

Water Table

Depths (feet)



# WATER WELL RECORD

Date 9.01.09 / 1.21

Owners Name CPFP Driller Drillwell Ltd.

LAT. [ ][ ][ ][ ] LONG. [ ][ ][ ][ ] WELL No. [10]2  
UTM Z [ ][ ][ ][ ][ ][ ] E [ ][ ][ ][ ][ ][ ] N UTM Date 1990

8. CASING: 1 ☐ Steel 2 ☐ Galvanized 3 ☐ Wood  
Materials 4 ☒ Plastic 5 ☐ Concrete

HOPE DIAMETER	85/8				ins
Diameter	8				ins
from	0				ft
to	85				ft
Thickness	0.322				ins

1 ☒ Welded 2 ☐ Cemented 3 ☐ Threaded 4 ☐ New 5 ☐ Use

Note: Three 2" PVC piezometer  
installed, 8" casing withdrawal

Open hole, from N/A to — ft Diameter —  
Grout: Nil

9.SCREEN: 1 ☐ Nominal 2 ☐ Pipe Size

Type 1 ☐ Continuous Slot 2 ☐ Perforated 3 ☐ Louvre  
☐ Other *2" slatted PVC*

Material ☐ Stainless Steel ☐ Plastic ☐ Other PVC  
Set from see to below below ground level

SCREEN & BLANKS				unit
-----------------	--	--	--	------

Length	A 4.5	B 3.	C 3..		11
Diam. ID	?	?	?		12

Slot Size	.020	.020	.020		ins
-----------	------	------	------	--	-----

from	5.0	28	72		11
to	2.5	31	75		

10	9.5	31	75	11
Fitting top Threaded bottom 5' tail on				

Gravel Pock Silica Sand

10. DEVELOPED BY: 1 ☐ Surgling 2 ☐ Jetting 3 ☒ A

4 ☐ Bailing      5 ☒ Pumping      ☐ Other \_\_\_\_\_

Rate see below Pump ☐ Bail ☐ Air ☒ Date 9/10/97  
YR Mo DY  
SWI before test see

PWL \_\_\_\_\_ ft end of test of \_\_\_\_\_ hrs \_\_\_\_\_ mins *below*

TIME in mins & DRAWDOWN in ft				TIME in mins & RECOVERY in ft			
1	2	3	4	5	6	7	8

mins	WL	mins	SWL	mins	WL	mins	SWL
A	1	9 PM	6.55	14			

B	12	9pm 6.53	Note: SWL from
---	----	----------	----------------

C 20 gpm 6:37 TOP 8" casing

2.	2" Monitoring well	11	2-3
----	--------------------	----	-----

3. WATER TYPE: 1 ☒ fresh 2 ☐ salty 3 ☐ clear 4 ☒ cloudy

colour \_\_\_\_\_ smell \_\_\_\_\_; gas 1 ☐ yes 2 ☒ no

4. WATER ANALYSIS: ☐ Hardness \_\_\_\_\_ mg/

2 ☐ Iron \_\_\_\_\_ mg/ 3 ☐ Chloride \_\_\_\_\_ mg/

4 ☐ pH    5 ☐ Cond.

Temp. \_\_\_\_\_ Date 

YR	MO	DT
----	----	----

### D. FINAL WELL COMPLETION DATA

Static Water Level \_\_\_\_\_ ft Pressure Head \_\_\_\_\_

Back filled

H-15 ft. B-36 ft. C-79.5 ft.

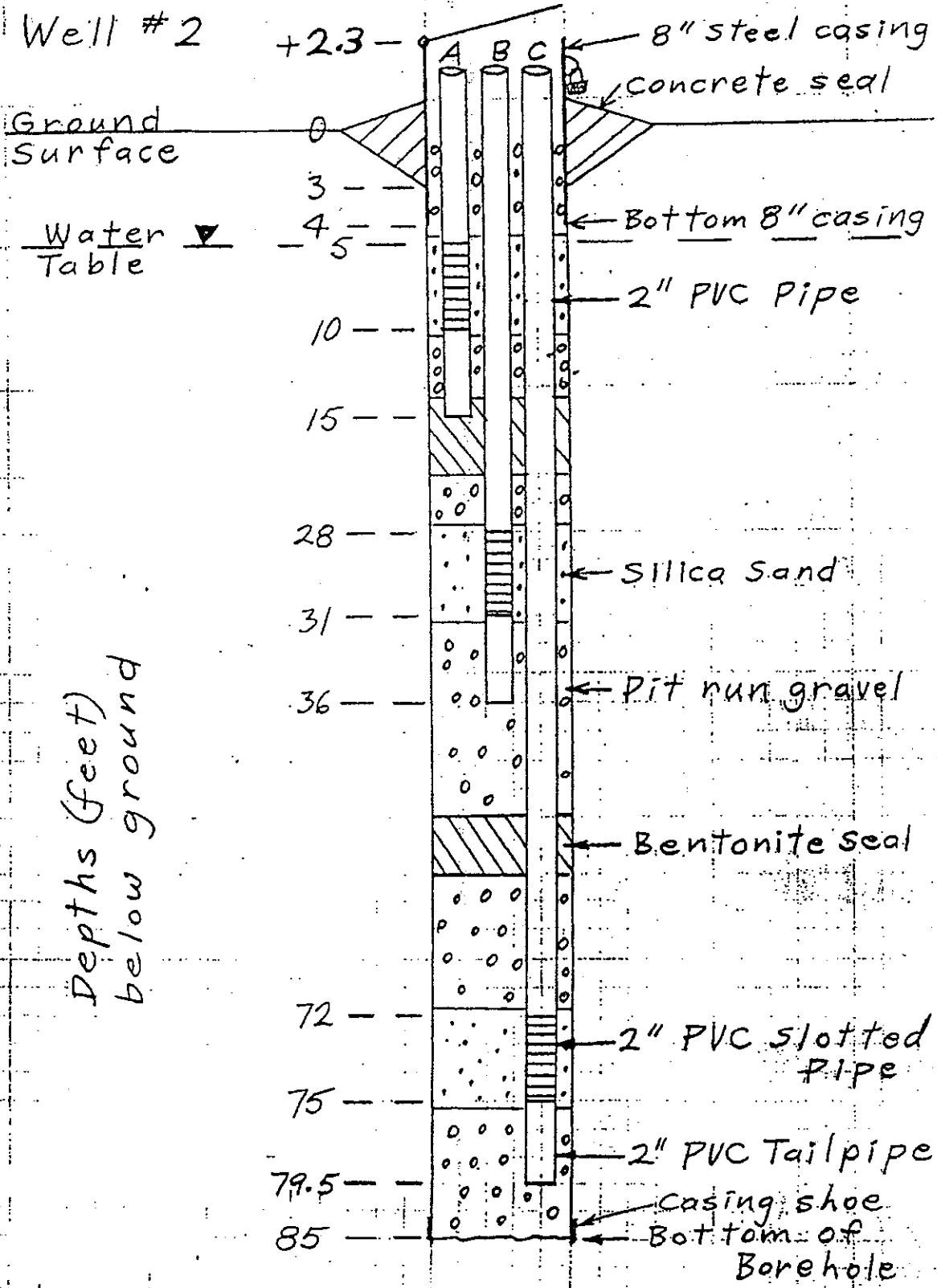
CONSULTANT KPA Engineering  
Ltd.

2/4/

KPA

Project	Tahsis	By	DL	Date	14/09/90	Page	2 of 4
Subject	Monitor Wells	Ckd.	DL	Date	"	Job No.	2690

Well #2



Depths (feet)  
below ground

Well Diagram

NTS

# WATER WELL RECORD

Date 9.01.09.13

Descriptive Location Near Tahsis wood waste dump, see sketch

Owners Name CPFPL Driller Drillwell Ltd.

LAT.            LONG.            WELL No. 103  
UTM Z            E            N UTM Date 1990

1. TYPE OF WORK ☒ New Well ☐ Reconditioned ☐ Deepened ☐ Abandoned

2. WORK METHOD ☒ Cable tool ☐ Bored ☐ Jetted ☒ Rotary ☐ mud ☐ air ☐ reverse ☐ Other           

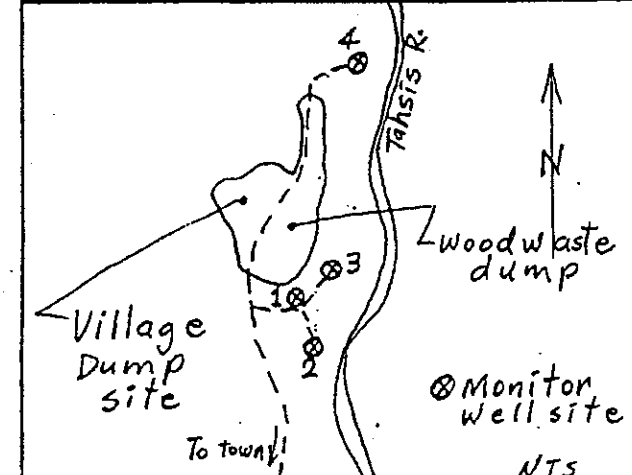
3. WATER WELL USE ☐ Domestic ☐ Municipal ☐ Irrigation ☒ Commercial & Industrial ☐ Other Monitoring

4. DRILLING ADDITIVES Nil

5. MEASUREMENTS from ☒ ground level ☐ top of casing Top of casing to ground level            ft

FROM	TO	6. WELL LOG DESCRIPTION	SWL
0	8	Fill & boulders	
8	12	Gravel & sand very silty, brown	
12	23	Gravel, silty brown	
23	26	Gravel, reddish	
26	36	Coarse clean gravel	
36	40	sand, little gravel, silty, brown	
40	65	Clean coarse sand	
65	76	Gravel & sand silty, brown (pieces of wood)	
76	79	Silty sand & gravel, grey	
79	84	Grey silty clay w/ gravel	

7. WELL LOCATION SKETCH



8. CASING: ☒ Steel ☐ Galvanized ☐ Wood ☐ Plastic ☐ Concrete ☐ Other           

Di. or Thickness	8 5/8				units
Diameter	8				ins
from	0				ft
to	84				ft
Thickness	0.322				ins

☒ Welded ☐ Cemented ☐ Threaded ☐ New ☐ Used  
Note: Three - 2" PVC piezometers installed, 8" casing with draw  
Open hole, from N/A to            ft Diameter            in  
Grout: N/A

9. SCREEN: ☐ Nominal ☒ Pipe Size Type ☐ Continuous Slot ☐ Perforated ☐ Louvre ☐ Other 2" slotted PVC  
Material ☐ Stainless Steel ☒ Plastic ☐ Other             
Set from see to below ft below ground level

SCREEN & BLANKS				units
Length	A-5	B-3	C-3	ft
Diam. ID	2	2	2	ins
Slot Size	.020	.020	.020	ins
from	6	32	70	ft
to	11	35	73	ft

Fittings, top Threaded bottom 5' tail pipe  
Gravel Pack silica sand

10. DEVELOPED BY: ☐ Surging ☐ Jetting ☒ Bailing ☒ Pumping ☐ Other           

11. TEST ☐ Pump ☐ Ball ☒ Air Date 9.01.09.13  
Rate            gpm Temp            °C SWL before test             
PWL            ft end of test of            hrs            mins

TIME in mins & DRAWDOWN in ft				TIME in mins & RECOVERY in			
mins	WT	mins	SWL	mins	WL	mins	WL
A	20	gpm 8.46	ft				
B	11	gpm 8.40					
C	18	gpm 8.27					

RECOMMENDED PUMP TYPE 2" monitoring well RECOMMENDED PUMP SETTING 2-3

13. WATER TYPE: ☐ fresh ☐ salty ☒ clear ☐ color colour            smell            gas ☐ yes ☐ no

14. WATER ANALYSIS: ☐ Hardness            mg/l ☐ Iron            mg/l ☐ Chloride            mg/l ☐ pH            ☐ Cond.            ☐ Temp.            Date           

15. FINAL WELL COMPLETION DATA  
Well Depth 5 ft Water Flowing            ft  
Static Water Level            ft Pressure Head            ft  
Back filled           

A - 16 B - 40 C - 80 ft  
16. CONSULTANT KPA Engineering Ltd.

KPA

Project Tahsis

By DL

Date 09/90

Page 3 of 4

Subject Monitor Wells

Ckd. DL

Date "

Job No. 2690

Well #3

Ground  
Surface

Water Table ▼

Depths (feet)  
below ground

+2.6 -

3 -

5 -

6 -

11 -

16 -

32 -

35 -

40 -

70 -

73 -

80 -

84 -

A

B

C

8" steel casing

concrete seal

Bottom 8" casing

2" PVC Pipe

Silica Sand

Pit run gravel

Bentonite Seal

2" PVC slotted  
Pipe

2" PVC Tail pipe

Casing shoe

Bottom of  
Borehole

Well Diagram

NTS

# WATER WELL RECORD

Date 19.10.91/4

Descriptive Location

Near Tahsis wood waste dump, see sketch

Owners Name

CPEPL

Driller

Drillwell Ltd.

LAT.

LONG.

WELL No.

1014

UTM

Z

E

N

UTM

Date 1990

1. TYPE OF WORK

☒ New Well  
☐ Deepened

☐ Reconditioned  
☐ Abandoned

2. WORK METHOD

☐ Cable tool  
☒ Rotary  
☐ Other

☐ Bored  
☐ mud  
☒ air  
☐ reverse

3. WATER WELL USE

☐ Domestic  
☒ Commercial  
☐ Other

☐ Municipal  
☒ Industrial  
Monitoring

4. DRILLING ADDITIVES

Nil

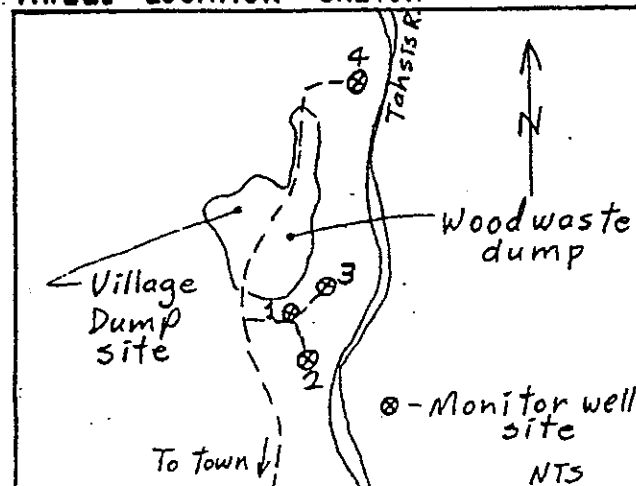
5. MEASUREMENTS

from ☒ ground level ☐ top of casing

Top of casing to ground level        ft

FROM	TO	6. WELL LOG DESCRIPTION	SWL
0	16	Gravel & sand	
16	19	silty gravel & peat	
19	34	silty grey gravel and sand with clay	
34	39	silty gravel, angular brown water	
39	54	silty brown gravel water bearing	
54	57	soupy grey silty sand, dry	

7. WELL LOCATION SKETCH



8. CASING Materials

☒ Steel  
☐ Plastic  
☐ Other

☐ Galvanized  
☒ Concrete

☐ Wood

units
inches
Diameter <u>8 5/8</u>
ft.
from <u>0</u>
to <u>55</u>
Thickness <u>0.322</u>
ins.

☒ Welded ☐ Cemented ☐ Threaded ☐ New ☐ Used  
Note: Two - 2" PVC piezometers installed, 8" casing withdrawn

Open hole, from NA to        ft Diameter        in  
Grout: N/A

9. SCREEN

☐ Nominal ☒ Pipe Size

Type ☐ Continuous Slot ☐ Perforated ☐ Louvre  
☐ Other 2" slotted PVC

Material ☐ Stainless Steel ☒ Plastic ☐ Other  
Set from see to below ft below ground level

SCREEN & BLANKS	units
Length <u>A-10</u> <u>B-3</u> Note: open	ft.
Diam. ID <u>2</u> <u>2</u> bottom at	ins.
Slot Size <u>.020</u> <u>.020</u> 21 feet	ins.
from <u>6</u> <u>45</u>	ft.
to <u>16</u> <u>48</u>	ft.

Fittings, top Threaded bottom 5' tail pipe  
Gravel Pack silica sand

10. DEVELOPED BY: ☐ Surging ☐ Jetting ☒ A  
☐ Bailing ☒ Pumping ☐ Other

11. TEST ☐ Pump ☐ Ball ☐ Air Date                       
Rate        gpm Temp        °C SWL before test         
PWL        ft end of test of        hrs        mins

TIME in mins & DRAWDOWN in ft	TIME in mins & RECOVERY in ft
mins	mins
WT	WL
mins	mins
SWL	SWL
A <u>0.75</u> <u>gpm</u> <u>19.86</u> ft	
B <u>10</u> <u>gpm</u> <u>20.6</u> ft	
	Note: <u>3 WL to top of 8" casing</u>

12. Recommended pump type: 2" monitoring well 2-3

13. WATER TYPE: ☐ fresh ☐ salty ☒ clear ☐ clot  
colour        small       ; gas ☐ yes ☐ no

14. WATER ANALYSIS: ☐ Hardness        mg  
☐ Iron        mg/l ☐ Chloride        mg  
☐ pH        ☐ Cond:         
☐ Temp.        Date                     

15. FINAL WELL COMPLETION DATA

Well Depth        ft Water Flowing         
Static Water Level        ft Pressure Head         
Back filled       

16. CONSULTANT A-21 B-55 feet  
KPA Engineering Ltd.



KPA

Project Tahsis

By DL

Date 14  
09/90

Page 4 of 4

Subject Monitor Wells

Ckd. DL

Date "

Job No. 2690

Well # 4 +2.43

Ground  
Surface0  
3  
4  
6Water Table  $\nabla$  16Open  
Bottom

21

Depths (feet)  
below ground

45

48

55

57

8" steel casing

Concrete seal

Bottom 8" casing

2" PVC Pipe

Dit run gravel

Bentonite seal

Silica sand

2" PVC slotted  
Pipe

2" PVC Tail pipe

Casing shoe

Bottom of  
Borehole

Well Diagram

NTS

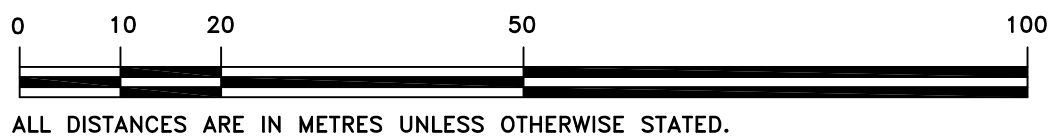
## Appendix C

### 2018 and 2019 Topographic Surveys

TOPOGRAPHIC SURVEY PLAN OF TAHSIS LAND FILL

SURVEY COMPLETED OCTOBER 30TH, 2018.

SCALE 1:750

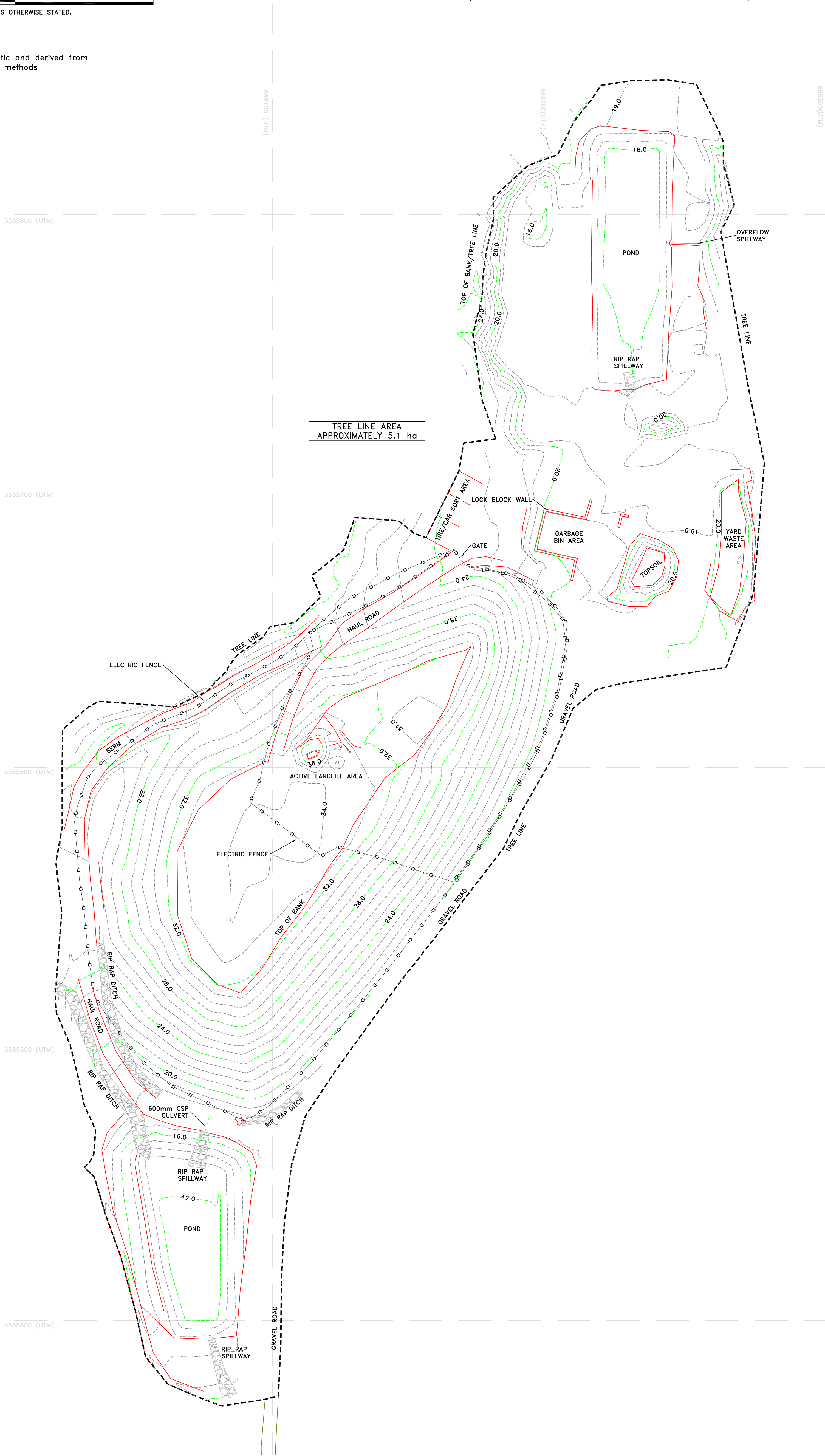
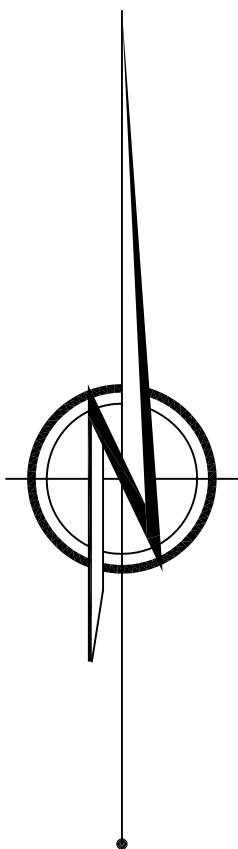


ALL DISTANCES ARE IN METRES UNLESS OTHERWISE STATED.

Contour Interval = 1.0m  
Note: All elevations are geodetic and derived from autonomous GPS survey methods

NOTE:  
VOLUME OF MATERIAL FROM EXISTING GRADE TO PROPOSED DESIGN  
FILL=7463m³  
CUT=10751m³

NOTE:  
FILL VOLUME OF MATERIAL FROM JANUARY 2018 TO OCTOBER 2018  
FILL=609m³





TOPOGRAPHIC SURVEY PLAN OF TAHSIS LAND FILL

SURVEY COMPLETED OCTOBER 30TH, 2019.

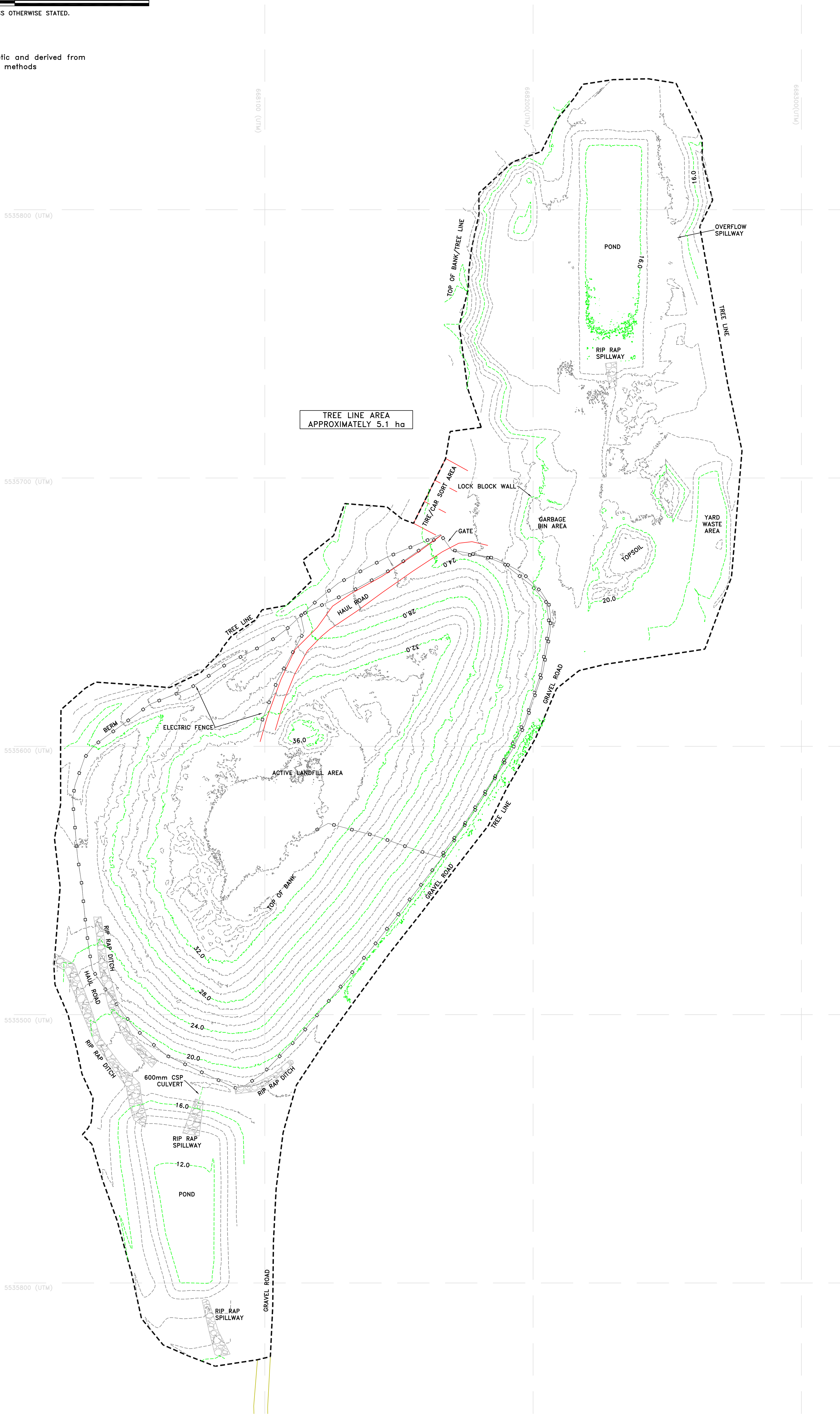
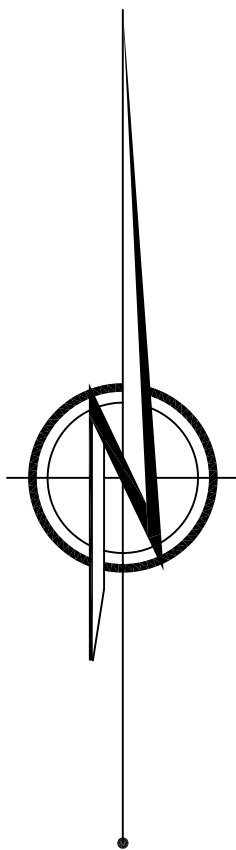
SCALE 1:750



ALL DISTANCES ARE IN METRES UNLESS OTHERWISE STATED.

Contour Interval = 1.0m  
Note: All elevations are geodetic and derived from autonomous GPS survey methods

NOTE:  
VOLUME OF MATERIAL FROM EXISTING GRADE TO PROPOSED REVISED DESIGN.  
FILL=13315m³  
CUT=1113m³  
FILL VOLUME FROM OCTOBER 2018 – OCTOBER 2019 = 4510m²



# Appendix D

## 2019 Closure and Post-Closure Fund Estimates Memorandum Excerpt



# Memorandum

February 6, 2020

To: Beth Dunlop, Comox Valley Regional District Ref. No.: 056484-51-12

From:  Jeremy Scott/cs/119-Rev.1 Tel: 604 248 3971

CC: Deacon Liddy

**Subject: 2019 Closure and Post-Closure Fund Estimates  
Comox Strathcona Waste Management  
Campbell River, Comox Valley, Gold River, Tahsis and Zeballos, British Columbia**

## 1. Introduction

This memorandum has been prepared by GHD Limited (GHD) for the Comox Valley Regional District (CVRD) to present the 2019 closure and post-closure (CPC) fund estimates for the following Comox Strathcona (CSWM) Solid Waste Management Centres (SWMCs):

- Campbell River
- Comox Valley – Historic Landfill & Engineered Cell
- Gold River
- Tahsis
- Zeballos

Table 1 presents a summary of the CPC cost estimates for the six SWMCs.

## 2. Calculation Methodology

Landfill CPC fund estimates have been calculated based on the methodology for calculating landfill liability described in PS 3270 – Solid Waste Landfill Closure & Post-closure Liability. The following equation presents a summary of the methodology:

$$E = [A \times (B/C)] - D$$

Where:

A = Present value of estimated CPC expenditures for landfill site

B = Total used capacity of the landfill

C = Total capacity of the landfill (both used and unused)



D = Total CPC liabilities/expenditures recognized to date

E = Landfill CPC fund estimate

The estimated total CPC expenditures for the landfill sites were considered to consist of capital and operations expenditures and post-closure operation and maintenance (O&M) costs. Estimated closure costs and scheduling were based on the Comox Strathcona Waste Management (CSWM) 2019-2023 Proposed Financial Plan capital schedule. Post-closure O&M costs were developed by GHD based on experience with similar sized landfills in southwestern BC. Post closure monitoring costs were forecast based on current monitoring costs as contained in the agreement between GHD and the CVRD dated May 14, 2014 for all sites except the Comox Valley WMC Cell 1 which was estimated based on GHD experience at CVRD SWMCs.

## **2.1 Inflation and Discount Rates**

All calculations of the present value of CPC costs were completed using the same rates for O&M inflation, construction cost inflation, and discount. The following list presents values and sources for inflation and discount rates applied:

- Construction cost inflation rate of 3.27% based on the 10 year average annual increase in the Vancouver non-residential building construction index from more recent available data (Q3 2019), as calculated by GHD.
- Discount rate of 2.81% based on the Municipal Finance Authority of BC's (MFA) 30 year indicative lending rate, at December 31, 2019, provided by the CSWM.
- Inflation rate of 1.65% based on the average annual percent change of the Consumer Price Index for BC (averaged over 2010-2019 period) as calculated by GHD.

Further details on values used for forecasts are presented below for each SWMC in turn.

## **3. Campbell River**

Details of the present value calculations for the Campbell River SWMC are presented in Table 2. At this time the CVRD plans to close the landfill by 2023 when it reaches final capacity. The following list summarizes the key inputs to the CPC Fund Update:

- Closure of the existing landfill footprint will take place in phases between 2020 and 2023 at a total cost of \$10,562,500.
- Annual cost of post closure operations and monitoring of \$90,000.
- Annual cost of post-closure landfill gas collection system operations and maintenance of \$100,000.
- Total used capacity to the end of 2019 of 2,608,492 cubic metres (m<sup>3</sup>) as compared to a total capacity of 2,700,000 m<sup>3</sup> (approximately 96.6% of total capacity used). Remaining airspace was estimated based on McElhanney Survey conducted November 2019 as compared to the top final contours surface prepared by GHD for the Campbell River 2017 Design, Operations and Closure Plan (GHD, 2018) (122,950 m<sup>3</sup>)



less an allowance for the placement of 0.75 metre thick final cover over the fill area (25,000 m<sup>3</sup>). Only the centre portion of the landfill where filling occurred in the last 2 years was included in the analysis.

- 30 year post closure period beginning in 2024.

The estimated present value of the CPC costs of the existing landfill is \$17,536,518. Based on the current airspace capacity used of 96.6 percent, the current landfill CPC liability is \$16,942,175.

#### 4. Comox Valley

Details of the present value calculations for the Comox Valley SWMC are presented in Tables 3 and 4. Separate calculations were developed for the historical Comox Valley SWMC and Cell 1 of the Comox Valley SWMC. The following list summarizes the key inputs to the CPC Fund Update for each of the portions of the Comox Valley SWMC:

##### *Historical Comox Valley SWMC (Table 3)*

- Closure of the historical landfill footprint was planned for two phases. The first phase was partially completed in 2015. Phase 2 began in 2018 and will be completed in 2020. The final closure costs are anticipated to be \$200,000 for 2020.
- Annual cost of post closure monitoring of \$90,000.
- Cost of post closure landfill maintenance of \$20,000 every five years.
- Annual cost of post-closure landfill gas collection system operations and maintenance of \$75,000.
- Total used capacity to end of 2019 of 3,390,559 m<sup>3</sup> compared to a total capacity of 3,390,559 m<sup>3</sup>. As 100% of total capacity is used the remaining airspace is 0 m<sup>3</sup>.
- 30 year post closure period beginning in 2020.

The estimated present value of the CPC cost of the historical Comox Valley SWMC landfill is \$4,872,111. Based on the current airspace capacity used of 100% percent, the current landfill CPC liability is \$4,872,111.

##### *Comox Valley SWMC Cell 1 (Table 4)*

- Closure of the Comox Valley SWMC Cell 1 is planned to consist of the following works:
  - Cell 1 design for partial closure and gas collection construction at \$328,000 for year 2020
  - Cell 1 gas collection construction at \$150,000 for year 2021
  - Cell 1 design for partial closure and gas collection construction at \$180,000 for 2022
  - Cell 1 design for partial closure and gas collection construction at \$330,000 for 2023
  - Cell 1 partial closure construction \$870,335 for 2024
- Annual cost of post closure monitoring of \$50,000.
- Cost of post closure landfill maintenance of \$10,000 every five years.
- Annual cost of post-closure LFG collection system operations and maintenance of \$25,000.





- Total used capacity to end of 2019 of 102,219 m<sup>3</sup> as compared to a total capacity of 449,178 m<sup>3</sup> (approximately 22.8% of total capacity used). Remaining airspace was determined based on survey data collected by McElhanney as compared to the base of final design contours from CVRD Fill plan.
- 30 year post closure period beginning in 2025.

The estimated present value of the CPC cost of Cell 1 is \$3,728,053. Based on the current airspace capacity used of 22.4 percent, the current landfill CPC liability is \$848,385.

## 5. Gold River

Details of the present value calculations for the Gold River SWMC are presented in Table 5. The following list summarizes the key inputs to the CPC Fund Update:

- Closure of the existing landfill footprint in 2026 at \$414,600 and 2027 at \$1,210,700.
- Annual cost of post closure operations and monitoring of \$26,500.
- Cost of post closure landfill maintenance of \$20,000 every five years.
- Total used capacity to end of 2019 of 54,870 m<sup>3</sup> as compared to a total capacity of 58,000 m<sup>3</sup> (approximately 94.6% of total capacity used). Remaining airspace was determined based on survey data collected by McElhanney and extrapolated from historical total airspace estimates.
- 30 year post closure period beginning in 2028.

The estimated present value of the CPC cost of the existing landfill is \$2,737,910. Based on the current airspace capacity used of 94.6 percent, the current landfill CPC liability is \$2,590,153.

## 6. Tahsis

Details of the present value calculations for the Tahsis SWMC are presented in Table 6. The following list summarizes the key inputs to the CPC Fund Update:

- Closure of the existing landfill footprint in 2024 at \$100,000 and 2025 at \$725,000.
- Annual cost of post closure operations and monitoring of \$24,000.
- Cost of post closure landfill maintenance of \$20,000 every five years.
- Total used capacity to the end of 2019 of 108,588 m<sup>3</sup> as compared to a total capacity of 113,500 m<sup>3</sup> (approximately 95.7% of total capacity used). Remaining airspace was determined based on survey data collected by McElhanney as compared to final design contours from GHD memo Tahsis Landfill - Fill Plan Update dated April 2018, less an allowance for 0.75 m of final cover.
- 30 year post closure period beginning in 2026.

The estimated present value of the CPC of the existing landfill is \$1,710,100. Based on the current airspace capacity used 95.7 percent, the current landfill CPC liability is \$1,636,085.



## 7. Zeballos

Details of the present value calculations for the Zeballos SWMC are presented in Table 7. The following list summarizes the key inputs to the CPC Fund Update:

- Closure of the existing landfill footprint in 2024 at \$96,000 and 2025 at \$480,000.
- Annual cost of post closure operations and monitoring of \$28,000.
- Cost of post closure landfill maintenance of \$20,000 every five years.
- Total used capacity to the end of 2019 of 8967 m<sup>3</sup> as compared to a total estimated capacity of 16,500 m<sup>3</sup> (approximately 54.3% of total capacity used) calculated based on topographical surveys conducted in October 2018 and November 2019 and extrapolated based on historical reports.
- 30 year post closure period beginning in 2026.

The estimated present value of the CPC cost of the existing landfill is \$1,512,298. Based on the current airspace capacity used of 54.3 percent the current landfill CPC liability is \$821,865.

## 8. Cortes

GHD is working with the CVRD and MOE to abandon the permit for this site. No further closure costs are to be incurred. Therefore no CPC liability estimate was completed.

Table 1

**Cost Estimate Summary**  
**2019 Closure and Post-Closure Fund Estimates**  
**Comox Strathcona Solid Waste Management Centres**

Waste Management Centre	Estimated Closure Year	Years to Closure	Total Closure/Post Closure Costs December 31, 2019 stated in 2014\$ (unless otherwise noted)	Inflated Closure/Post Closure Costs to year of Expenditure (3.2688% for construction, 1.6503% for O&M)	PV of Inflated Closure/ Post Closure Costs (MFA 30 year rate 2.81%)	% of Capacity used to December 31, 2019	Dec 31, 2019 Closure/ Post Closure Care Liability
Campbell River	2023	4	\$ 16,262,500	\$ 22,124,825	\$ 17,536,518	96.61%	\$ 16,942,175
Comox Valley Historical Landfill	2019	0	\$ 5,270,000	\$ 7,408,120	\$ 4,872,111	100.00%	4,872,111
Comox Valley Cell 1	2023	6	\$ 4,168,335	\$ 5,359,319	\$ 3,728,053	22.76%	848,385
Gold River	2027	8	\$ 2,540,300	\$ 3,929,036	\$ 2,737,910	94.60%	2,590,153
Tahsis	2025	6	\$ 1,665,000	\$ 2,486,061	\$ 1,710,100	95.67%	1,636,085
Zeballos	2025	6	\$ 1,536,000	\$ 2,318,573	\$ 1,512,298	54.35%	821,865
			\$ 31,442,135	\$ 43,625,934	\$ 32,096,989		
Current year	2019						
Total Closure/Post closure liability December 31, 2019							\$ 27,710,775

**Table 2: Landfill Liability - Campbell River Waste Management Centre**

Data:		31-Dec-19					
Landfill Cover Option		LLDPE					
Landfill Closure Date (approximate)		2023					
Post Closure Period (years)		30					
Current (Dec 2019) Cumulative Waste Volume (m3)		2,608,492		Note 1			
Remaining airspace volume (m3)		91,508		Note 2			
Landfill Capacity at Closure (m3)		2,700,000		Note 2			
Closure Construction Costs (2014\$)(2020-2024 PB)		\$ 10,562,500		Note 3			
Annual post closure O&M (2014\$)		\$ 90,000		Note 4			
Annual post closure LFG O&M (2014\$)		\$ 100,000		Note 5			
Construction cost escalation rate		3.2688%		Note 6			
Discount rate		2.81%		Note 7		MFA Dec 2019 = 2.81%	
Inflation rate		1.6503%		Note 8			

Year	Years for FV calcs	Years for NPV	Construction Cash Flow 2014 \$	Maintenance Cash Flow 2014 \$	Cash Flow plus Inflation	Present Value	Description of Cost
2014							
2020	6	1	\$ 525,000	\$ -	\$ 636,756	\$ 619,352	Ph 2 LFG and final cover design
2021	7	2	\$ 6,150,000	\$ -	\$ 7,702,959	\$ 7,287,640	Ph 2 LFG and final cover construction
2022	8	3	\$ 125,000	\$ -	\$ 161,682	\$ 148,784	Ph 3 closure design/surface water
2023	9	4	\$ 3,762,500	\$ -	\$ 5,025,703	\$ 4,498,373	Ph 3 LFG and final cover design
2024	10	5		\$ 190,000	\$ 223,789	\$ 194,833	Ph 3 LFG and final cover construction
2025	11	6		\$ 190,000	\$ 227,482	\$ 192,635	Annual O&M plus annual LFG O&M
2026	12	7		\$ 190,000	\$ 231,236	\$ 190,462	Annual O&M plus annual LFG O&M
2027	13	8		\$ 190,000	\$ 235,052	\$ 188,314	Annual O&M plus annual LFG O&M
2028	14	9		\$ 190,000	\$ 238,931	\$ 186,189	Annual O&M plus annual LFG O&M
2029	15	10		\$ 190,000	\$ 242,874	\$ 184,089	Annual O&M plus annual LFG O&M
2030	16	11		\$ 190,000	\$ 246,882	\$ 182,012	Annual O&M plus annual LFG O&M
2031	17	12		\$ 190,000	\$ 250,957	\$ 179,959	Annual O&M plus annual LFG O&M
2032	18	13		\$ 190,000	\$ 255,098	\$ 177,929	Annual O&M plus annual LFG O&M
2033	19	14		\$ 190,000	\$ 259,308	\$ 175,922	Annual O&M plus annual LFG O&M
2034	20	15		\$ 190,000	\$ 263,587	\$ 173,938	Annual O&M plus annual LFG O&M
2035	21	16		\$ 190,000	\$ 267,937	\$ 171,976	Annual O&M plus annual LFG O&M
2036	22	17		\$ 190,000	\$ 272,359	\$ 170,036	Annual O&M plus annual LFG O&M
2037	23	18		\$ 190,000	\$ 276,853	\$ 168,118	Annual O&M plus annual LFG O&M
2038	24	19		\$ 190,000	\$ 281,422	\$ 166,221	Annual O&M plus annual LFG O&M
2039	25	20		\$ 190,000	\$ 286,066	\$ 164,346	Annual O&M plus annual LFG O&M
2040	26	21		\$ 190,000	\$ 290,787	\$ 162,492	Annual O&M plus annual LFG O&M
2041	27	22		\$ 190,000	\$ 295,586	\$ 160,659	Annual O&M plus annual LFG O&M
2042	28	23		\$ 190,000	\$ 300,464	\$ 158,847	Annual O&M plus annual LFG O&M
2043	29	24		\$ 190,000	\$ 305,423	\$ 157,055	Annual O&M plus annual LFG O&M
2044	30	25		\$ 190,000	\$ 310,463	\$ 155,284	Annual O&M plus annual LFG O&M
2045	31	26		\$ 190,000	\$ 315,586	\$ 153,532	Annual O&M plus annual LFG O&M
2046	32	27		\$ 190,000	\$ 320,794	\$ 151,800	Annual O&M plus annual LFG O&M
2047	33	28		\$ 190,000	\$ 326,088	\$ 150,088	Annual O&M plus annual LFG O&M
2048	34	29		\$ 190,000	\$ 331,470	\$ 148,395	Annual O&M plus annual LFG O&M
2049	35	30		\$ 190,000	\$ 336,940	\$ 146,721	Annual O&M plus annual LFG O&M
2050	36	31		\$ 190,000	\$ 342,500	\$ 145,066	Annual O&M plus annual LFG O&M
2051	37	32		\$ 190,000	\$ 348,152	\$ 143,429	Annual O&M plus annual LFG O&M
2052	38	33		\$ 190,000	\$ 353,898	\$ 141,811	Annual O&M plus annual LFG O&M
2053	39	34		\$ 190,000	\$ 359,738	\$ 140,212	Annual O&M plus annual LFG O&M
<b>TOTAL COST</b>			<b>\$ 10,562,500</b>	<b>\$ 5,700,000</b>	<b>\$ 22,124,825</b>	<b>\$ 17,536,518</b>	
<b>NPV of Estimated Closure and Post Closure Costs =</b>						<b>\$ 17,536,518</b>	
<b>Landfill Liability in Dec 2019 (\$) =</b>						<b>\$ 16,942,175</b>	NPV x (Cumulative Capacity Used)/(Total Estimated Capacity)

**Notes:**

- (1) Airspace consumed calculated based on operational data for waste received at the site during 2019.
- (2) Total airspace remaining and waste in place calculated as of December 31, 2019 based on McElhanney Survey conducted November 2019 as compared to the top final contours surface prepared by GHD for the Campbell River 2017 Design, Operations and Closure Plan (GHD, 2018) less an allowance for the placement of 0.75 metre thick final cover over the fill area. Only the centre portion of the landfill where filling occurred in the last 2 years was included in the analysis.
- (3) Construction costs in 2014\$
- (4) Annual post closure operating and maintenance costs include environmental monitoring costs.
- (5) Annual Post Closure Landfill Gas System costs calculated assuming landfill gas collection system will be finalized in 2021.
- (6) Construction cost inflation rate applied to forecast construction costs, calculated based on 10 year average annual increase in Vancouver non-residential building construction index (CANSIM Table 18-10-0135-01) (latest index Q4 2019).
- (7) Discount rate calculated based on MFA 30 year borrowing rate as of December 31, 2019
- (8) Operations and maintenance inflation rate applied to operations and maintenance costs. Calculated based on the average of the annual percent change of the Consumer price index for BC (averaged over 2010-2019 period) (CANSIM Table 18-10-0004-01)

**Table 3: Landfill Liability - Comox Valley Waste Management Centre - Historical Landfill**

Data:	31-Dec-19	
Landfill Cover Option	LLDPE	
Landfill Closure Date (approximate)	Early 2020	
Post Closure Period (years)	30	
Current (Dec 2019) waste in place (m3)	3,390,559	Note 1
Remaining airspace (Dec 2019) (m3)	0	Note 1
Landfill Capacity at Closure (m3)	3,390,559	Note 2
Closure construction costs (2014\$)	\$ 200,000	Note 3
Annual post closure O&M (2014\$)	\$ 90,000	Note 4
5th year post closure O&M costs (2014\$)	\$ 110,000	Note 4
Annual post closure LFG O&M (2014\$)	\$ 75,000	Note 5
Construction cost escalation rate	3.2688%	Note 6
Discount rate	2.81%	Note 7
Inflation rate	1.6503%	Note 8

Year	Years for FV calcs	Years for NPV	Construction Costs Cash Flow (2014 \$)	Monitoring / Maintenance Cash Flow (2014 \$)	Cash Flow plus Inflation	Present Value	Description of Cost
2014							
2020	6	1	\$ 200,000	\$ 165,000	\$ 424,600	\$ 412,995	Cwfd 2019 closure + Annual O&M plus LFG
2021	7	2		\$ 165,000	\$ 185,031	\$ 175,054	Annual O&M plus annual LFG O&M
2022	8	3		\$ 165,000	\$ 188,084	\$ 173,080	Annual O&M plus annual LFG O&M
2023	9	4		\$ 185,000	\$ 214,362	\$ 191,870	Annual O&M plus annual LFG O&M plus 5 year maintenance
2024	10	5		\$ 165,000	\$ 194,343	\$ 169,197	Annual O&M plus annual LFG O&M
2025	11	6		\$ 165,000	\$ 197,550	\$ 167,288	Annual O&M plus annual LFG O&M
2026	12	7		\$ 165,000	\$ 200,810	\$ 165,401	Annual O&M plus annual LFG O&M
2027	13	8		\$ 165,000	\$ 204,124	\$ 163,535	Annual O&M plus annual LFG O&M
2028	14	9		\$ 185,000	\$ 232,644	\$ 181,290	Annual O&M plus annual LFG O&M plus 5 year maintenance
2029	15	10		\$ 165,000	\$ 210,917	\$ 159,867	Annual O&M plus annual LFG O&M
2030	16	11		\$ 165,000	\$ 214,398	\$ 158,063	Annual O&M plus annual LFG O&M
2031	17	12		\$ 165,000	\$ 217,936	\$ 156,280	Annual O&M plus annual LFG O&M
2032	18	13		\$ 165,000	\$ 221,533	\$ 154,518	Annual O&M plus annual LFG O&M
2033	19	14		\$ 185,000	\$ 252,484	\$ 171,293	Annual O&M plus annual LFG O&M plus 5 year maintenance
2034	20	15		\$ 165,000	\$ 228,905	\$ 151,051	Annual O&M plus annual LFG O&M
2035	21	16		\$ 165,000	\$ 232,682	\$ 149,347	Annual O&M plus annual LFG O&M
2036	22	17		\$ 165,000	\$ 236,522	\$ 147,663	Annual O&M plus annual LFG O&M
2037	23	18		\$ 165,000	\$ 240,425	\$ 145,997	Annual O&M plus annual LFG O&M
2038	24	19		\$ 185,000	\$ 274,016	\$ 161,847	Annual O&M plus annual LFG O&M plus 5 year maintenance
2039	25	20		\$ 165,000	\$ 248,426	\$ 142,722	Annual O&M plus annual LFG O&M
2040	26	21		\$ 165,000	\$ 252,526	\$ 141,112	Annual O&M plus annual LFG O&M
2041	27	22		\$ 165,000	\$ 256,693	\$ 139,520	Annual O&M plus annual LFG O&M
2042	28	23		\$ 165,000	\$ 260,929	\$ 137,946	Annual O&M plus annual LFG O&M
2043	29	24		\$ 185,000	\$ 297,385	\$ 152,922	Annual O&M plus annual LFG O&M plus 5 year maintenance
2044	30	25		\$ 165,000	\$ 269,612	\$ 134,852	Annual O&M plus annual LFG O&M
2045	31	26		\$ 165,000	\$ 274,062	\$ 133,330	Annual O&M plus annual LFG O&M
2046	32	27		\$ 165,000	\$ 278,585	\$ 131,826	Annual O&M plus annual LFG O&M
2047	33	28		\$ 165,000	\$ 283,182	\$ 130,339	Annual O&M plus annual LFG O&M
2048	34	29		\$ 185,000	\$ 322,747	\$ 144,490	Annual O&M plus annual LFG O&M plus 5 year maintenance
2049	35	30		\$ 165,000	\$ 292,606	\$ 127,415	Annual O&M plus annual LFG O&M
<b>TOTAL COST</b>			<b>\$ 200,000</b>	<b>\$ 5,070,000</b>	<b>\$ 7,408,120</b>	<b>\$ 4,872,111</b>	
<b>NPV of Estimated Closure and Post Closure Costs =</b>						<b>\$ 4,872,111</b>	
<b>Landfill Liability in Dec 2019 (\$) =</b>						<b>\$ 4,872,111</b>	NPV x (Cumulative Capacity Used)/(Total Estimated Capacity)

**Notes:**

- (1) Landfill final cover installed Summer 2019
- (2) Total site capacity based on Annual Operations and Monitoring Report (GHD, 2017) and revised final contours (EBA, 2017).
- (3) Construction costs in 2014\$ from proposed financial plan capital schedules.
- (4) Annual post closure operating and maintenance costs include environmental monitoring costs, estimated based on GHD experience at CVRD waste management centres.
- (5) Annual Post Closure Landfill Gas System costs calculated assuming landfill gas collection system will be finalized in 2021. Estimated based on GHD experience at similar sites in British Columbia.
- (6) Construction cost inflation rate applied to forecast construction costs, calculated based on 10 year average annual increase in Vancouver non-residential building construction index (CANSIM Table 18-10-0135-01) (latest index Q4 2019).
- (7) Discount rate calculated based on MFA 30 year borrowing rate as of December 31, 2019
- (8) Operations and maintenance inflation rate applied to operations and maintenance costs. Calculated based on the average of the annual percent change of the Consumer price index for BC (averaged over 2010-2019 period) (CANSIM Table 18-10-0004-01)

**Table 4: Landfill Liability - Comox Valley Waste Management Centre - Cell 1 (Progressive Closure)**

<b>Data:</b>	<b>31-Dec-19</b>	
Landfill Cover Option	LLDPE	
Landfill Closure Date (approximate)	2024	
Post Closure Period (years)	30	
Current (Dec 2019) waste in place (m3)	102,219	Note 1
Remaining airspace (Dec 2019) (m3)	346,960	Note 2
Landfill Capacity at Closure (m3)	449,178	Note 3
Closure construction costs (2019\$) (2020-2024 PB)	<b>\$1,858,335</b>	Note 4
Annual post closure O&M (2019\$)	\$50,000	Note 5
5th year post closure O&M costs (2019\$)	\$60,000	Note 5
Annual post closure LFG O&M (2019\$)	\$25,000	Note 6
Construction cost escalation rate	3.2688%	Note 7
Discount rate	2.81%	Note 8
Inflation rate	1.6503%	Note 9

Year	Years for FV calcs	Years for NPV	Construction Costs Cash Flow (2019 \$)	Monitoring / Maintenance Cash Flow (2019 \$)	Cash Flow plus Inflation	Present Value	Decription of Cost
2020	1	1	\$ 328,000		\$ 338,722	\$ 329,464	Cell 1 design for partial closure/gas collection
2021	2	2	\$ 150,000		\$ 159,967	\$ 151,342	Cell 1 gas collection construction
2022	3	3	\$ 180,000		\$ 198,235	\$ 182,420	Cell 1 design for partial closure/gas collection constr
2023	4	4	\$ 330,000		\$ 375,310	\$ 335,930	Cell 1 design for partial closure/gas collection constr
2024	5	5	\$ 870,335		\$ 1,022,189	\$ 889,927	Cell 1 partial closure construction
2025	6	6		\$ 75,000	\$ 82,739	\$ 70,065	
2026	7	7		\$ 75,000	\$ 84,105	\$ 69,275	
2027	8	8		\$ 75,000	\$ 85,493	\$ 68,493	
2028	9	9		\$ 85,000	\$ 98,491	\$ 76,750	
2029	10	10		\$ 75,000	\$ 88,338	\$ 66,957	
2030	11	11		\$ 75,000	\$ 89,796	\$ 66,201	
2031	12	12		\$ 75,000	\$ 91,277	\$ 65,454	
2032	13	13		\$ 75,000	\$ 92,784	\$ 64,716	
2033	14	14		\$ 85,000	\$ 106,890	\$ 72,518	
2034	15	15		\$ 75,000	\$ 95,871	\$ 63,264	
2035	16	16		\$ 75,000	\$ 97,454	\$ 62,551	
2036	17	17		\$ 75,000	\$ 99,062	\$ 61,845	
2037	18	18		\$ 75,000	\$ 100,697	\$ 61,147	
2038	19	19		\$ 85,000	\$ 116,006	\$ 68,519	
2039	20	20		\$ 75,000	\$ 104,048	\$ 59,776	
2040	21	21		\$ 75,000	\$ 105,765	\$ 59,101	
2041	22	22		\$ 75,000	\$ 107,510	\$ 58,435	
2042	23	23		\$ 75,000	\$ 109,284	\$ 57,776	
2043	24	24		\$ 85,000	\$ 125,899	\$ 64,740	
2044	25	25		\$ 75,000	\$ 112,921	\$ 56,479	
2045	26	26		\$ 75,000	\$ 114,784	\$ 55,842	
2046	27	27		\$ 75,000	\$ 116,679	\$ 55,212	
2047	28	28		\$ 75,000	\$ 118,604	\$ 54,590	
2048	29	29		\$ 85,000	\$ 136,636	\$ 61,170	
2049	30	30		\$ 75,000	\$ 122,551	\$ 53,365	
2050	31	31		\$ 75,000	\$ 124,574	\$ 52,763	
2051	32	32		\$ 75,000	\$ 126,629	\$ 52,168	
2052	33	33		\$ 75,000	\$ 128,719	\$ 51,579	
2053	34	34		\$ 85,000	\$ 148,289	\$ 57,797	
2054	35	35		\$ 75,000	\$ 133,003	\$ 50,422	
<b>TOTAL COST</b>			<b>\$ 1,858,335</b>	<b>\$ 2,310,000</b>	<b>\$ 5,359,319</b>	<b>\$ 3,728,053</b>	
<b>NPV of Estimated Closure and Post Closure Costs =</b>						<b>\$ 3,728,053</b>	
<b>Landfill Liability in Dec 2019 (\$) =</b>						<b>\$848,385</b>	NPV x (Cumulative Capacity Used)/(Total Estimated Capacity)

**Notes:**

- (1) Waste in place calculated based on the difference of landfill capacity at closure and remaining airspace
- (2) Remaining airspace capacity calculated based on comparison of November 2019 survey and liner top of gravel survey pro-rated to Dec 31 2019 using tonnage data provided by CVRD
- (3) Landfill capacity at closure calculated based on comparison of Final stage contours and top of stone liner survey
- (4) Construction costs in 2017\$ from proposed financial plan capital schedules.
- (5) Annual post closure operating and maintenance costs include environmental monitoring costs, estimated based on GHD experience at CVRD
- (6) Annual Post Closure Landfill Gas System costs calculated assuming landfill gas collection system will be finalized in 2024. Estimated based on GHD experience at similar sites in British Columbia.
- (7) Construction cost inflation rate applied to forecast construction costs, calculated based on 10 year average annual increase in Vancouver non-residential building construction index (CANSIM Table 18-10-0135-01) (latest index Q4 2019).
- (8) Discount rate calculated based on MFA 30 year borrowing rate as of December 31, 2019.
- (9) Operations and maintenance inflation rate applied to operations and maintenance costs. Calculated based on the average of the annual percent change of the Consumer price index for BC (averaged over 2010-2019 period) (CANSIM Table 18-10-0004-01)

**Table 5: Landfill Liability Assessment - Gold River Waste Management Centre**

Data:	31-Dec-19	
Landfill Cover Option	GCL	
Landfill Closure Date (approximate)	2027	
Post Closure Period (years)	30	
Current (Dec 2019) waste in place (m3)	54,870	Note 1
Landfill Capacity at Closure (m3)	58,000	Note 2
Closure Costs (2014\$) (2020-2024 PB)	<b>\$1,625,300</b>	Note 3
Annual post closure O&M (2014\$)	\$26,500	Note 4
5th year post closure O&M costs (2014\$)	\$46,500	Note 4
Construction cost escalation rate	3.2688%	Note 5
Discount rate	2.81%	Note 6
Inflation rate	1.6503%	Note 7

Year	Years for FV	Years for PV	Cash Flow (2014\$)		Cash Flow plus Inflation	Present Value	Description of Cost
			Construction/ Other	Monitoring /Maintenance			
2014							
2020	6	1	-		-	-	
2021	7	2	-		-	-	
2022	8	3	-		-	-	
2023	9	4	-		-	-	
2024	10	5			-	-	
2025	11	6			-	-	
2026	12	7	\$ 414,600		\$ 609,897	\$ 502,353	Closure engineering based on option 2 DOC plan
2027	13	8	\$ 1,210,700		\$ 1,839,215	\$ 1,473,499	Closure construction
2028	14	9		\$ 26,500	\$ 33,325	\$ 25,969	Annual O&M
2029	15	10		\$ 26,500	\$ 33,875	\$ 25,676	Annual O&M
2030	16	11		\$ 26,500	\$ 34,434	\$ 25,386	Annual O&M
2031	17	12		\$ 26,500	\$ 35,002	\$ 25,100	Annual O&M
2032	18	13		\$ 46,500	\$ 62,432	\$ 43,546	Annual O&M plus allowance for 5 year maintenance
2033	19	14		\$ 26,500	\$ 36,167	\$ 24,537	Annual O&M
2034	20	15		\$ 26,500	\$ 36,763	\$ 24,260	Annual O&M
2035	21	16		\$ 26,500	\$ 37,370	\$ 23,986	Annual O&M
2036	22	17		\$ 26,500	\$ 37,987	\$ 23,716	Annual O&M
2037	23	18		\$ 46,500	\$ 67,756	\$ 41,145	Annual O&M plus allowance for 5 year maintenance
2038	24	19		\$ 26,500	\$ 39,251	\$ 23,183	Annual O&M
2039	25	20		\$ 26,500	\$ 39,899	\$ 22,922	Annual O&M
2040	26	21		\$ 26,500	\$ 40,557	\$ 22,663	Annual O&M
2041	27	22		\$ 26,500	\$ 41,226	\$ 22,408	Annual O&M
2042	28	23		\$ 46,500	\$ 73,535	\$ 38,876	Annual O&M plus allowance for 5 year maintenance
2043	29	24		\$ 26,500	\$ 42,598	\$ 21,905	Annual O&M
2044	30	25		\$ 26,500	\$ 43,301	\$ 21,658	Annual O&M
2045	31	26		\$ 26,500	\$ 44,016	\$ 21,414	Annual O&M
2046	32	27		\$ 26,500	\$ 44,742	\$ 21,172	Annual O&M
2047	33	28		\$ 46,500	\$ 79,806	\$ 36,732	Annual O&M plus allowance for 5 year maintenance
2048	34	29		\$ 26,500	\$ 46,231	\$ 20,697	Annual O&M
2049	35	30		\$ 26,500	\$ 46,994	\$ 20,464	Annual O&M
2050	36	31		\$ 26,500	\$ 47,770	\$ 20,233	Annual O&M
2051	37	32		\$ 26,500	\$ 48,558	\$ 20,005	Annual O&M
2052	38	33		\$ 46,500	\$ 86,612	\$ 34,706	Annual O&M plus allowance for 5 year maintenance
2053	39	34		\$ 26,500	\$ 50,174	\$ 19,556	Annual O&M
2054	40	35		\$ 26,500	\$ 51,002	\$ 19,335	Annual O&M
2055	41	36		\$ 26,500	\$ 51,844	\$ 19,117	Annual O&M
2056	42	37		\$ 26,500	\$ 52,699	\$ 18,901	Annual O&M
2057	43	38		\$ 46,500	\$ 93,998	\$ 32,793	Annual O&M plus allowance for 5 year maintenance
<b>TOTAL COST</b>			<b>\$1,625,300</b>	<b>\$915,000</b>	<b>\$3,929,036</b>	<b>\$2,737,910</b>	
<b>NPV of Estimated Closure and Post Closure Costs =</b>						<b>\$2,737,910</b>	
<b>Landfill Liability in Dec 2019 (\$) =</b>						<b>\$2,590,153</b>	NPV x (Cumulative Capacity Used)/(Total Estimated Capacity)

**Notes:**

- (1) Remaining capacity as of December 31, 2019 calculated based on surveys conducted October 9 2018 and October 28 2019 prorated to end of 2019.
- (2) Total site capacity based on Annual Operations and Monitoring Report (GHD, 2017).
- (3) Construction costs in 2014\$ from proposed financial plan capital schedules. Transfer Station costs are not included in closure costs.
- (4) Annual post closure operating and maintenance costs include environmental monitoring costs, estimated based on GHD experience at CVRD waste management centres.
- (5) Construction cost inflation rate applied to forecast construction costs, calculated based on 10 year average annual increase in Vancouver non-residential building construction index (CANSIM Table 18-10-0135-01) (latest index Q4 2019).
- (6) Discount rate calculated based on MFA 30 year borrowing rate as of December 31, 2019
- (7) Operations and maintenance inflation rate applied to operations and maintenance costs. Calculated based on the average of the annual percent change of the Consumer price index for BC (averaged over 2010-2019 period) (CANSIM Table 18-10-0004-01)



**Table 6: Landfill Liability Assessment - Tahsis Waste Management Centre**

<b>Data:</b>	<b>31-Dec-2019</b>
Landfill Cover Option	GCL
Landfill Closure Date (approximate)	2025
Post Closure Period (years)	30
Current (Dec 2019) waste in place (m3)	108,588
Remaining Airspace (m3)	4,912
Landfill Capacity at Closure (m3)	113,500
Closure Costs (2014\$) (2020-2024 PB)	\$ 825,000
Annual post closure O&M (2014\$)	\$ 24,000
5th year post closure O&M costs (2014\$)	\$ 44,000
Construction cost escalation rate	3.2688%
Discount rate	2.81%
Inflation rate	1.6503%

Note 1  
Note 1  
Note 2  
Note 3  
Note 4  
Note 4  
Note 5  
Note 6  
Note 7

Year	Years for FV	Years for PV	Cash Flow (2014\$)		Cash Flow plus Inflation	Present Value	Description of Cost
			Construction/ Other	Monitoring /Maintenance			
2014			\$ -		\$ -	\$ -	
2020	6	1	\$ -		\$ -	\$ -	
2021	7	2	\$ -		\$ -	\$ -	
2022	7	3	\$ -		\$ -	\$ -	
2023	9	4	\$ -		\$ -	\$ -	
2024	10	5	\$ 100,000		\$ 137,940	\$ 120,092	Final closure engineering (2014\$) based on Opt 2 DOC
2025	11	6	\$ 725,000		\$ 1,032,752	\$ 874,549	Final closure construction/final capping (2014\$)
2026	12	7	\$ 24,000	\$ 24,000	\$ 29,209	\$ 24,058	Annual O&M
2027	13	8	\$ 24,000	\$ 24,000	\$ 29,691	\$ 23,787	Annual O&M
2028	14	9	\$ 24,000	\$ 24,000	\$ 30,181	\$ 23,519	Annual O&M
2029	15	10	\$ 24,000	\$ 24,000	\$ 30,679	\$ 23,253	Annual O&M
2030	16	11	\$ 44,000	\$ 44,000	\$ 57,173	\$ 42,150	Annual O&M plus allowance for 5 year maintenance
2031	17	12	\$ 24,000	\$ 24,000	\$ 31,700	\$ 22,732	Annual O&M
2032	18	13	\$ 24,000	\$ 24,000	\$ 32,223	\$ 22,475	Annual O&M
2033	19	14	\$ 24,000	\$ 24,000	\$ 32,755	\$ 22,222	Annual O&M
2034	20	15	\$ 24,000	\$ 24,000	\$ 33,295	\$ 21,971	Annual O&M
2035	21	16	\$ 44,000	\$ 44,000	\$ 62,049	\$ 39,826	Annual O&M plus allowance for 5 year maintenance
2036	22	17	\$ 24,000	\$ 24,000	\$ 34,403	\$ 21,478	Annual O&M
2037	23	18	\$ 24,000	\$ 24,000	\$ 34,971	\$ 21,236	Annual O&M
2038	24	19	\$ 24,000	\$ 24,000	\$ 35,548	\$ 20,996	Annual O&M
2039	25	20	\$ 24,000	\$ 24,000	\$ 36,135	\$ 20,760	Annual O&M
2040	26	21	\$ 44,000	\$ 44,000	\$ 67,340	\$ 37,630	Annual O&M plus allowance for 5 year maintenance
2041	27	22	\$ 24,000	\$ 24,000	\$ 37,337	\$ 20,294	Annual O&M
2042	28	23	\$ 24,000	\$ 24,000	\$ 37,953	\$ 20,065	Annual O&M
2043	29	24	\$ 24,000	\$ 24,000	\$ 38,580	\$ 19,839	Annual O&M
2044	30	25	\$ 24,000	\$ 24,000	\$ 39,216	\$ 19,615	Annual O&M
2045	31	26	\$ 44,000	\$ 44,000	\$ 73,083	\$ 35,555	Annual O&M plus allowance for 5 year maintenance
2046	32	27	\$ 24,000	\$ 24,000	\$ 40,521	\$ 19,175	Annual O&M
2047	33	28	\$ 24,000	\$ 24,000	\$ 41,190	\$ 18,958	Annual O&M
2048	34	29	\$ 24,000	\$ 24,000	\$ 41,870	\$ 18,745	Annual O&M
2049	35	30	\$ 24,000	\$ 24,000	\$ 42,561	\$ 18,533	Annual O&M
2050	36	31	\$ 44,000	\$ 44,000	\$ 79,316	\$ 33,594	Annual O&M plus allowance for 5 year maintenance
2051	37	32	\$ 24,000	\$ 24,000	\$ 43,977	\$ 18,117	Annual O&M
2052	38	33	\$ 24,000	\$ 24,000	\$ 44,703	\$ 17,913	Annual O&M
2053	39	34	\$ 24,000	\$ 24,000	\$ 45,441	\$ 17,711	Annual O&M
2054	40	35	\$ 24,000	\$ 24,000	\$ 46,190	\$ 17,511	Annual O&M
2055	41	36	\$ 44,000	\$ 44,000	\$ 86,080	\$ 31,742	Annual O&M plus allowance for 5 year maintenance
<b>TOTAL COST</b>			<b>\$ 825,000</b>	<b>\$ 840,000</b>	<b>\$ 2,486,061</b>	<b>\$ 1,710,100</b>	
<b>NPV of Estimated Closure and Post Closure Costs =</b>						<b>\$ 1,710,100</b>	
<b>Landfill Liability in Dec 2019 (\$) =</b>						<b>\$ 1,636,085</b>	NPV x (Cumulative Capacity Used)/(Total Estimated Capacity)

**Notes:**

- (1) Remaining capacity as of December 31, 2019 calculated based on surveys conducted October 2019 and Final top of cover survey prorated to end of 2019. 0.75m of final cover was assumed and subtracted from the final top of cover survey
- (2) Total site capacity based on Annual Operations and Monitoring Report (GHD, 2017).
- (3) Construction costs in 2014\$ from proposed financial plan capital schedules. Transfer Station costs are not included in closure costs.
- (4) Annual post closure operating and maintenance costs include environmental monitoring costs, estimated based on GHD experience at CVRD waste management centres.
- (5) Construction cost inflation rate applied to forecast construction costs, calculated based on 10 year average annual increase in Vancouver non-residential building construction index (CANSIM Table 18-10-0135-01) (latest index Q4 2019).
- (6) Discount rate calculated based on MFA 30 year borrowing rate as of December 31, 2019.
- (7) Operations and maintenance inflation rate applied to operations and maintenance costs. Calculated based on the average of the annual percent change of the Consumer price index for BC (averaged over 2010-2019 period) (CANSIM Table 18-10-0004-01)

**Table 7: Landfill Liability Assessment - Zeballos Waste Management Centre**

<b>Data:</b>	<b>31-Dec-2019</b>
Landfill Cover Option	GCL
Landfill Closure Date (approximate)	2025
Post Closure Period (years)	30
Current (Dec 2019) waste in place (m3)	8967
Remaining Airspace (m3)	7533
Landfill Capacity at Closure (m3)	16500
Closure Costs (2014\$) (2019-2023 PB)	\$ 576,000
Annual post closure O&M (2014\$)	\$ 28,000
5th year post closure O&M costs (2014\$)	\$ 48,000
Construction cost escalation rate	3.2688%
Discount rate	2.81%
Inflation rate	1.6503%

Note 1  
Note 1  
Note 2  
Note 3  
Note 4  
Note 4  
Note 5  
Note 6  
Note 7

Year	Years for FV	Years for PV	Cash Flow (2014\$)		Cash Flow plus Inflation	Net Present Value	Description of Cost
			Construction/ Other	Monitoring /Maintenance			
2014							
2020	6	1					
2021	7	2					
2022	8	3					
2023	9	4					
2024	10	5	\$ 96,000		\$ 132,422	\$ 115,288	Final closure engineering, option 2 DOC plan
2025	11	6	\$ 480,000		\$ 683,753	\$ 579,012	Final closure construction/final capping
2026	12	7		\$ 28,000	\$ 34,077	\$ 28,068	Annual O&M
2027	13	8		\$ 28,000	\$ 34,639	\$ 27,751	Annual O&M
2028	14	9		\$ 28,000	\$ 35,211	\$ 27,438	Annual O&M
2029	15	10		\$ 28,000	\$ 35,792	\$ 27,129	Annual O&M
2030	16	11		\$ 48,000	\$ 62,370	\$ 45,982	Annual O&M plus allowance for 5 year maintenance
2031	17	12		\$ 28,000	\$ 36,983	\$ 26,520	Annual O&M
2032	18	13		\$ 28,000	\$ 37,593	\$ 26,221	Annual O&M
2033	19	14		\$ 28,000	\$ 38,214	\$ 25,925	Annual O&M
2034	20	15		\$ 28,000	\$ 38,844	\$ 25,633	Annual O&M
2035	21	16		\$ 48,000	\$ 67,689	\$ 43,446	Annual O&M plus allowance for 5 year maintenance
2036	22	17		\$ 28,000	\$ 40,137	\$ 25,058	Annual O&M
2037	23	18		\$ 28,000	\$ 40,799	\$ 24,775	Annual O&M
2038	24	19		\$ 28,000	\$ 41,473	\$ 24,496	Annual O&M
2039	25	20		\$ 28,000	\$ 42,157	\$ 24,219	Annual O&M
2040	26	21		\$ 48,000	\$ 73,462	\$ 41,051	Annual O&M plus allowance for 5 year maintenance
2041	27	22		\$ 28,000	\$ 43,560	\$ 23,676	Annual O&M
2042	28	23		\$ 28,000	\$ 44,279	\$ 23,409	Annual O&M
2043	29	24		\$ 28,000	\$ 45,010	\$ 23,145	Annual O&M
2044	30	25		\$ 28,000	\$ 45,752	\$ 22,884	Annual O&M
2045	31	26		\$ 48,000	\$ 79,727	\$ 38,787	Annual O&M plus allowance for 5 year maintenance
2046	32	27		\$ 28,000	\$ 47,275	\$ 22,371	Annual O&M
2047	33	28		\$ 28,000	\$ 48,055	\$ 22,118	Annual O&M
2048	34	29		\$ 28,000	\$ 48,848	\$ 21,869	Annual O&M
2049	35	30		\$ 28,000	\$ 49,654	\$ 21,622	Annual O&M
2050	36	31		\$ 48,000	\$ 86,526	\$ 36,648	Annual O&M plus allowance for 5 year maintenance
2051	37	32		\$ 28,000	\$ 51,307	\$ 21,137	Annual O&M
2052	38	33		\$ 28,000	\$ 52,153	\$ 20,899	Annual O&M
2053	39	34		\$ 28,000	\$ 53,014	\$ 20,663	Annual O&M
2054	40	35		\$ 28,000	\$ 53,889	\$ 20,430	Annual O&M
2055	41	36		\$ 48,000	\$ 93,906	\$ 34,627	Annual O&M plus allowance for 5 year maintenance
<b>TOTAL COST</b>			<b>\$ 576,000</b>	<b>\$ 960,000</b>	<b>\$ 2,318,573</b>	<b>\$ 1,512,298</b>	
<b>NPV of Estimated Closure and Post Closure Costs =</b>						<b>\$ 1,512,298</b>	
<b>Landfill Liability in Dec 2019 (\$) =</b>						<b>\$ 821,865</b>	NPV x (Cumulative Capacity Used)/(Total Estimated Capacity)

**Notes:**

- (1) Remaining capacity as of December 31, 2019 calculated based on surveys conducted November 2019 and top of waste survey prorated to end of 2019.
- (2) Total site capacity based on Annual Operations and Monitoring Report (GHD, 2017).
- (3) Construction costs in 2014\$ from proposed financial plan capital schedules. Transfer Station costs are not included in closure costs.
- (4) Annual post closure operating and maintenance costs include environmental monitoring costs, estimated based on GHD experience at CVRD waste management centres.
- (5) Construction cost inflation rate applied to forecast construction costs, calculated based on 10 year average annual increase in Vancouver non-residential building construction index (CANSIM Table 18-10-0135-01) (latest index Q4 2019).
- (6) Discount rate calculated based on MFA 30 year borrowing rate as of December 31, 2019
- (7) Operations and maintenance inflation rate applied to operations and maintenance costs. Calculated based on the average of the annual percent change of the Consumer price index for BC (averaged over 2010-2019 period) (CANSIM Table 18-10-0004-01)

# Appendix E

## Environmental Monitoring Specifications

## Environmental Monitoring Program Specification – 2019

**PROJECT:** Comox Strathcona Waste Management  
Tahsis Waste Management Centre

**PROJECT NO.:** 056484-54

**PROJECT MANAGER:** Greg Ferraro

**PROJECT COORDINATOR:** Michaela Dyck

<b>MONITORING STAFF:</b>	<b>RESPONSIBILITY</b>
Natasha Turl	Field Technician(s)
Chris Thorne	
Airesse MacPhee	QA/QC Chemist
Laurie Clark	Database Manager

**LABORATORIES USED:** ALS Environmental, Burnaby, British Columbia

<b>AUTHORIZATION:</b>	<b>MONITORING EVENT(S)</b>	<b>PC/PM SIGNATURE</b>
	April, October	_____

Revision #	Date	Revision	GHD
1	Apr 2014	Monitoring Specification creation.	MND
2	Jun 2014	Added phosphorus to the metals scan.	MND
3	Feb 2016	Updated field and database staffing, added WG matrix to field blank.	TE
4	Aug 2016	Updated project staffing.	MND
5	May 2017	Updated Site access information.	MND
6	Jan 2018	Updated project staffing.	NT
7	Apr 2018	Updated tips section and project staffing.	NT
8	Apr 2019	Included monitoring wells PFP#1A, PFP#2A, PFP#3A, and PFP#4A to the sample collection and removed the corresponding "B" monitoring wells.	NT

### WATER QUALITY MONITORING

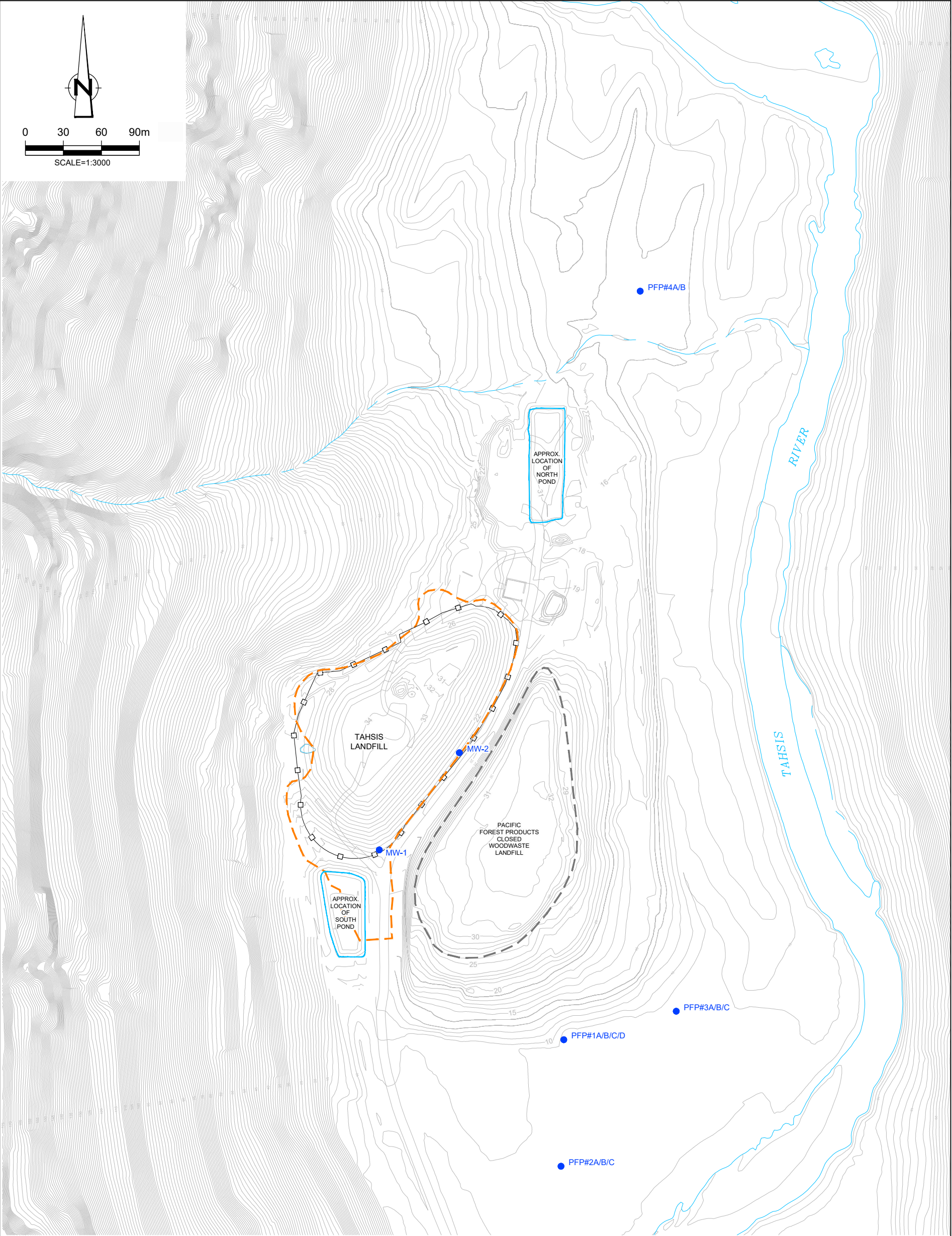
Monitoring Locations: Figure 1 and Table 1

Monitoring Frequency: Table 1

Monitoring Parameters: Table 2

Contact Public Works (currently Greg) that we will be on-site (250-934-6337). Public Works will open the gate for us. Public Works has a copy of the GHD well keys. Landfill open on Wednesdays, or can go to the Village Office (250-934-6344) for the key.





LEGEND

- APPROXIMATE LIMIT OF WASTE
- BEAR FENCE
- APPROXIMATE GROUNDWATER WELL LOCATION



SOURCE: TOPOGRAPHICAL INFORMATION BASED ON SURVEY DATED NOVEMBER 14, 2016  
COMBINED WITH SURVEY DATED OCTOBER 30, 2018 BY McELHANNEY ASSOCIATES.  
CAMPBELL RIVER, B.C. WELL LOCATIONS BASED ON SURVEY DATA PROVIDED BY TETRA  
TECH EBA. WELLS SURVEYED BY QUARMBY LAND SURVEYING, JAN. 20, 2005. LIMIT OF  
WASTE FROM TETRA TECH EBA, UPDATED CLOSURE PLAN, AUGUST 2013.

figure 1  
MONITORING LOCATIONS  
FIRST QUARTER 2019 MONITORING EVENT  
TAHSIS LANDFILL  
*Comox-Strathcona Waste Management*

**Sampling Schedule**  
**Environmental Monitoring Program Specification - 2019**

				Semi-annual	
Monitoring Location	Monitoring Location Purpose	Sample Matrix	Hydraulic Monitoring	April	October
Groundwater Monitoring Program (14 locations)					
MW-1	Southern toe of the landfill.	WG	√	Schedule A	Schedule A
MW-2	Northeast portion of the lanfill.	WG	√	Schedule A	Schedule A
PFP#1(A)	Downgradient.	WG	√	Schedule A	Schedule A
PFP#1(B)	Downgradient.	WG	√	-	-
PFP#1(C)	Downgradient.	WG	√	-	-
PFP#1(D)	Downgradient.	WG	√	-	-
PFP#2(A)	Downgradient.	WG	√	Schedule A	Schedule A
PFP#2(B)	Downgradient.	WG	√	-	-
PFP#2(C)	Downgradient.	WG	√	-	-
PFP#3(A)	Downgradient.	WG	√	Schedule A	Schedule A
PFP#3(B)	Downgradient.	WG	√	-	-
PFP#3(C)	Downgradient.	WG	√	-	-
PFP#4(A)	Background.	WG	√	Schedule A	Schedule A
PFP#4(B)	Background.	WG	√	-	-
Field Quality Assurance/Quality Control					
Field Blank		WG	-	Schedule A	-
Groundwater Duplicate		WG	-	Schedule A	-

**Notes:**

- WG - Groundwater
- √ - Every monitoring event

**Analytical Parameters  
Environmental Monitoring Program Specification - 2019**

Groundwater	
Schedule A	
<b>Hydraulic Monitoring</b>	
Water level	√
Depth to bottom of well	√
<b>Field Parameters</b>	
Dissolved Oxygen	√
Oxidation-Reduction Potential (ORP)	√
pH	√
Conductivity (uS/cm)	√
Temperature	√
Total Dissolved Solids (TDS)	√
Turbidity	√
<b>General Chemistry</b>	
Alkalinity (Speciated)	√
Chloride (Dissolved)	√
Flouride	√
pH	√
Conductivity	√
Sulphate (Dissolved)	√
<b>Nutrients</b>	
Ammonia-N	√
Nitrate (as N)	√
Nitrite (as N)	√
Nitrate/Nitrite	√
<b>Metals [incl. hardness, mercury]</b>	
Dissolved Metals	√

## Appendix F

# Field Sample Keys and Laboratory Reports





## GHD Field Sample Key (FSK)

Site Tahsis Landfill (056484-54)

Sample Reason Spring 2019 EMP

Sampler Name M. Dyck & D. Botero

Sampling Company GHD Ltd.

Laboratory(s) ALS Environmental

SSOW Reference Code : \_\_\_\_\_

Sampling Company																							
Laboratory(s)							ALS Environmental																
Sample ID	Location	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Sample Type	Sample Matrix	Grab or Composite	Parent Sample ID for Field Dups	Footnote(s)	Temperature			pH	Eh / ORP		Conductivity		Turbidity		DO		TDS		
									Volume of Water Purged (L)	Sample Temperature	Temperature Units	Field pH (s.u.)	Eh / ORP	Eh / ORP Units	Conductivity	Conductivity Units	Turbidity	Turbidity Units	Dissolved Oxygen	Dissolved Oxygen Units	Total Dissolved Solids	Total Dissolved Solids Units	
WG-56484-080519-DB-01	PFP#4A	5/8/2019	9:45	N	WG	grab			8	7.22	C	6.94	234	mV	152	uS/cm	58	ntu	-	mg/L	0.099	g/L	
WG-56484-080519-DB-02	PFP#3A	5/8/2019	10:20	N	WG	grab			21	7.52	C	6.91	261	mV	184	uS/cm	10.7	ntu	-	mg/L	0.12	g/L	
WG-56484-080519-DB-03	PFP#1A	5/8/2019	10:50	N	WG	grab			24	10.42	C	6.93	252	mV	684	uS/cm	180	ntu	-	mg/L	0.437	g/L	
WG-56484-080519-DB-04	PFP#2A	5/8/2019	11:20	N	WG	grab			28	8.87	C	7.25	253	mV	426	uS/cm	37	ntu	-	mg/L	0.277	g/L	
WG-56484-080519-DB-05	MW-2	5/8/2019	11:55	N	WG	grab			39	7.98	C	8.08	229	mV	176	uS/cm	0.0	ntu	-	mg/L	0.114	g/L	
WG-56484-080519-DB-06	MW-1	5/8/2019	12:30	N	WG	grab			36	9.59	C	7.82	235	mV	307	uS/cm	0.3	ntu	-	mg/L	0.199	g/L	
WG-56484-080519-DB-07	Field Blank	5/8/2019	12:45	FB	WG	grab			-	-	C	-	-	mV	-	uS/cm	-	ntu	-	mg/L	-	g/L	

Footnotes

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____





GHD Limited  
ATTN: Airesse MacPhee  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Date Received: 10-MAY-19  
Report Date: 30-MAY-19 18:33 (MT)  
Version: FINAL

Client Phone: 613-727-0510

## Certificate of Analysis

**Lab Work Order #:** L2271564  
**Project P.O. #:** 73515713  
**Job Reference:** 056484-55  
**C of C Numbers:**  
**Legal Site Desc:** Tahsis (Phase 05) GW

Selam Worku  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2271564-1	WG-56484-080519-DB-01							
Sampled By: M. Dyck/ D. Botero on 08-MAY-19 @ 09:45								
Matrix: WG								
Physical Tests								
Conductivity		162		2.0	uS/cm		15-MAY-19	R4636061
Hardness (as CaCO3)		79.2		0.50	mg/L		21-MAY-19	
pH		8.13		0.10	pH		15-MAY-19	R4636061
Anions and Nutrients								
Alkalinity, Bicarbonate (as CaCO3)		77.5		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Total (as CaCO3)		77.5		1.0	mg/L		15-MAY-19	R4636061
Ammonia, Total (as N)		0.0073		0.0050	mg/L		12-MAY-19	R4631453
Chloride (Cl)		1.72		0.50	mg/L		11-MAY-19	R4635753
Fluoride (F)		<0.020		0.020	mg/L		11-MAY-19	R4635753
Nitrate (as N)		0.120		0.0050	mg/L		11-MAY-19	R4635753
Nitrite (as N)		<0.0010		0.0010	mg/L		11-MAY-19	R4635753
Sulfate (SO4)		1.69		0.30	mg/L		11-MAY-19	R4635753
Dissolved Metals								
Dissolved Mercury Filtration Location		LAB					29-MAY-19	R4649166
Dissolved Metals Filtration Location		LAB					21-MAY-19	R4639879
Aluminum (Al)-Dissolved		0.0124		0.0010	mg/L	21-MAY-19	21-MAY-19	R4639780
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	21-MAY-19	21-MAY-19	R4639780
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	21-MAY-19	21-MAY-19	R4639780
Barium (Ba)-Dissolved		0.00052		0.00010	mg/L	21-MAY-19	21-MAY-19	R4639780
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	21-MAY-19	21-MAY-19	R4639780
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	21-MAY-19	21-MAY-19	R4639780
Boron (B)-Dissolved		<0.010		0.010	mg/L	21-MAY-19	21-MAY-19	R4639780
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	21-MAY-19	21-MAY-19	R4639780
Calcium (Ca)-Dissolved		27.8		0.050	mg/L	21-MAY-19	21-MAY-19	R4639780
Cesium (Cs)-Dissolved		<0.000010		0.000010	mg/L	21-MAY-19	21-MAY-19	R4639780
Chromium (Cr)-Dissolved		<0.00010		0.00010	mg/L	21-MAY-19	21-MAY-19	R4639780
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	21-MAY-19	21-MAY-19	R4639780
Copper (Cu)-Dissolved		<0.00020		0.00020	mg/L	21-MAY-19	21-MAY-19	R4639780
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	21-MAY-19	21-MAY-19	R4639780
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	21-MAY-19	21-MAY-19	R4639780
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	21-MAY-19	21-MAY-19	R4639780
Magnesium (Mg)-Dissolved		2.37		0.0050	mg/L	21-MAY-19	21-MAY-19	R4639780
Manganese (Mn)-Dissolved		0.00032		0.00010	mg/L	21-MAY-19	21-MAY-19	R4639780
Mercury (Hg)-Dissolved		0.0000100	WSMB	0.0000050	mg/L	29-MAY-19	29-MAY-19	R4647372
Molybdenum (Mo)-Dissolved		0.000105		0.000050	mg/L	21-MAY-19	21-MAY-19	R4639780
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	21-MAY-19	21-MAY-19	R4639780
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	21-MAY-19	21-MAY-19	R4639780
Potassium (K)-Dissolved		<0.050		0.050	mg/L	21-MAY-19	21-MAY-19	R4639780
Rubidium (Rb)-Dissolved		<0.00020		0.00020	mg/L	21-MAY-19	21-MAY-19	R4639780

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2271564-1    WG-56484-080519-DB-01 Sampled By:    M. Dyck/ D. Botero on 08-MAY-19 @ 09:45 Matrix:        WG								
<b>Dissolved Metals</b>								
Selenium (Se)-Dissolved		0.000058		0.000050	mg/L	21-MAY-19	21-MAY-19	R4639780
Silicon (Si)-Dissolved		0.827		0.050	mg/L	21-MAY-19	21-MAY-19	R4639780
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	21-MAY-19	21-MAY-19	R4639780
Sodium (Na)-Dissolved		0.838		0.050	mg/L	21-MAY-19	21-MAY-19	R4639780
Strontium (Sr)-Dissolved		0.0409		0.00020	mg/L	21-MAY-19	21-MAY-19	R4639780
Sulfur (S)-Dissolved		<0.50		0.50	mg/L	21-MAY-19	21-MAY-19	R4639780
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	21-MAY-19	21-MAY-19	R4639780
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	21-MAY-19	21-MAY-19	R4639780
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	21-MAY-19	21-MAY-19	R4639780
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	21-MAY-19	21-MAY-19	R4639780
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	21-MAY-19	21-MAY-19	R4639780
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	21-MAY-19	21-MAY-19	R4639780
Uranium (U)-Dissolved		0.000144		0.000010	mg/L	21-MAY-19	21-MAY-19	R4639780
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	21-MAY-19	21-MAY-19	R4639780
Zinc (Zn)-Dissolved		<0.0010		0.0010	mg/L	21-MAY-19	21-MAY-19	R4639780
Zirconium (Zr)-Dissolved		<0.000060		0.000060	mg/L	21-MAY-19	21-MAY-19	R4639780
L2271564-2    WG-56484-080519-DB-02 Sampled By:    M. Dyck/ D. Botero on 08-MAY-19 @ 10:20 Matrix:        WG								
<b>Physical Tests</b>								
Conductivity		198		2.0	uS/cm		15-MAY-19	R4636061
Hardness (as CaCO3)		86.3		0.50	mg/L		14-MAY-19	
pH		8.29		0.10	pH		15-MAY-19	R4636061
<b>Anions and Nutrients</b>								
Alkalinity, Bicarbonate (as CaCO3)		99.4		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Total (as CaCO3)		99.4		1.0	mg/L		15-MAY-19	R4636061
Ammonia, Total (as N)		<0.0050		0.0050	mg/L		12-MAY-19	R4631453
Chloride (Cl)		1.63		0.50	mg/L		11-MAY-19	R4635753
Fluoride (F)		<0.020		0.020	mg/L		11-MAY-19	R4635753
Nitrate (as N)		0.0837		0.0050	mg/L		11-MAY-19	R4635753
Nitrite (as N)		<0.0010		0.0010	mg/L		11-MAY-19	R4635753
Sulfate (SO4)		1.83		0.30	mg/L		11-MAY-19	R4635753
<b>Dissolved Metals</b>								
Dissolved Mercury Filtration Location		FIELD					11-MAY-19	R4631173
Dissolved Metals Filtration Location		FIELD					13-MAY-19	R4633086
Aluminum (Al)-Dissolved		0.0044		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Barium (Ba)-Dissolved		0.00093		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2271564-2    WG-56484-080519-DB-02 Sampled By:    M. Dyck/ D. Botero on 08-MAY-19 @ 10:20 Matrix:        WG								
<b>Dissolved Metals</b>								
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Boron (B)-Dissolved		<0.010		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Calcium (Ca)-Dissolved		31.2		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Cesium (Cs)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Chromium (Cr)-Dissolved		0.00022		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Copper (Cu)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Magnesium (Mg)-Dissolved		2.02		0.0050	mg/L	13-MAY-19	14-MAY-19	R4634451
Manganese (Mn)-Dissolved		0.00013		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	11-MAY-19	13-MAY-19	R4632265
Molybdenum (Mo)-Dissolved		0.000125		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Potassium (K)-Dissolved		0.118		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Rubidium (Rb)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Selenium (Se)-Dissolved		0.000080		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silicon (Si)-Dissolved		1.10		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Sodium (Na)-Dissolved		0.820		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Strontium (Sr)-Dissolved		0.0381		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Sulfur (S)-Dissolved		0.70		0.50	mg/L	13-MAY-19	14-MAY-19	R4634451
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	13-MAY-19	14-MAY-19	R4634451
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Uranium (U)-Dissolved		0.000184		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Zinc (Zn)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Zirconium (Zr)-Dissolved		<0.000060		0.000060	mg/L	13-MAY-19	14-MAY-19	R4634451
L2271564-3    WG-56484-080519-DB-03 Sampled By:    M. Dyck/ D. Botero on 08-MAY-19 @ 10:50 Matrix:        WG								
<b>Physical Tests</b>								
Conductivity		527		2.0	uS/cm		15-MAY-19	R4636061
Hardness (as CaCO3)		349		0.50	mg/L		14-MAY-19	
pH		7.74		0.10	pH		15-MAY-19	R4636061

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2271564-3	WG-56484-080519-DB-03							
Sampled By: M. Dyck/ D. Botero on 08-MAY-19 @ 10:50								
Matrix: WG								
<b>Physical Tests</b>								
<b>Anions and Nutrients</b>								
Alkalinity, Bicarbonate (as CaCO3)		288		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Total (as CaCO3)		288		1.0	mg/L		15-MAY-19	R4636061
Ammonia, Total (as N)		<0.0050		0.0050	mg/L		12-MAY-19	R4631453
Chloride (Cl)		2.03		0.50	mg/L		11-MAY-19	R4635753
Fluoride (F)		<0.020		0.020	mg/L		11-MAY-19	R4635753
Nitrate (as N)		0.129		0.0050	mg/L		11-MAY-19	R4635753
Nitrite (as N)		<0.0010		0.0010	mg/L		11-MAY-19	R4635753
Sulfate (SO4)		1.92		0.30	mg/L		11-MAY-19	R4635753
<b>Dissolved Metals</b>								
Dissolved Mercury Filtration Location		FIELD					11-MAY-19	R4631173
Dissolved Metals Filtration Location		FIELD					13-MAY-19	R4633086
Aluminum (Al)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Barium (Ba)-Dissolved		0.00591		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Boron (B)-Dissolved		0.018		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Cadmium (Cd)-Dissolved		0.0000087		0.0000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Calcium (Ca)-Dissolved		126		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Cesium (Cs)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Chromium (Cr)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Copper (Cu)-Dissolved		0.00061		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Magnesium (Mg)-Dissolved		8.49		0.0050	mg/L	13-MAY-19	14-MAY-19	R4634451
Manganese (Mn)-Dissolved		0.00199		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	11-MAY-19	13-MAY-19	R4632265
Molybdenum (Mo)-Dissolved		0.000055		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Potassium (K)-Dissolved		0.946		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Rubidium (Rb)-Dissolved		0.00038		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Selenium (Se)-Dissolved		0.000054		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silicon (Si)-Dissolved		2.21		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2271564-3    WG-56484-080519-DB-03 Sampled By:    M. Dyck/ D. Botero on 08-MAY-19 @ 10:50 Matrix:        WG								
<b>Dissolved Metals</b>								
Sodium (Na)-Dissolved		2.23		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Strontium (Sr)-Dissolved		0.154		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Sulfur (S)-Dissolved		0.84		0.50	mg/L	13-MAY-19	14-MAY-19	R4634451
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	13-MAY-19	14-MAY-19	R4634451
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Uranium (U)-Dissolved		0.000374		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Zinc (Zn)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Zirconium (Zr)-Dissolved		<0.000060		0.000060	mg/L	13-MAY-19	14-MAY-19	R4634451
L2271564-4    WG-56484-080519-DB-04 Sampled By:    M. Dyck/ D. Botero on 08-MAY-19 @ 11:20 Matrix:        WG								
<b>Physical Tests</b>								
Conductivity		396		2.0	uS/cm		15-MAY-19	R4636061
Hardness (as CaCO3)		223		0.50	mg/L		14-MAY-19	
pH		8.26		0.10	pH		15-MAY-19	R4636061
<b>Anions and Nutrients</b>								
Alkalinity, Bicarbonate (as CaCO3)		233		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Total (as CaCO3)		233		1.0	mg/L		15-MAY-19	R4636061
Ammonia, Total (as N)		<0.0050		0.0050	mg/L		12-MAY-19	R4631453
Chloride (Cl)		1.77		0.50	mg/L		11-MAY-19	R4635753
Fluoride (F)		<0.020		0.020	mg/L		11-MAY-19	R4635753
Nitrate (as N)		0.175		0.0050	mg/L		11-MAY-19	R4635753
Nitrite (as N)		<0.0010		0.0010	mg/L		11-MAY-19	R4635753
Sulfate (SO4)		1.46		0.30	mg/L		11-MAY-19	R4635753
<b>Dissolved Metals</b>								
Dissolved Mercury Filtration Location		FIELD					11-MAY-19	R4631173
Dissolved Metals Filtration Location		FIELD					13-MAY-19	R4633086
Aluminum (Al)-Dissolved		0.0015		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Barium (Ba)-Dissolved		0.00278		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Boron (B)-Dissolved		0.011		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	13-MAY-19	14-MAY-19	R4634451

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2271564-4    WG-56484-080519-DB-04 Sampled By:    M. Dyck/ D. Botero on 08-MAY-19 @ 11:20 Matrix:        WG								
<b>Dissolved Metals</b>								
Calcium (Ca)-Dissolved		80.0		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Cesium (Cs)-Dissolved		0.000015		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Chromium (Cr)-Dissolved		0.00025		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Copper (Cu)-Dissolved		0.00023		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Magnesium (Mg)-Dissolved		5.65		0.0050	mg/L	13-MAY-19	14-MAY-19	R4634451
Manganese (Mn)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	11-MAY-19	13-MAY-19	R4632265
Molybdenum (Mo)-Dissolved		0.000071		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Potassium (K)-Dissolved		0.491		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Rubidium (Rb)-Dissolved		0.00022		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Selenium (Se)-Dissolved		0.000054		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silicon (Si)-Dissolved		2.27		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Sodium (Na)-Dissolved		1.61		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Strontium (Sr)-Dissolved		0.0969		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Sulfur (S)-Dissolved		0.51		0.50	mg/L	13-MAY-19	14-MAY-19	R4634451
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	13-MAY-19	14-MAY-19	R4634451
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Uranium (U)-Dissolved		0.000390		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Zinc (Zn)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Zirconium (Zr)-Dissolved		<0.000060		0.000060	mg/L	13-MAY-19	14-MAY-19	R4634451
L2271564-5    WG-56484-080519-DB-05 Sampled By:    M. Dyck/ D. Botero on 08-MAY-19 @ 11:55 Matrix:        WG								
<b>Physical Tests</b>								
Conductivity		190		2.0	uS/cm		15-MAY-19	R4636061
Hardness (as CaCO3)		88.4		0.50	mg/L		14-MAY-19	
pH		8.28		0.10	pH		15-MAY-19	R4636061
<b>Anions and Nutrients</b>								
Alkalinity, Bicarbonate (as CaCO3)		92.4		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2271564-5	WG-56484-080519-DB-05							
Sampled By:	M. Dyck/ D. Botero on 08-MAY-19 @ 11:55							
Matrix:	WG							
Anions and Nutrients								
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Total (as CaCO3)		92.4		1.0	mg/L		15-MAY-19	R4636061
Ammonia, Total (as N)		<0.0050		0.0050	mg/L		12-MAY-19	R4631453
Chloride (Cl)		1.87		0.50	mg/L		11-MAY-19	R4635753
Fluoride (F)		<0.020		0.020	mg/L		11-MAY-19	R4635753
Nitrate (as N)		0.0900		0.0050	mg/L		11-MAY-19	R4635753
Nitrite (as N)		<0.0010		0.0010	mg/L		11-MAY-19	R4635753
Sulfate (SO4)		2.51		0.30	mg/L		11-MAY-19	R4635753
Dissolved Metals								
Dissolved Mercury Filtration Location		FIELD					11-MAY-19	R4631173
Dissolved Metals Filtration Location		FIELD					13-MAY-19	R4633086
Aluminum (Al)-Dissolved		0.0101		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Barium (Ba)-Dissolved		0.00087		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Boron (B)-Dissolved		<0.010		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Calcium (Ca)-Dissolved		31.7		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Cesium (Cs)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Chromium (Cr)-Dissolved		0.00013		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Copper (Cu)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Magnesium (Mg)-Dissolved		2.22		0.0050	mg/L	13-MAY-19	14-MAY-19	R4634451
Manganese (Mn)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	11-MAY-19	13-MAY-19	R4632265
Molybdenum (Mo)-Dissolved		0.000132		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Potassium (K)-Dissolved		0.099		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Rubidium (Rb)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Selenium (Se)-Dissolved		0.000076		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silicon (Si)-Dissolved		0.755		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Sodium (Na)-Dissolved		0.985		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Strontium (Sr)-Dissolved		0.0468		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Sulfur (S)-Dissolved		1.00		0.50	mg/L	13-MAY-19	14-MAY-19	R4634451

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2271564-5    WG-56484-080519-DB-05 Sampled By:    M. Dyck/ D. Botero on 08-MAY-19 @ 11:55 Matrix:        WG								
<b>Dissolved Metals</b>								
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	13-MAY-19	14-MAY-19	R4634451
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Uranium (U)-Dissolved		0.000249		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Zinc (Zn)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Zirconium (Zr)-Dissolved		<0.000060		0.000060	mg/L	13-MAY-19	14-MAY-19	R4634451
L2271564-6    WG-56484-080519-DB-06 Sampled By:    M. Dyck/ D. Botero on 08-MAY-19 @ 12:30 Matrix:        WG								
<b>Physical Tests</b>								
Conductivity		283		2.0	uS/cm		15-MAY-19	R4636061
Hardness (as CaCO3)		156		0.50	mg/L		14-MAY-19	
pH		8.13		0.10	pH		15-MAY-19	R4636061
<b>Anions and Nutrients</b>								
Alkalinity, Bicarbonate (as CaCO3)		149		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Total (as CaCO3)		149		1.0	mg/L		15-MAY-19	R4636061
Ammonia, Total (as N)		<0.0050		0.0050	mg/L		12-MAY-19	R4631453
Chloride (Cl)		2.04		0.50	mg/L		11-MAY-19	R4635753
Fluoride (F)		<0.020		0.020	mg/L		11-MAY-19	R4635753
Nitrate (as N)		0.238		0.0050	mg/L		11-MAY-19	R4635753
Nitrite (as N)		<0.0010		0.0010	mg/L		11-MAY-19	R4635753
Sulfate (SO4)		3.80		0.30	mg/L		11-MAY-19	R4635753
<b>Dissolved Metals</b>								
Dissolved Mercury Filtration Location		FIELD					11-MAY-19	R4631173
Dissolved Metals Filtration Location		FIELD					13-MAY-19	R4633086
Aluminum (Al)-Dissolved		0.0035		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Barium (Ba)-Dissolved		0.00216		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Boron (B)-Dissolved		0.017		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Calcium (Ca)-Dissolved		55.0		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Cesium (Cs)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Chromium (Cr)-Dissolved		0.00019		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2271564-6	WG-56484-080519-DB-06							
Sampled By: M. Dyck/ D. Botero on 08-MAY-19 @ 12:30								
Matrix: WG								
<b>Dissolved Metals</b>								
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Copper (Cu)-Dissolved		0.00028		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Magnesium (Mg)-Dissolved		4.59		0.0050	mg/L	13-MAY-19	14-MAY-19	R4634451
Manganese (Mn)-Dissolved		0.00047		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	11-MAY-19	13-MAY-19	R4632265
Molybdenum (Mo)-Dissolved		0.000073		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Potassium (K)-Dissolved		0.317		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Rubidium (Rb)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Selenium (Se)-Dissolved		0.000067		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silicon (Si)-Dissolved		1.13		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Sodium (Na)-Dissolved		1.35		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Strontium (Sr)-Dissolved		0.0694		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Sulfur (S)-Dissolved		1.28		0.50	mg/L	13-MAY-19	14-MAY-19	R4634451
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	13-MAY-19	14-MAY-19	R4634451
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Uranium (U)-Dissolved		0.000181		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Zinc (Zn)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Zirconium (Zr)-Dissolved		<0.000060		0.000060	mg/L	13-MAY-19	14-MAY-19	R4634451
L2271564-7	WG-56484-080519-DB-07							
Sampled By: M. Dyck/ D. Botero on 08-MAY-19 @ 12:45								
Matrix: WG								
<b>Physical Tests</b>								
Conductivity		<2.0		2.0	uS/cm		15-MAY-19	R4636061
Hardness (as CaCO3)		<0.50		0.50	mg/L		14-MAY-19	
pH		5.57		0.10	pH		15-MAY-19	R4636061
<b>Anions and Nutrients</b>								
Alkalinity, Bicarbonate (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Alkalinity, Total (as CaCO3)		<1.0		1.0	mg/L		15-MAY-19	R4636061
Ammonia, Total (as N)		<0.0050		0.0050	mg/L		12-MAY-19	R4631453

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2271564-7	WG-56484-080519-DB-07							
Sampled By: M. Dyck/ D. Botero on 08-MAY-19 @ 12:45								
Matrix: WG								
<b>Anions and Nutrients</b>								
Chloride (Cl)		<0.50		0.50	mg/L		11-MAY-19	R4635753
Fluoride (F)		<0.020		0.020	mg/L		11-MAY-19	R4635753
Nitrate (as N)		<0.0050		0.0050	mg/L		11-MAY-19	R4635753
Nitrite (as N)		<0.0010		0.0010	mg/L		11-MAY-19	R4635753
Sulfate (SO4)		<0.30		0.30	mg/L		11-MAY-19	R4635753
<b>Dissolved Metals</b>								
Dissolved Mercury Filtration Location		FIELD					11-MAY-19	R4631173
Dissolved Metals Filtration Location		FIELD					13-MAY-19	R4633086
Aluminum (Al)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Barium (Ba)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Boron (B)-Dissolved		<0.010		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Calcium (Ca)-Dissolved		<0.050		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Cesium (Cs)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Chromium (Cr)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Copper (Cu)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	13-MAY-19	14-MAY-19	R4634451
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Magnesium (Mg)-Dissolved		<0.0050		0.0050	mg/L	13-MAY-19	14-MAY-19	R4634451
Manganese (Mn)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	11-MAY-19	13-MAY-19	R4632265
Molybdenum (Mo)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Potassium (K)-Dissolved		<0.050		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Rubidium (Rb)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Selenium (Se)-Dissolved		<0.000050		0.000050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silicon (Si)-Dissolved		<0.050		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Sodium (Na)-Dissolved		<0.050		0.050	mg/L	13-MAY-19	14-MAY-19	R4634451
Strontium (Sr)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Sulfur (S)-Dissolved		<0.50		0.50	mg/L	13-MAY-19	14-MAY-19	R4634451
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	13-MAY-19	14-MAY-19	R4634451
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2271564-7      WG-56484-080519-DB-07								
Sampled By:    M. Dyck/ D. Botero on 08-MAY-19 @ 12:45								
Matrix:        WG								
<b>Dissolved Metals</b>								
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	13-MAY-19	14-MAY-19	R4634451
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	13-MAY-19	14-MAY-19	R4634451
Uranium (U)-Dissolved		<0.000010		0.000010	mg/L	13-MAY-19	14-MAY-19	R4634451
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	13-MAY-19	14-MAY-19	R4634451
Zinc (Zn)-Dissolved		<0.0010		0.0010	mg/L	13-MAY-19	14-MAY-19	R4634451
Zirconium (Zr)-Dissolved		<0.000060		0.000060	mg/L	13-MAY-19	14-MAY-19	R4634451

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Parameter Qualifier key listed:

Qualifier	Description
WSMB	Due to lab error, water sample for dissolved Hg was filtered after BrCl preservation. Non-detect results are unaffected. Detected D-Hg results may be biased high.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity when required during preparation of other tests - e.g. TDS, metals, etc.			
F-IC-N-VA	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC or CPMS	APHA 3030B/6020A (mod)
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC
This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.			
NO2-L-IC-N-VA	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-VA	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value
This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode			
It is recommended that this analysis be conducted in the field.			
SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

## Reference Information

### GLOSSARY OF REPORT TERMS

*Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.*

*mg/kg - milligrams per kilogram based on dry weight of sample*

*mg/kg ww - milligrams per kilogram based on wet weight of sample*

*mg/kg lwt - milligrams per kilogram based on lipid weight of sample*

*mg/L - unit of concentration based on volume, parts per million.*

*< - Less than.*

*D.L. - The reporting limit.*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*







## Quality Control Report

Workorder: L2271564

Report Date: 30-MAY-19

Page 2 of 12

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Aïresse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>HG-D-CVAA-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4632265</b>							
<b>WG3047343-3 DUP</b>		<b>L2271563-3</b>						
Mercury (Hg)-Dissolved		<0.0000050	<0.0000050	RPD-NA	mg/L	N/A	20	13-MAY-19
<b>WG3047343-2 LCS</b>								
Mercury (Hg)-Dissolved			94.5		%		80-120	13-MAY-19
<b>WG3047343-1 MB</b>								
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	13-MAY-19
<b>WG3047343-4 MS</b>		<b>L2271565-2</b>						
Mercury (Hg)-Dissolved			92.1		%		70-130	13-MAY-19
<b>Batch</b>	<b>R4647372</b>							
<b>WG3062065-3 DUP</b>		<b>L2271564-1</b>						
Mercury (Hg)-Dissolved		0.0000100	0.0000100		mg/L	0.2	20	29-MAY-19
<b>WG3062065-2 LCS</b>								
Mercury (Hg)-Dissolved			99.7		%		80-120	29-MAY-19
<b>WG3062065-1 MB</b>								
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	29-MAY-19
<b>MET-D-CCMS-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4634451</b>							
<b>WG3048430-3 DUP</b>		<b>L2271564-2</b>						
Aluminum (Al)-Dissolved		0.0044	0.0041		mg/L	8.8	20	14-MAY-19
Antimony (Sb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	14-MAY-19
Arsenic (As)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	14-MAY-19
Barium (Ba)-Dissolved		0.00093	0.00090		mg/L	3.5	20	14-MAY-19
Beryllium (Be)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	14-MAY-19
Bismuth (Bi)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	14-MAY-19
Boron (B)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	14-MAY-19
Cadmium (Cd)-Dissolved		<0.0000050	<0.0000050	RPD-NA	mg/L	N/A	20	14-MAY-19
Calcium (Ca)-Dissolved		31.2	32.2		mg/L	3.1	20	14-MAY-19
Cesium (Cs)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	14-MAY-19
Chromium (Cr)-Dissolved		0.00022	0.00023		mg/L	4.4	20	14-MAY-19
Cobalt (Co)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	14-MAY-19
Copper (Cu)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	14-MAY-19
Iron (Fe)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	14-MAY-19
Lead (Pb)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	14-MAY-19
Lithium (Li)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	14-MAY-19
Magnesium (Mg)-Dissolved		2.02	2.01		mg/L	0.4	20	14-MAY-19



## Quality Control Report

Workorder: L2271564

Report Date: 30-MAY-19

Page 3 of 12

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>MET-D-CCMS-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4634451</b>							
<b>WG3048430-3</b>	<b>DUP</b>	<b>L2271564-2</b>						
Manganese (Mn)-Dissolved		0.00013	0.00014		mg/L	5.1	20	14-MAY-19
Molybdenum (Mo)-Dissolved		0.000125	0.000124		mg/L	1.3	20	14-MAY-19
Nickel (Ni)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	14-MAY-19
Phosphorus (P)-Dissolved		<0.050	<0.050	RPD-NA	mg/L	N/A	20	14-MAY-19
Potassium (K)-Dissolved		0.118	0.116		mg/L	1.9	20	14-MAY-19
Rubidium (Rb)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	14-MAY-19
Selenium (Se)-Dissolved		0.000080	0.000057	J	mg/L	0.000023	0.0001	14-MAY-19
Silicon (Si)-Dissolved		1.10	1.14		mg/L	3.3	20	14-MAY-19
Silver (Ag)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	14-MAY-19
Sodium (Na)-Dissolved		0.820	0.809		mg/L	1.3	20	14-MAY-19
Strontium (Sr)-Dissolved		0.0381	0.0384		mg/L	0.7	20	14-MAY-19
Sulfur (S)-Dissolved		0.70	0.66		mg/L	6.1	20	14-MAY-19
Tellurium (Te)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	14-MAY-19
Thallium (Tl)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	14-MAY-19
Thorium (Th)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	14-MAY-19
Tin (Sn)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	14-MAY-19
Titanium (Ti)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	14-MAY-19
Tungsten (W)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	14-MAY-19
Uranium (U)-Dissolved		0.000184	0.000186		mg/L	1.3	20	14-MAY-19
Vanadium (V)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	14-MAY-19
Zinc (Zn)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	14-MAY-19
Zirconium (Zr)-Dissolved		<0.000060	<0.000060	RPD-NA	mg/L	N/A	20	14-MAY-19
<b>WG3048430-2</b>	<b>LCS</b>							
Aluminum (Al)-Dissolved			100.0		%		80-120	14-MAY-19
Antimony (Sb)-Dissolved			99.0		%		80-120	14-MAY-19
Arsenic (As)-Dissolved			93.9		%		80-120	14-MAY-19
Barium (Ba)-Dissolved			95.2		%		80-120	14-MAY-19
Beryllium (Be)-Dissolved			92.6		%		80-120	14-MAY-19
Bismuth (Bi)-Dissolved			97.2		%		80-120	14-MAY-19
Boron (B)-Dissolved			92.7		%		80-120	14-MAY-19
Cadmium (Cd)-Dissolved			94.8		%		80-120	14-MAY-19
Calcium (Ca)-Dissolved			92.7		%		80-120	14-MAY-19
Cesium (Cs)-Dissolved			99.3		%		80-120	14-MAY-19



## Quality Control Report

Workorder: L2271564

Report Date: 30-MAY-19

Page 4 of 12

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA		Water						
Batch	R4634451							
WG3048430-2		LCS						
Chromium (Cr)-Dissolved			94.6		%		80-120	14-MAY-19
Cobalt (Co)-Dissolved			96.3		%		80-120	14-MAY-19
Copper (Cu)-Dissolved			94.5		%		80-120	14-MAY-19
Iron (Fe)-Dissolved			94.5		%		80-120	14-MAY-19
Lead (Pb)-Dissolved			96.9		%		80-120	14-MAY-19
Lithium (Li)-Dissolved			91.1		%		80-120	14-MAY-19
Magnesium (Mg)-Dissolved			96.4		%		80-120	14-MAY-19
Manganese (Mn)-Dissolved			97.4		%		80-120	14-MAY-19
Molybdenum (Mo)-Dissolved			92.9		%		80-120	14-MAY-19
Nickel (Ni)-Dissolved			95.6		%		80-120	14-MAY-19
Phosphorus (P)-Dissolved			96.6		%		70-130	14-MAY-19
Potassium (K)-Dissolved			95.9		%		80-120	14-MAY-19
Rubidium (Rb)-Dissolved			97.1		%		80-120	14-MAY-19
Selenium (Se)-Dissolved			93.1		%		80-120	14-MAY-19
Silicon (Si)-Dissolved			98.2		%		60-140	14-MAY-19
Silver (Ag)-Dissolved			98.6		%		80-120	14-MAY-19
Sodium (Na)-Dissolved			97.1		%		80-120	14-MAY-19
Strontium (Sr)-Dissolved			96.4		%		80-120	14-MAY-19
Sulfur (S)-Dissolved			89.4		%		80-120	14-MAY-19
Tellurium (Te)-Dissolved			100.3		%		80-120	14-MAY-19
Thallium (Tl)-Dissolved			98.0		%		80-120	14-MAY-19
Thorium (Th)-Dissolved			100.2		%		80-120	14-MAY-19
Tin (Sn)-Dissolved			93.7		%		80-120	14-MAY-19
Titanium (Ti)-Dissolved			94.2		%		80-120	14-MAY-19
Tungsten (W)-Dissolved			97.9		%		80-120	14-MAY-19
Uranium (U)-Dissolved			97.8		%		80-120	14-MAY-19
Vanadium (V)-Dissolved			95.1		%		80-120	14-MAY-19
Zinc (Zn)-Dissolved			97.3		%		80-120	14-MAY-19
Zirconium (Zr)-Dissolved			93.9		%		80-120	14-MAY-19
WG3048430-1		MB						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	14-MAY-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	14-MAY-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	14-MAY-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	14-MAY-19



## Quality Control Report

Workorder: L2271564

Report Date: 30-MAY-19

Page 5 of 12

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA		Water						
Batch	R4634451							
WG3048430-1	MB							
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	14-MAY-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	14-MAY-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	14-MAY-19
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	14-MAY-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	14-MAY-19
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	14-MAY-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	14-MAY-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	14-MAY-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	14-MAY-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	14-MAY-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	14-MAY-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	14-MAY-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	14-MAY-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	14-MAY-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	14-MAY-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	14-MAY-19
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	14-MAY-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	14-MAY-19
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	14-MAY-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	14-MAY-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	14-MAY-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	14-MAY-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	14-MAY-19
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	14-MAY-19
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	14-MAY-19
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	14-MAY-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	14-MAY-19
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	14-MAY-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	14-MAY-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	14-MAY-19
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	14-MAY-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	14-MAY-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	14-MAY-19



## Quality Control Report

Workorder: L2271564

Report Date: 30-MAY-19

Page 6 of 12

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>MET-D-CCMS-VA</b>		<b>Water</b>						
<b>Batch R4634451</b>								
<b>WG3048430-1 MB</b>								
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	14-MAY-19
Zirconium (Zr)-Dissolved			<0.000060		mg/L		0.00006	14-MAY-19
<b>Batch R4639780</b>								
<b>WG3054859-3 DUP</b>		<b>L2271564-1</b>						
Aluminum (Al)-Dissolved		0.0124	0.0121		mg/L	2.4	20	21-MAY-19
Antimony (Sb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	21-MAY-19
Arsenic (As)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	21-MAY-19
Barium (Ba)-Dissolved		0.00052	0.00054		mg/L	3.7	20	21-MAY-19
Beryllium (Be)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	21-MAY-19
Bismuth (Bi)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	21-MAY-19
Boron (B)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	21-MAY-19
Cadmium (Cd)-Dissolved		<0.0000050	<0.0000050	RPD-NA	mg/L	N/A	20	21-MAY-19
Calcium (Ca)-Dissolved		27.8	28.0		mg/L	0.7	20	21-MAY-19
Cesium (Cs)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	21-MAY-19
Chromium (Cr)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	21-MAY-19
Cobalt (Co)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	21-MAY-19
Copper (Cu)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	21-MAY-19
Iron (Fe)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	21-MAY-19
Lead (Pb)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	21-MAY-19
Lithium (Li)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	21-MAY-19
Magnesium (Mg)-Dissolved		2.37	2.42		mg/L	1.9	20	21-MAY-19
Manganese (Mn)-Dissolved		0.00032	0.00038		mg/L	18	20	21-MAY-19
Molybdenum (Mo)-Dissolved		0.000105	0.000096		mg/L	8.4	20	21-MAY-19
Nickel (Ni)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	21-MAY-19
Phosphorus (P)-Dissolved		<0.050	<0.050	RPD-NA	mg/L	N/A	20	21-MAY-19
Potassium (K)-Dissolved		<0.050	0.050	RPD-NA	mg/L	N/A	20	21-MAY-19
Rubidium (Rb)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	21-MAY-19
Selenium (Se)-Dissolved		0.000058	0.000059		mg/L	1.4	20	21-MAY-19
Silicon (Si)-Dissolved		0.827	0.838		mg/L	1.3	20	21-MAY-19
Silver (Ag)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	21-MAY-19
Sodium (Na)-Dissolved		0.838	0.828		mg/L	1.1	20	21-MAY-19
Strontium (Sr)-Dissolved		0.0409	0.0399		mg/L	2.4	20	21-MAY-19
Sulfur (S)-Dissolved		<0.50	<0.50	RPD-NA	mg/L	N/A	20	21-MAY-19



## Quality Control Report

Workorder: L2271564

Report Date: 30-MAY-19

Page 7 of 12

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>MET-D-CCMS-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4639780</b>							
<b>WG3054859-3</b>	<b>DUP</b>	<b>L2271564-1</b>						
Tellurium (Te)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	21-MAY-19
Thallium (Tl)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	21-MAY-19
Thorium (Th)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	21-MAY-19
Tin (Sn)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	21-MAY-19
Titanium (Ti)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	21-MAY-19
Tungsten (W)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	21-MAY-19
Uranium (U)-Dissolved		0.000144	0.000152		mg/L	5.3	20	21-MAY-19
Vanadium (V)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	21-MAY-19
Zinc (Zn)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	21-MAY-19
Zirconium (Zr)-Dissolved		<0.000060	<0.000060	RPD-NA	mg/L	N/A	20	21-MAY-19
<b>WG3054859-2</b>	<b>LCS</b>							
Aluminum (Al)-Dissolved			95.0		%		80-120	21-MAY-19
Antimony (Sb)-Dissolved			94.1		%		80-120	21-MAY-19
Arsenic (As)-Dissolved			93.8		%		80-120	21-MAY-19
Barium (Ba)-Dissolved			98.8		%		80-120	21-MAY-19
Beryllium (Be)-Dissolved			98.1		%		80-120	21-MAY-19
Bismuth (Bi)-Dissolved			97.3		%		80-120	21-MAY-19
Boron (B)-Dissolved			95.0		%		80-120	21-MAY-19
Cadmium (Cd)-Dissolved			94.9		%		80-120	21-MAY-19
Calcium (Ca)-Dissolved			94.5		%		80-120	21-MAY-19
Cesium (Cs)-Dissolved			95.1		%		80-120	21-MAY-19
Chromium (Cr)-Dissolved			93.5		%		80-120	21-MAY-19
Cobalt (Co)-Dissolved			94.4		%		80-120	21-MAY-19
Copper (Cu)-Dissolved			92.6		%		80-120	21-MAY-19
Iron (Fe)-Dissolved			92.9		%		80-120	21-MAY-19
Lead (Pb)-Dissolved			98.3		%		80-120	21-MAY-19
Lithium (Li)-Dissolved			99.5		%		80-120	21-MAY-19
Magnesium (Mg)-Dissolved			101.3		%		80-120	21-MAY-19
Manganese (Mn)-Dissolved			94.8		%		80-120	21-MAY-19
Molybdenum (Mo)-Dissolved			99.96		%		80-120	21-MAY-19
Nickel (Ni)-Dissolved			95.6		%		80-120	21-MAY-19
Phosphorus (P)-Dissolved			95.2		%		70-130	21-MAY-19
Potassium (K)-Dissolved			96.1		%		80-120	21-MAY-19



## Quality Control Report

Workorder: L2271564

Report Date: 30-MAY-19

Page 8 of 12

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA		Water						
Batch	R4639780							
WG3054859-2	LCS							
Rubidium (Rb)-Dissolved			97.2		%		80-120	21-MAY-19
Selenium (Se)-Dissolved			94.0		%		80-120	21-MAY-19
Silicon (Si)-Dissolved			91.1		%		60-140	21-MAY-19
Silver (Ag)-Dissolved			97.9		%		80-120	21-MAY-19
Sodium (Na)-Dissolved			91.0		%		80-120	21-MAY-19
Strontium (Sr)-Dissolved			96.1		%		80-120	21-MAY-19
Sulfur (S)-Dissolved			84.1		%		80-120	21-MAY-19
Tellurium (Te)-Dissolved			91.5		%		80-120	21-MAY-19
Thallium (Tl)-Dissolved			97.3		%		80-120	21-MAY-19
Thorium (Th)-Dissolved			88.1		%		80-120	21-MAY-19
Tin (Sn)-Dissolved			94.0		%		80-120	21-MAY-19
Titanium (Ti)-Dissolved			90.1		%		80-120	21-MAY-19
Tungsten (W)-Dissolved			98.9		%		80-120	21-MAY-19
Uranium (U)-Dissolved			95.0		%		80-120	21-MAY-19
Vanadium (V)-Dissolved			93.9		%		80-120	21-MAY-19
Zinc (Zn)-Dissolved			92.6		%		80-120	21-MAY-19
Zirconium (Zr)-Dissolved			93.4		%		80-120	21-MAY-19
WG3054859-1	MB							
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	21-MAY-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	21-MAY-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	21-MAY-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	21-MAY-19
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	21-MAY-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	21-MAY-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	21-MAY-19
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	21-MAY-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	21-MAY-19
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	21-MAY-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	21-MAY-19
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	21-MAY-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	21-MAY-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	21-MAY-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	21-MAY-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	21-MAY-19

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA		Water						
Batch	R4639780							
WG3054859-1		MB						
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	21-MAY-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	21-MAY-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	21-MAY-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	21-MAY-19
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	21-MAY-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	21-MAY-19
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	21-MAY-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	21-MAY-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	21-MAY-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	21-MAY-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	21-MAY-19
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	21-MAY-19
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	21-MAY-19
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	21-MAY-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	21-MAY-19
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	21-MAY-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	21-MAY-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	21-MAY-19
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	21-MAY-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	21-MAY-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	21-MAY-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	21-MAY-19
Zirconium (Zr)-Dissolved			<0.000060		mg/L		0.00006	21-MAY-19
NH3-F-VA		Water						
Batch	R4631453							
WG3047426-3		DUP	L2271564-1					
Ammonia, Total (as N)			0.0073	0.0068	mg/L	7.5	20	12-MAY-19
WG3047426-2		LCS						
Ammonia, Total (as N)				96.6	%		85-115	12-MAY-19
WG3047426-1		MB						
Ammonia, Total (as N)				<0.0050	mg/L		0.005	12-MAY-19
WG3047426-4		MS	L2271564-2					
Ammonia, Total (as N)				96.9	%		75-125	12-MAY-19
NO2-L-IC-N-VA		Water						





## Quality Control Report

Workorder: L2271564

Report Date: 30-MAY-19

Page 10 of 12

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>NO2-L-IC-N-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4635753</b>							
<b>WG3047079-3</b>	<b>DUP</b>	<b>L2271563-1</b>						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	11-MAY-19
<b>WG3047079-2</b>	<b>LCS</b>							
Nitrite (as N)			100.5		%		90-110	11-MAY-19
<b>WG3047079-1</b>	<b>MB</b>							
Nitrite (as N)			<0.0010		mg/L		0.001	11-MAY-19
<b>WG3047079-4</b>	<b>MS</b>	<b>L2271564-2</b>						
Nitrite (as N)			100.4		%		75-125	11-MAY-19
<b>NO3-L-IC-N-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4635753</b>							
<b>WG3047079-3</b>	<b>DUP</b>	<b>L2271563-1</b>						
Nitrate (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	11-MAY-19
<b>WG3047079-2</b>	<b>LCS</b>							
Nitrate (as N)			101.5		%		90-110	11-MAY-19
<b>WG3047079-1</b>	<b>MB</b>							
Nitrate (as N)			<0.0050		mg/L		0.005	11-MAY-19
<b>WG3047079-4</b>	<b>MS</b>	<b>L2271564-2</b>						
Nitrate (as N)			102.0		%		75-125	11-MAY-19
<b>PH-PCT-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4636061</b>							
<b>WG3047082-2</b>	<b>CRM</b>	<b>VA-PH7-BUF</b>						
pH			6.99		pH		6.9-7.1	15-MAY-19
<b>WG3047082-5</b>	<b>DUP</b>	<b>L2271563-1</b>						
pH		7.05	7.02	J	pH	0.03	0.3	15-MAY-19
<b>SO4-IC-N-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4635753</b>							
<b>WG3047079-3</b>	<b>DUP</b>	<b>L2271563-1</b>						
Sulfate (SO4)		<0.30	<0.30	RPD-NA	mg/L	N/A	20	11-MAY-19
<b>WG3047079-2</b>	<b>LCS</b>							
Sulfate (SO4)			101.0		%		90-110	11-MAY-19
<b>WG3047079-1</b>	<b>MB</b>							
Sulfate (SO4)			<0.30		mg/L		0.3	11-MAY-19
<b>WG3047079-4</b>	<b>MS</b>	<b>L2271564-2</b>						
Sulfate (SO4)			100.3		%		75-125	11-MAY-19

# Quality Control Report

Workorder: L2271564

Report Date: 30-MAY-19

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Page 11 of 12

Contact: Airesse MacPhee

## Legend:

---

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

## Sample Parameter Qualifier Definitions:

---

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

---

# Quality Control Report

Workorder: L2271564

Report Date: 30-MAY-19

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4  
Contact: Airesse MacPhee

Page 12 of 12

## Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
<b>Physical Tests</b>							
pH by Meter (Automated)							
	1	08-MAY-19 09:45	15-MAY-19 07:59	0.25	166	hours	EHTR-FM
	2	08-MAY-19 10:20	15-MAY-19 07:59	0.25	166	hours	EHTR-FM
	3	08-MAY-19 10:50	15-MAY-19 07:59	0.25	165	hours	EHTR-FM
	4	08-MAY-19 11:20	15-MAY-19 07:59	0.25	165	hours	EHTR-FM
	5	08-MAY-19 11:55	15-MAY-19 07:59	0.25	164	hours	EHTR-FM
	6	08-MAY-19 12:30	15-MAY-19 07:59	0.25	163	hours	EHTR-FM
	7	08-MAY-19 12:45	15-MAY-19 07:59	0.25	163	hours	EHTR-FM

## Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.  
EHTR: Exceeded ALS recommended hold time prior to sample receipt.  
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.  
EHT: Exceeded ALS recommended hold time prior to analysis.  
Rec. HT: ALS recommended hold time (see units).

Notes\*:  
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.  
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2271564 were received on 10-MAY-19 18:16.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



L2271564-COFC

COC Number: 15 - 56484-05

Page 1 of 1 - 080519

<b>Report To</b> Contact and company name below will appear on the final report		<b>Report Format / Distribution</b>		<b>Select Service Level Below - Please confirm all E&amp;P TATs with your AM - surcharges will apply</b>									
Company: GHD Limited		Select Report Format: <input checked="" type="checkbox"/> PDF <input checked="" type="checkbox"/> EXCEL <input checked="" type="checkbox"/> EDD (DIGITAL)		<b>Regular [R]</b> <input checked="" type="checkbox"/> Standard TAT if received by 3 pm - business days - no surcharges apply									
Contact: Airesse MacPhee		Quality Control (QC) Report with Report <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		<b>PRIORITY (Business Days)</b>		4 day [P4] <input type="checkbox"/>		<b>EMERGENCY</b>		1 Business day [E1] <input type="checkbox"/>			
Phone:		<input type="checkbox"/> Compare Results to Criteria on Report - provide details below if box checked				3 day [P3] <input type="checkbox"/>				Same Day, Weekend or Statutory holiday [E0] <input type="checkbox"/>			
Company address below will appear on the final report		Select Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX											
Street: 651 Colby Drive		Email 1 or Fax: <a href="mailto:airesse.macphee@ghd.com">airesse.macphee@ghd.com</a>		Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm									
City/Province: Waterloo, ON		Email 2: See PO		For tests that can not be performed according to the service level selected, you will be contacted.									
Postal Code: N2V 1C2		Email 3:		<b>Analysis Request</b>									
Invoice To: Same as Report To <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		<b>Invoice Distribution</b>		Indicate Filtered (F), Preserved (P) or Filtered and Preserved (FP) below									
Copy of Invoice with Report <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		Select Invoice Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX											
Contact:		Email 1 or Fax:											
		Email 2:											
<b>Project Information</b>		<b>Oil and Gas Required Fields (client use)</b>											
ALS Account # / Quote #: Q72562		AFE/Cost Center:		PO#:								Number of Containers	
Job #: 11179286- CVRD		Major/Minor Code:		Routing Code:									
PO / AFE:		Requisitioner:											
LSD: Tahsis (Phase 05) GW		Location:											
ALS Lab Work Order # (lab use only)		ALS Contact: <i>Selam Wanku</i>		Sampler: <i>M. Dyck 03010</i>									
ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Alkalinity (speciated)	Ammonia-N	Anions (Cl, F, SO4, NO2, NO3)	pH	Conductivity	MET-DIS (w/fig. Phosphorus, Sulfur, Hardness)			
	WG-56484-080519-DB-01	08-MAY-19	9:45	WG	X	X	X	X	X	X	4		
	-02		10:20										
	-03		10:50										
	-04		11:20										
	-05		11:55										
	-06		12:30										
	-07		12:45										
<b>Drinking Water (DW) Samples<sup>1</sup> (client use)</b>		<b>Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)</b>		<b>SAMPLE CONDITION AS RECEIVED (lab use only)</b>									
Are samples taken from a Regulated DW System? <input type="checkbox"/> YES <input type="checkbox"/> NO		<i>sampled not field altered or preserved. Short hold times</i>		Frozen <input type="checkbox"/> SIF Observations Yes <input type="checkbox"/> No <input type="checkbox"/>									
Are samples for human drinking water use? <input type="checkbox"/> YES <input type="checkbox"/> NO				Ice Packs <input type="checkbox"/> Ice Cubes <input checked="" type="checkbox"/> Custody seal intact Yes <input type="checkbox"/> No <input type="checkbox"/>									
		Cooling Initiated <input type="checkbox"/>											
		INITIAL COOLER TEMPERATURES °C											
		FINAL COOLER TEMPERATURES °C <i>Dang</i>											
<b>SHIPMENT RELEASE (client use)</b>		<b>INITIAL SHIPMENT RECEPTION (lab use only)</b>		<b>FINAL SHIPMENT RECEPTION (lab use only)</b>									
Released by: <i>[Signature]</i> Date: <i>May 9, 2019</i> Time: <i>11:30</i>		Received by: Date: Time:		Received by: <i>CW</i> Date: <i>May 10</i> Time: <i>20:50</i>									

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.



GHD Field Sample Key (FSK)

Site

Site Name (056484-54)

Sample Reason

Tahsis Q2 EMP

Sampler Name

Chris Thorne, David Botero

Sampling Company

GHD Ltd.

Laboratory(s)

ALS

SSOW Reference Code :

Laboratory(s) <span>ALS</span>											Temperature		pH	Eh / ORP		Conductivity		Turbidity		DO		TDS		
Sample ID	Location	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Sample Type	Sample Matrix	Grab or Composite	Start Depth (in bgs)	End Depth (in bgs)	Parent Sample ID for Field Dups	Footnote(s)	Volume of Water Purged (L)	Sample Temperature	Temperature Units	Field pH (s.u.)	Eh / ORP	Eh / ORP Units	Conductivity	Conductivity Units	Turbidity	Turbidity Units	Dissolved Oxygen	Dissolved Oxygen Units	Total Dissolved Solids	Total Dissolved Solids Units
WG56484-271119-08	PFP#4A	11/27/2019	9:30	N	WG	grab					14	8.92	C	7.59	206	mV	239	uS/cm	14.7	ntu	-	mg/L	0.155	g/L
WG56484-271119-09	PFP#3A	11/27/2019	10:30	N	WG	grab					21	7.84	C	7.36	226	mV	410	uS/cm	0	ntu	-	mg/L	0.267	g/L
WG56484-271119-10	PFP#1A	11/27/2019	11:00	N	WG	grab					220	6.54	C	7.82	-51	mV	301	uS/cm	0	ntu	-	mg/L	0.196	g/L
WG56484-271119-11	PFP#2A	11/27/2019	11:40	N	WG	grab					35	7.76	C	7.07	58	mV	491	uS/cm	0	ntu	-	mg/L	0.319	g/L
WG56484-271119-12	MW-2	11/27/2019	12:05	N	WG	grab					48	7.59	C	7.77	80	mV	264	uS/cm	0	ntu	-	mg/L	0.172	g/L
WG56484-271119-13	MW-1	11/27/2019	12:40	N	WG	grab					52	9.82	C	7.61	111	mV	274	uS/cm	0	ntu	-	mg/L	0.178	g/L
													C			mV		uS/cm		ntu		mg/L		g/L
													C			mV		uS/cm		ntu		mg/L		g/L
													C			mV		uS/cm		ntu		mg/L		g/L
													C			mV		uS/cm		ntu		mg/L		g/L
													C			mV		uS/cm		ntu		mg/L		g/L
													C			mV		uS/cm		ntu		mg/L		g/L
													C			mV		uS/cm		ntu		mg/L		g/L
													C			mV		uS/cm		ntu		mg/L		g/L
													C			mV		uS/cm		ntu		mg/L		g/L
													C			mV		uS/cm		ntu		mg/L		g/L

Footnotes

1.

2.

3.

4.

5.

6.

Key

Required Field

Populate When Appropriate

Field Data



GHD Limited  
ATTN: Airesse MacPhee  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Date Received: 28-NOV-19  
Report Date: 06-DEC-19 19:16 (MT)  
Version: FINAL

Client Phone: 613-727-0510

## Certificate of Analysis

**Lab Work Order #:** L2389505  
**Project P.O. #:** 73515713-2  
**Job Reference:** 056484-54  
**C of C Numbers:**  
**Legal Site Desc:** Phase 54 - Tahsis GW

Selam Worku  
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2389505-1	WG-56484-271119-CT-08							
Sampled By: C. Thorne on 27-NOV-19 @ 09:30								
Matrix: GW								
Physical Tests								
Conductivity		216		2.0	uS/cm		30-NOV-19	R4929176
Hardness (as CaCO3), dissolved		103		0.50	mg/L		30-NOV-19	
pH		8.18		0.10	pH		30-NOV-19	R4929176
Anions and Nutrients								
Alkalinity, Bicarbonate (as CaCO3)		115		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Total (as CaCO3)		115		1.0	mg/L		30-NOV-19	R4929176
Ammonia, Total (as N)		0.0058		0.0050	mg/L		30-NOV-19	R4929363
Chloride (Cl)		1.12		0.50	mg/L		29-NOV-19	R4930106
Fluoride (F)		<0.020		0.020	mg/L		29-NOV-19	R4930106
Nitrate and Nitrite (as N)		0.0615		0.0051	mg/L		03-DEC-19	
Nitrate (as N)		0.0615		0.0050	mg/L		29-NOV-19	R4930106
Nitrite (as N)		<0.0010		0.0010	mg/L		29-NOV-19	R4930106
Sulfate (SO4)		1.68		0.30	mg/L		29-NOV-19	R4930106
Dissolved Metals								
Dissolved Mercury Filtration Location		FIELD					30-NOV-19	R4929172
Dissolved Metals Filtration Location		FIELD					29-NOV-19	R4928762
Aluminum (Al)-Dissolved		0.0058		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Barium (Ba)-Dissolved		0.00248		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Boron (B)-Dissolved		<0.010		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Calcium (Ca)-Dissolved		36.0		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Cesium (Cs)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Chromium (Cr)-Dissolved		0.00016		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Copper (Cu)-Dissolved		0.00066		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Magnesium (Mg)-Dissolved		3.12		0.0050	mg/L	29-NOV-19	30-NOV-19	R4928947
Manganese (Mn)-Dissolved		0.00089		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	30-NOV-19	01-DEC-19	R4929433
Molybdenum (Mo)-Dissolved		0.000091		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Potassium (K)-Dissolved		0.059		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2389505-1    WG-56484-271119-CT-08 Sampled By:   C. Thorne on 27-NOV-19 @ 09:30 Matrix:        GW								
<b>Dissolved Metals</b>								
Rubidium (Rb)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Selenium (Se)-Dissolved		0.000090		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Silicon (Si)-Dissolved		1.28		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Sodium (Na)-Dissolved		1.04		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Strontium (Sr)-Dissolved		0.0499		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Sulfur (S)-Dissolved		0.84		0.50	mg/L	29-NOV-19	30-NOV-19	R4928947
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	29-NOV-19	30-NOV-19	R4928947
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Uranium (U)-Dissolved		0.000170		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Zinc (Zn)-Dissolved		0.0014		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Zirconium (Zr)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
L2389505-2    WG-56484-271119-CT-09 Sampled By:   C. Thorne on 27-NOV-19 @ 10:30 Matrix:        GW								
<b>Physical Tests</b>								
Conductivity		376		2.0	uS/cm		30-NOV-19	R4929176
Hardness (as CaCO3), dissolved		191		0.50	mg/L		30-NOV-19	
pH		8.19		0.10	pH		30-NOV-19	R4929176
<b>Anions and Nutrients</b>								
Alkalinity, Bicarbonate (as CaCO3)		217		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Total (as CaCO3)		217		1.0	mg/L		30-NOV-19	R4929176
Ammonia, Total (as N)		<0.0050		0.0050	mg/L		30-NOV-19	R4929363
Chloride (Cl)		1.64		0.50	mg/L		29-NOV-19	R4930106
Fluoride (F)		<0.020		0.020	mg/L		29-NOV-19	R4930106
Nitrate and Nitrite (as N)		0.240		0.0051	mg/L		03-DEC-19	
Nitrate (as N)		0.240		0.0050	mg/L		29-NOV-19	R4930106
Nitrite (as N)		<0.0010		0.0010	mg/L		29-NOV-19	R4930106
Sulfate (SO4)		2.53		0.30	mg/L		29-NOV-19	R4930106
<b>Dissolved Metals</b>								
Dissolved Mercury Filtration Location		FIELD					30-NOV-19	R4929172
Dissolved Metals Filtration Location		FIELD					29-NOV-19	R4928762
Aluminum (Al)-Dissolved		0.0022		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2389505-2    WG-56484-271119-CT-09 Sampled By:   C. Thorne on 27-NOV-19 @ 10:30 Matrix:        GW								
<b>Dissolved Metals</b>								
Barium (Ba)-Dissolved		0.00293		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Boron (B)-Dissolved		<0.010		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Calcium (Ca)-Dissolved		69.7		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Cesium (Cs)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Chromium (Cr)-Dissolved		0.00019		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Copper (Cu)-Dissolved		0.00049		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Magnesium (Mg)-Dissolved		4.01		0.0050	mg/L	29-NOV-19	30-NOV-19	R4928947
Manganese (Mn)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	30-NOV-19	01-DEC-19	R4929433
Molybdenum (Mo)-Dissolved		0.000089		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Potassium (K)-Dissolved		0.164		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Rubidium (Rb)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Selenium (Se)-Dissolved		0.000083		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Silicon (Si)-Dissolved		1.87		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Sodium (Na)-Dissolved		1.23		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Strontium (Sr)-Dissolved		0.0827		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Sulfur (S)-Dissolved		1.02		0.50	mg/L	29-NOV-19	30-NOV-19	R4928947
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	29-NOV-19	30-NOV-19	R4928947
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Uranium (U)-Dissolved		0.000333		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Zinc (Zn)-Dissolved		<0.0010		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Zirconium (Zr)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
L2389505-3    WG-56484-271119-CT-10 Sampled By:   C. Thorne on 27-NOV-19 @ 11:00 Matrix:        GW								
<b>Physical Tests</b>								
Conductivity		269		2.0	uS/cm		30-NOV-19	R4929176

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2389505-3      WG-56484-271119-CT-10								
Sampled By:    C. Thorne on 27-NOV-19 @ 11:00								
Matrix:        GW								
<b>Physical Tests</b>								
Hardness (as CaCO3), dissolved		100		0.50	mg/L		30-NOV-19	
pH		8.23		0.10	pH		30-NOV-19	R4929176
<b>Anions and Nutrients</b>								
Alkalinity, Bicarbonate (as CaCO3)		141		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Total (as CaCO3)		141		1.0	mg/L		30-NOV-19	R4929176
Ammonia, Total (as N)		3.45		0.13	mg/L		30-NOV-19	R4929363
Chloride (Cl)		1.36		0.50	mg/L		29-NOV-19	R4930106
Fluoride (F)		0.305		0.020	mg/L		29-NOV-19	R4930106
Nitrate and Nitrite (as N)		<0.0051		0.0051	mg/L		03-DEC-19	
Nitrate (as N)		<0.0050		0.0050	mg/L		29-NOV-19	R4930106
Nitrite (as N)		<0.0010		0.0010	mg/L		29-NOV-19	R4930106
Sulfate (SO4)		3.57		0.30	mg/L		29-NOV-19	R4930106
<b>Dissolved Metals</b>								
Dissolved Mercury Filtration Location		FIELD					30-NOV-19	R4929172
Dissolved Metals Filtration Location		FIELD					29-NOV-19	R4928762
Aluminum (Al)-Dissolved		0.0021		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Barium (Ba)-Dissolved		0.00016		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Boron (B)-Dissolved		0.310		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Calcium (Ca)-Dissolved		19.9		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Cesium (Cs)-Dissolved		0.000033		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Chromium (Cr)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Copper (Cu)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Iron (Fe)-Dissolved		0.056		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Lithium (Li)-Dissolved		0.0038		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Magnesium (Mg)-Dissolved		12.2		0.0050	mg/L	29-NOV-19	30-NOV-19	R4928947
Manganese (Mn)-Dissolved		0.00752		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	30-NOV-19	01-DEC-19	R4929433
Molybdenum (Mo)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Phosphorus (P)-Dissolved		0.661		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Potassium (K)-Dissolved		4.76		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Rubidium (Rb)-Dissolved		0.00187		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2389505-3    WG-56484-271119-CT-10 Sampled By:   C. Thorne on 27-NOV-19 @ 11:00 Matrix:        GW								
<b>Dissolved Metals</b>								
Selenium (Se)-Dissolved		0.000155		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Silicon (Si)-Dissolved		10.5		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Sodium (Na)-Dissolved		10.0		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Strontium (Sr)-Dissolved		0.129		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Sulfur (S)-Dissolved		2.19		0.50	mg/L	29-NOV-19	30-NOV-19	R4928947
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	29-NOV-19	30-NOV-19	R4928947
Tungsten (W)-Dissolved		0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Uranium (U)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Zinc (Zn)-Dissolved		<0.0010		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Zirconium (Zr)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
L2389505-4    WG-56484-271119-CT-11 Sampled By:   C. Thorne on 27-NOV-19 @ 11:40 Matrix:        GW								
<b>Physical Tests</b>								
Conductivity		447		2.0	uS/cm		30-NOV-19	R4929176
Hardness (as CaCO3), dissolved		233		0.50	mg/L		30-NOV-19	
pH		7.94		0.10	pH		30-NOV-19	R4929176
<b>Anions and Nutrients</b>								
Alkalinity, Bicarbonate (as CaCO3)		273		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Total (as CaCO3)		273		1.0	mg/L		30-NOV-19	R4929176
Ammonia, Total (as N)		<0.0050		0.0050	mg/L		30-NOV-19	R4929363
Chloride (Cl)		1.47		0.50	mg/L		29-NOV-19	R4930106
Fluoride (F)		<0.020		0.020	mg/L		29-NOV-19	R4930106
Nitrate and Nitrite (as N)		0.348		0.0051	mg/L		03-DEC-19	
Nitrate (as N)		0.348		0.0050	mg/L		29-NOV-19	R4930106
Nitrite (as N)		<0.0010		0.0010	mg/L		29-NOV-19	R4930106
Sulfate (SO4)		1.74		0.30	mg/L		29-NOV-19	R4930106
<b>Dissolved Metals</b>								
Dissolved Mercury Filtration Location		FIELD					30-NOV-19	R4929172
Dissolved Metals Filtration Location		FIELD					29-NOV-19	R4928762
Aluminum (Al)-Dissolved		0.0019		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Barium (Ba)-Dissolved		0.00314		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2389505-4    WG-56484-271119-CT-11 Sampled By:    C. Thorne on 27-NOV-19 @ 11:40 Matrix:        GW								
<b>Dissolved Metals</b>								
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Boron (B)-Dissolved		0.014		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Calcium (Ca)-Dissolved		84.4		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Cesium (Cs)-Dissolved		0.000017		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Chromium (Cr)-Dissolved		0.00018		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Copper (Cu)-Dissolved		0.00041		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Magnesium (Mg)-Dissolved		5.44		0.0050	mg/L	29-NOV-19	30-NOV-19	R4928947
Manganese (Mn)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	30-NOV-19	01-DEC-19	R4929433
Molybdenum (Mo)-Dissolved		0.000082		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Potassium (K)-Dissolved		0.522		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Rubidium (Rb)-Dissolved		0.00021		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Selenium (Se)-Dissolved		0.000072		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Silicon (Si)-Dissolved		2.38		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Sodium (Na)-Dissolved		1.47		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Strontium (Sr)-Dissolved		0.102		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Sulfur (S)-Dissolved		0.82		0.50	mg/L	29-NOV-19	30-NOV-19	R4928947
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	29-NOV-19	30-NOV-19	R4928947
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Uranium (U)-Dissolved		0.000348		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Zinc (Zn)-Dissolved		<0.0010		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Zirconium (Zr)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
L2389505-5    WG-56484-271119-CT-12 Sampled By:    C. Thorne on 27-NOV-19 @ 12:05 Matrix:        GW								
<b>Physical Tests</b>								
Conductivity		240		2.0	uS/cm		30-NOV-19	R4929176
Hardness (as CaCO3), dissolved		117		0.50	mg/L		30-NOV-19	

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2389505-5      WG-56484-271119-CT-12								
Sampled By:    C. Thorne on 27-NOV-19 @ 12:05								
Matrix:        GW								
<b>Physical Tests</b>								
pH		8.22		0.10	pH		30-NOV-19	R4929176
<b>Anions and Nutrients</b>								
Alkalinity, Bicarbonate (as CaCO3)		125		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Total (as CaCO3)		125		1.0	mg/L		30-NOV-19	R4929176
Ammonia, Total (as N)		<0.0050		0.0050	mg/L		30-NOV-19	R4929363
Chloride (Cl)		2.38		0.50	mg/L		29-NOV-19	R4930106
Fluoride (F)		<0.020		0.020	mg/L		29-NOV-19	R4930106
Nitrate and Nitrite (as N)		0.346		0.0051	mg/L		03-DEC-19	
Nitrate (as N)		0.346		0.0050	mg/L		29-NOV-19	R4930106
Nitrite (as N)		<0.0010		0.0010	mg/L		29-NOV-19	R4930106
Sulfate (SO4)		3.20		0.30	mg/L		29-NOV-19	R4930106
<b>Dissolved Metals</b>								
Dissolved Mercury Filtration Location		FIELD					30-NOV-19	R4929172
Dissolved Metals Filtration Location		FIELD					29-NOV-19	R4928762
Aluminum (Al)-Dissolved		0.0075		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Barium (Ba)-Dissolved		0.00458		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Boron (B)-Dissolved		0.022		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Calcium (Ca)-Dissolved		42.5		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Cesium (Cs)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Chromium (Cr)-Dissolved		0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Copper (Cu)-Dissolved		0.00087		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Magnesium (Mg)-Dissolved		2.72		0.0050	mg/L	29-NOV-19	30-NOV-19	R4928947
Manganese (Mn)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	30-NOV-19	01-DEC-19	R4929433
Molybdenum (Mo)-Dissolved		0.000171		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Potassium (K)-Dissolved		0.151		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Rubidium (Rb)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Selenium (Se)-Dissolved		0.000095		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2389505-5    WG-56484-271119-CT-12 Sampled By:   C. Thorne on 27-NOV-19 @ 12:05 Matrix:        GW								
<b>Dissolved Metals</b>								
Silicon (Si)-Dissolved		1.00		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Sodium (Na)-Dissolved		1.63		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Strontium (Sr)-Dissolved		0.0647		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Sulfur (S)-Dissolved		1.33		0.50	mg/L	29-NOV-19	30-NOV-19	R4928947
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	29-NOV-19	30-NOV-19	R4928947
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Uranium (U)-Dissolved		0.000276		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Zinc (Zn)-Dissolved		0.0046		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Zirconium (Zr)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
L2389505-6    WG-56484-271119-CT-13 Sampled By:   C. Thorne on 27-NOV-19 @ 12:40 Matrix:        GW								
<b>Physical Tests</b>								
Conductivity		252		2.0	uS/cm		30-NOV-19	R4929176
Hardness (as CaCO3), dissolved		123		0.50	mg/L		30-NOV-19	
pH		8.18		0.10	pH		30-NOV-19	R4929176
<b>Anions and Nutrients</b>								
Alkalinity, Bicarbonate (as CaCO3)		142		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Carbonate (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Hydroxide (as CaCO3)		<1.0		1.0	mg/L		30-NOV-19	R4929176
Alkalinity, Total (as CaCO3)		142		1.0	mg/L		30-NOV-19	R4929176
Ammonia, Total (as N)		<0.0050		0.0050	mg/L		30-NOV-19	R4929363
Chloride (Cl)		1.27		0.50	mg/L		29-NOV-19	R4930106
Fluoride (F)		<0.020		0.020	mg/L		29-NOV-19	R4930106
Nitrate and Nitrite (as N)		0.160		0.0051	mg/L		03-DEC-19	
Nitrate (as N)		0.160		0.0050	mg/L		29-NOV-19	R4930106
Nitrite (as N)		<0.0010		0.0010	mg/L		29-NOV-19	R4930106
Sulfate (SO4)		1.93		0.30	mg/L		29-NOV-19	R4930106
<b>Dissolved Metals</b>								
Dissolved Mercury Filtration Location		FIELD					30-NOV-19	R4929172
Dissolved Metals Filtration Location		FIELD					29-NOV-19	R4928762
Aluminum (Al)-Dissolved		0.0018		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Antimony (Sb)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Arsenic (As)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Barium (Ba)-Dissolved		0.00189		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Beryllium (Be)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2389505-6    WG-56484-271119-CT-13								
Sampled By:    C. Thorne on 27-NOV-19 @ 12:40								
Matrix:        GW								
<b>Dissolved Metals</b>								
Bismuth (Bi)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Boron (B)-Dissolved		<0.010		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cadmium (Cd)-Dissolved		<0.0000050		0.0000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Calcium (Ca)-Dissolved		43.7		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Cesium (Cs)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Chromium (Cr)-Dissolved		0.00013		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Cobalt (Co)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Copper (Cu)-Dissolved		0.00039		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Iron (Fe)-Dissolved		<0.010		0.010	mg/L	29-NOV-19	30-NOV-19	R4928947
Lead (Pb)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Lithium (Li)-Dissolved		<0.0010		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Magnesium (Mg)-Dissolved		3.42		0.0050	mg/L	29-NOV-19	30-NOV-19	R4928947
Manganese (Mn)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Mercury (Hg)-Dissolved		<0.0000050		0.0000050	mg/L	30-NOV-19	01-DEC-19	R4929433
Molybdenum (Mo)-Dissolved		<0.000050		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Nickel (Ni)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Phosphorus (P)-Dissolved		<0.050		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Potassium (K)-Dissolved		0.126		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Rubidium (Rb)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Selenium (Se)-Dissolved		0.000082		0.000050	mg/L	29-NOV-19	30-NOV-19	R4928947
Silicon (Si)-Dissolved		1.26		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Silver (Ag)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Sodium (Na)-Dissolved		1.15		0.050	mg/L	29-NOV-19	30-NOV-19	R4928947
Strontium (Sr)-Dissolved		0.0492		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Sulfur (S)-Dissolved		0.91		0.50	mg/L	29-NOV-19	30-NOV-19	R4928947
Tellurium (Te)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947
Thallium (Tl)-Dissolved		<0.000010		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Thorium (Th)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Tin (Sn)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Titanium (Ti)-Dissolved		<0.00030		0.00030	mg/L	29-NOV-19	30-NOV-19	R4928947
Tungsten (W)-Dissolved		<0.00010		0.00010	mg/L	29-NOV-19	30-NOV-19	R4928947
Uranium (U)-Dissolved		0.000106		0.000010	mg/L	29-NOV-19	30-NOV-19	R4928947
Vanadium (V)-Dissolved		<0.00050		0.00050	mg/L	29-NOV-19	30-NOV-19	R4928947
Zinc (Zn)-Dissolved		<0.0010		0.0010	mg/L	29-NOV-19	30-NOV-19	R4928947
Zirconium (Zr)-Dissolved		<0.00020		0.00020	mg/L	29-NOV-19	30-NOV-19	R4928947

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2389505-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2389505-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2389505-1, -2, -3, -4, -5, -6

Sample Parameter Qualifier key listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0
Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).			
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-IC-N-VA	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HARDNESS-D-CALC-VA	Water	Hardness (as CaCO3), dissolved	APHA 2340B
"Hardness (as CaCO3), dissolved" is calculated from the sum of dissolved Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. "Total Hardness" refers to the sum of Calcium and Magnesium Hardness. Hardness is normally or preferentially calculated from dissolved Calcium and Magnesium concentrations, because it is a property of water due to dissolved divalent cations.			
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC
This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.			
NO2-L-IC-N-VA	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-VA	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value
This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode			



Reference Information

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA                      Water                      Sulfate in Water by IC                      EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

*Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.*

*mg/kg - milligrams per kilogram based on dry weight of sample*

*mg/kg wwt - milligrams per kilogram based on wet weight of sample*

*mg/kg lwt - milligrams per kilogram based on lipid weight of sample*

*mg/L - unit of concentration based on volume, parts per million.*

*< - Less than.*

*D.L. - The reporting limit.*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*

*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*





## Quality Control Report

Workorder: L2389505

Report Date: 06-DEC-19

Page 2 of 10

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>HG-D-CVAA-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4929433</b>							
<b>WG3232386-7 DUP</b>		<b>L2389499-7</b>						
Mercury (Hg)-Dissolved		<0.0000050	<0.0000050	RPD-NA	mg/L	N/A	20	01-DEC-19
<b>WG3232386-6 LCS</b>			110.0		%		80-120	01-DEC-19
Mercury (Hg)-Dissolved								
<b>WG3232386-5 MB</b>			<0.0000050		mg/L		0.000005	01-DEC-19
Mercury (Hg)-Dissolved								
<b>WG3232386-8 MS</b>		<b>L2389499-8</b>	106.6		%		70-130	01-DEC-19
Mercury (Hg)-Dissolved								
<b>MET-D-CCMS-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4928947</b>							
<b>WG3231852-3 DUP</b>		<b>L2389505-1</b>						
Aluminum (Al)-Dissolved		0.0058	0.0051		mg/L	13	20	30-NOV-19
Antimony (Sb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	30-NOV-19
Arsenic (As)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	30-NOV-19
Barium (Ba)-Dissolved		0.00248	0.00240		mg/L	3.3	20	30-NOV-19
Beryllium (Be)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	30-NOV-19
Bismuth (Bi)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	30-NOV-19
Boron (B)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	30-NOV-19
Cadmium (Cd)-Dissolved		<0.0000050	<0.0000050	RPD-NA	mg/L	N/A	20	30-NOV-19
Calcium (Ca)-Dissolved		36.0	36.0		mg/L	0.1	20	30-NOV-19
Cesium (Cs)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	30-NOV-19
Chromium (Cr)-Dissolved		0.00016	0.00016		mg/L	4.3	20	30-NOV-19
Cobalt (Co)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	30-NOV-19
Copper (Cu)-Dissolved		0.00066	0.00064		mg/L	2.8	20	30-NOV-19
Iron (Fe)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	30-NOV-19
Lead (Pb)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	30-NOV-19
Lithium (Li)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	30-NOV-19
Magnesium (Mg)-Dissolved		3.12	3.12		mg/L	0.1	20	30-NOV-19
Manganese (Mn)-Dissolved		0.00089	0.00087		mg/L	1.8	20	30-NOV-19
Molybdenum (Mo)-Dissolved		0.000091	0.000092		mg/L	0.3	20	30-NOV-19
Nickel (Ni)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	30-NOV-19
Phosphorus (P)-Dissolved		<0.050	<0.050	RPD-NA	mg/L	N/A	20	30-NOV-19
Potassium (K)-Dissolved		0.059	0.058		mg/L	1.8	20	30-NOV-19
Rubidium (Rb)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	30-NOV-19
Selenium (Se)-Dissolved		0.000090	0.000079		mg/L	13	20	30-NOV-19



## Quality Control Report

Workorder: L2389505

Report Date: 06-DEC-19

Page 3 of 10

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>MET-D-CCMS-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4928947</b>							
<b>WG3231852-3 DUP</b>		<b>L2389505-1</b>						
Silicon (Si)-Dissolved		1.28	1.26		mg/L	2.0	20	30-NOV-19
Silver (Ag)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	30-NOV-19
Sodium (Na)-Dissolved		1.04	1.04		mg/L	0.2	20	30-NOV-19
Strontium (Sr)-Dissolved		0.0499	0.0490		mg/L	1.8	20	30-NOV-19
Sulfur (S)-Dissolved		0.84	0.87		mg/L	3.4	20	30-NOV-19
Tellurium (Te)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	30-NOV-19
Thallium (Tl)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	30-NOV-19
Thorium (Th)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	30-NOV-19
Tin (Sn)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	30-NOV-19
Titanium (Ti)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	30-NOV-19
Tungsten (W)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	30-NOV-19
Uranium (U)-Dissolved		0.000170	0.000160		mg/L	5.9	20	30-NOV-19
Vanadium (V)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	30-NOV-19
Zinc (Zn)-Dissolved		0.0014	0.0014		mg/L	0.1	20	30-NOV-19
Zirconium (Zr)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	30-NOV-19
<b>WG3231852-2 LCS</b>								
Aluminum (Al)-Dissolved			93.4		%		80-120	30-NOV-19
Antimony (Sb)-Dissolved			96.3		%		80-120	30-NOV-19
Arsenic (As)-Dissolved			97.1		%		80-120	30-NOV-19
Barium (Ba)-Dissolved			97.2		%		80-120	30-NOV-19
Beryllium (Be)-Dissolved			94.6		%		80-120	30-NOV-19
Bismuth (Bi)-Dissolved			95.8		%		80-120	30-NOV-19
Boron (B)-Dissolved			91.5		%		80-120	30-NOV-19
Cadmium (Cd)-Dissolved			94.7		%		80-120	30-NOV-19
Calcium (Ca)-Dissolved			95.9		%		80-120	30-NOV-19
Cesium (Cs)-Dissolved			99.9		%		80-120	30-NOV-19
Chromium (Cr)-Dissolved			97.0		%		80-120	30-NOV-19
Cobalt (Co)-Dissolved			95.1		%		80-120	30-NOV-19
Copper (Cu)-Dissolved			93.2		%		80-120	30-NOV-19
Iron (Fe)-Dissolved			98.1		%		80-120	30-NOV-19
Lead (Pb)-Dissolved			97.8		%		80-120	30-NOV-19
Lithium (Li)-Dissolved			92.8		%		80-120	30-NOV-19
Magnesium (Mg)-Dissolved			94.6		%		80-120	30-NOV-19



## Quality Control Report

Workorder: L2389505

Report Date: 06-DEC-19

Page 4 of 10

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA		Water						
Batch	R4928947							
WG3231852-2	LCS							
Manganese (Mn)-Dissolved			95.4		%		80-120	30-NOV-19
Molybdenum (Mo)-Dissolved			95.9		%		80-120	30-NOV-19
Nickel (Ni)-Dissolved			94.2		%		80-120	30-NOV-19
Phosphorus (P)-Dissolved			102.6		%		70-130	30-NOV-19
Potassium (K)-Dissolved			98.7		%		80-120	30-NOV-19
Rubidium (Rb)-Dissolved			91.1		%		80-120	30-NOV-19
Selenium (Se)-Dissolved			101.4		%		80-120	30-NOV-19
Silicon (Si)-Dissolved			99.3		%		60-140	30-NOV-19
Silver (Ag)-Dissolved			99.6		%		80-120	30-NOV-19
Sodium (Na)-Dissolved			97.0		%		80-120	30-NOV-19
Strontium (Sr)-Dissolved			100.9		%		80-120	30-NOV-19
Sulfur (S)-Dissolved			103.9		%		80-120	30-NOV-19
Tellurium (Te)-Dissolved			99.9		%		80-120	30-NOV-19
Thallium (Tl)-Dissolved			97.4		%		80-120	30-NOV-19
Thorium (Th)-Dissolved			94.4		%		80-120	30-NOV-19
Tin (Sn)-Dissolved			95.9		%		80-120	30-NOV-19
Titanium (Ti)-Dissolved			92.0		%		80-120	30-NOV-19
Tungsten (W)-Dissolved			98.5		%		80-120	30-NOV-19
Uranium (U)-Dissolved			97.2		%		80-120	30-NOV-19
Vanadium (V)-Dissolved			97.2		%		80-120	30-NOV-19
Zinc (Zn)-Dissolved			97.2		%		80-120	30-NOV-19
Zirconium (Zr)-Dissolved			98.4		%		80-120	30-NOV-19
WG3231852-1	MB							
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	30-NOV-19
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	30-NOV-19
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	30-NOV-19
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	30-NOV-19
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	30-NOV-19
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	30-NOV-19
Boron (B)-Dissolved			<0.010		mg/L		0.01	30-NOV-19
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	30-NOV-19
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	30-NOV-19
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	30-NOV-19
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	30-NOV-19



## Quality Control Report

Workorder: L2389505

Report Date: 06-DEC-19

Page 5 of 10

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>MET-D-CCMS-VA</b>								
<b>Water</b>								
<b>Batch</b>	<b>R4928947</b>							
<b>WG3231852-1 MB</b>								
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	30-NOV-19
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	30-NOV-19
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	30-NOV-19
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	30-NOV-19
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	30-NOV-19
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	30-NOV-19
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	30-NOV-19
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	30-NOV-19
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	30-NOV-19
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	30-NOV-19
Potassium (K)-Dissolved			<0.050		mg/L		0.05	30-NOV-19
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	30-NOV-19
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	30-NOV-19
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	30-NOV-19
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	30-NOV-19
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	30-NOV-19
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	30-NOV-19
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	30-NOV-19
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	30-NOV-19
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	30-NOV-19
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	30-NOV-19
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	30-NOV-19
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	30-NOV-19
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	30-NOV-19
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	30-NOV-19
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	30-NOV-19
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	30-NOV-19
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	30-NOV-19
<b>WG3231852-4 MS</b>		<b>L2389505-2</b>						
Aluminum (Al)-Dissolved			91.6		%		70-130	30-NOV-19
Antimony (Sb)-Dissolved			96.9		%		70-130	30-NOV-19
Arsenic (As)-Dissolved			103.8		%		70-130	30-NOV-19
Barium (Ba)-Dissolved			94.2		%		70-130	30-NOV-19
Beryllium (Be)-Dissolved			92.8		%		70-130	30-NOV-19



## Quality Control Report

Workorder: L2389505

Report Date: 06-DEC-19

Page 6 of 10

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>MET-D-CCMS-VA</b>		<b>Water</b>						
<b>Batch</b>	<b>R4928947</b>							
<b>WG3231852-4 MS</b>		<b>L2389505-2</b>						
Bismuth (Bi)-Dissolved			91.7		%		70-130	30-NOV-19
Boron (B)-Dissolved			94.5		%		70-130	30-NOV-19
Cadmium (Cd)-Dissolved			94.6		%		70-130	30-NOV-19
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	30-NOV-19
Cesium (Cs)-Dissolved			101.1		%		70-130	30-NOV-19
Chromium (Cr)-Dissolved			95.0		%		70-130	30-NOV-19
Cobalt (Co)-Dissolved			92.1		%		70-130	30-NOV-19
Copper (Cu)-Dissolved			89.6		%		70-130	30-NOV-19
Iron (Fe)-Dissolved			94.8		%		70-130	30-NOV-19
Lead (Pb)-Dissolved			92.6		%		70-130	30-NOV-19
Lithium (Li)-Dissolved			87.8		%		70-130	30-NOV-19
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	30-NOV-19
Manganese (Mn)-Dissolved			93.4		%		70-130	30-NOV-19
Molybdenum (Mo)-Dissolved			91.9		%		70-130	30-NOV-19
Nickel (Ni)-Dissolved			90.5		%		70-130	30-NOV-19
Phosphorus (P)-Dissolved			109.9		%		70-130	30-NOV-19
Potassium (K)-Dissolved			96.5		%		70-130	30-NOV-19
Rubidium (Rb)-Dissolved			92.3		%		70-130	30-NOV-19
Selenium (Se)-Dissolved			115.4		%		70-130	30-NOV-19
Silicon (Si)-Dissolved			95.5		%		70-130	30-NOV-19
Silver (Ag)-Dissolved			96.6		%		70-130	30-NOV-19
Sodium (Na)-Dissolved			97.9		%		70-130	30-NOV-19
Strontium (Sr)-Dissolved			N/A	MS-B	%		-	30-NOV-19
Sulfur (S)-Dissolved			107.3		%		70-130	30-NOV-19
Tellurium (Te)-Dissolved			101.1		%		70-130	30-NOV-19
Thallium (Tl)-Dissolved			93.0		%		70-130	30-NOV-19
Thorium (Th)-Dissolved			94.5		%		70-130	30-NOV-19
Tin (Sn)-Dissolved			94.7		%		70-130	30-NOV-19
Titanium (Ti)-Dissolved			94.0		%		70-130	30-NOV-19
Tungsten (W)-Dissolved			95.2		%		70-130	30-NOV-19
Uranium (U)-Dissolved			93.8		%		70-130	30-NOV-19
Vanadium (V)-Dissolved			96.5		%		70-130	30-NOV-19
Zinc (Zn)-Dissolved			96.1		%		70-130	30-NOV-19



## Quality Control Report

Workorder: L2389505

Report Date: 06-DEC-19

Page 7 of 10

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>MET-D-CCMS-VA</b>	<b>Water</b>							
<b>Batch R4928947</b>								
<b>WG3231852-4 MS</b>		<b>L2389505-2</b>						
Zirconium (Zr)-Dissolved			92.1		%		70-130	30-NOV-19
<b>NH3-F-VA</b>	<b>Water</b>							
<b>Batch R4929363</b>								
<b>WG3232149-3 DUP</b>		<b>L2389505-1</b>						
Ammonia, Total (as N)		0.0058	0.0063		mg/L	8.2	20	30-NOV-19
<b>WG3232149-2 LCS</b>								
Ammonia, Total (as N)			97.3		%		85-115	30-NOV-19
<b>WG3232149-1 MB</b>								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	30-NOV-19
<b>WG3232149-4 MS</b>		<b>L2389505-2</b>						
Ammonia, Total (as N)			101.9		%		75-125	30-NOV-19
<b>NO2-L-IC-N-VA</b>	<b>Water</b>							
<b>Batch R4930106</b>								
<b>WG3231876-3 DUP</b>		<b>L2389505-1</b>						
Nitrite (as N)		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	29-NOV-19
<b>WG3231876-2 LCS</b>								
Nitrite (as N)			101.0		%		90-110	29-NOV-19
<b>WG3231876-1 MB</b>								
Nitrite (as N)			<0.0010		mg/L		0.001	29-NOV-19
<b>WG3231876-4 MS</b>		<b>L2389505-2</b>						
Nitrite (as N)			102.2		%		75-125	29-NOV-19
<b>NO3-L-IC-N-VA</b>	<b>Water</b>							
<b>Batch R4930106</b>								
<b>WG3231876-3 DUP</b>		<b>L2389505-1</b>						
Nitrate (as N)		0.0615	0.0612		mg/L	0.6	20	29-NOV-19
<b>WG3231876-2 LCS</b>								
Nitrate (as N)			101.0		%		90-110	29-NOV-19
<b>WG3231876-1 MB</b>								
Nitrate (as N)			<0.0050		mg/L		0.005	29-NOV-19
<b>WG3231876-4 MS</b>		<b>L2389505-2</b>						
Nitrate (as N)			102.1		%		75-125	29-NOV-19
<b>PH-PCT-VA</b>	<b>Water</b>							





## Quality Control Report

Workorder: L2389505

Report Date: 06-DEC-19

Page 8 of 10

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Contact: Airesse MacPhee

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed	
PH-PCT-VA		Water							
Batch	R4929176								
WG3231883-2	CRM	VA-PH7-BUF							
pH			7.03		pH		6.9-7.1	30-NOV-19	
WG3231883-4	DUP	L2389505-1							
pH		8.18	8.18	J	pH	0.00	0.3	30-NOV-19	
SO4-IC-N-VA		Water							
Batch	R4930106								
WG3231876-3	DUP	L2389505-1							
Sulfate (SO4)		1.68	1.67		mg/L	0.6	20	29-NOV-19	
WG3231876-2	LCS							29-NOV-19	
Sulfate (SO4)			100.6		%		90-110		
WG3231876-1	MB								
Sulfate (SO4)			<0.30		mg/L		0.3	29-NOV-19	
WG3231876-4	MS	L2389505-2							29-NOV-19
Sulfate (SO4)			101.6		%		75-125		

# Quality Control Report

Workorder: L2389505

Report Date: 06-DEC-19

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4

Page 9 of 10

Contact: Airesse MacPhee

## Legend:

---

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

## Sample Parameter Qualifier Definitions:

---

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

---

# Quality Control Report

Workorder: L2389505

Report Date: 06-DEC-19

Client: GHD Limited  
# 400 - 179 Colonnade Road  
Ottawa ON K2E 7J4  
Contact: Airesse MacPhee

Page 10 of 10

## Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
<b>Physical Tests</b>							
pH by Meter (Automated)							
	1	27-NOV-19 09:30	30-NOV-19 10:25	0.25	73	hours	EHTR-FM
	2	27-NOV-19 10:30	30-NOV-19 10:25	0.25	72	hours	EHTR-FM
	3	27-NOV-19 11:00	30-NOV-19 10:25	0.25	72	hours	EHTR-FM
	4	27-NOV-19 11:40	30-NOV-19 10:25	0.25	71	hours	EHTR-FM
	5	27-NOV-19 12:05	30-NOV-19 10:25	0.25	70	hours	EHTR-FM
	6	27-NOV-19 12:40	30-NOV-19 10:25	0.25	70	hours	EHTR-FM

## Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.  
EHTR: Exceeded ALS recommended hold time prior to sample receipt.  
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.  
EHT: Exceeded ALS recommended hold time prior to analysis.  
Rec. HT: ALS recommended hold time (see units).

Notes\*:  
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.  
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2389505 were received on 28-NOV-19 18:10.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



# Appendix G

## Data Quality Assessment and Validation Memoranda



# Memorandum

June 14, 2019

To: Michaela Dyck, Natasha Turl, Lainey Kong

Ref. No.: 056484-55  
Tahsis

From: Airesse MacPhee/vl/71

Tel: 604-248-3661

CC:

**Subject: Data Quality Assessment and Validation**

Laboratory: ALS Canada Ltd.

Date(s) Sampled: May 8, 2019

Lab Job No.: L2271564

Media Sampled: Groundwater

QA/QC	Criteria	Pass	Qualifiers	Fail	N/A
Holding Times	Analyte specific	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Field Duplicate (blind)	Matrix specific	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Field Blank (blind)	Non-detect	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Trip Blank	Non-detect	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Temperature	Analyte specific	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lab QA/QC	Within standard recoveries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data OK for Use	Yes <input type="checkbox"/> With Qualifiers <input checked="" type="checkbox"/> No <input type="checkbox"/>	Initial: AM			

The following results are qualified due to holding time exceedances:

Lab Report #	Sample Date (mm/dd/yyyy)	Sample ID	Analyte	Result	Qualifier	Units
L2271564	05/08/2019	WG-56484-080519-DB-01	pH, lab	8.13	J	s.u.
L2271564	05/08/2019	WG-56484-080519-DB-02	pH, lab	8.29	J	s.u.
L2271564	05/08/2019	WG-56484-080519-DB-03	pH, lab	7.74	J	s.u.
L2271564	05/08/2019	WG-56484-080519-DB-04	pH, lab	8.26	J	s.u.
L2271564	05/08/2019	WG-56484-080519-DB-05	pH, lab	8.28	J	s.u.
L2271564	05/08/2019	WG-56484-080519-DB-06	pH, lab	8.13	J	s.u.

Due to lab error, water sample for dissolved Hg was filtered after BrCl preservation. Non-detect results are unaffected, detected dissolved Hg results may be biased high:

Lab Report #	Sample Date (mm/dd/yyyy)	Sample ID	Analyte	Result	Qualifier	Units
L2271564	05/08/2019	WG-56484-080519-DB-01	Mercury (dissolved)	0.0000100	J	mg/L



Notes:

J - Estimated concentration

s.u. - Standard pH Units



# Memorandum

January 15, 2019

To: Michaela Dyck, Natasha Turl, Chris Thorne

Ref. No.: 056484-54  
Tahsis

From: Airesse MacPhee/vl/80

Subject: Data Quality Assessment and Validation

Laboratory: ALS Canada Ltd.

Date(s) Sampled: November 27, 2019

Lab Job No.: L2389505

Sampled By: Chris Thorne

Media  
Sampled: Groundwater

QA/QC	Criteria	Pass	Qualifiers	Fail	N/A
Holding Times	Method specific	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Field Duplicate (blind)	Matrix specific	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Field Blank (blind)	Non-detect	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Trip Blank	Non-detect	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Temperature	Analyte specific	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lab QA/QC	Within standard recoveries	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data OK for Use	Yes <input type="checkbox"/> With Qualifiers <input checked="" type="checkbox"/> No <input type="checkbox"/>	Initial: AM			

The following results are qualified due to holding time exceedance:

Lab Report #	Sample Date (mm/dd/yyyy)	Sample ID	Analyte	Result	Qualifier	Units
L2389505	11/27/2019	WG-56484-271119-CT-08	pH, lab	8.18	J	s.u.
L2389505	11/27/2019	WG-56484-271119-CT-09	pH, lab	8.19	J	s.u.
L2389505	11/27/2019	WG-56484-271119-CT-10	pH, lab	8.23	J	s.u.
L2389505	11/27/2019	WG-56484-271119-CT-11	pH, lab	7.94	J	s.u.
L2389505	11/28/2019	WG-56484-271119-CT-12	pH, lab	8.22	J	s.u.
L2389505	11/27/2019	WG-56484-271119-CT-13	pH, lab	8.18	J	s.u.





Notes:

J       Estimated concentration  
s.u.     Standard pH Units

# Appendix H

## Historical Groundwater/Surface Water Chemistry Trend Plots

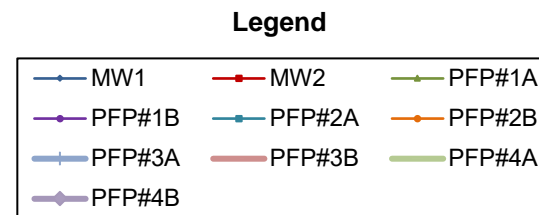
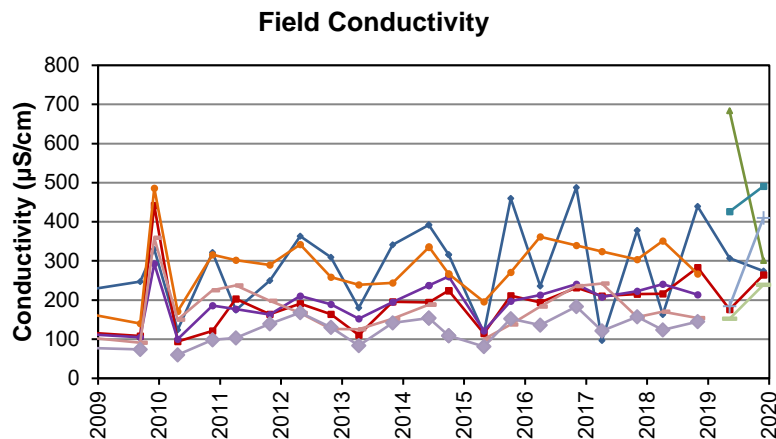
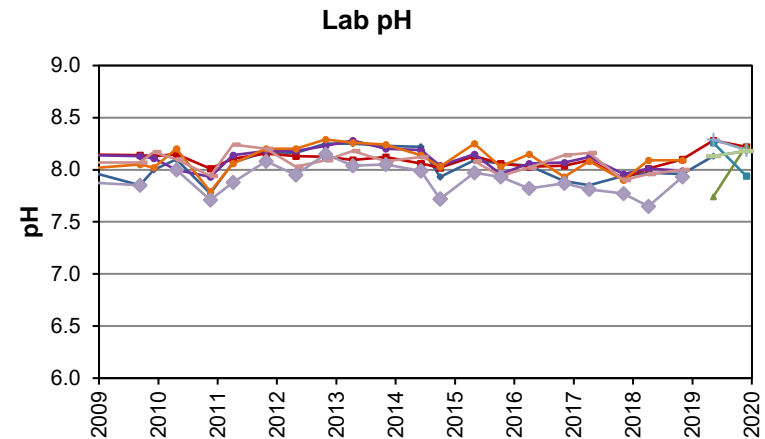
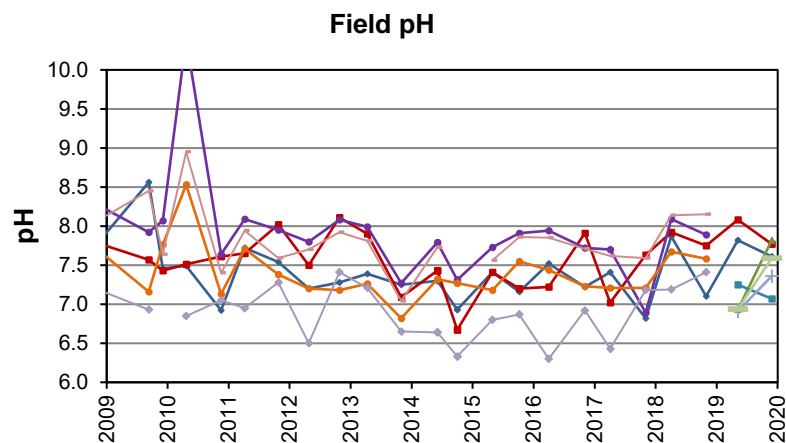


figure H-1

HISTORICAL GROUNDWATER DATA (Field and Lab pH, Field Conductivity)

2019 OPERATIONS AND MONITORING REPORT

TAHSIS LANDFILL

*Comox Strathcona Waste Management*



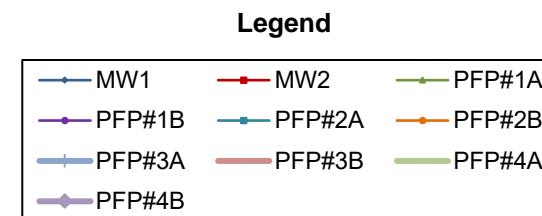
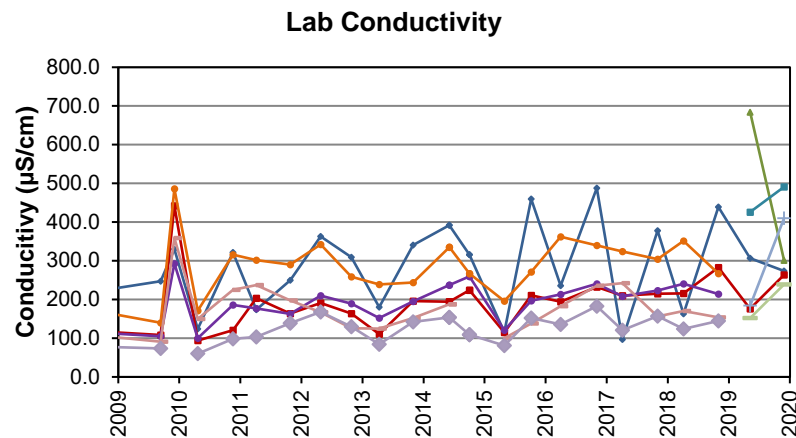
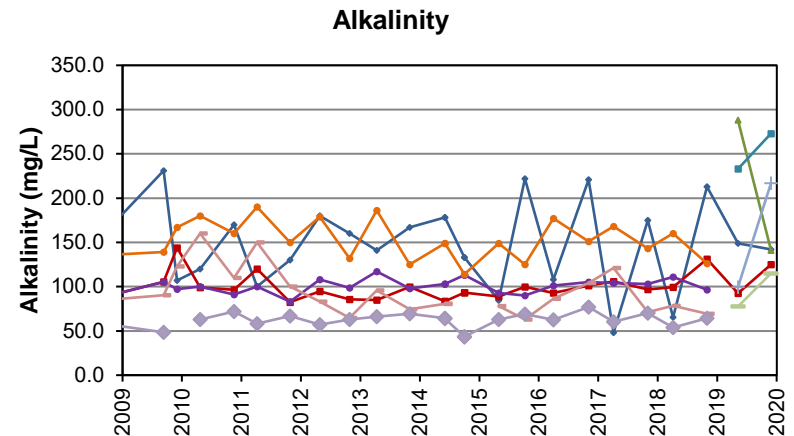
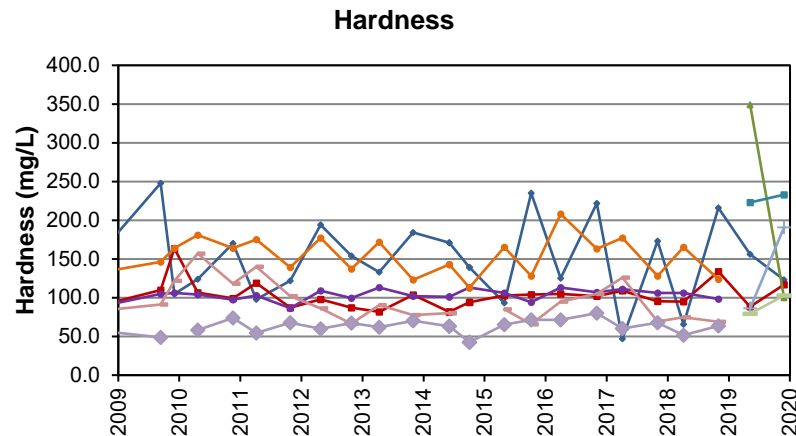


figure H-2

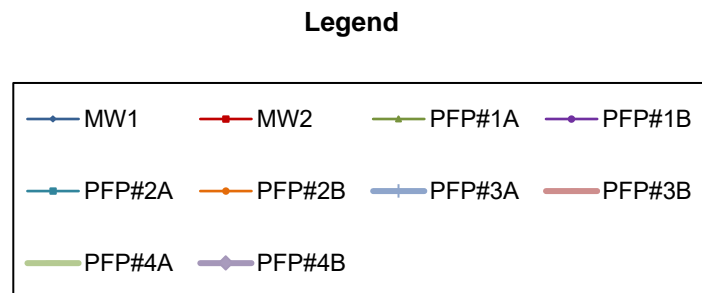
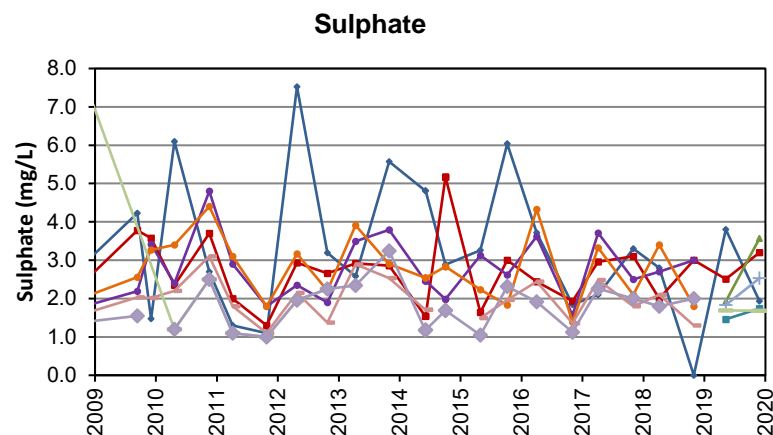
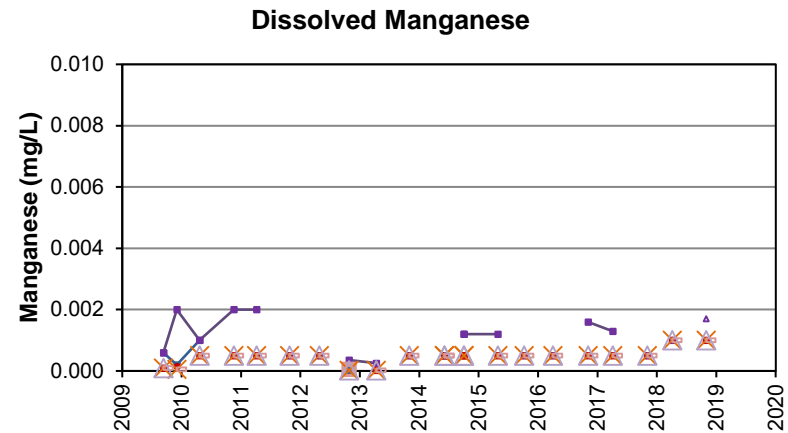
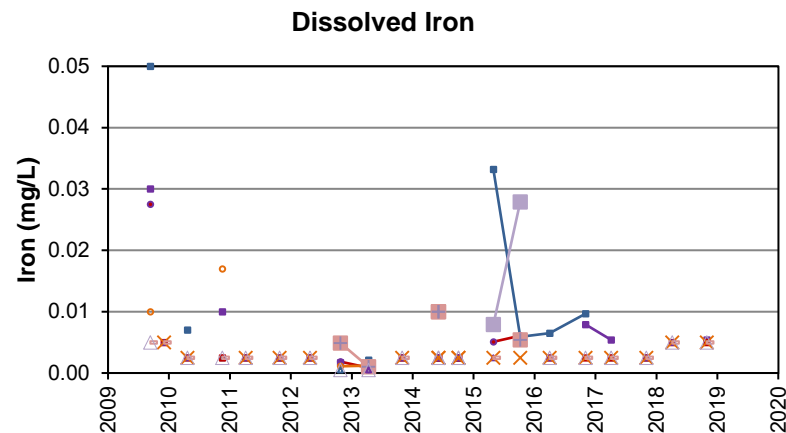
HISTORICAL GROUNDWATER DATA (Hardness, Alkalinity and Lab Conductivity)

2019 OPERATIONS AND MONITORING REPORT

TAHSIS LANDFILL

*Comox Strathcona Waste Management*





NOTE: Empty data markers denote concentrations below laboratory detection limit. 1/2 of laboratory detection limit has been graphed for illustrative purposes.

figure H-3

HISTORICAL GROUNDWATER DATA (Iron, Manganese, Sulphate)  
2019 OPERATIONS AND MONITORING REPORT  
TAHSIS LANDFILL

*Comox Strathcona Waste Management*





## about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

**Greg Ferraro**

Greg.Ferraro@ghd.com  
604.248.3670

**Michaela Dyck**

Michaela.Dyck@ghd.com  
604.248.3928

[www.ghd.com](http://www.ghd.com)