Regional District of
Kitimat-Stikine

2018 FORCEMAN RIDGE WASTE MANAGEMENT FACILITY ANNUAL REPORT

June 2019

Prepared for:

British Columbia Ministry of
Environment & Climate Change
Strategy
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Forceman Ridge Waste Management Facility Overview

The Forceman Ridge Waste Management Facility (Forceman) opened in November 2016 and is owned and operated by the Regional District of Kitimat-Stikine (Regional District or RDKS). It is located 30 km south of the City of Terrace at 3112 Highway 37, access is via the Chist Creek Forest Service Road.

The Landfill is responsible for the management of municipal solid and liquid waste generated from commercial and residential sources in the Greater Terrace area in accordance with the Regional District Kitimat-Stikine Solid Waste Management Plan (1995). The majority of solid waste is consolidated at the Thornhill Transfer Station, also owned and managed by the Regional District, and hauled to Forceman for final disposal.

Landfill operations are regulated by the Ministry of Environment's Operation Certificate MR-17227, issued in November 2008, and amended in April 2017. Operations are conducted in accordance with the Forceman Ridge Landfill Design Operations and Closure Plan prepared by Sperling Hansen Associates in 2017.

The footprint for the entire Waste Management Facility is 53.5 ha in size; this area includes buffer reserves. The facility contains a compost facility, septage receiving facility, five stage leachate treatment and detection system, and an engineered landfill. Currently the landfill filling is in Phase 1A.

Figure 1 Overview Forceman Ridge Waste Management Facility

The landfill is double lined with a high-density polyethylene and clay matting composite with leachate capture. Captured leachate is pumped to the 90,000 m^3 equalization pond. Leachate is pumped from the equalization pond to the aeration pond, which has 30 diffusers for bio-oxidation treatment. After treatment in the aeration pond, leachate is pumped to the sedimentation pond, which allows for settling of biomasses and any suspended solids. Treated leachate is then sent through a sand filter and discharged at the phytoremediation orchard. The details of the Facility water quality monitoring program, including groundwater, surface water, and leachate results will be discussed in a document prepared by Sperling Hansen Associates and can be found in Section 2. An overview of the Waste Management Facility is shown in Figure 1.

Landfill gas management has not yet begun at the Landfill. A landfill gas generation model is currently being developed to estimate gas volumes and installation of gas lines will begin in 2019.

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1.0 Introduction

This annual report covers the period from January to December 2018 and has been prepared to fulfill the requirements of the Forceman Operational Certificate MR-17227.

Issued by the Ministry of Environment in November 2008, and amended in April 2017, the Operational Certificate authorizes the discharge of municipal solid and liquid wastes and outlines the criteria for environmental and human protection at the Forceman Facility.

This report meets the requirements in Section (14.2) of the Operational Certificate by providing the following information:

- Total volume or tonnage of waste discharged to the landfill during 2018;
- Total volume or tonnage of waste composted during 2018;
- Total volume or tonnage of waste recycled and diverted during 2018;
- Total volume of sewage waste collected in the septage receiving facility during 2018,
- Occurrences or observations of wildlife attempting to access the facility; and
- The results and evaluation of all the monitoring programs has been undertaken by Sperling Hansen Associates, and is shown in Section 2.

2.0 Waste Disposal

The Forceman Ridge Waste Management Facility serves residents and business in the Greater Terrace area. In 2018, the population that utilized the landfill was 19,500. The facility also accepts waste from industrial sources and contaminated soils from outside the designated service area; these wastes are charged a 25% sur-charge on tipping fees.

2.1 Solid Waste Disposal

Solid waste is typically hauled to the Thornhill Transfer Station, sorted, compacted and hauled to the Forceman Ridge Facility. In 2018, a total of 8936.98 tonnes of municipal and industrial solid waste including; garbage, construction and demolition waste, and various types of controlled waste was disposed of in the landfill within Phase 1A, lifts 1 and 2. The annual totals from January through to December 2018 of solid waste received at the Forceman Ridge Waste Management Facility are shown in Table 1. Tonnages for diverted wastes are also included in the table.

Table 1: Waste Discharge Quantities for 2018

Material	2018 Quantity (tonnes)
Waste Discharge	
Refuse received from Thornhill Transfer Station	7758.98
Construction and Demolition waste received from Thornhill Transfer Station	355.06
Controlled Wastes – Direct Haul to Forceman Ridge	
Asbestos	29.22
Construction and Demolition	727.18
Industrial refuse	63.93
Land Clearing	2.61
Diversion	
Organics received from Thornhill Transfer Station	1454.15
Septage as received - prior to dewatering**	1106.2**
Dewatered septage solids to compost	308.24
Contaminated soils – low contamination used on site	1773.37
Clean wood waste accepted as Controlled Waste	96.1
Total landfilled as waste	**8936.98**
Total diverted materials	**3631.86**

Note: *Cover and road construction materials are not included in the waste discharge quantities.
**Tonnage prior to dewatering not included in total diverted materials; dewatered septage solids are processed separately through the compost facility to be used as landfill cover.

2.1.1 Garbage

Garbage is defined as discharged materials, substances, or objects, not including Controlled Wastes (animal carcasses weighing more than 50 kg, asbestos, contaminated soils, construction and demolition or land clearing wastes over five cubic meters, clean soils, broken concrete, broken asphalt, ash from incinerators, and septage), Restricted Wastes (metal, organics, and recyclable materials), or Prohibited Waste (hazardous or radioactive waste, slaughter waste, smoldering or flammable material, explosive or highly combustible materials, broken concrete or asphalt 300 millimeters in diameter or greater, Extended Producer Responsibility (EPR) Materials, tires, and cardboard and paper products, whether or not they fall within the definition of EPR materials). Garbage is disposed of in the landfill.

Garbage is consolidated and compacted at the Thornhill Transfer Station and hauled to Forceman Ridge.

In 2018, 7758.98 tonnes of garbage was disposed of in the landfill.

2.1.2 Asbestos

Asbestos materials that do not constitute as hazardous materials, are accepted from residential and commercial customers at the Forceman Ridge Facility through a Controlled Waste Application process. Asbestos waste is accepted at pre-scheduled times for direct burial in the landfill.

In 2018, 29.22 tonnes of various forms of asbestos waste was disposed of in the Forceman Ridge landfill.

2.1.3 Construction and Demolition

Construction and demolition material is mainly wood waste, with soft construction materials like dry wall and insulation. It is defined as, waste produced from the construction, renovation, and demolition of buildings and other structures, but does not include waste containing or contaminated with asbestos, creosote, polychlorinated biphenyl (PCBS) or any other Hazardous Waste.

In 2018, 1082.24 tonnes of construction and demolition waste was disposed of in the landfill.

2.1.4 Industrial Refuse

Industrial refuse is garbage that comes from industrial sources outside of the Terrace Solid Waste service area, but within the Regional District; the majority of the industrial sources are mines.

In 2018, 63.93 tonnes of industrial refuse was disposed of in the landfill.

2.1.5 Land Clearing Debris

Land clearing debris is defined as waste produced from the clearing of land for development, other than Organic Materials (vegetative matter, tree branches under 75 millimeters, and compostable structural wood waste), and includes trunks, stumps, tree branches 75 millimeters in diameter or greater, tops and whole trees. Due to presence of rock and gravel within this material, this is often deposited in the landfill.

In 2018, 2.61 tonnes of land clearing materials was disposed of in the landfill.

3.0 Diverted Materials

Diverted materials are collected utilizing several methods depending on the material type and/or the producer source: collected at the Thornhill Transfer Station, collected in curbside pick-up, collected by commercial haulers, or deposited at designated Extended Producer Responsibility Stewardship Depots.

3.1.1 Clean Wood Waste

Clean wood waste is considered any wood product that has not be treated or painted. Clean wood is segregated, chipped, and used as hog fuel in the Compost Facility.

In 2018, 96.1 tonnes total of clean wood waste was collected and diverted.

3.1.2 Contaminated Soils – Suitable for Cover

Contaminated soils are defined as soils, that contain contaminants in concentrations less than "hazardous waste" as defined by the Hazardous Waste Regulation.

In 2018, 1773.37 tonnes was collected and utilized as cover material on the landfill.

3.1.3 Extended Producer Responsibility Products

The Regional District does not track the volume of extended producer responsibility (EPR) products that residents self-haul to one of the many depots in the Terrace area. The City of Terrace provide curbside collection of Printed Paper & Packaging (PPP) for residents. The Regional District also provides curbside collection of PPP for residents serviced by the Thornhill Transfer Station and Forceman Ridge.

4.0 Organics Collection and Compost Facility

Since November 2016, Forceman Ridge has operated a compost facility for residential, commercial, and industrial organics in the Terrace area. Organics are collected via curbside for residential waste, or residents can self-haul to the Transfer Station. Organics collection for businesses and industry is done via commercial haulers. Collected organics are all taken to the Thornhill Transfer Station, consolidated and hauled to the Forceman Ridge Compost Facility. The City of Terrace operates a yard and garden waste collection for windrow composting from May to September and utilizes the finished product in municipal parks and community garden areas.

The Forceman Ridge Compost Facility utilizes a Gore® composting process to produce Grade A compost. The facility hosts three windrow stations inside a Mega-Dome®, and two curing bays outside. Collected organics are mixed with hog fuel, which is collected from a local sawmill or from chipping diverted untreated and unprocessed wood residue. Temperature, oxygen, and moisture levels are monitored during the process. It takes approximately eight weeks to generate the Grade A compost material. Finished product is slated to be used as cover material to close the Thornhill Landfill, and on the Forceman Ridge Landfill. Leachate from the compost facility is collected and stored in separate containment near the compost facility. The collected leachate is used for additional moisture for the compost; any surplus of leachate is sent through the leachate treatment process.

In 2018, the Forceman Ridge facility diverted 1550.25 tonnes of organics to the Compost Facility. In September 2018, the composted material was screened, resulting in 359 tonnes of final material which was used as cover material in the Thornhill Landfill closure.

4.1.1 Septage

Septage is disposed of directly in the Forceman Ridge Septage receiving facility. The facility has two lagoons available for disposal. Liquid from dewatering is treated in the leachate treatment system. Septage is defined as septic tank pumpage and treated sewage sludge, but does not include Other Sewage Wastes (wastewater, sewage or slurry, including catch basins, oil water separators, or shop floor drains).

In 2018, 1106.2 tonnes of septage was disposed of in the septage facility. Once the septage lagoons are full, the dewatered solids are mixed with wood chips and the resulting product will is placed in one of the compost bays. In 2018, 308.24 tonnes of dewatered septage was transferred to the Compost Facility for processing. The final composted product will be utilized as cover material for the landfill.

5.0 Environmental Monitoring Report

Environmental monitoring for the Forceman Ridge Waste Management Facility was conducted by a Regional District of Kitimat-Stikine Environmental Technician, following Ministry of Environment and Climate Change Strategy, 2013 British Columbia Field Sampling Manual. All in-situ and laboratory data for groundwater, surface water, and leachate estimates have been analyzed and reviewed by Sperling Hanson Associates. The complied data, interpretation, and recommendations can be found in Section 2.

6.0 Wildlife Occurrences and Observations

The Forceman Ridge Facility is located in an area with bears, wolves, coyotes, several species of birds of prey, and many other species of mammals that may attempt access to the facility. To prevent wildlife from gaining access the entire facility is enclosed in a 2.1-meter-high composite electrified fence. To prevent vectors from gaining access to the landfill active face, the Revelstoke Iron Grizzly (RIG), an alternative daily cover, is positioned each day to cover all waste. Soil from site is used as intermediate cover.

Facility operators are required to inspect the fence line daily, testing for proper voltage, proper tension on fence stands, overall condition of the fence, and signs of wildlife activity. The results of the inspections are recorded on the Daily Operation Inspection Forms.

There were no mammalian wildlife incidents or encounters observed during 2018 at the Forceman Ridge facility. There was minimal vector activity from birds, including raptor species (bald eagles), and corvid species (crows and ravens).

6.1 Bird Control

Birds, such as ravens, crows, are a nuisance at landfill sites, as they can scatter litter into the surrounding environment. Bird control at Forceman is based on thorough and complete cover of waste. The active face is only exposed when a load of waste is delivered to the landfill at Forceman Ridge. In between loads, the active face is covered with an alternative daily cover, the Revelstoke Iron Grizzly (RIG) plates.

7.0 Landfill Gas Collection

Landfill gas collection and flaring has not been initiated at the Forceman Ridge Facility. The Forceman Ridge site is now in the planning and design stage. A landfill gas generation model is currently being developed to estimate gas volumes and installation of gas lines will begin in 2019.

8.0 Summary

During 2018, 8936.98 tonnes of total of refuse including garbage, construction and demolition materials, and controlled waste was disposed of in the Forceman Ridge landfill, and 3631.86 tonnes of materials were diverted from the landfill. These materials include; 1454.15 tonnes of organics, 308.24 tonnes of dewatered septage, 1773.37 tonnes of low-level contaminated soils, and 96.1 tonnes of clean wood.

There were no mammalian wildlife incidents or encounters observed during 2018 at the Forceman Ridge facility. There was minimal vector activity from birds, including raptor species (bald eagles), and corvid species (crows and ravens).

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Section 2 Environmental Monitoring Report

Forceman Ridge Waste Management Facility
2018 Annual Monitoring Report
- FINAL -

PREPARED FOR: REGIONAL DISTRICT OF KITIMAT-STIKINE

PREPARED BY: SPERLING HANSEN ASSOCIATES

June 19, 2019

PRJ19008

SPERLING
HANSEN
ASSOCIATES

• Landfill Engineering
• Solid Waste Planning
• Environmental Monitoring
• Landfill Fire Control

June 19th, 2019 PRJ19008

Mr. Roger Tooms
Manager, Works and Services
Regional District of Kitimat-Stikine
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Terrace, B.C., V8G 4E1

Dear Mr. Tooms,

RE: Forceman Ridge WMF 2018 Annual Monitoring Report

Sperling Hansen Associates (SHA) is pleased to provide you with the Forceman Ridge WMF 2018 Annual Monitoring Report. This document reports on the site conditions, groundwater and surface water quality, leachate discharge characteristics as well as the monitoring program for 2018.

If you have any questions regarding this report or require any further information, please do not hesitate to contact me.

Yours truly,

SPERLING HANSEN ASSOCIATES

Carly Wolfe, EIT
Bioresource Engineer

EXECUTIVE SUMMARY

Sperling Hansen Associates (SHA) was retained by the Regional District of Kitimat-Stikine (RDKS) to prepare a 2018 Annual Monitoring Report for the Forceman Ridge Waste Management Facility which includes the Forceman Ridge Regional Landfill. This report details a review of the site conditions, groundwater and surface water quality monitoring results, groundwater flow analysis and leachate discharge characteristics for the year of 2018, as regulated by the Operational Certificate (OC) 17227.

Analytical results in this report have been compared to the appropriate guidelines established in the OC. Groundwater results were compared to the Contaminated Sites Regulation (CSR) for Drinking Water (DW). Surface water guidelines were not specified in the OC but the results were compared to the British Columbia Water Quality Guidelines (BCWQG) for Aquatic Life (AW). Leachate data was compared to the OC specified discharge criteria. Lastly, soil guidelines were not specified in the OC but the soil data was compared to the CSR soil standards for DW and AW.

The groundwater monitoring program includes four groups of monitoring wells: 1) background wells for establishing uncontaminated ground water condition, 2) early warning wells to determine early signs of leachate impact, 3) compliance wells for regulatory compliance, and 4) groundwater flow direction wells for establishing groundwater flow conditions. Surface water samples were collected at five surface water monitoring locations at Onion Lake, Clearwater Lakes and the streams that drain these water bodies. In general, post landfill results for groundwater and surface water quality are similar to pre-landfill results, indicating no discernable impact from leachate at these locations.

The groundwater flow velocity for the landfill was calculated to estimate the time required for leachate leaving the existing landfill to reach the down gradient environment. A porosity of 0.4 was selected for the soil. The porosity assumes the material is homogeneous. The resulting velocity is 1.5 meters per day which equates to a travel time of 4 years for groundwater to travel the 2.2 km from the edge of the Landfill footprint to Upper Clearwater Lake. However, this only serves as a rough estimate and does not consider localized soil stratigraphy or varying hydraulic conductivity across the site. Furthermore, these limitations also apply to areas outside the Landfill borders with the addition of varying flow depth.

The leachate monitoring plan is to establish an understanding of baseline operational conditions for the four-stage leachate treatment process and discharge compliance at the discharge compliance point, as specified by the OC. Sampling results indicate that the leachate is highly diluted and effectively treated as it passes through the treatment system, as the concentrations of leachate indicator parameters decrease after each treatment stage. There was one exceedance of the OC criteria for iron at the OC discharge compliance point in April 2018.

Once the RDKS received the water quality data from the lab indicating the exceedance, they immediately discontinued the discharge and a preliminary notification was sent to Eric Pierce of the Ministry of Environment and Climate Change Strategy (ENV). The RDKS installed re-circulation for the system and water quality sampling commenced in May for both total and dissolved iron at all key sampling locations along the treatment train. No leachate was discharged until water quality results were well under the OC requirements. This is reflected in the water quality results from the May and August sampling events when iron was 2.2 – 2.5 mg/L which is below the OC Criteria of 6 mg/L. Other than the iron exceedance during the April sampling event, all sampling parameters were below the OC discharge criteria at the compliance point (F5) throughout 2018.

Phytoremediation soil samples were taken once in 2018 to establish background soil conditions prior to leachate discharge, as stipulated by the OC 17227. All results are compliant with the criteria and did not show signs of metals accumulation or excessive salinity in the phytoremediation soil.

It was reported that the volumes discharged from the pumps of the leachate treatment system were unreliable for 2018. Therefore, SHA performed a leachate discharge estimate using relevant climate data to estimate the volume of leachate discharged to the Phytoremediation area in 2018. Calculations indicate that approximately 45,000 m3 of leachate was discharged in 2018.

Overall, environmental monitoring results indicate that the Landfill is not having any discernable impact on the surrounding environment. As 2018 is only the second year that the landfill was in operation, it is not viable to establish long term water quality trends at this time.

SHA recommends that the following measures be taken:

- Continue the groundwater, surface water, and leachate monitoring program as per the OC.
- Ensure that pump data is recorded accurately.
- Ensure that one duplicate sample is collected during each sampling event from one of the discharge points.
- Continue monitoring the iron levels in leachate at the compliance point (F5) to ensure that they do not exceed the OC discharge criteria.
- pH, Redox Potential eH, conductivity, total iron, and dissolved iron samples should be collected at key locations along the leachate treatment chain at raw leachate, raw compost, EQ Pond, Aeration Pond, Sedimentation Pond and Sand Filter discharge locations on a monthly basis.
- Field samples should be collected using a hatch kit to establish a correlation between field iron concentrations and lab concentrations for leachate.
- Obtain and keep current, the laboratory precision, accuracy and blank quality control criteria for each laboratory analyzed parameters from the analytical laboratory.
- Develop a dynamic groundwater flow model with MODFLOW software to interpret groundwater flow patterns and leachate plume migration. Realistically, this option would only be necessary if leachate impacts were observed.

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1. INTRODUCTION

Sperling Hansen Associates (SHA) was retained by the Regional District of Kitimat-Stikine (RDKS) to prepare a 2018 Annual Monitoring Report for the Forceman Ridge Waste Management Facility (WMF), which includes the Forceman Ridge Regional Landfill (Landfill).

The Landfill is located approximately 30 kilometers (km) south of Terrace and 600 meters (m) off Highway 37 as shown on Figure 3-1. The legal location of the Landfill is described as District Lot 8128, Range 5, within the Coast District.

The Landfill operations began in November of 2016 when the Ministry of Environment and Climate Change Strategy (ENV) approved the Operational Certificate (OC) 17227 issued on November 7th, 2008. A copy of the OC 17227 can be found in Appendix D.

The OC requires that the quality of the constituents within the discharge at the Landfill are typical of municipal solid waste (MSW), the landfill must exclude all un-authorized special wastes, waste oils, automobiles, automobile batteries, appliances containing ozone depleting substances, large animal carcasses, and slaughter house or fish hatchery wastes and by-products. In addition, the OC requires all authorized liquid waste discharge shall be typical of septic tank pumpage, holding tank effluent, sewage treatment plant sludges, and wash water and grit from drain sumps at car and light truck wash facilities parking lots.

MSW residuals are being transferred in Titan end dump trailers from Thornhill Transfer Station to the Landfill's active phase. The Landfill will be expanded progressively in seven phases, each with several sub phases. Currently, only 2.1 Ha Phase 1A is being developed to an elevation of 238 m. Next, Phase 1B will be extended laterally to the west to the same 238 m elevation. Phase 1C and 1D will then be added to the north, followed by Phase 1E and 1F, also to the north. Phases 2 through 7 will then be piggy backed northward to elevation 252 m on top of Phase 1A to 1F. Phase 1B will be expanded to the west in about 10 years time.

Protection of groundwater resources was of paramount importance to the community during the Landfill sighting. Thus, a double geomembrane liner system, equipped with a leak detection system was added in Phase 1A to provide early warning of potential problems. The leachate treatment system situated on the east side of the landfill was designed for minimum impact as well. The system includes a 90,000 m^3 equalization lagoon capable of storing a full year of leachate production, an aeration lagoon complete with 30 diffusers, a sedimentation pond, a sand filter and a 2.5 Ha phytoremediation area planted with more than 4,000 poplar, alder and cottonwood trees. During the summer treatment season the trees will uptake most of the treated leachate that will be generated on this project, resulting in minimal discharge to the environment.

SHA developed the Landfill Design, Operations, and Closure Plan (DOCP), which presents the design and operational considerations for the Landfill (Sperling Hansen 2015). The DOCP provides a lifespan analysis and gives additional details on the environmental control systems as well as outlines environmental monitoring programs for groundwater, surface water, leachate discharge and phytoremediation soils sampling.

RDKS initiated their surface water and groundwater sampling monitoring program in 2017, with their first sampling event occurring in April of 2017. This report is the second annual surface water and groundwater report prepared since the site was commissioned in November 2016. This report details a review of the site conditions, groundwater and surface water quality monitoring results, groundwater flow direction, and leachate discharge characteristics for the year of 2018, as regulated by the Operational Certificate (OC) 17227.

2. SCOPE OF WORK

The Operational Certificate and/or the DOCP stipulates that the following monitoring should be completed at the Landfill:

- Monthly measurements of field parameters (pH, conductivity, temperature, dissolved oxygen, turbidity and pump hours) from five stations (F1 to F5) throughout the leachate treatment system as shown on Figure 4 (Appendix A).
- Quarterly sampling of the five leachate monitoring stations.
- Monthly measurements of field parameters (pH, conductivity, temperature, water level) from ten monitoring wells (two background wells, four early detection wells and four compliance wells).
- Quarterly sampling of the ten monitoring wells.
- Annual water level measurements from six monitoring wells.
- Monthly measurements of field parameters (pH, conductivity, temperature, turbidity and estimated flow rate) from five surface water monitoring locations.
- Quarterly sampling of the five surface water stations.
- Compilation of an annual environmental monitoring report (this report).

3. SITE DESCRIPTION

3.1 Physiography and Topography

The Landfill is located off Chist Creek Forest Service Road, approximately mid-way between Terrace and Kitimat along Highway 37. The Landfill is located on the northeast crest of the Onion Lake Flats, south of Forceman Ridge. The Landfill site occupies a total area of 53.5 hectares including buffer reserves, as shown on Figure 3-1. The existing topography slopes from north to south as shown on Figure 1 (Appendix A).

The elevation of the ground surface surrounding the Landfill is approximately 230 meters above sea level (masl). The Landfill is located within the Skeena watershed; the Skeena River is the second-longest river entirely within British Columbia.

SHA completed an extensive review and analysis of available climate data to estimate the anticipated leachate generation volumes at the Landfill as part of the detailed design process undertaken in 2015 and

early 2016. The Forceman Ridge Landfill is located in a relatively rainy/snowy/wet region of the province (SHA 2015).

The average annual precipitation at the Terrace Airport is 1,341 mm/year based on the 1980 to 2000 precipitation data. A review of the available 56-year climatic record indicates that the highest precipitation occurred in 1991 when the Terrace Airport station experienced 1,847.2 mm of precipitation.

SHA also undertook a statistical review of the Terrace Airport rainfall data. The historic mean of precipitation from 1956 to 2014 is 1,315 mm/year and the standard deviation is 202.3 mm. The 1 in 100 return period event (99% of data to left of normal curve) is 2.33 standard deviations from mean. In this case, the 1 in 100 year rainfall predicted for the Terrace Airport station is 1,786 mm/year.

Figure 3-1: Landfill Site Location

3.2 Regional and Local Surficial and Bedrock Geology

The regional and local surficial geology of the Landfill comprises of quaternary glaciofluvial sediments which consist mainly of deltaic sands and gravels that span at least 10 m in thickness (Clague 1983).

The regional and local shallow bedrock geology of the Landfill consist of Paleozoic intrusive rocks. These Paleozoic rocks consist mainly of diorite, granodiorite, tonalite, and metagabbro. The Landfill resides within a Paleozoic intermontane volcanic belt (Nelson 2009).

Previous investigations conducted by Golder Associates and AGRA in December of 2013 and 1997 to 2005 respectively, determined the underlying surficial geology at the Landfill consisted of surficial fills and topsoil and stratifies sands and gravels extending to a depth of at least 60 meters below grade (mbg). Borehole logs are available for reference in Appendix E.

The stratified sands and gravel material ranges from gravelly sand to sandy gravel, with layers of clean sand and some cobbles throughout. The lithology was brown to brown grey in colour with some oxidation staining present. Grain sieve analysis done on samples of this material were typically found to be well-graded. Based on the drilling done by AGRA and Golder, subsurface geology at the Landfill typically consists of the following sequence from native ground surface:

- 0.6 m or less of topsoil and surficial fill
- 0.6 to 60 m of stratified sand and gravel
- 60 m Bedrock

3.3 Applicable Regulatory Criteria

The Landfill is required to operate in accordance with the monitoring requirements outlined in the amended Operational Certificate (#17227) approved by the BC Ministry of Environment, last amended on April 20, 2017, that stipulates the following conditions with respect to groundwater quality:

- The characteristics of the groundwater at the property boundary shall not exceed drinking water (DW) standards in Schedule 3.2[1] of the Contaminated Sites Regulation (CSR). Where natural background water quality concentrations exceed the aforementioned standard, the characteristics of the groundwater at the property boundary must not exceed background concentrations.

- Where monitoring shows contaminant concentrations exceed the applicable water use, or other standards, the Operational Certificate holder shall notify the Director and take one of the following actions outlined in the OC under Section 6 subsection 16.

Criteria for the surface water monitoring program is not specified in the OC, as such SHA established that the Approved Water Quality Guidelines (BCWQG) for the protection of Aquatic Life (AW) will be applied to all surface water samples. As is standard SHA practice, limits from “A Compendium of Working Water Quality Guidelines for British Columbia: 2017 Edition" were used for parameters which currently don't have approved water quality limits.

[1] CSR standards have been updated and Schedule 3.2 replaced the redacted Schedule 6

The surface water monitoring program is not intended to serve as a detection / compliance program. Rather the program will be maintained to monitor the overall health of the receiving environment. This is the case because water quality in surface waters of Onion Lake and Clearwater drainage may be affected by other anthropogenic uses, in particular Hwy 37. Also, it is estimated that the travel time for groundwater to reach the lakes is on the order of 4 years.

Criteria for the Phytoremediation soil sample program is not specified in the OC, as such SHA established that the CSR Industrial Land Use Criteria for Drinking Water (CSR-DW) and groundwater flowing to aquatic life habitat (CSR-AW) would be used for all soil samples (CSR Schedule 3.1).

3.4 Groundwater

Since 1997, sixteen (16) groundwater monitoring wells have been drilled and completed at the Landfill as shown on Figure 2 in Appendix A. A historical summary of the installment of the groundwater monitoring well network is provided below:

- 1997: AGRA installed MW-01 to MW-03, with MW-01 being located to the east of the property, MW-02 located to the northeast of the property and MW-03 located in the southwest portion of the property;
- 2000: Golder installed MW-04 to MW-06 which are located south of the property;
- 2003: Golder installed MW-07 to MW-12 which are located west and south of the property;
- 2009: Golder installed MW-13 and MW-14, with MW-13 located to the northeast of the property and MW-14 located to the southeast of the property;
- 2016: SHA installed MW-15 and MW-16, located along the south property line of the site.
- 2017: RDKS installed replacement wells for MW-15 and MW-16 as the original 2016 wells proved to be dry part of the year.

Historical groundwater elevations for the Landfill are reported to range from 187.64 masl (MW-02) to 184.29 masl (MW-01) taken in the year 2006. These elevations correspond to about 43 m and 47 m below existing ground level (mbg), respectively. Throughout the eight-year monitoring period, fluctuations of the groundwater table were approximately 2 m in MW-03 and approximately 4 m in MW-02. Higher water levels were recorded during the later spring and early summer months.

Golder 2006 reported the groundwater flows direction to be towards the southeast and there is a regional groundwater flow divide to the south of the Landfill which extends southwest to northeast. Groundwater from the north side of the site discharges into Onion and Clearwater Lakes, while groundwater from the south side of the site discharges into a wetland north of Kitimat River.

The groundwater monitoring well network has been sub-divided into three categories as outlined within the OC 17227; background monitoring wells, early detection monitoring wells and compliance property boundary monitoring wells. In addition to these wells, an additional six wells (MW-05, MW-06, MW-10, MW-11, MW-12 and MW-14) are to be monitored annually for water levels. A list of the sub-divided categories and corresponding monitoring wells are provided below in Table 3-1 for reference and are shown on Figure 2 (Appendix A).

Table 3-1: Description of Groundwater Monitoring Locations

Well Type	Monitoring Location	UTM Coordinates (+/- 5m)	Description
Background Well	MW-02 (E251531)	531429.292 E 6018918.294 N	Located northeast of the property and considered to be up-gradient of the WMF and thus represents background groundwater quality
Background well	MW-13 (E287385)	531474.768 E 6019310.351 N	Located northeast of the property and north of MW-02 and considered to be up-gradient of the WMF and thus represents background groundwater quality
Early Detection Well	MW-01 (E251530)	531389.758 E 6018097.03 N	Located along the east property line
Early Detection Well	MW-03 (E251532)	530751.085 E 6018175.245 N	Located at the southwest portion of the property
Early Detection Well	MW-15 (E302210)	531174.897 E 6017953.145 N	Located at the southeast property line
Early Detection Well	MW-16 (E302211)	531014.933 E 6017983.296 N	Located at the south property line
Compliance Property Well	MW-04 (E251533)	530838.009 E 6017265.713 N	Located approximately 900 meters south of the property
Compliance Property Well	MW-07 (E251530)	530310.586 E 6019126.073 N	Located approximately 1 km northwest of the property
Compliance Property Well	MW-08 (E302210)	529937.722 E 6018353.56 N	Located approximately 750 meters west of the property on the north side of the Christ Creek Forest Road
Compliance Property Well	MW-09 (E302211)	530045.064 E 6017464.218 N	Located approximately 900 meters southwest of the property
Water Level only	MW-05	529926.085 E 6016425.245 N	Located approximately 2 km southwest of the property and west of the Stewart-Cassiar Highway
Water Level only	MW-06	531226.085 E 6015925.245 N	Located approximately 2.5 km south of the property
Water Level only	MW-10	531376.085 E 6016475.245 N	Located approximately 1.5 km south of the property
Water Level only	MW-11	532126.085 E 6015625.245 N	Located approximately 3 km southeast of the property
Water Level only	MW-12	530651.085 E 6016325.245 N	Located approximately 2 km south of the property
Water Level only	MW-14	531960.532 E 6017131.66 N	Located approximately 1.2 km southeast of the property

A provincial water well and aquifer records search was performed using the Government iMap BC georeferenced database to help understand the regional hydrostratigraphic units in proximity to the Landfill. The results of the water well and aquifer search are summarized below for reference.

- Aquifer 0794: Located 3 km west of the Landfill – The unconfined aquifer consists of undifferentiated intermixed glaciofluvial and lacustrine deltaic sediments and is 11.7 km^2. Reported yields are 0.1 and 7.0 L/s. Depth to water 18 to 53 mbg. This aquifer is used for commercial and industrial water users.

- Aquifer 0818: Located 3 km west of the Landfill – The confined aquifer consists of glaciofluvial and lacustrine deltaic sediments comprised of sand and gravel and is 0.6 km^2. Reported yields are 3.8 and 10 L/s. Depth to water ranges from 84 to 85 mbg. This aquifer is used for commercial and industrial water users.

- Water wells: The results of the water well search indicate there are ten (10) water well users in a 5 km radius of the site.

3.5 Surface Water

There are three lakes, Onion Lake, Lower and Upper Clearwater Lakes and two surface water receiving environments, Onion Creek, and Clearwater Creek located downgradient from the Landfill, as shown on Figure 2 (Appendix A).

Baseline surface water sampling stations will be sampled and maintained on the southeast outlet of Onion Lake, at the outlet of Upper Clearwater Lake, and at the outlet of Lower Clearwater Lake where groundwater seepage / drainage has been observed. Two additional sites, at the outflow creek from Onion Lake and Clearwater Creek immediately upstream of where these creeks cross the existing Forest Service Road, will be sampled as per the sampling program outlined in Section 2. A description of the surface water sampling locations is provided below in Table 3-2.

Table 3-2: Description of Surface Water Monitoring Locations

Monitoring Location	UTM Coordinates (+/- 5m)	Description
SW-01	529691.578 E 6018322.753 N	East side of Onion Lake
SW-02	528942.587 E 6017456.235 N	Outlet of Upper Clearwater lake
SW-03	528778.181 E 6018126.088 N	Outlet of Lower Clearwater Lake
SW-04	528325.255 E 6019465.882 N	Creek from Onion Lake
SW-05	528450.437 E 6019552.438 N	Clearwater Creek

One of the primary objectives of the surface water management plan is to minimize leachate production by means of surface water diversion. Secondary objectives are to prevent erosion of the operational and final cover systems, to prevent ponding of surface water on the cover system, to control flooding of the active landfill areas and control surface water in a manner compatible with the proposed end-uses. In order to manage the surface water from the Landfill and to protect the Landfill area from erosion as mentioned above, crest ditches will be constructed and lined with an erosion control blanket to convey the surface water to various downchutes located along the slopes of the landfill. The downchutes will then convey the surface water to the toe ditches, installed along the toe of the landfill footprint, inside the perimeter berm and access roads.

Clean run-on water will be diverted by the perimeter berm to prevent any site flooding. Site flooding has occurred in the past because of the existing topography which can be viewed in Figure 1. In general, the existing topography slopes downwards from North to South which allowed two flood events to occur in November 2016 and January 2017 that contributed large volumes of run-on water to the North border and subsequently the Phase 1B excavation. An investigation revealed that during extreme precipitation and snow melt events the old Scully Creek forest service road collects run-off from a large upland catchment and conveys that run-off westward along the road until a slight escarpment is reached approximately at the middle of the landfill excavation. The perimeter berm will mitigate this issue.

3.6 Leachate

Leachate samples are collected at five designated sampling locations at F1, F2, F3, F4 and F5, as shown on Figure 4 and described in Table 1. Leachate station F5 is the OC 17227 compliance point for leachate discharge onto the phytoremediation area. All five leachate sample stations have been equipped with stop-cock sampling ports that make sample collection efficient and convenient. Furthermore, an annual soil sample from the phytoremediation area is to be collected and tested, as per the OC 17227. Section 2 details the sampling frequency and sampling parameters for the leachate monitoring program.

The leachate treatment system has been designed to reduce contaminant concentrations through the four-stage treatment process (equalization, aeration, sedimentation, sand filter) and to consume the majority of the treated effluent in the on-site phytoremediation plantation. The leachate monitoring plan is to establish an understanding of baseline operational conditions and discharge compliance. Discharge compliance criteria is detailed in the OC 17227, which can be viewed in Appendix D.

Landfill leachate typically has elevated concentrations of several indicator parameters. Conductivity is a parameter indicative of the total amount of dissolved minerals in a water sample and higher conductivity levels (>500 µS/cm) are often indicative of leachate impact. Chloride is also used as a leachate indicator at municipal landfills since chlorine is a common constituent of materials disposed of in municipal solid waste. Chloride has low affinity to soil or other matter meaning that it remains dissolved in solution after it enters a water system. Raw leachate from municipal landfills typically has very high chloride concentrations that typically occur in the range of 100 mg/L to 3,000 mg/L. Chloride concentrations typically decrease as the leachate mixes with the groundwater and becomes diluted. Ammonia is another indicator of landfill impact.

Leachate generation modelling completed by SHA as part of the development of the DOCP for the site showed that the average annual leachate production is 1,413 mm, 353 mm, and 0.43 mm per year for active areas, temporary closed areas, and geomembrane capped areas, respectively. Under extreme

conditions, the annual leachate production is 1957 mm, 489 mm, and 0.86 mm for active areas, temporary closed areas, and geomembrane capped areas, respectively. A summary of the design precipitation and leachate generation rates for the Landfill is presented in Table 20 in Appendix B.

4. METHODS

4.1 Field Techniques

Monitoring well construction details including ENV identifier and elevations are summarized in Table 1. In 2018 there were sixteen (16) active monitoring wells, five (5) surface water stations, and five (5) leachate monitoring stations. Surface water, groundwater, and leachate sampling frequency and sampling parameters are listed within Table 1 and Section 2.

The methods used to develop and sample each monitoring well and leachate/surface water station are outlined within the British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air Emissions, Water, Wastewater, Soil, Sediment and Biological Samples (BC 2013)".

Sampling events for the groundwater and surface water monitoring programs took place in April, July, and November of 2018, as per Tables 4-1 and 4-2. Samples were not collected in the first quarter due to freezing conditions. As in previous years, the water quality monitoring in 2018 was conducted by RDKS personnel. Monitoring locations are shown in Figure 2, in Appendix A.

Table 4-1: 2018 Surface Water Monitoring Events

Monitoring Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4
SW-01	-	-	July 17, 2018	Nov 19, 2018
SW-02	-	-	July 17, 2018	Nov 19, 2018
SW-03	-	April 12, 2018	July 17, 2018	Nov 19, 2018
SW-04	-	April 12, 2018	July 17, 2018	Nov 19, 2018
SW-05	-	April 12, 2018	July 17, 2018	Nov 19, 2018

Table 4-2: 2018 Groundwater Monitoring Events

Monitoring Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Background Wells				
MW-2	-	April 10, 2018	July 19, 2018	Nov 20, 2018
MW-13	-	-	-	-
Early Detection Wells				
MW-1	-	April 9, 2018	July 18, 2018	Nov 20, 2018
MW-3	-	April 10, 2018	-	Nov 20, 2018
MW-4	-	April 11, 2018	July 18, 2018	Nov 20, 2018
MW-7	-	-	-	-
MW-8	-	April 10, 2018	July 18, 2018	Nov 21, 2018
MW-9	-	-	July 19, 2018	Nov 20, 2018
MW-15	-	April 9, 2018	July 18, 2018	Nov 21, 2018
MW-16	-	April 9, 2018	July 18, 2018	Nov 21, 2018
Groundwater Levels Only				
MW-5	-	-	-	Oct 25, 2018
MW-6	-	-	-	Oct 25, 2018
MW-10	-	-	-	Oct 25, 2018
MW-11	-	-	-	Oct 25, 2018
MW-12	-	-	-	Oct 25, 2018
MW-14	-	-	-	Oct 25, 2018

Table 4-3: 2018 Leachate Monitoring Events

Monitoring Location	Quarter 1	Quarter 2	Quarter 3	Quarter 4
F1	-	May 18, 2018	July 16, 2018	-
F2	-	May 18, 2018	July 16, 2018	-
F3	-	-	July 16, 2018	-
F4	-	May 18, 2018	July 16, 2018	-
F5	-	April 25, 2018 May 18, 2018	August 27, 2018	-

4.2 Quality Assurance

The OC 17227 stipulates for the Landfill a quality assurance and quality control plan as part of their sampling program. The OC 17227 stipulates the terms of the quality assurance program under Section 13.4.3. As part of the program the Landfill must report the results of their field duplicate in terms of the degree of variation as the relative percent difference. The calculation of the relative percent difference is provided below for reference:

$$RPD = \frac{D1 - D2}{\frac{D1 + D2}{2}} X\ 100\%$$

Where:

RPD = Relative Percent Difference
D1 = Measured value of the first duplicate
D2 = Measured value of the second duplicate

5. RESULTS

5.1 Groundwater

The groundwater flow conceptual model for the Landfill was generated using the October 2018 groundwater elevation data which was collected by the RDKS, as shown on Figure 3 (Appendix A). The groundwater level and elevation data can be found in Table 1 (Appendix B). The monitoring wells at the Landfill are screened within an unconfined shallow aquifer consisting of well graded sands and gravels.

The predominant groundwater flow direction at the Landfill is directed towards the center of the Landfill. There is a local groundwater divide just south of the Landfill as shown on Figure 3. The bottom of the Landfill is lined with a geomembrane liner as discussed in Section 3.6. The Landfill's geomembrane liner impedes natural infiltration of precipitation and as a result has created a localized groundwater elevation low point. Groundwater flow is driven in part by gravitational forces, as such groundwater will move from high elevation to low elevation. Taking into consideration the Landfill is a localized groundwater elevation low, groundwater will naturally migrate towards the Landfill. The groundwater flow conceptual model will require more information ie. the drilling of more boreholes and measuring the water elevation within the local lakes and rivers to confirm if the conceptual model is spatially accurate.

The average groundwater elevations measured at the Landfill in 2018 are provided within summary Table 5-1 below. An average, minimum, maximum and difference between minimum and maximum are provided for reference. In December 2018, the lowest groundwater elevation at the Landfill was measured within MW-09 (151.40 masl) and the highest groundwater elevation was measured within MW-14 (201.03 masl). Groundwater elevations fluctuated at a maximum of 5.30 m throughout the year at MW-07 which is located northwest of the Landfill. The remainder of the groundwater elevations within the monitoring wells fluctuated between 0.56 m to 3.82 m annually.

Table 5-1: 2018 Groundwater Elevation Summary Table

MW	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Average	182.11	185.89	182.55	173.69	Dry	168.29	185.15	185.30	152.44	170.89	166.53	167.69	Dry	199.33	181.50	182.74
Min	181.09	184.25	182.15	173.25	Dry	168.03	180.86	184.68	151.40	170.41	165.66	167.49	Dry	197.21	180.57	181.99
Max	182.97	187.97	183.09	174.34	Dry	168.59	186.16	185.67	152.82	171.23	167.05	167.86	Dry	201.03	182.14	183.98
Diff	1.88	3.72	0.94	1.09	Dry	0.56	5.30	0.99	1.42	0.82	1.39	0.37	Dry	3.82	1.57	1.99

5.2 Average Linear Groundwater Velocity

The average linear groundwater velocity was calculated for the Landfill, ie. the amount of time it takes for leachate leaving the Landfill to reach the down gradient property boundary assuming groundwater is flowing away from the Landfill. The stratified sands and gravel materials underlying the Landfill are assumed to transmit groundwater through its more permeable sandy layers; therefore, the hydraulic conductivity of 7×10^{-6} m/s was selected based on typical hydraulic values for sands and gravels.

The flow of groundwater beneath the site was calculated using Darcy's Law as shown by the relationship:

$$q\ (m/s) = -k \times (\Delta h/\Delta l)$$

where: k = hydraulic conductivity,
$\Delta h/\Delta l$ = hydraulic gradient

Figure 3 shows the groundwater flow contours for the Landfill. The hydraulic gradient can be determined by the head differentials which can be inferred from the groundwater contours map. It is observed that the hydraulic gradient at the landfill is on average 1 m of head per 10 m of distance. With the above hydraulic conductivity and the hydraulic gradient, the Darcy velocity q is calculated at 0.6 m/d

The resultant advective velocity of the groundwater can be determined from q using the porosity of the soil as shown in the relationship below:

$$v = q/n$$

where: v = velocity in m/s
n = porosity of soil

A porosity of 0.4 was selected for the soil. The porosity assumes the material is homogeneous. The resulting velocity is 1.5 m/d which equates to a travel time of 4 years for groundwater to travel the 2.2 km from the edge of the Landfill footprint to Upper Clearwater Lake. However, this only serves as a rough estimate and does not consider localized soil stratigraphy or varying hydraulic conductivity across the site. Furthermore, these limitations also apply to areas outside the Landfill borders with the addition of varying flow depth.

5.3 Groundwater Quality

Groundwater quality data for 2018 as well as historical data are summarized in Tables 2 to 14, which are available in Appendix B. As seen in the tables, some parameter guidelines are dependent upon hardness

or pH, which were taken into account when determining if the parameter concentrations exceeded CSR DW Guidelines.

5.3.1 Background Groundwater Quality

Background water quality is observed from sampling results corresponding to Monitoring Wells MW-02 and MW-13. The monitoring well network categories are described in detail in Section 3.4.

A local background groundwater characterization was completed for the Landfill to establish a benchmark to compare all 2018 groundwater quality data against. Below is a list of the key leachate indicator parameters used in the background groundwater characterization for 2018, along with their corresponding values. As MW-13 was dry during all sampling events in 2018, only water quality data from MW-02 was used in the background groundwater characterization for 2018.

- pH ranges from 5.84 to 6.48.
- Hardness ranges from 17.8 to 25.9 mg/L as CaCO3.
- Conductivity ranges from 28 to 57 µS/cm.
- Ammonia ranges from a non-detectable limit to 0.0134 mg/L.
- Chlorides were non-detectable.
- Manganese ranges from 0.032 to 0.0613 mg/L.
- Iron ranges from a non-detectable limit to 0.074 mg/L.

There were no BC CSR DW Guideline exceedances for the background groundwater monitoring well network in 2018, nor have there been any exceedances in previous sampling events. In general, the dissolved metals concentrations, if detectable, are at least one order of magnitude below the CSR-DW criteria.

5.3.2 Early Detection and Compliance Monitoring Well Network

Water quality for the early detection wells fall into two categories, pre-landfill results and post landfill results. Specifically, pre-landfill results correspond to values prior to the year of 2016, whereas post landfill results are after this time. The following monitoring wells are part of the early detection monitoring well network; MW-01, MW-03, MW-04, MW-07, MW-08, MW-09, MW-15 and MW-16. All paragraphs beginning with an "*" denote the monitoring well is a compliance point.

MW-01 is located at the south east corner of the Landfill property line boundary. The leachate groundwater quality indicator parameters were all below background concentrations (Section 5.3.1). All groundwater parameters analyzed during the 2018 program were below CSR DW Guidelines.

MW-03 is located at the south west corner of the Landfill. The leachate groundwater quality indicator parameters at MW-03 were all below background concentrations (Section 5.3.1) with the exception of conductivity and hardness. Conductivity ranged from 66.5 – 79.9 µS/cm and hardness ranged from 47.3 – 60.0 mg/L. The pH at this location was more basic than background and ranged from 7.33 – 7.90 pH.All groundwater parameters analyzed during the 2018 program were below CSR DW Guidelines.

MW-15 is located at the southern perimeter boundary of the Landfill. Groundwater concentrations were all below leachate groundwater quality indicator parameters with the exception of conductivity and hardness. Conductivity ranged from 97.6 - 157 µS/cm and hardness ranged from 75.7 - 79.5 mg/L. The pH at this location was more basic than background and ranged from 7.5 to 7.9 pH. All parameters analyzed during the 2018 program were below CSR DW Guidelines.

MW-16 is located at the southern perimeter boundary of the Landfill. Groundwater concentrations were all below leachate groundwater quality indicator parameters with the exception of conductivity and hardness. Conductivity ranged from 90.3 - 147 µS/cm and hardness ranged from 71.1 – 72.9 mg/L. The pH at this location was more basic than background and ranged from 7.24 to 7.81 pH. All parameters analyzed during the 2018 program were below CSR DW Guidelines.

*MW-04 is a compliance point and is located approximately 800 m south of the Landfill. The leachate groundwater quality indicator concentrations were all similar to or slightly above the background concentrations stated in Section 5.3.1. All groundwater parameters analyzed during the 2018 program were below CSR DW Guidelines.

*MW-07 is located approximately 500 m northwest of the Landfill. Groundwater sampling at this located was not conducted in 2018 as the well was dry during the sampling events. However, concentrations during 2017 sampling were all below the leachate groundwater quality indicator parameters listed in Section 5.3.1 with the exception of conductivity and hardness. The pH at this location was more basic than background and ranged from 8.1 - 8.4 pH. All groundwater parameters analyzed during the 2017 program were below CSR DW Guidelines.

*MW-08 is located approximately 500 m west of the Landfill. Groundwater concentrations were all similar to or below leachate groundwater quality indicator parameters listed in Section 5.3.1. All parameters analyzed during the 2018 program were below CSR DW Guidelines.

*MW-09 is located south west of the Landfill. Groundwater concentrations were all below leachate groundwater quality indicator parameters listed in Section 5.31 with the exception of chloride. The concentration of chloride at MW-09 ranged from 1.13 – 1.4 mg/L All parameters analyzed during the 2018 program were below CSR DW Guidelines.

MW-12 which is located north of upper Kitimat road on the east side of Stewart-Cassiar Highway was sampled on July 19, 2018. This well had previously been sampled on April 3, 2013 and Oct 22, 2012. The July 19, 2018 sampling results showed that the water quality at this location continues to be compliant with no exceedances of the guidelines.

5.4 Surface Water Quality

Surface water quality data for 2018, as well as historical data are summarized in Tables 15 to 19 and are available in Appendix B. Some parameter guidelines are dependent upon hardness or pH which were taken into account when determining if the parameter concentrations exceeded BC WQG-AW Guidelines.

5.4.1 Surface Water Monitoring Stations

Surface water samples were collected at the five surface water monitoring locations; at Onion Lake (SW-01), Clearwater Lakes (SW-02 and SW-03) and the streams that drain these water bodies (SW-04 and SW-05). Surface water monitoring locations can be viewed on Figure 2. Each monitoring location is specified for sampling frequency and monitoring parameters as required by the DOCP surface water monitoring program, regulated by the OC 17227. This program is summarized in Section 2.0.

Baseline surface water sampling stations were maintained on the southeast side of Onion Lake where groundwater seepage / drainage is located, at the outlet of Upper Clearwater Lake, and at the outlet of Lower Clearwater Lake. Two additional sites at the outflow creek from Onion Lake and Clearwater Creek immediately upstream of where these creeks cross the existing Forest Service Road are sampled for field parameters only.

5.4.1.1 SW-01 (Onion Lake)

SW-01 was sampled once for pre-landfill water quality results (prior to 2016), in October of 2012. Below is a list of parameters and values from that sampling event which are key leachate indicating parameters for pre-landfill conditions.

- pH: 6.3
- Hardness: 3.9 mg/L as CaCO3
- Conductivity: 33.7 µS/cm
- Ammonia: Not Detected
- Chloride: 10.3 mg/L
- Manganese-Total: 0.0211 mg/L
- Iron-Total: 0.0304 mg/L

SW-01 was sampled quarterly for post-landfill water quality results starting in 2017. Post landfill results obtained at SW-01 in 2018 are summarized below with a list of parameters and value ranges for key leachate indicator parameters.

- pH ranged from 6.72 to 6.87.
- Hardness ranged from 2.48 to 2.67 as CaCO3.
- Conductivity ranged from 18.7 to 25.9 µS/cm.
- Ammonia was not detectable except for the July 2018 sampling event when ammonia was 0.006 mg/L. This value was not in exceedance of BCWQG-AW.
- Chloride ranged from 6.14 to 6.22 mg/L.
- Manganese-Total ranged from 0.0116 to 0.0394 mg/L.
- Iron-Total ranged from 0.010 to 0.028 mg/L.

In general, total metals concentrations if detectable were at least one order of magnitude below theBCWQG-AW criteria for post-landfill results. No exceedances of the BCWQG-AW occurred in 2018.

5.4.1.2 SW-02 (Upper Clearwater Lake)

SW-02 was sampled twice for pre-landfill water quality results (prior to 2016), in October 2012 and April 2013. Below is a list of parameters and values ranges for key leachate indicating parameters for pre-landfill conditions.

- pH ranged from 7.8 to 8.0.
- Hardness ranged from 74.8 and 75.6 mg/L as CaCO3.
- Conductivity was 154 µS/cm for both events.
- Ammonia was not detectable for both sampling events.
- Chloride ranged from 1.1 to 1.8 mg/L.
- Manganese-Total was not detectable in 2012. During the 2013 sample, this parameter was in exceedance of the BCWQG-AW criteria with a value of 2.06 mg/L.
- Iron-Total was not detectable in 2012. During the 2013 sample, this value was below the criteria value with 0.0171 mg/L.

In general, the total metals concentrations, if detectable, did not exceed the BCWQG-AW criteria.

SW-02 was sampled quarterly for post-landfill water quality results starting in 2017. Post landfill results obtained at SW-02 in 2018 are summarized below with a list of parameters and value ranges for key leachate indicating parameters.

- pH ranges from 8.19 to 8.29.
- Hardness ranged from 74.4 to 75.3 mg/L as CaCO3.
- Conductivity ranged from 98.3 to 124.1 µS/cm.
- Ammonia ranged from 0.0053 to 0.0097 mg/L.
- Chloride was 0.84 mg/L at both sampling events.
- Manganese-Total was 0.0013 at both sampling events.
- Iron-Total was not detectable during the 2018 sampling events.

In general, the total metals concentrations, if detectable, were not in exceedance of the BCWQG-AWcriteria

5.4.1.3 SW-03 (Lower Clearwater Lake)

Similar to SW-02, SW-03 was sampled twice for pre-landfill results (prior to 2016), in October 2012 and April 2013. Below is a list of parameters and values ranges for key leachate indicating parameters for pre-landfill conditions.

- pH ranged from 7.9 to 8.2.
- Hardness ranged from 72.8 to 73.3 mg/L as CaCO3.
- Conductivity ranged from 149 to 151 µS/cm for both events.
- Ammonia was not detectable for both sampling events.

- Chloride ranged from 1.3 to 1.7 mg/L.
- Manganese-Total was not detectable for both sampling events.
- Iron-Total ranged from 0.0069 to 0.0091 mg/L.

In general, total metals concentrations, if detectable, were at least one order of magnitude below the BCWQG-AW criteria for post-landfill results.

SW-03 was sampled quarterly for post-landfill water quality results starting in 2017. Post landfill results obtained in 2018 are summarized below with a list of parameters and value ranges for key leachate indicating parameters.

- pH ranges from 8.15 to 8.24 pH.
- Hardness ranged from 70.2 to 73.9 mg/L as CaCO3.
- Conductivity ranged from 91 to 126 µS/cm.
- Ammonia was not detectable except for the April 2018 sampling event when ammonia was 0.0063 mg/L.
- Chloride ranged from 0.86 to 0.90 mg/L.
- Manganese-Total ranged from 0.00070 to 0.0010 mg/L.
- Iron-Total was non detectable in 2018.

In general, the total metals concentrations, if detectable, were not in exceedance of the BCWQG-AW criteria

5.4.1.4 SW-04 (Creek from Onion Lake)

Only post landfill data was available for SW-04. Monitoring location SW-04 was sampled quarterly for post-landfill water quality results starting in 2017. The results obtained in 2018 are summarized below with a list of parameters and value ranges for key leachate indicating parameters.

- pH ranges from 7.65 to 7.94.
- Hardness ranged from 26.4 to 39.4 mg/L as CaCO3.
- Conductivity ranged from 49.9 to 85.2 µS/cm.
- Ammonia was not detectable except for the April 2018 sampling event when ammonia was 0.0058 mg/L.
- Chloride ranged from 7.02 to 13.8 mg/L.
- Manganese-Total ranged from 0.0094 to 0.244 mg/L.
- Iron-Total ranged from 0.055 to 0.795 mg/L.

In general, the total metals concentrations, if detectable, were not in exceedance of the BCWQG-AW criteria

5.4.1.5 SW-05 (Clearwater Creek)

Only post landfill data was available for SW-05. Monitoring location SW-05 was sampled quarterly for post-landfill water quality results starting in 2017. The results obtained in 2018 are summarized below with a list of parameters and value ranges for key leachate indicating parameters.

- pH ranges from 6.58 to 8.12.
- Hardness ranged from 72.1 to 74.8 mg/L as CaCO3.
- Conductivity ranged from 90.7 to 117.1 µS/cm.
- Ammonia was not detectable except for the April 2018 sampling event when ammonia was 0.0057 mg/L.
- Chloride ranged from 1.05 to 1.12 mg/L.
- Manganese-Total ranged from 0.0006 to 0.0015 mg/L.
- Iron-Total was non detectable except for the July 2018 sampling event when iron was 0.010 mg/L.

In general, the total metals concentrations, if detectable, were not in exceedance of the BCWQG-AW criteria

5.5 Leachate monitoring

5.5.1 Leachate Monitoring Stations and Criteria

The Forceman WMF has been designed with a state-of-the-art leachate treatment system that comprises of five stages: (1) equalization, (2) aeration, (3) sedimentation, (4) sand filtration, and (5) phytoremediation. The four stages, prior to phytoremediation, take place within lined treatment ponds. In the final step, Phytoremediation, treated leachate is discharged by drip irrigation onto a 1.85 Ha area planted with 2,800 hybrid poplars, cotton woods, and alders that uptake the treated leachate.

Field readings of pH, conductivity, alkalinity, dissolved oxygen, turbidity and temperature are to be collected at the leachate monitoring locations. Field readings at the monitoring locations are to be conducted by the RDKS monitoring technician on a monthly basis during the first two years of operation, and then quarterly during periods of discharge (April to October) thereafter. Laboratory samples are to be extracted from sampling ports at each pump station initially at a quarterly frequency for the first two years, and then at an annual frequency in subsequent years. A one-time sample of VOCs is required for background levels.

Water quality sampling was conducted in May and July 2018 at four of the leachate monitoring locations (F1 to F4) shown on Figure 4. Water quality sampling was conducted in April, May and August 2018 for leachate monitoring location compliance point F5. The water quality results for the monitoring locations described above are presented in Tables 21 to 25 in Appendix B. VOCs were not sampled in 2018 and are scheduled to be sampled in 2019 for background levels as per the OC.

5.5.1.1 F1: Raw Leachate

Leachate monitoring station F1 was sampled in May and July 2018 and water quality at this location is representative of raw leachate. During the May 2018 sampling event, only total iron and dissolved iron

were analyzed. Water quality sampling results can be viewed in Table 21. Field conductivity at this location was moderately high at 3,750 uS/cm, which is typical for landfill leachate. The pH (6.16) was below the OC site discharge criteria of pH 6.5 – 8.5. In addition, iron concentrations exceeded the OC criteria during both sampling events. All other sampling parameters were within the OC criteria. Exceedances of the OC criteria at this location are for discussion only, since OC criteria need only be met at the discharge location (F5).

5.5.1.2 F2: Raw Septage

Leachate monitoring station F2 was sampled in May and July 2018 and water quality at this location is representative of raw septage. During the May 2018 sampling event, only total iron and dissolved iron were analyzed. Water quality sampling results can be viewed in Table 22. Field conductivity at this location was low at 250 uS/cm during the May sampling event. This is in contrast to conductivity at this location in 2017 which was very high and ranged from 23,000 to 26,400 uS/cm, which is to be expected given that water quality at this location is representative of raw septage. The reason for the very low conductivity during the May sampling event is unknown at this time. The pH (4.86 pH) was below the OC site discharge Criteria of pH 6.5 – 8.5. Ammonia and iron concentrations exceeded the OC criteria during the July 2018 sampling event. Exceedances of the OC criteria at this location are for discussion only, since OC criteria need only be met at the discharge location (F5).

5.5.1.3 F3: Equalization Pond

Leachate monitoring station F3 was sampled once in July 2018. Water quality at this location is representative of outflow from the equalization pond. The water quality results are shown in Table 23 and indicate that the effluent has been highly diluted at this location as leachate indicator parameters such as ammonia, chloride, and iron were markedly lower at F3 than F1 and F2. Furthermore, pH at F3 is close to neutral (7.21 pH) and is within the range set out in the OC (6.5 – 8.5 pH) compared to acidic conditions at F1 and F2. Conductivity was not sampled at this location in 2018. However, in 2017, conductivity was low and ranged from 456 to 578 uS/cm.

Iron concentrations exceeded the OC site discharge criteria during the July 2018 sampling event. Overall, results indicate that the leachate is being highly diluted in the equalization pond. Exceedances of the OC criteria at this location are for discussion only, since OC criteria need only be met at the discharge location (F5).

5.5.1.4 F4: Aeration Pond

Leachate monitoring station F4 was sampled in May and July 2018. Water quality at this location is representative of outflow from the aeration pond and water quality results for this location can be viewed in Table 24. During the May 2018 sampling event, only total iron and dissolved iron were analyzed.

Field conductivity at this location was low at 377 uS/cm. The pH (7.46 pH) was within the range set out in the OC (6.5 – 8.5). Ammonia was lower at this location than F3, indicating sufficient removal of ammonia in the aeration pond. The only parameter that exceeded the OC criteria was iron concentration during the July sampling event. Exceedances of the OC criteria at this location are for discussion only, since OC criteria need only be met at the discharge location (F5).

5.5.1.5 F5: Sand Cyclone

Leachate monitoring station F5 is the compliance point as per the OC criteria and is located at the sand cyclone outlet. The leachate treatment system was shut down for the winter in 2017 and leachate treatment started up again on April 23, 2018. The first compliance sample was collected on April 25, 2018 and water quality results for this location can be viewed in Table 25. The April water quality results indicated that the iron concentration at F5 exceeded the OC criteria. Once the RDKS received the water quality data from the lab indicating the exceedance, they immediately discontinued the discharge and a preliminary notification was sent to Eric Pierce of ENV. The RDKS installed a re-circulation system to recirculate leachate from the sand filter to the EQ Pond and water quality sampling again commenced in May for both total and dissolved iron at all key sampling locations along the treatment train. No leachate was discharged until water quality results were well under the OC requirements. This is reflected in the water quality results from May, when iron was 2.21 mg/L which is below the OC Criteria of 6 mg/L. Another compliance sample was collected in August and iron was 2.5 mg/L. All parameters in the May and August sampling events were below the OC Criteria.

SHA suspects that the iron exceedance in April was due to start up of the system after the winter shutdown. Some treated leachate was stored in all parts of the system over the winter months while the discharge component was turned off since the phytoremediation area was dormant. SHA suspects that the leachate stored within the sand filter dissolved some metals from the soil, which resulted in the initial slug of treated leachate from the sand filter to become elevated in dissolved iron. Once the initial slug of leachate had moved through the system, iron levels at sand filter discharge location F5 dropped to 2.2 – 2.5 mg/L.

With the exception of the iron exceedance in April described above, the water quality results at F5 indicate that the leachate that was treated in 2018 was being highly attenuated and sufficiently treated as it moves through the leachate treatment system.

5.5.1.6 F6: Compost

Leachate monitoring station F6 was sampled once in May 2018 for field readings and iron concentration only. Water quality at this location is representative of run-off originating from the compost facility.

Field conductivity at this location was very high at 15,220 uS/cm. The pH (4.8 pH) was acidic and out of range of the OC Criteria (6.5 – 8.5). The iron concentration was high at 109 mg/L and exceeded the OC criteria of 6 mg/L. Exceedances of the OC criteria at this location are for discussion only, since OC criteria need only be met at the discharge location (F5).

SHA is aware that run-off from the compost facility combines with septage (F2) and is discharged to the EQ Pond. Also, the leachate condensate pump in the compost leachate tank is designed to pump to the septage dewatering facility if the high level is reached inside the tank. Thus, an estimation of the nutrients load and flow will give a better idea as to what is being discharged into the equalization pond from the sewage and the compost facility.

5.5.2 Leachate Discharge Estimate

The system consists of one pressure sensor controlled pump station to pump the leachate from the base of the landfill to the top of the equalization pond (Pump Station 1), a second float controlled pump station to refill the aeration pond (Pump Station 3), and a third timer controlled pump station to distribute treated effluent into the drip irrigation system (Pump Station 5).

It was reported that the volumes discharged from the pumps and pumping hours were not reliable for 2018. Therefore, SHA has performed a leachate discharge estimate using relevant climate data to estimate the volume of treated leachate discharged to the Phytoremediation area in 2018. Climate data for the 12-month period from November 2017 to October 2018 (inclusive) was obtained from the nearby weather station 'Terrace A' located at the Terrace Airport. The data reflects precipitation and temperature starting from November 2017 when the discharge was ceased for the 2017 year. Storage in the EQ pond occurred from November 2017 to March 2018 and discharge occurred from April 2018 to October 2018. The precipitation and temperature data for this period is shown in Table 5-2 below.

Table 5-2: Climate Data from Weather Station Terrace A (Nov-17 to Oct-18)

Month	Total Precipitation (mm)	Average Temperature(C)
Nov-17	227.3	-0.7
Dec-17	31.3	-3.8
Jan-18	137.3	-2.3
Feb-18	131.4	-5.2
Mar-18	36.8	1.2
Apr-18	45.2	5.7
May-18	57.5	12.5
Jun-18	37.1	13.9
Jul-18	22.4	19.2
Aug-18	9.4	18.6
Sep-18	24.2	11.9
Oct-18	94.4	6.5
Storage Period	564.1	
Discharge Period	290.2	
Total	**854.3**	

RDKS provided the elevation of the maximum water level that was achieved in 2017/2018 and the minimum operating level is known. Using the above climate data for estimating precipitation input on the ponds and evaporation from the pond surfaces and using aforementioned operational levels in the EQ pond, SHA estimated the volume of leachate discharged from the EQ pond and then finally to the Phytoremediation area in 2018. The estimated volume of leachate discharged onto the phytoremediation area was approximately 45,000 m^3, equivalent to approximately 215 m^3/day over the 7 month discharge period. The estimated discharge rate is in compliance with the OC, which states that the maximum authorized rate of discharge is 609 m^3/day and the average rate of discharge is 400 m^3/day. Details of the leachate discharge estimate calculation can be found in Appendix F.

It is important to note that the discharge volume from the EQ pond is based on the operational levels in the pond set based on the design flow to the EQ pond. The maximum elevation of the pond has also been set based on the design flow estimate. Since the annual (Nov 2017-Oct 2018) precipitation was only 854.3 mm, while the design average precipitation is 1986 mm/year, elevation in the pond did not reach the maximum operating level. Hence the discharge from the EQ pond was also less than the

average design flow. SHA recommends that pump records be preserved and checked periodically to make sure that the data being recorded makes sense. If any anomalies are recorded, an immediate measure needs to be taken to make necessary adjustments to get accurate data.

5.6 Phytoremediation Soil Sample

Phytoremediation soil samples were taken on April 25, 2018. As per the OC, the composite soil sample was assembled from 4 locations in the phytoremediation area. The results can be viewed in Table 27. In 2017, four discrete samples (Site A, B, C, and D) were analysed rather than a composite of the 4 locations. Soil results were compared against the Contaminated Sites Regulation Industrial Land Use criteria for Drinking Water and Aquatic Life. All results were compliant with the criteria and do not show signs of metals accumulation or excessive salinity in the phytoremediation soil.

6. DISCUSSION

6.1 Groundwater

A summary of the groundwater quality results for the background, early detection, and compliance monitoring wells are shown in Table 6-1 below. In general, the 2018 post landfill results are similar to the pre-landfill results. Also, the early detection and compliance property groundwater monitoring well network water quality was all below CSR DW Guidelines.

Leachate indicator parameters such as conductivity, chloride, manganese, and iron have been graphed in Charts 1 through 4 as a visual representation of pre-landfill and post-landfill water quality. All conductivity results are representative of naturally occurring water, with conductivity less than 200 µS/cm. Select monitoring wells, MW-15 and MW-16 are displaying signs of slightly elevated conductivity values. MW-03 had the highest conductivity value of any station in the monitoring well network, 157 µS/cm. It is difficult to know if elevated conductivity values at these two wells are due to activities from the Landfill as there are no pre-landfill conductivity values for these locations. However, conductivity levels at MW-15 and MW-16 have risen slightly since 2017 and as such should be monitored over the course of next year to confirm that the elevated conductivity values do not continue to increase over time. Both MW-15 and MW-16 are early detection wells.

Table 6-1: Summary of Groundwater Quality Results 2018

	Background Wells (MW-02, 13)	Early Detection Wells (MW-01, 03, 15, 16)		Compliance Monitoring Wells (MW-04, 07, 08, 09)	
		Pre-Landfill (prior to 2016)	*Post-Landfill (post 2016)*	*Pre-Landfill (prior to 2016)*	*Post-Landfill (post 2016)*
pH	5.84 – 6.48	6.8 – 8.7	7.52 – 8.17	6.3 – 8.6	5.98 – 7.96
Hardness	17.8 – 25.9	10.4 – 14.9	15.8 – 79.5	8.5 – 22.9	11.4 – 31.1
Conductivity (µS/cm)	28 – 57	Not Sampled	29.3 – 157	26.7 – 27.5	22.4 – 68
Ammonia (mg/L)	ND - 0.0134	ND – 0.19	ND – 0.0082	0.05 – 0.06	ND – 0.0295
Chloride (mg/L)	ND	ND	ND	ND – 2.4	ND – 1.4
Manganese (mg/L)	0.032 – 0.0613	0.0053 – 0.339	0.0001 - 0.0316	0.00082 – 0.348	0.0020 – 0.234
Iron (mg/L)	ND – 0.074	ND - 0.0923	ND – 0.014	ND – 0.0338	ND – 0.536
ND is non-detectable.					

6.2 Surface Water

A summary of the surface water quality results for surface water monitoring locations SW-01 to SW-05 is shown in Table 6-2 below. In general, the 2018 post landfill results are not significantly different from the pre-landfill results. Leachate indicator parameters such as conductivity, chloride, manganese, iron, and aluminum have been graphed in Charts 5 through 9 as a visual representation of pre-landfill and post-landfill water quality. All conductivity results are representative of naturally occurring water with conductivity less than 200 µS/cm. This is expected given the distance of the sample locations from the Landfill.

Table 6-2: Summary of Surface Water Results 2018

	SW-01		SW-02	
	Pre Landfill (prior to 2016)	*Post Landfill (post 2016)*	*Pre Landfill (prior to 2016)*	*Post Landfill (post 2016)*
pH	6.3	6.7 – 6.9	7.8 – 8.0	8.2 – 8.3
Hardness	3.9	2.48 – 2.67	74.8 – 75.6	74.4 – 75.3
Conductivity (µS/cm)	33.7	18.7 – 25.9	154	98 – 124
Ammonia (mg/L)	ND	ND – 0.006	ND	0.0053 – 0.0097
Chloride (mg/L)	10.3	6.14 – 6.22	1.1 – 1.8	0.84
Manganese (mg/L)	0.0211	0.0116 – 0.0394	ND – 2.06	0.00013
Iron (mg/L)	0.0304	0.010 – 0.028	ND – 0.0171	ND
	SW-03		**SW-04**	**SW-05**
	Pre Landfill	*Post Landfill*	*Post Landfill*	*Post Landfill*
pH	7.9 – 8.2	8.2	7.7 – 7.9	6.6 – 8.1
Hardness	72.8 – 73.3	70.2 – 73.9	26.4 – 39.4	72.1 – 74.8
Conductivity (µS/cm)	149 - 151	91 – 126	50 - 85	91 - 117
Ammonia (mg/L)	ND	ND	ND – 0.0058	ND – 0.0057
Chloride (mg/L)	1.3 – 1.7	0.86 – 0.90	7.02 – 13.8	1.05 – 1.12
Manganese (mg/L)	ND	0.00070 – 0.0010	0.00937 – 0.244	0.0006 – 0.0015
Iron (mg/L)	0.0069 – 0.0091	ND	0.055 – 0.795	ND – 0.010
ND is non-detectable.				

6.3 Leachate

The performance of the leachate treatment system can be evaluated by analyzing the water quality results for each monitoring location throughout the system. The OC criteria discharge parameters pH, ammonia, chloride, cadmium, iron, and zinc have been graphed in Charts 10 to 15 to create a visual representation of the change in water quality as the effluent moves through the treatment system.

As seen in Chart 10, the pH of the effluent increases from acidic 4.9-6.2 at F1 and F2 to a neutral pH within the OC criteria range of 6.5-8.5 at F4 and F5. As seen in Chart 11, ammonia concentrations remain below the OC criteria at all monitoring locations except for F2 (raw septage). Ammonia concentrations are seen to decrease significantly as the effluent moves through the aeration system, based on the water quality results at F4 and F5 sampling locations. Chloride concentrations remain below the OC criteria at all sampling locations. A reduction in chloride concentrations is evident beginning at F3 (EQ pond) and reduced further at F4 and F5.

As seen in Chart 13, raw septage has the highest cadmium concentration compared to the other sampling locations, though all cadmium concentrations remain below the OC criteria limit. Iron concentrations at F1 and F2 are much higher than the other sampling locations. This is to be expected given the low pH at F1 and F2 since acidic conditions promote dissolution of iron and therefore increased dissolved iron concentrations in the leachate. Zinc concentrations are low at all sampling locations and remain below the OC criteria limit.

It is hard to establish long-term water quality trends as 2018 was only the second year that the system was in operation and leachate sampling was conducted. Nevertheless, it is evident that as the leachate passes through the system it is highly diluted and effectively treated as the concentrations of leachate indicator parameters decrease as the leachate moves through the system. With the exception of the iron exceedance in April 2018 described in Section 5.6.5, all sampling parameters are below the OC discharge criteria at the compliance point (F5).

7. QUALITY ASSURANCE AND QUALITY CONTROL

A quality assurance and quality control (QA/QC) program is a system of procedures, checks, audits and corrective actions that will assist in ensuring that the data generated at the laboratory is of the highest achievable quality. This is of prime importance, as the monitoring data forms the basis for all of the conclusions regarding the impact of the Landfill on the surrounding environment. As per the OC, one duplicate sample should be collected during each sampling event from one of the discharge points. Furthermore, each duplicate sample should be submitted to the laboratory; one of the pair identified as the regular sample, and the other, as a blind sample identified by a fictitious site-name established solely to identify the duplicate sample. The results of the field duplicates in terms of the degree of variation as the relative percent difference should be reported for each parameter, as specified in the OC.

In 2018, duplicate samples were obtained during the April, July, and November surface water sampling events at surface water monitoring locations SW-03, SW-01, and SW-05 respectively. The results of the duplicate samples and the degree of variation as the relative percent difference for each parameter are presented in Tables 15, 17 and 19. One duplicate sample was also obtained during the November groundwater sampling event at groundwater monitoring location MW-15. The results of the duplicate

sample and the degree of variation as the relative percent difference for each parameter is presented in Table 6.

In general, the duplicate samples obtained in 2018 had a relative percent difference less than 20%, with the exception of three analytes. A summary of the analytes which were out of compliance (RPD > 20%) are listed below in Table 7-1.

Table 7-1: Summary of Duplicate Sample Non-Compliance

Sampling Location	Monitoring Event	Analyte	RPD
SW-01	July 17, 2018	Ammonia	21.05%
SW-03	April 12, 2018	Selenium	33.33%
SW-05	November 19, 2018	Manganese	59.97%

8. CONCLUSIONS AND RECOMMENDATIONS

2018 was the second year of operation at the Forceman Ridge Regional Landfill. For surface water and groundwater, the post landfill results are not significantly different from the 2017 and pre-landfill results, indicating no discernable leachate impact. All conductivity results are representative of naturally occurring water with conductivity less than 200 µS/cm. Based on the 2018 sampling results, there is no discernable leachate impact at any of the groundwater or surface water monitoring locations.

Leachate was sampled from five locations throughout the leachate treatment system. Results indicate that as the leachate passes through the system it is highly diluted and effectively treated. Most importantly, all sampling parameters except for iron during the April sampling event were below the OC discharge criteria at the compliance point (F5). It is hard to establish long-term water quality trends as 2018 was only the second year that the system was in operation and water quality sampling was conducted.

Phytoremediation soil samples were taken once in 2018. All results are compliant with the criteria and do not show signs of metals accumulation or excessive salinity in the phytoremediation soil.

SHA recommends that the following measures be taken:

- Continue the groundwater monitoring program as per the OC.
- Continue the surface water monitoring program as per the OC.
- Continue the leachate monitoring program as per the OC.
- Continue the soil sampling program as per the OC.
- Ensure that pump data is recorded accurately.
- Continue monitoring the iron levels in leachate at the compliance point (F5) to ensure that they do not exceed the OC discharge criteria.
- pH, Redox Potential eH, conductivity, total iron, and dissolved iron samples should be collected at

key locations along the leachate treatment chain at raw leachate, raw compost, EQ Pond, Aeration Pond, Sedimentation Pond and Sand Filter discharge locations on a monthly basis.

- Field samples should be collected using a hatch kit to establish a correlation between field iron concentrations and lab concentrations for leachate.
- Ensure that one duplicate sample is collected during each sampling event from one of the discharge points.
- Obtain and keep current, the laboratory precision, accuracy and blank quality control criteria for each laboratory analyzed parameters from the analytical laboratory.
- Develop a dynamic groundwater flow model with MODFLOW software to interpret groundwater flow patterns and leachate plume migration. Realistically, this option would only be necessary if leachate impacts were observed. More monitoring well locations must be added to the network to confirm if the conceptual model is accurate.

9. STATEMENT OF LIMITATIONS

This report has been prepared by Sperling Hansen Associates (SHA) on behalf of the Regional District of Kitimat-Stikine in accordance with generally accepted engineering practices to a level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions in British Columbia, subject to the time limits and financial and physical constraints applicable to the services.

The report, which specifically includes all tables, charts, and figures, is based on engineering analysis by SHA staff of data compiled during the course of the project. Except where specifically stated to the contrary, the information on which this study is based has been obtained from external sources. This external information has not been independently verified or otherwise examined by Sperling Hansen Associates to determine its accuracy and completeness. Sperling Hansen Associates has relied in good faith on this information and does not accept responsibility of any deficiency, misstatements or inaccuracies contained in the reports as a result of omissions, misinterpretation and/or fraudulent acts of the persons interviewed or contacted, or errors or omissions in the reviewed documentation.

The report is intended solely for the use of the Regional District of Kitimat-Stikine. Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Sperling Hansen Associates does not accept any responsibility for other uses of the material contained herein nor for damages, if any, suffered by any third party because of decisions made or actions based on this report. Copying of this intellectual property for other purposes is not permitted.

The findings and conclusions of this report are valid only as of the date of this report. The interpretations presented in this report and the conclusions and recommendations that are drawn are based on information that was made available to Sperling Hansen Associates during the course of this project. Should additional new data become available in the future, Sperling Hansen Associates should be requested to re-evaluate the findings of this report and modify the conclusions and recommendations drawn, as required.

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June 19, 2019

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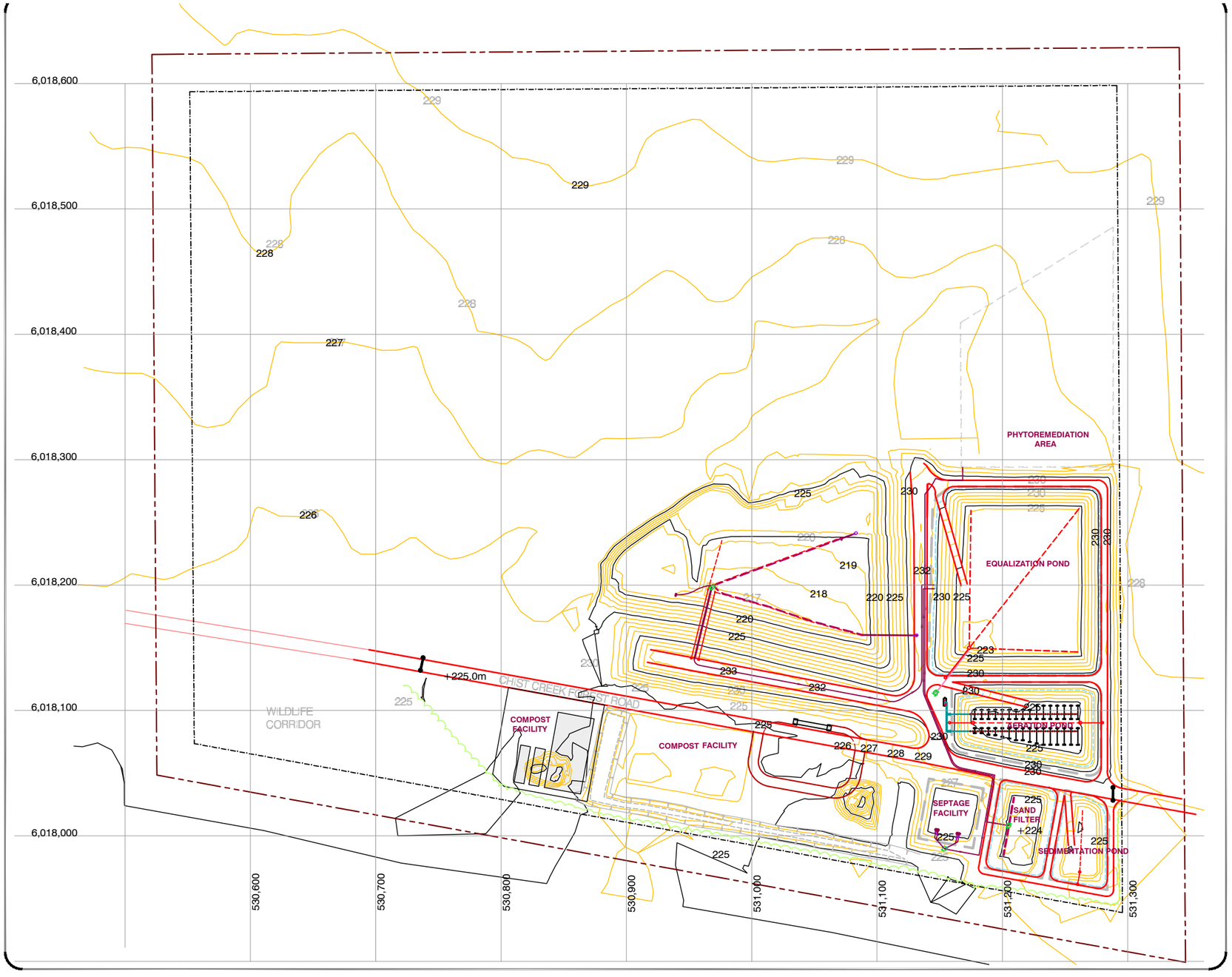
Appendix A: Figures



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SPERLING HANSEN ASSOCIATES

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- Design & Operations Plans
- Landfill Siting
- Environmental Monitoring

#8 - 1225 East Keith Road
North Vancouver, B.C. V7J 1J3

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LEGEND:

- 5m EXISTING CONTOUR
- 1m EXISTING CONTOUR
- 5m DESIGN CONTOUR
- 1m DESIGN CONTOUR
- ROAD
- PROPERTY BOUNDARY
- 30 m OFFSET
- LEAK DETECTION TRENCH
- SLOTTED LEACHATE PIPE
- SOLID LEACHATE PIPE
- PUMP STATION
- CLEAN OUT

CLIENT: Regional District of Kitimat-Stikine

PROJECT:

FORCEMAN RIDGE WMF
2018 ANNUAL MONITORING REPORT

TITLE:

2017 TOPOGRAPHY

SCALE:	DATE: 2019/02/20 yyyy/mm/dd	PROJECT NO: PRJ 19008
DESIGNED	TS	DRAWING NO: **FIGURE 1**
DRAWN	BR	
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BACKGROUND LOCATION:
MW-13

EARLY WARNING LOCATIONS:
MW-01, MW-03, MW-15 & MW-16

COMPLIANCE MONITORING LOCATIONS:
MW-04, MW-07, MW-08 & MW-09

GROUNDWATER FLOW DIRECTION WELLS:
MW-01, MW-02, MW-05, MW-06, MW-10, MW-11, MW-12, & MW-14

SW-04
SW-05
CLEARWATER CREEK
STEWART - CASSIAR HWY
MW-13
MW-07
MW-02
PROPERTY LINE
SEE INSERT BELOW
SW-01
MW-08
ONION LAKE
SCULLY CREEK FOREST ROAD
SS
LANDFILL
MW-03
CHIST CREEK FOREST ROAD
TL
MW-01
SW-03
LOWER CLEARWATER LAKE
SITE BUILDING
MW-17 FUTURE
MW-16
MW-15
SW-02
UPPER CLEARWATER LAKE
MW-09
37
MW-04
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© 2015 Cnes/Spot Image
©20 MW-14 Google
MW-05
MW-10
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MW-12
MW-06
MW-11
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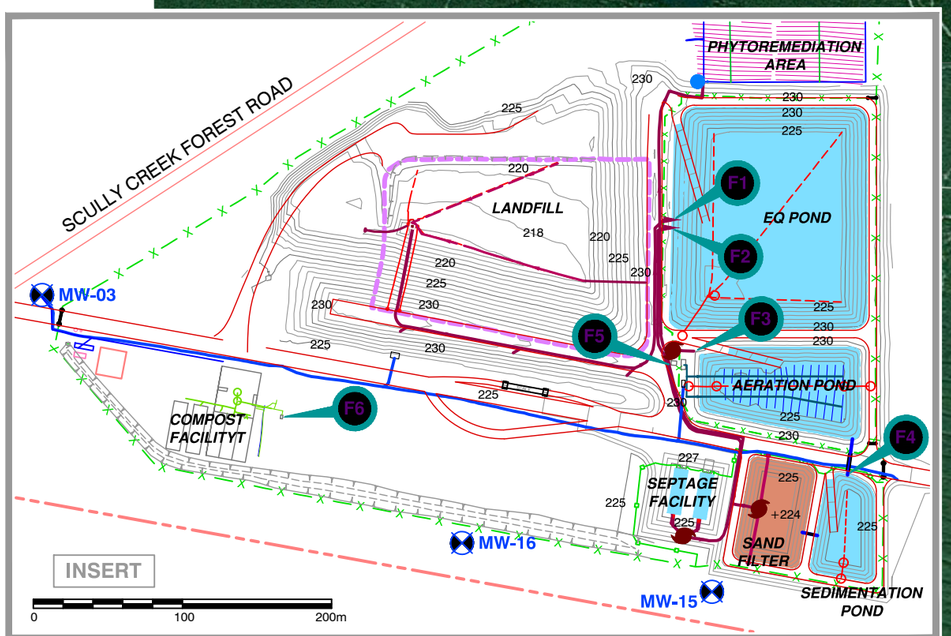

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LEGEND:

- ROAD
- PROPERTY LINE
- CREEK
- LANDFILL BOUNDARY
- MW-08 — MONITORING WELL
- SW-02 — SURFACE WATER MONITORING LOCATION
- TL — TREATED LEACHATE SAMPLE SITE AT CYCLONE
- SS — SOIL SAMPLE LOCATION
- PHYTOREMEDIATION AREA

LEACHATE SAMPLING LOCATIONS:

- F1 — RAW LANDFILL LEACHATE
- F2 — RAW SEPTAGE / COMPOSTING EFFLUENT
- F3 — AERATION POND INLET
- F4 — SEDIMENTATION POND INLET
- F5 — SAND CYCLONE (E249852)
- F6 — COMPOST FACILITY

CLIENT:
Regional District of Kitimat-Stikine

PROJECT:
FORCEMAN RIDGE WMF
2018 ANNUAL MONITORING REPORT

TITLE:
FORCEMAN LANDFILL
MONITORING PROGRAM

SCALE:	DATE:	PROJECT NO:
AS SHOWN	2018/02/20 yyyy/mm/dd	PRJ 19008
DESIGNED	.	DRAWING NO:
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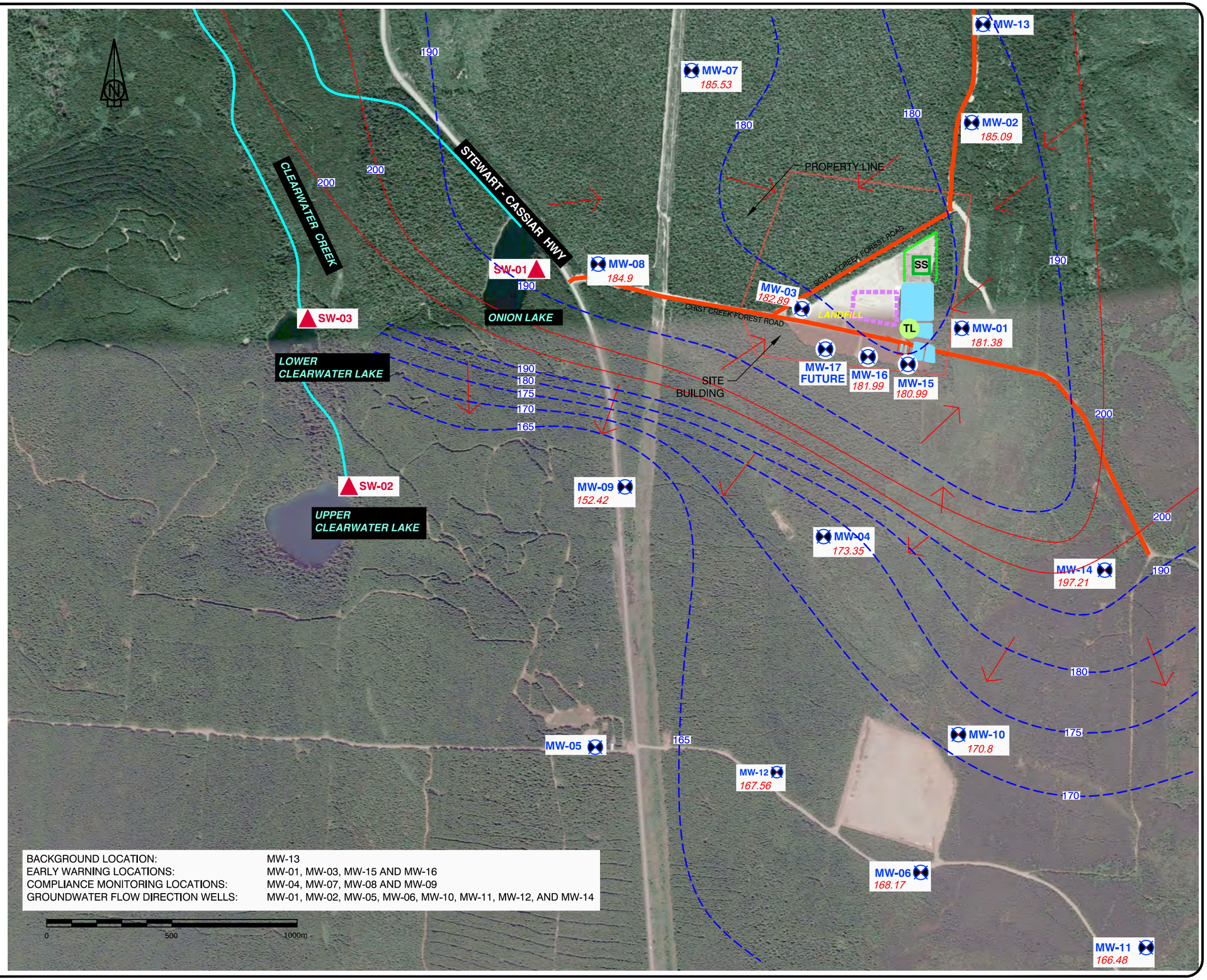

BACKGROUND LOCATION:	MW-13
EARLY WARNING LOCATIONS:	MW-01, MW-03, MW-15 AND MW-16
COMPLIANCE MONITORING LOCATIONS:	MW-04, MW-07, MW-08 AND MW-09
GROUNDWATER FLOW DIRECTION WELLS:	MW-01, MW-02, MW-05, MW-06, MW-10, MW-11, MW-12, AND MW-14

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LEGEND:

- ROAD
- PROPERTY LINE
- CREEK
- LANDFILL BOUNDARY
- MW-08 / 184.90 — MONITORING WELL / GROUNDWATER ELEVATION (m ASL)
- SW-02 — SURFACE WATER MONITORING LOCATION
- TL — TREATED LEACHATE SAMPLE SITE AT CYCLONE
- SS — SOIL SAMPLE LOCATION
- PHYTOREMEDIATION AREA
- GROUNDWATER CONTOURS OCTOBER 2018
- FLOW DIRECTION
- GROUND WATER FLOW DIVIDE

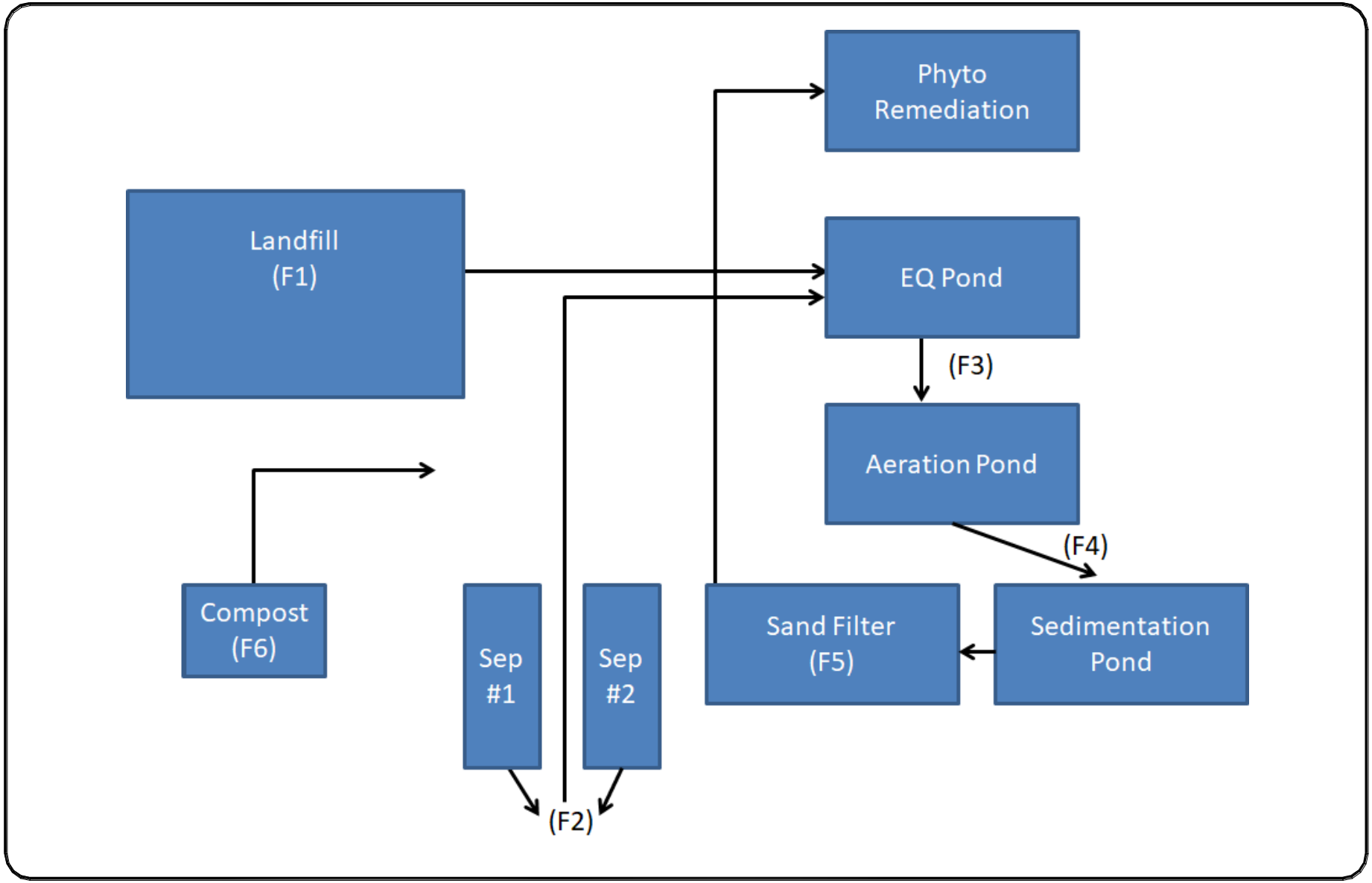
CLIENT:
Regional District of Kitimat-Stikine

PROJECT:
FORCEMAN RIDGE WMF
2018 ANNUAL MONITORING REPORT

TITLE:
GROUNDWATER CONTOURS OCTOBER 2018

SCALE:	DATE:	PROJECT NO:
1:15,000	2019/02/20 yyyy/mm/dd	PRJ 19008

DESIGNED	AM	DRAWING NO:
DRAWN	NL/AD	**FIGURE 3**
CHECKED	DK	



Sperling Hansen Associates	Regional District of Kitimat-Stikine	PROJECT: Forceman Ridge WMF 2018 Annual Monitoring Report	TITLE: Leachate Monitoring Locations	SCALE: N/A	DATE: 2019/02/21 yyyy/mm/dd
				DESIGNED AM	PROJECT NO: PRJ19008
				DRAWN AM	DRAWING NO: Figure 4
				CHECKED IB	

Appendix B: Tables

Table 1. Forceman Landfill Monitoring Program

Monitoring Location	MOE Identifyer	Ground Elevation (mASL)	Top of Well Elevation (m)	Stick-up (m)	Well Bottom Elevation (m)	Well Depth (m)	Depth to Water* (m)	Water Column (m)	Well Type	Pump Installed (y/n)	Sampling Technique	Sampling Frequency	Field Readings	OC/RDKS Locations	Description	Comments
Groundwater Monitoring Wells																
MW-1	E251530	226.69	227.63	0.94	164.63	63.1	43.73	19.4	6"	Y	1" SS Pump	Quarterly	Monthly	OC	Early Warn, (WL, cond, temp - monthly)	
MW-2	E251531	230.43	231.43	1.00	171.43	60.0	43.37	16.6	6"			Quarterly	Quarterly	OC	GW Level, Cond, Temp - Quarterly	
MW-3	E251532	225.72	226.68	0.96	168.68	57.0	42.40	14.6	6"	Y	Supply Well Pump	Quarterly	Monthly	OC	Early Warn, (WL, cond, temp - monthly)	Supply well. Tap in site trailer.
MW-4	E251533	196.98	198.24	1.26	169.28	24.8	23.31	1.5	6"	Y	1.66" PVC Bladder	Quarterly	Monthly	OC	Compliance, (WL, cond, temp - monthly)	
MW-5	E251534	209.33	210.46	1.13	151.02	59.4	45.37	14.1	6"	Y	Existing supply pump	Annually	Annually	OC	Ski Club Supply Well, GW Level, Cond, Temp - Annually	Annual water sampling
MW-6	E251535	200.30	201.53	1.23	166.48	35.1	31.76	3.3					Annually	OC	GW Level	
MW-7	E287379	229.93	230.82	0.89	164.63	44.2	44.15	0.1	2"	Y	1" SS Pump	Quarterly	Monthly	OC	Compliance, (WL, cond, temp - monthly)	
MW-8	E287380	194.62	195.62	1.00	171.43	14.4	9.26	5.1	2"	Y	PVC Bladder	Quarterly	Monthly	OC	Compliance, (WL, cond, temp - monthly)	Has both barologger and level logger
MW-9	E287381		203.4		168.68	51.8	49.65	2.2	2"	Y	1" SS Pump	Quarterly	Monthly	OC	Compliance, (WL, cond, temp - monthly)	Level logger
MW-10	E287382		198.94		169.28	27.7	26.30	1.4	2"	Y	1" SS Pump		Annually	OC	GW Level	
MW-11	E287383		202.89		151.02	51.9	35.82	16.1					Annually	OC	GW Level	
MW-12	E287384	209.65	210.49	0.84	166.48	44.5	41.56	2.9	2"	Y	1" SS Pump		Annually	OC	GW Level	
MW-13	E287385	231.54	232.48	0.94		44.2	Dry	Dry	2"	Y	1" SS Pump	Quarterly	Monthly	OC	Background	
MW-14	E287386	222.91	223.88	0.97			23.97						Annually	OC	GW Level	
MW-15-old	E302210					45.72	Dry	-	2" PVC		Bailer	Quarterly		OC	Early Warn, (WL, cond, temp - monthly)	
MW15-new						61.53	44.07	17.460833	2" PVC				Monthly			
MW-16-old	E302211					45.10	44.79	-	2" PVC		Bailer	Quarterly		OC	Early Warn, (WL, cond, temp - monthly)	
MW16-new						61.55	44.56	16.9875	2" PVC				Monthly			
MW-17	Future Well													OC	Early Warn.	Future well
Surface Water Monitoring Stations																
SW-1	E273828											Quarterly	Monthly	OC	Onion Lake	
SW-2	E273829											Quarterly	Monthly	OC	Upper Clearwater	
SW-3	E273831											Quarterly	Monthly	OC	Lower Clearwater	
SW-4	E306587											Quarterly	Monthly	OC	Ck. from Onion Lk	
SW-5	E296117											Quarterly	Monthly	OC	Clearwater Ck.	
Leachate Monitoring																
F1												Quarterly	Monthly	RDKS	Raw leachate	
F2												Quarterly	Monthly	RDKS	Raw septage and leachate from composting	
F3												Quarterly	Monthly	RDKS	Aeration pumping well into aeration pond	
F4												Quarterly	Monthly	RDKS	Sedimentation pond gravity inflow	
F5	E249852											Quarterly	Monthly	OC/RDKS	Sand filter pumping well	Treated leachate to phyto.
Soil Sampling																
Phyto Remediation	E306624											Annually	-	OC	Annual testing for metals before leachate application	

*average readings from historical sampling events

Background Well
Early Detection Wells
Compliance Wells
Surface Water Monitoring Stations
Leachate Monitoring Locations
Water level Monitoring
Soil Sampling

Table 2: Groundwater Quality Results Sampling Location MW-2 (E251531)

		BC MoE Guidelines	22-Oct-12	2-Apr-13	2-Oct-17	14-Nov-17	10-Apr-18	19-Jul-18	20-Nov-18
Field	**Units**	**CSR-DW (2)**							
Conductivity	uS/cm	-	-	-	29.1	29.9	28	49	57
pH	pH	-	-	-	6.36	6.31	5.84	5.97	6.48
Dissolved Oxygen	mg/L	-	-	-	9.7	-	9.2	8.2	1
Temperature	°C	-	-	-	4.3	4.5	4	4	4.4
Water elevation	m	-	-	-	-	-	45.79	44.54	46.83
Analyte	Units								
Conductivity	uS/cm	-	18.8	-	-				
Hardness (as CaCO3)	mg/L	-	-	7.42	24.7	-	17.8	22.8	25.9
pH	pH	-	7	7	6.6	7.21	7.43		
Total Suspended Solids	mg/L	-	-	-	270				
Total Dissolved Solids	mg/L	-	9	-	24				
Alkalinity, Total (as CaCO3)	mg/L	-	12.6	13	24	-	22.2	31.1	25.2
Ammonia, Total (as N)	mg/L	-	0.06	-	<0.03	<0.0050	<0.0050	0.0058	0.0134
Total Nitrogen as N	mg/L	-	0.317	-	0.383				
Bromide (Br)	mg/L	-							<0.050
Chloride (Cl)	mg/L	250 (2)	ND	ND	<1	0.51	<0.50	<0.50	<0.50
Fluoride (F)	mg/L	1.5 (2)	ND	ND	<0.1	-	0.021	0.027	0.023
Nitrate (as N)	mg/L	10 (2)	ND	ND	<0.01	0.212	0.227	0.227	0.227
Nitrite (as N)	mg/L	1.0 (2)	ND	ND	<0.1	-	<0.0010	<0.0010	<0.0010
Sulfate (SO4)	mg/L	500 (2)	-	1.3	1.3	1.13	1.03	1.06	0.98
Total Organic Carbon	mg/L	-	-	ND	-	-	0.85	8.43	6.4
BOD	mg/L	-	-	-	-	-			
COD	mg/L	-	-	-	-	-	37	49	28
Dissolved Metals									
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	ND	ND	<0.005	0.0015	0.0015	0.002	0.0047
Antimony (Sb)-Dissolved	mg/L	0.006(2)	ND	ND	<0.0002	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)-Dissolved	mg/L	0.01(2)	ND	0.000048	0.0005	<0.00010	<0.00010	<0.00010	<0.00010
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.0018	0.0014	0.0085	0.0192	0.00867	0.0092	0.00828
Beryllium (Be)-Dissolved	mg/L	0.008(2)	ND	ND	<0.0001	<0.00010	<0.00010	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	<0.0001	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	mg/L	5.0(2)	ND	ND	<0.005	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	0.000074	ND	0.000014	0.0000129	0.000029	0.0000234	0.00008
Calcium (Ca)-Dissolved	mg/L	-	-	-	5.99	-	6.12	7.75	8.8
Cesium (Cs) - Dissolved	mg/L	-	-	-		-	<0.000010	<0.000010	<0.000010
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	ND	ND	<0.0005	<0.00010	<0.00010	<0.00010	0.00011
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	ND	0.00003	0.00012	0.00016	0.00014	0.00015	<0.00010
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.00071	ND	<0.0004	<0.00020	<0.00020	<0.00020	0.00034
Iron (Fe)-Dissolved	mg/L	6.5(2)	ND	0.953	<0.01	0.060	0.074	<0.010	0.014
Lead (Pb)-Dissolved	mg/L	0.01(2)	ND	ND	<0.0002	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Dissolved	mg/L	0.008 (2)	ND	ND	0.00012	<0.0010	<0.0010	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	0.118	ND	0.763	0.658	0.62	0.832	0.956
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	0.137	0.153	0.0313	0.0461	0.032	0.0613	0.0495
Mercury (Hg)-Dissolved	mg/L	0.001(2)	ND	ND	<0.00001	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	ND	0.000125	<0.0001	0.000062	<0.000050	<0.000050	<0.000050
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-	0.00055	0.00059	0.00073	0.00061	0.00071
Phosphorus - Dissolved	mg/L	-	-	-	<0.05	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	-	-	0.35	-	0.367	0.423	0.444
Rubidium (Rb) - Dissovled	mg/L	-	-	-		-	0.00036	0.0005	0.0005
Selenium (Se)-Dissolved	mg/L	0.01 (2)	ND	ND	<0.0005	<0.000050	<0.000050	<0.000050	<0.000050
Silicon - Dissolved	mg/L	-	0.276	0.156	6.1	5.66	5.7	5.62	5.54
Silver (Ag)-Dissolved	mg/L	0.02 (2)	ND	ND	<0.00005	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	200(2)	1.89	1.64	1.66	2.03	1.6	1.64	1.71
Strontium - Dissolved	mg/L	-	0.0185	0.0193	0.0417	0.0432	0.0483	0.0557	0.0483
Sulfur- Dissolved	mg/L	-	-	-	<3	<0.50	<0.50	<0.50	<0.50
Tellurium - Dissolved	mg/L	-	-	-	<0.0005	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	-	-	<0.00002	<0.000010	<0.000010	<0.000010	<0.000010
Thorium - Dissolved	mg/L	-	-	-	<0.0001	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	2.5 (2)	ND	ND	<0.0002	<0.00010	<0.00010	<0.00010	0.00028
Titanium (Ti)-Dissolved	mg/L	-	-	-	<0.005	-	<0.00030	<0.00030	<0.00030
Tungsten (W) - Dissovled	mg/L	0.003 (2)	-	-		-	<0.00010	<0.00010	<0.00010
Uranium (U)-Dissolved	mg/L	0.020	ND	ND	<0.00002	<0.000010	<0.000010	<0.000010	<0.000010
Vanadium (V)-Dissolved	mg/L	0.020 (2)	ND	ND	<0.001	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	ND	ND	<0.004	0.0013	<0.0010	<0.0010	<0.0010
Zirconium - Dissolved	mg/L	-	ND	ND	<0.0001	<0.000060	<0.000060	<0.000060	<0.000060
Volatile Organic Compounds (Water)				-					
Benzene	mg/L	0.005 (2)	-	-	-	-	-	-	-
Bromodichloromethane	mg/L	0.1(2)	-	-	-	-	-	-	-
Bromoform	mg/L	0.1(2)	-	-	-	-	-	-	-
Carbon Tetrachloride	mg/L	0.002(2)	-	-	-	-	-	-	-
Chlorobenzene	mg/L	0.08(2)	-	-	-	-	-	-	-
Dibromochloromethane	mg/L	0.1(2)	-	-	-	-	-	-	-
Chloroethane	mg/L	-	-	-	-	-	-	-	-
Chloroform	mg/L	0.1(2)	-	-	-	-	-	-	-
Chloromethane	mg/L	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	mg/L	0.2(2)	-	-	-	-	-	-	-
1,3-Dichlorobenzene	mg/L	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	mg/L	0.005(2)	-	-	-	-	-	-	-
1,1-Dichloroethane	mg/L	0.03(2)	-	-	-	-	-	-	-
1,2-Dichloroethane	mg/L	0.005(2)	-	-	-	-	-	-	-
1,1-Dichloroethylene	mg/L	0.014(2)	-	-	-	-	-	-	-
cis-1,2-Dichloroethylene	mg/L	0.008(2)	-	-	-	-	-	-	-
trans-1,2-Dichloroethylene	mg/L	0.08(2)	-	-	-	-	-	-	-
Dichloromethane	mg/L	0.05(2)	-	-	-	-	-	-	-
1,2-Dichloropropane	mg/L	0.0045(2)	-	-	-	-	-	-	-
cis-1,3-Dichloropropylene	mg/L	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropylene	mg/L	-	-	-	-	-	-	-	-
1,3-Dichloropropene (cis & trans)	mg/L	0.0015(2)	-	-	-	-	-	-	-
Ethylbenzene	mg/L	0.14(2)	-	-	-	-	-	-	-
Methyl t-butyl ether (MTBE)	mg/L	0.095(2)	-	-	-	-	-	-	-
Styrene	mg/L	0.8(2)	-	-	-	-	-	-	-
1,1,1,2-Tetrachloroethane	mg/L	0.006(2)	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	mg/L	0.008(2)	-	-	-	-	-	-	-
Tetrachloroethylene	mg/L	0.03(2)	-	-	-	-	-	-	-
Toluene	mg/L	0.06(2)	-	-	-	-	-	-	-
1,1,1-Trichloroethane	mg/L	8(2)	-	-	-	-	-	-	-
1,1,2-Trichloroethane	mg/L	0.003(2)	-	-	-	-	-	-	-
Trichloroethylene	mg/L	0.005(2)	-	-	-	-	-	-	-
Trichlorofluoromethane	mg/L	1(2)	-	-	-	-	-	-	-
Vinyl Chloride	mg/L	0.002(2)	-	-	-	-	-	-	-
ortho-Xylene	mg/L	-	-	-	-	-	-	-	-
meta- & para-Xylene	mg/L	-	-	-	-	-	-	-	-
Xylenes	mg/L	0.09(2)	-	-	-	-	-	-	-

NOTES

(1) BC MoE Approved and Working Water Quality Guidelines, last updated March 2018
(2) BC Contaminated Sites Regulation (CSR) for drinking water, Schedule 3.2, last updated January 2019
(3) All criteria limits for BCWQG - Drinking Quality Guidelines based on Total Metal Concentration except Aluminum (Dissolved)
(4) BC MoE Water Quality Guidelines for Protection of Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 3: Groundwater Quality Results Sampling Location MW-13 (E287385)

		BC MoE Guidelines	22-Oct-12	3-Apr-13	12-Jun-13	5-Apr-17	6-Jul-17	14-Nov-17
Field	**Units**	**CSR-DW (2)**						
Conductivity	uS/cm	-	-	-	-	31	81	17.7
pH	pH	-	-	-	-	6.5	7.8	5.88
Temperature	°C	-	-	-	-	4.5	4.7	4.1
Dissolved Oxygen	mg/L	-	-	-	-	-	4.3	11
Water elevation	m	-	-	-	-	-	-	-
Analyte	Units							
Conductivity	uS/cm	-	17.2	-	-	145		-
Hardness (as CaCO3)	mg/L	-	-	27.3	-	-	25.5	11.6
pH	pH	-	6	6.7	-	8	8	6.86
Total Suspended Solids	mg/L	-	-	-		1.1		
Total Dissolved Solids	mg/L	-	8	-	-	82		
Alkalinity, Total (as CaCO3)	mg/L	-	10.6	32	56.7	-	37	12.2
Ammonia, Total (as N)	mg/L	-	ND	-	<0.03	<0.03	<0.03	0.0127
Total Nitrogen as N	mg/L	-	0.25	-	-			
Bromide (Br)	mg/L	-						
Chloride (Cl)	mg/L	250 (2)	ND	ND	-	1.1	1.4	<0.50
Fluoride (F)	mg/L	1.5 (2)	ND	ND	-	-	<0.10	0.023
Nitrate (as N)	mg/L	10 (2)	0.047	0.057	-	<0.01	<0.01	0.14
Nitrite (as N)	mg/L	1.0 (2)	0.0052	ND	-	-	0.15	<0.0010
Sulfate (SO4)	mg/L	500 (2)	-	1.52	-	2.6	2.6	0.48
Total Organic Carbon	mg/L	-	-	ND	-	-	<0.50	1.89
BOD	mg/L	-	-	-	-	-		
COD	mg/L	-	-	-	-	-	-	<20
Dissolved Metals								
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	0.0170	0.0096	-	<0.0050	0.0468	0.0309
Antimony (Sb)-Dissolved	mg/L	0.006(2)	ND	0.000082	-	<0.00010	0.00035	<0.00010
Arsenic (As)-Dissolved	mg/L	0.01(2)	ND	0.00068	-	0.00159	<0.00050	<0.00010
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.0145	0.0101	-	0.018	<0.0050	0.0187
Beryllium (Be)-Dissolved	mg/L	0.008(2)	ND	ND	-	<0.00010	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	-	<0.00010	<0.00010	<0.000050
Boron (B)-Dissolved	mg/L	5.0(2)	ND	ND	-	<0.004	<0.0050	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	0.000053	0.000127	-	<0.00001	0.00008	0.0000119
Calcium (Ca)-Dissolved	mg/L	-	-	-	-	-	8.92	4.05
Cessium - Di	mg/L	-	-	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	ND	ND	-	<0.0005	<0.00050	<0.00010
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	ND	0.000022	-	<0.00005	<0.00010	<0.00010
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.00120	0.02020	-	<0.0002	0.00033	<0.00020
Iron (Fe)-Dissolved	mg/L	6.5(2)	ND	ND	-	<0.010	<0.010	<0.010
Lead (Pb)-Dissolved	mg/L	0.01(2)	ND	0.000159	-	<0.0001	<0.00010	<0.000050
Lithium (Li)-Dissolved	mg/L	0.008 (2)	ND	ND	-	0.001	0.00012	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	0.290	0.860	-	1.82	0.21	0.370
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	0.0036	0.00937	-	0.00026	0.00287	0.00121
Mercury (Hg)-Dissolved	mg/L	0.001(2)	ND	ND	-	<0.00002	<0.000020	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	ND	0.000059	-	0.0003	0.00471	<0.000050
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-	-	<0.0002	0.00021	<0.00050
Phosphorus - Dissolved	mg/L	-	-	-	-	<0.05	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	-	-	-	-	0.87	0.225
Rubidium - (Rb)- Dissolved	mg/L	-	-	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	0.01 (2)	ND	ND	-	<0.00050	<0.00050	0.000076
Silicon - Dissolved	mg/L	-	2.98	3.21	-	4.8	<1.0	2.98
Silver (Ag)-Dissolved	mg/L	0.02 (2)	ND	ND	-	<0.00005	<0.000050	<0.000010
Sodium (Na)-Dissolved	mg/L	200(2)	1.02	1.28	-	1.69	5.55	0.825
Strontium - Dissolved	mg/L	-	0.0375	0.0605	-	0.0864	0.0629	0.0510
Sulfur- Dissolved	mg/L	-	-	-	-	<3.0	<3.0	<0.50
Tellurium (Te) - Dissolved	mg/L	-	-	-	-	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	-	-	-	<0.00002	<0.000020	<0.000010
Thorium (Th)- Dissolved	mg/L	-	-	-	-	<0.00010	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	2.5 (2)	ND	ND	-	<0.00020	0.00975	<0.00010
Titanium (Ti)-Dissolved	mg/L	-	-	-	-	-	<0.0050	<0.00030
Tungsten (W) - Dissolved	mg/L	0.003 (2)	-	-	-	-	-	<0.00010
Uranium (U)-Dissolved	mg/L	0.020	ND	0.000044	-	0.0001	<0.000020	-
Vanadium (V)-Dissolved	mg/L	0.020 (2)	ND	ND	-	<0.0010	<0.0010	-
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	ND	0.379	-	<0.0040	<0.0040	-
Zirconium - Dissolved	mg/L	-	ND	ND	-	<0.00010	<0.00010	-
Volatile Organic Compounds (Water)				-				
Benzene	mg/L	0.005 (2)	-	-	-	-	-	-
Bromodichloromethane	mg/L	0.1(2)	-	-	-	-	-	-
Bromoform	mg/L	0.1(2)	-	-	-	-	-	-
Carbon Tetrachloride	mg/L	0.002(2)	-	-	-	-	-	-
Chlorobenzene	mg/L	0.08(2)	-	-	-	-	-	-
Dibromochloromethane	mg/L	0.1(2)	-	-	-	-	-	-
Chloroethane	mg/L	-	-	-	-	-	-	-
Chloroform	mg/L	0.1(2)	-	-	-	-	-	-
Chloromethane	mg/L	-	-	-	-	-	-	-
1,2-Dichlorobenzene	mg/L	0.2(2)	-	-	-	-	-	-
1,3-Dichlorobenzene	mg/L	-	-	-	-	-	-	-
1,4-Dichlorobenzene	mg/L	0.005(2)	-	-	-	-	-	-
1,1-Dichloroethane	mg/L	0.03(2)	-	-	-	-	-	-
1,2-Dichloroethane	mg/L	0.005(2)	-	-	-	-	-	-
1,1-Dichloroethylene	mg/L	0.014(2)	-	-	-	-	-	-
cis-1,2-Dichloroethylene	mg/L	0.008(2)	-	-	-	-	-	-
trans-1,2-Dichloroethylene	mg/L	0.08(2)	-	-	-	-	-	-
Dichloromethane	mg/L	0.05(2)	-	-	-	-	-	-
1,2-Dichloropropane	mg/L	0.0045(2)	-	-	-	-	-	-
cis-1,3-Dichloropropylene	mg/L	-	-	-	-	-	-	-
trans-1,3-Dichloropropylene	mg/L	-	-	-	-	-	-	-
1,3-Dichloropropene (cis & trans)	mg/L	0.0015(2)	-	-	-	-	-	-
Ethylbenzene	mg/L	0.14(2)	-	-	-	-	-	-
Methyl t-butyl ether (MTBE)	mg/L	0.095(2)	-	-	-	-	-	-
Styrene	mg/L	0.8(2)	-	-	-	-	-	-
1,1,1,2-Tetrachloroethane	mg/L	0.006(2)	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	mg/L	0.008(2)	-	-	-	-	-	-
Tetrachloroethylene	mg/L	0.03(2)	-	-	-	-	-	-
Toluene	mg/L	0.06(2)	-	-	-	-	-	-
1,1,1-Trichloroethane	mg/L	8(2)	-	-	-	-	-	-
1,1,2-Trichloroethane	mg/L	0.003(2)	-	-	-	-	-	-
Trichloroethylene	mg/L	0.005(2)	-	-	-	-	-	-
Trichlorofluoromethane	mg/L	1(2)	-	-	-	-	-	-
Vinyl Chloride	mg/L	0.002(2)	-	-	-	-	-	-
ortho-Xylene	mg/L	-	-	-	-	-	-	-
meta- & para-Xylene	mg/L	-	-	-	-	-	-	-
Xylenes	mg/L	0.09(2)	-	-	-	-	-	-

NOTES

(1) BC MoE Approved and Working Water Quality Guidelines, last updated March 2018
(2) BC Contaminated Sites Regulation (CSR) for drinking water, Schedule 3.2, last updated January 2019
(3) All criteria limits for BCWQG - Drinking Quality Guidelines based on Total Metal Concentration except Aluminum (Dissolved)
(4) BC MoE Water Quality Guidelines for Protection of Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 4: Groundwater Quality Results Sampling Location MW-1 (E251530)

		BC MoE Guidelines	22-Oct-12	2-Apr-13	5-Apr-17	6-Jul-17	2-Oct-17	14-Nov-17	9-Apr-18	18-Jul-18	20-Nov-18
Field	**Units**	**CSR-DW (2)**									
Conductivity	uS/cm	-	-	-	129	28.8	34.4	32.6	29.3	36	42
pH	pH	-	-	-	7.9	8.3	6.49	6.33	5.81	5.75	6.15
Dissolved Oxygen	mg/L	-	-	-	-	2.5	-	9.8	8.6	7.3	0.8
Temperature	°C	-	-	-	5.8	6.8	5	4.7	4.8	5.1	5
Water elevation	m	-	-	-	-	-	-	-	45.91	44.74	46.54
Analyte	Units										
Conductivity	uS/cm	-	15.2	-	-		58.9	-			
Hardness (as CaCO3)	mg/L	-	-	10.4	13.1	6.15	-	23.1	19.7	19.3	15.8
pH	pH	-	6.8	7	6.7	6	6.8	7.26	7.52		
Total Suspended Solids	mg/L	-	-	-	230						
Total Dissolved Solids	mg/L	-	7	-	-		29				
Alkalinity, Total (as CaCO3)	mg/L	-	10.2	13.6	18	12	-	27	28.1	1	21.9
Ammonia, Total (as N)	mg/L	-	0.19	-	<0.03	0.06	<0.03	<0.005	0.0066	0.0082	<0.0050
Total Nitrogen as N	mg/L	-	0.322	-	-		0.175				
Bromide (Br)	mg/L	-								<0.050	<0.050
Chloride (Cl)	mg/L	250 (2)	ND	ND	<1.0	1.3	<1.0	<0.5	<0.50	<0.50	<0.50
Fluoride (F)	mg/L	1.5 (2)	ND	ND	<0.10	<0.10	-	0.044	0.051	0.047	0.043
Nitrate (as N)	mg/L	10 (2)	ND	ND	0.041	0.2	<0.01	0.156	0.148	0.166	0.166
Nitrite (as N)	mg/L	1.0 (2)	ND	ND	<0.01	<0.01	-	<0.001	<0.0010	<0.0010	<0.0010
Sulfate (SO4)	mg/L	500 (2)	-	1.06	1.1	<1.0	<1.0	0.64	0.66	0.65	0.67
Total Organic Carbon	mg/L	-	-	2.14	0.59	1.1	-	0.52	3.76	1.95	5.2
BOD	mg/L	-	-	-	-		-				
COD	mg/L	-	-	-	-	-	-	<20	<20	<20	23
Dissolved Metals											
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	ND	ND	<0.0050	<0.0050	<0.005	0.0024	0.0024	0.0039	0.0038
Antimony (Sb)-Dissolved	mg/L	0.006(2)	ND	0.000056	<0.00010	<0.00010	<0.0002	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)-Dissolved	mg/L	0.01(2)	ND	0.000201	<0.00050	<0.00050	<0.0005	<0.00010	<0.00010	<0.00010	<0.00010
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.0013	0.00155	0.0137	<0.0050	0.0071	0.00683	0.0057	0.00587	0.00563
Beryllium (Be)-Dissolved	mg/L	0.008(2)	ND	ND	<0.00010	<0.00010	<0.0001	<0.00010	<0.00010	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.0001	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	mg/L	5.0(2)	ND	ND	0.008	<0.0050	<0.005	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	0.000016	0.000008	0.00002	0.000034	0.000023	0.0000573	0.0000309	0.0000183	0.0000939
Calcium (Ca)-Dissolved	mg/L	-	-	-	4.49	2.23	-	8.01	6.53	6.33	5.24
Cesium (Cs)- Dissolved	mg/L	-	-	-	-	-	-	-	<0.000010	<0.000010	<0.000010
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	ND	ND	<0.0005	<0.00050	<0.0005	<0.00010	0.00013	0.00014	0.00012
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	ND	0.000764	0.00211	0.0002	0.00014	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.00069	ND	0.0005	0.00022	<0.0004	<0.00020	<0.00020	<0.00020	0.00024
Iron (Fe)-Dissolved	mg/L	6.5(2)	0.0082	0.0923	0.735	<0.010	<0.01	0.012	<0.010	<0.010	0.011
Lead (Pb)-Dissolved	mg/L	0.01(2)	ND	ND	<0.0001	<0.00010	<0.0002	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Dissolved	mg/L	0.008 (2)	ND	ND	<0.0001	0.00055	<0.0001	<0.0010	<0.0010	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	0.149	0.31	0.457	0.213	0.79	0.755	0.831	0.849	0.66
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	0.374	0.339	0.39	0.356	0.032	0.0198	0.00776	0.00517	0.00575
Mercury (Hg)-Dissolved	mg/L	0.001(2)	ND	ND	<0.00002	<0.000020	<0.00001	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	ND	0.000284	0.00016	<0.00010	<0.0001	<0.000050	<0.000050	<0.000050	<0.000050
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-	0.0065	0.00105	<0.0004	<0.00050	<0.00050	<0.00050	<0.00050
Phosphorus - Dissolved	mg/L	-	-	-	<0.05	<0.050	<0.05	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	-	-	0.27	1.09	-	0.270	0.25	0.273	0.27
Rubidium (Rb) - Dissolved	mg/L	-	-	-	-	-	-	-	0.00036	0.00039	0.00037
Selenium (Se)-Dissolved	mg/L	0.01 (2)	ND	0.000056	<0.00050	<0.00050	<0.0005	<0.000050	<0.000050	<0.000050	<0.000050
Silicon - Dissolved	mg/L	-	0.481	0.22	2.8	1.1	5.4	5.10	5.23	4.93	5.28
Silver (Ag)-Dissolved	mg/L	0.02 (2)	ND	ND	<0.00005	<0.000050	<0.00005	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	200(2)	1.70	1.35	1.57	1.95	1.4	1.29	1.4	1.5	1.55
Strontium - Dissolved	mg/L	-	0.0153	0.0326	0.0393	0.0161	0.0423	0.0439	0.0454	0.0446	0.0408
Sulfur- Dissolved	mg/L	-	-	-	<3.0	<3.0	<3	<0.50	<0.50	<0.50	<0.50
Tellurium - Dissolved	mg/L	-	-	-	<0.00020	<0.00020	<0.0005	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	-	-	<0.00002	<0.000020	<0.00002	<0.000010	<0.000010	<0.000010	<0.000010
Thorium - Dissolved	mg/L	-	-	-	<0.00010	<0.00010	<0.0001	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	2.5 (2)	ND	ND	<0.00020	<0.00020	<0.0002	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Dissolved	mg/L	-	-	-	<0.0050	<0.0050	-	<0.00030	<0.00030	<0.00030	<0.00030
Tungston (W) - Dissolved	mg/L	0.003 (2)	-	-	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010
Uranium (U)-Dissolved	mg/L	0.020	ND	ND	<0.00002	<0.000020	<0.00002	-	<0.000010	<0.000010	<0.000010
Vanadium (V)-Dissolved	mg/L	0.020 (2)	ND	ND	<0.0010	<0.0010	<0.001	-	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	ND	ND	0.0178	<0.0040	<0.004	-	<0.0010	<0.0010	0.0011
Zirconium - Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.0001	-	<0.000060	<0.000060	<0.000060
Volatile Organic Compounds (Water)				-							
Benzene	mg/L	0.005 (2)	-	-	-	-	-	-			
Bromodichloromethane	mg/L	0.1(2)	-	-	-	-	-	-			
Bromoform	mg/L	0.1(2)	-	-	-	-	-	-			
Carbon Tetrachloride	mg/L	0.002(2)	-	-	-	-	-	-			
Chlorobenzene	mg/L	0.08(2)	-	-	-	-	-	-			
Dibromochloromethane	mg/L	0.1(2)	-	-	-	-	-	-			
Chloroethane	mg/L	-	-	-	-	-	-	-			
Chloroform	mg/L	0.1(2)	-	-	-	-	-	-			
Chloromethane	mg/L	-	-	-	-	-	-	-			
1,2-Dichlorobenzene	mg/L	0.2(2)	-	-	-	-	-	-			
1,3-Dichlorobenzene	mg/L	-	-	-	-	-	-	-			
1,4-Dichlorobenzene	mg/L	0.005(2)	-	-	-	-	-	-			
1,1-Dichloroethane	mg/L	0.03(2)	-	-	-	-	-	-			
1,2-Dichloroethane	mg/L	0.005(2)	-	-	-	-	-	-			
1,1-Dichloroethylene	mg/L	0.014(2)	-	-	-	-	-	-			
cis-1,2-Dichloroethylene	mg/L	0.008(2)	-	-	-	-	-	-			
trans-1,2-Dichloroethylene	mg/L	0.08(2)	-	-	-	-	-	-			
Dichloromethane	mg/L	0.05(2)	-	-	-	-	-	-			
1,2-Dichloropropane	mg/L	0.0045(2)	-	-	-	-	-	-			
cis-1,3-Dichloropropylene	mg/L	-	-	-	-	-	-	-			
trans-1,3-Dichloropropylene	mg/L	-	-	-	-	-	-	-			
1,3-Dichloropropene (cis & trans)	mg/L	0.0015(2)	-	-	-	-	-	-			
Ethylbenzene	mg/L	0.14(2)	-	-	-	-	-	-			
Methyl t-butyl ether (MTBE)	mg/L	0.095(2)	-	-	-	-	-	-			
Styrene	mg/L	0.8(2)	-	-	-	-	-	-			
1,1,1,2-Tetrachloroethane	mg/L	0.006(2)	-	-	-	-	-	-			
1,1,2,2-Tetrachloroethane	mg/L	0.008(2)	-	-	-	-	-	-			
Tetrachloroethylene	mg/L	0.03(2)	-	-	-	-	-	-			
Toluene	mg/L	0.06(2)	-	-	-	-	-	-			
1,1,1-Trichloroethane	mg/L	8(2)	-	-	-	-	-	-			
1,1,2-Trichloroethane	mg/L	0.003(2)	-	-	-	-	-	-			
Trichloroethylene	mg/L	0.005(2)	-	-	-	-	-	-			
Trichlorofluoromethane	mg/L	1(2)	-	-	-	-	-	-			
Vinyl Chloride	mg/L	0.002(2)	-	-	-	-	-	-			
ortho-Xylene	mg/L	-	-	-	-	-	-	-			
meta- & para-Xylene	mg/L	-	-	-	-	-	-	-			
Xylenes	mg/L	0.09(2)	-	-	-	-	-	-			

NOTES

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(3) All criteria limits for BCWQG - Drinking Quality Guidelines based on Total Metal Concentration except Aluminum (Dissolved)
(4) BC MoE Water Quality Guidelines for Protection of Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 5: Groundwater Quality Results Sampling Location MW-3 (E251532)

		BC MoE Guidelines	22-Oct-12	2-Apr-13	6-Apr-17	6-Jul-17	2-Oct-17	14-Nov-17	10-Apr-18	20-Nov-18
Field	**Units**	**CSR-DW (2)**								
Conductivity	uS/cm	-	-	-	132	108	82	78.6	66.5	79.9
pH	pH	-	-	-	7.6	8.7	8.15	8.92	7.33	7.9
Dissolved Oxygen	mg/L	-	-	-	12	16.6	6	7.6	8.2	0.6
Temperature	°C	-	-	-	-	3.7	-	3	4.6	8.1
Water elevation	m	-	-	-	-	-	-	-	44.53	
Analyte	Units									
Conductivity	uS/cm	-	29.3	-	-		121	-		
Hardness (as CaCO3)	mg/L	-	-	14.9	62	52.5	-	54.1	47.3	60
pH	pH	-	8.7	8.7	8.1	8.8	7.6	8.23	7.93	
Total Suspended Solids	mg/L	-	-	-	<1.0		1			
Total Dissolved Solids	mg/L	-	13	-	-		60			
Alkalinity, Total (as CaCO3)	mg/L	-	17.3	18.1	65	61	-	56.4	53.4	60.9
Ammonia, Total (as N)	mg/L	-	0.03	-	<0.03	<0.03	<0.03	<0.0050	0.0055	<0.0050
Total Nitrogen as N	mg/L	-	0.233	-	-		0.0848			
Bromide (Br)	mg/L	-								<0.050
Chloride (Cl)	mg/L	250 (2)	1	ND	<1.0	<1.0	<1	<0.50	<0.50	<0.50
Fluoride (F)	mg/L	1.5 (2)	0.13	0.12	<0.10	<0.01	-	0.039	0.041	0.045
Nitrate (as N)	mg/L	10 (2)	ND	ND	0.034	0.01	<0.01	0.0061	0.0104	0.036
Nitrite (as N)	mg/L	1.0 (2)	ND	ND	<0.01	<0.01	-	<0.0010	<0.0010	<0.0010
Sulfate (SO4)	mg/L	500 (2)	-	1.13	1.5	1.6	1.5	1.15	0.93	1.04
Total Organic Carbon	mg/L	-	-	ND	<0.50	<0.50	-	<0.50	<0.50	<0.50
BOD	mg/L	-	-	-	-		-			
COD	mg/L	-	-	-	-	-	-	<20	<20	<20
Dissolved Metals										
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	ND	0.0101	<0.0050	0.0073	0.0146	0.0038	0.0022	0.0024
Antimony (Sb)-Dissolved	mg/L	0.006(2)	ND	ND	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010
Arsenic (As)-Dissolved	mg/L	0.01(2)	ND	0.000052	0.00065	0.0006	0.00093	0.00051	0.00058	0.00113
Barium (Ba)-Dissolved	mg/L	1.0(2)	ND	0.00058	0.0087	0.0061	0.0086	0.00631	0.00797	0.0111
Beryllium (Be)-Dissolved	mg/L	0.008(2)	ND	ND	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	mg/L	5.0(2)	ND	ND	<0.004	0.0241	<0.0050	<0.010	<0.010	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	ND	ND	<0.00001	<0.000010	0.000021	0.000338	0.0000322	<0.0000050
Calcium (Ca)-Dissolved	mg/L	-	-	-	21.5	11.9	-	13.5	16.8	21.8
Cesium (Cs) - Dissolved	mg/L	-	-	-	-	-	-	-	<0.000010	<0.000010
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	ND	ND	<0.0005	0.00069	<0.00050	0.00019	0.00035	0.00029
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	ND	ND	<0.00005	0.00079	<0.00010	0.00025	<0.00010	<0.00010
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.00093	ND	0.0079	0.00841	0.0209	0.0211	0.00366	0.00315
Iron (Fe)-Dissolved	mg/L	6.5(2)	ND	ND	0.016	<0.010	<0.010	0.012	0.014	<0.010
Lead (Pb)-Dissolved	mg/L	0.01(2)	ND	ND	0.0006	0.00028	0.00086	0.000922	0.000051	0.000135
Lithium (Li)-Dissolved	mg/L	0.008 (2)	ND	ND	0.0007	0.00464	0.00078	0.0017	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	0.277	ND	1.36	5.52	1.38	4.95	1.32	1.33
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	0.0178	0.0053	0.00569	0.00496	0.00885	0.0145	0.0316	0.00025
Mercury (Hg)-Dissolved	mg/L	0.001(2)	ND	ND	<0.00002	<0.000020	<0.000010	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	ND	0.000222	<0.00010	0.00013	0.00012	0.000129	0.000251	0.000052
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-	<0.0002	0.00174	0.00115	0.00120	<0.00050	<0.00050
Phosphorus - Dissolved	mg/L	-	-	-	<0.05	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	-	-	0.51	0.46	-	0.563	0.505	0.524
Rubidium (Rd) - Dissolved	mg/L	-	-	-	-	-	-	-	0.00028	0.00032
Selenium (Se)-Dissolved	mg/L	0.01 (2)	ND	ND	<0.00050	<0.00050	<0.00050	0.000080	<0.000050	0.00008
Silicon - Dissolved	mg/L	-	ND	ND	5.1	4.5	5.2	4.14	4.01	5.11
Silver (Ag)-Dissolved	mg/L	0.02 (2)	ND	ND	<0.00005	<0.000050	<0.000050	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	200(2)	1.43	1.28	1.74	1.68	1.78	1.62	1.67	1.77
Strontium - Dissolved	mg/L	-	0.0286	0.0283	0.0803	0.0424	0.0761	0.0496	0.0705	0.0794
Sulfur- Dissolved	mg/L	-	-	-	<3.0	<3.0	<3.0	<0.50	0.58	<0.50
Tellurium - Dissolved	mg/L	-	-	-	<0.00020	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	-	-	<0.00002	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010
Thorium - Dissolved	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	2.5 (2)	ND	ND	<0.00020	<0.00020	<0.00020	0.00081	0.00026	<0.00010
Titanium (Ti)-Dissolved	mg/L	-	-	-	<0.0050	<0.0050	-	<0.00030	<0.00030	<0.00030
Tungston (W)- Dissolved	mg/L	0.003 (2)	-	-	-	-	-	0.00012	0.00028	<0.00010
Uranium (U)-Dissolved	mg/L	0.020	ND	ND	<0.00002	<0.000020	0.000026	-	0.000013	0.000022
Vanadium (V)-Dissolved	mg/L	0.020 (2)	ND	ND	<0.0010	<0.0010	<0.0010	-	<0.00050	0.00099
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	ND	ND	0.0111	0.0169	0.0302	-	0.0158	0.0073
Zirconium - Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	-	<0.000060	<0.000060
Volatile Organic Compounds (Water)				-						
Benzene	mg/L	0.005 (2)	-	-	-	-	-	-	-	-
Bromodichloromethane	mg/L	0.1(2)	-	-	-	-	-	-	-	-
Bromoform	mg/L	0.1(2)	-	-	-	-	-	-	-	-
Carbon Tetrachloride	mg/L	0.002(2)	-	-	-	-	-	-	-	-
Chlorobenzene	mg/L	0.08(2)	-	-	-	-	-	-	-	-
Dibromochloromethane	mg/L	0.1(2)	-	-	-	-	-	-	-	-
Chloroethane	mg/L	-	-	-	-	-	-	-	-	-
Chloroform	mg/L	0.1(2)	-	-	-	-	-	-	-	-
Chloromethane	mg/L	-	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	mg/L	0.2(2)	-	-	-	-	-	-	-	-
1,3-Dichlorobenzene	mg/L	-	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	mg/L	0.005(2)	-	-	-	-	-	-	-	-
1,1-Dichloroethane	mg/L	0.03(2)	-	-	-	-	-	-	-	-
1,2-Dichloroethane	mg/L	0.005(2)	-	-	-	-	-	-	-	-
1,1-Dichloroethylene	mg/L	0.014(2)	-	-	-	-	-	-	-	-
cis-1,2-Dichloroethylene	mg/L	0.008(2)	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethylene	mg/L	0.08(2)	-	-	-	-	-	-	-	-
Dichloromethane	mg/L	0.05(2)	-	-	-	-	-	-	-	-
1,2-Dichloropropane	mg/L	0.0045(2)	-	-	-	-	-	-	-	-
cis-1,3-Dichloropropylene	mg/L	-	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropylene	mg/L	-	-	-	-	-	-	-	-	-
1,3-Dichloropropene (cis & trans)	mg/L	0.0015(2)	-	-	-	-	-	-	-	-
Ethylbenzene	mg/L	0.14(2)	-	-	-	-	-	-	-	-
Methyl t-butyl ether (MTBE)	mg/L	0.095(2)	-	-	-	-	-	-	-	-
Styrene	mg/L	0.8(2)	-	-	-	-	-	-	-	-
1,1,1,2-Tetrachloroethane	mg/L	0.006(2)	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	mg/L	0.008(2)	-	-	-	-	-	-	-	-
Tetrachloroethylene	mg/L	0.03(2)	-	-	-	-	-	-	-	-
Toluene	mg/L	0.06(2)	-	-	-	-	-	-	-	-
1,1,1-Trichloroethane	mg/L	8(2)	-	-	-	-	-	-	-	-
1,1,2-Trichloroethane	mg/L	0.003(2)	-	-	-	-	-	-	-	-
Trichloroethylene	mg/L	0.005(2)	-	-	-	-	-	-	-	-
Trichlorofluoromethane	mg/L	1(2)	-	-	-	-	-	-	-	-
Vinyl Chloride	mg/L	0.002(2)	-	-	-	-	-	-	-	-
ortho-Xylene	mg/L	-	-	-	-	-	-	-	-	-
meta- & para-Xylene	mg/L	-	-	-	-	-	-	-	-	-
Xylenes	mg/L	0.09(2)	-	-	-	-	-	-	-	-

NOTES

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(3) All criteria limits for BCWQG - Drinking Quality Guidelines based on Total Metal Concentration except Aluminum (Dissolved)
(4) BC MoE Water Quality Guidelines for Protection of Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 6: Groundwater Quality Results Sampling Location MW-15 (302210)

		BC MoE Guidelines	2-Oct-17	14-Nov-17	9-Apr-18	18-Jul-18	21-Nov-18	21-Nov-18	21-Nov-18
							Duplicate	Sample	RPD
Field	**Units**	**CSR-DW (2)**							
Conductivity	uS/cm	-	90.3	96.2	97.6	157	-	157	-
pH	pH	-	8.39	8.29	7.8	7.51	-	7.9	-
Dissolved Oxygen	mg/L	-	14.2	10.5	9.8	7.1	-	0.3	-
Temperature	°C	-	5.5	5.0	4.9	5.3	-	5.1	-
Water elevation	m	-	-	-	44.66	43.8	-	45.37	-
Analyte	Units								
Conductivity	uS/cm	-	152	-					-
Hardness (as CaCO3)	mg/L	-	-	72.9	75.7	79.5	80.2	79.2	0.63%
pH	pH	-	7.9	8.1	8.17				-
Total Suspended Solids	mg/L	-	-	-					-
Total Dissolved Solids	mg/L	-	75	-					-
Alkalinity, Total (as CaCO3)	mg/L	-	77	78.1	82.4	83.6	87.4	77.5	6.00%
Ammonia, Total (as N)	mg/L	-	<0.03	-	0.0052	<0.0050	<0.0050	<0.0050	-
Total Nitrogen as N	mg/L	-	0.0827	-					-
Bromide (Br)	mg/L	-			<0.050	<0.050	<0.050	<0.050	-
Chloride (Cl)	mg/L	250 (2)	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	-
Fluoride (F)	mg/L	1.5 (2)	<0.1	0.032	0.034	0.034	0.027	0.027	0.00%
Nitrate (as N)	mg/L	10 (2)	<0.01	0.089	0.0908	0.0873	0.0949	0.0941	0.42%
Nitrite (as N)	mg/L	1.0 (2)	<0.01	<0.001	<0.0010	<0.0010	<0.0010	<0.0010	-
Sulfate (SO4)	mg/L	500 (2)	-	1.08	1.03	1.02	0.93	0.91	1.09%
Total Organic Carbon	mg/L	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	-
BOD	mg/L	-	-	-					-
COD	mg/L	-	-	-	<20	<20	<20	<20	-
Dissolved Metals									
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	<0.0050	0.0026	0.0023	0.0029	0.0057	0.005	6.54%
Antimony (Sb)-Dissolved	mg/L	0.006(2)	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Arsenic (As)-Dissolved	mg/L	0.01(2)	0.00072	0.00082	0.00074	0.00078	0.0007	0.0007	0.00%
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.0139	0.0200	0.0165	0.0165	0.0176	0.0167	2.62%
Beryllium (Be)-Dissolved	mg/L	0.008(2)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Bisumuth - Dissolved	mg/L	-	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	-
Boron (B)-Dissolved	mg/L	5.0(2)	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	-
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	<0.000010	<0.0000050	0.0000177	0.0000149	0.000225	0.000229	0.88%
Calcium (Ca)-Dissolved	mg/L	-	-	-	28.2	29.6	29.9	29.5	0.67%
Cessium (Cs) - Dissolved	mg/L	-	-	-	<0.000010	<0.000010	<0.000010	<0.000010	-
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	<0.00050	0.00039	0.00021	0.00035	0.00042	0.00039	3.70%
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	<0.00040	<0.00020	<0.00020	<0.00020	0.00025	0.00024	2.04%
Iron (Fe)-Dissolved	mg/L	6.5(2)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
Lead (Pb)-Dissolved	mg/L	0.01(2)	<0.00020	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	-
Lithium (Li)-Dissolved	mg/L	0.008 (2)	0.00079	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	-
Magnesium (Mg)-Dissolved	mg/L	-	1.22	1.33	1.27	1.39	1.34	1.35	0.37%
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	0.00032	0.00014	0.0001	0.00014	0.00059	0.00055	3.51%
Mercury (Hg)-Dissolved	mg/L	0.001(2)	<0.000010	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	-
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	<0.00010	<0.000050	<0.000050	<0.00010	<0.000050	<0.000050	-
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-	<0.00050	<0.00050	<0.00050	<0.00050	-
Phosphorus - Dissolved	mg/L	-	-	-	<0.050	<0.050	<0.050	<0.050	-
Potassium (K)-Dissolved	mg/L	-	-	-	0.543	0.602	0.588	0.589	0.08%
Rubidium (Rd) - Dissolved	mg/L	-	-	-	0.00022	<0.00020	0.00024	0.00021	6.67%
Selenium (Se)-Dissolved	mg/L	0.01 (2)	<0.00050	0.000080	0.000069	0.000082	<0.000050	<0.000050	-
Silicon - Dissolved	mg/L	-	5.7	5.49	5.47	5.05	5.64	5.68	0.35%
Silver (Ag)-Dissolved	mg/L	0.02 (2)	<0.000050	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Sodium (Na)-Dissolved	mg/L	200(2)	1.47	1.39	1.51	1.59	1.65	1.66	0.30%
Strontium - Dissolved	mg/L	-	0.0799	0.0852	0.0948	0.0894	0.0925	0.0932	0.38%
Sulfur- Dissolved	mg/L	-	-	-	<0.50	<0.50	<0.50	<0.50	-
Tellurium - Dissolved	mg/L	-	-	-	<0.00020	<0.00020	<0.00020	<0.00020	-
Thallium (Tl)-Dissolved	mg/L	-	-	-	<0.000010	<0.000010	<0.000010	<0.000010	-
Thorium - Dissolved	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	-
Tin (Sn)-Dissolved	mg/L	2.5 (2)	<0.00020	<0.00010	<0.00010	<0.00010	0.00018	0.00018	0.00%
Titanium (Ti)-Dissolved	mg/L	-	-	-	<0.00030	<0.00030	<0.00030	<0.00030	-
Tungston (W) - Dissovled	mg/L	0.003 (2)	-	-	<0.00010	<0.00010	<0.00010	<0.00010	-
Uranium (U)-Dissolved	mg/L	0.020	0.000027	0.000022	0.000026	0.00003	0.00003	0.00003	0.00%
Vanadium (V)-Dissolved	mg/L	0.020 (2)	<0.0010	0.00082	0.00075	0.00077	0.00074	0.00072	1.37%
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	<0.0040	<0.0010	<0.0010	<0.0010	0.005	0.0044	6.38%
Zirconium - Dissolved	mg/L	-	<0.00010	<0.000060	<0.000060	<0.000060	<0.000060	<0.000060	-
Volatile Organic Compounds (Water)									
Benzene	mg/L	0.005 (2)	-	-	-	-	-	-	-
Bromodichloromethane	mg/L	0.1(2)	-	-	-	-	-	-	-
Bromoform	mg/L	0.1(2)	-	-	-	-	-	-	-
Carbon Tetrachloride	mg/L	0.002(2)	-	-	-	-	-	-	-
Chlorobenzene	mg/L	0.08(2)	-	-	-	-	-	-	-
Dibromochloromethane	mg/L	0.1(2)	-	-	-	-	-	-	-
Chloroethane	mg/L	-	-	-	-	-	-	-	-
Chloroform	mg/L	0.1(2)	-	-	-	-	-	-	-
Chloromethane	mg/L	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	mg/L	0.2(2)	-	-	-	-	-	-	-
1,3-Dichlorobenzene	mg/L	-	-	-	-	-	-	-	-
1,4-Dichlorobenzene	mg/L	0.005(2)	-	-	-	-	-	-	-
1,1-Dichloroethane	mg/L	0.03(2)	-	-	-	-	-	-	-
1,2-Dichloroethane	mg/L	0.005(2)	-	-	-	-	-	-	-
1,1-Dichloroethylene	mg/L	0.014(2)	-	-	-	-	-	-	-
cis-1,2-Dichloroethylene	mg/L	0.008(2)	-	-	-	-	-	-	-
trans-1,2-Dichloroethylene	mg/L	0.08(2)	-	-	-	-	-	-	-
Dichloromethane	mg/L	0.05(2)	-	-	-	-	-	-	-
1,2-Dichloropropane	mg/L	0.0045(2)	-	-	-	-	-	-	-
cis-1,3-Dichloropropylene	mg/L	-	-	-	-	-	-	-	-
trans-1,3-Dichloropropylene	mg/L	-	-	-	-	-	-	-	-
1,3-Dichloropropene (cis & trans)	mg/L	0.0015(2)	-	-	-	-	-	-	-
Ethylbenzene	mg/L	0.14(2)	-	-	-	-	-	-	-
Methyl t-butyl ether (MTBE)	mg/L	0.095(2)	-	-	-	-	-	-	-
Styrene	mg/L	0.8(2)	-	-	-	-	-	-	-
1,1,1,2-Tetrachloroethane	mg/L	0.006(2)	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	mg/L	0.008(2)	-	-	-	-	-	-	-
Tetrachloroethylene	mg/L	0.03(2)	-	-	-	-	-	-	-
Toluene	mg/L	0.06(2)	-	-	-	-	-	-	-
1,1,1-Trichloroethane	mg/L	8(2)	-	-	-	-	-	-	-
1,1,2-Trichloroethane	mg/L	0.003(2)	-	-	-	-	-	-	-
Trichloroethylene	mg/L	0.005(2)	-	-	-	-	-	-	-
Trichlorofluoromethane	mg/L	1(2)	-	-	-	-	-	-	-
Vinyl Chloride	mg/L	0.002(2)	-	-	-	-	-	-	-
ortho-Xylene	mg/L	-	-	-	-	-	-	-	-
meta- & para-Xylene	mg/L	-	-	-	-	-	-	-	-
Xylenes	mg/L	0.09(2)	-	-	-	-	-	-	-

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(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

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AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 7: Groundwater Quality Results Sampling Location MW-16 (E02211)

		BC MoE Guidelines	5-Apr-17	2-Oct-17	14-Nov-17	9-Apr-18	18-Jul-18	21-Nov-18
Field	**Units**	**CSR-DW (2)**						
Conductivity	uS/cm	-	124	94.3	90.7	90.3	146	147
pH	pH	-	7.8	8.37	8.23	7.24	7.81	7.81
Dissolved Oxygen	mg/L	-	-	14.2	9.8	12.1	7.9	0.3
Temperature	°C	-	-	5.8	4.6	4.8	5.6	5
Water elevation	m	-	-	-	44.6	45.15	44.31	45.03
Analyte	Units							
Conductivity	uS/cm	-	137	-	-	-	-	-
Hardness (as CaCO3)	mg/L	-	-	75	72.9	71.1	72.8	72.9
pH	pH	-	8	8	8.08	8.13	-	-
Total Suspended Solids	mg/L	-	-	-	-	-	-	-
Total Dissolved Solids	mg/L	-	81	-	-	-	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	94	80	77.8	77.2	77.7	77.5
Ammonia, Total (as N)	mg/L	-	<0.03	-	<0.005	0.0061	<0.0050	<0.0050
Total Nitrogen as N	mg/L	-	-	-	-	-	-	-
Bromide (Br)	mg/L	-	-	-	-	<0.050	<0.050	<0.050
Chloride (Cl)	mg/L	250 (2)	<1.0	<1	<0.50	<0.50	<0.50	<0.50
Fluoride (F)	mg/L	1.5 (2)	<0.1	<0.1	0.036	0.039	0.039	0.038
Nitrate (as N)	mg/L	10 (2)	0.028	<0.01	0.0793	0.0686	0.0747	0.0767
Nitrite (as N)	mg/L	1.0 (2)	<0.01	<0.01	<0.001	<0.0010	<0.0010	<0.0010
Sulfate (SO4)	mg/L	500 (2)	-	1.3	1.01	1.02	0.96	0.92
Total Organic Carbon	mg/L	-	-	-	<0.50	<0.50	<0.50	<0.50
BOD	mg/L	-	-	-	-	-	-	-
COD	mg/L	-	-	-	<20	<20	<20	<20
Dissolved Metals								
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	0.0106	<0.0050	0.0054	0.0036	0.0028	0.0037
Antimony (Sb)-Dissolved	mg/L	0.006(2)	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)-Dissolved	mg/L	0.01(2)	0.00052	0.00055	0.00063	0.00061	0.00057	0.00058
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.138	0.0161	0.01780	0.01910	0.01810	0.01810
Beryllium (Be)-Dissolved	mg/L	0.008(2)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	mg/L	5.0(2)	0.014	<0.0050	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	0.00003	0.000018	<0.0000050	0.00003	0.00001	0.00008
Calcium (Ca)-Dissolved	mg/L	-	-	-	26.90000	26.30000	26.90000	27.10000
Cesium (Cs)- Dissolved	mg/L	-	-	-	<0.000010	<0.000010	<0.000010	<0.000010
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	0.0005	<0.00050	0.00038	0.00026	0.00037	0.00038
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	0.00012	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.0042	<0.00040	<0.00020	<0.00020	<0.00020	<0.00020
Iron (Fe)-Dissolved	mg/L	6.5(2)	<0.010	<0.010	0.01000	<0.010	<0.010	<0.010
Lead (Pb)-Dissolved	mg/L	0.01(2)	<0.0001	<0.00020	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Dissolved	mg/L	0.008 (2)	0.0007	0.00096	0.00110	<0.0010	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	0.992	1.37	1.40	1.29	1.38	1.27
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	0.0371	0.00752	0.00651	0.00314	0.00211	0.00186
Mercury (Hg)-Dissolved	mg/L	0.001(2)	<0.00002	<0.000010	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	0.00027	<0.00010	0.00005	0.00006	<0.00010	0.00005
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-	<0.00050	<0.00050	<0.00050	<0.00050
Phosphorus - Dissolved	mg/L	-	-	-	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	-	-	0.60800	0.62500	0.64400	0.60200
Rubidium (Rd) - Dissolved	mg/L	-	-	-	0.00039	0.00043	0.00042	0.00042
Selenium (Se)-Dissolved	mg/L	0.01 (2)	<0.00050	<0.00050	0.00009	0.00009	0.00007	0.00010
Silicon - Dissolved	mg/L	-	4.5	5.5	5.28000	5.46000	5.15000	5.29000
Silver (Ag)-Dissolved	mg/L	0.02 (2)	<0.00005	<0.000050	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	200(2)	1.75	1.55	1.41	1.51	1.61	1.60
Strontium - Dissolved	mg/L	-	0.0715	0.0912	0.0918	0.0953	0.0916	0.0886
Sulfur- Dissolved	mg/L	-	-	-	<0.50	0.57000	<0.50	<0.50
Tellurium - Dissolved	mg/L	-	-	-	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	-	-	<0.000010	<0.000010	<0.000010	<0.000010
Thorium - Dissolved	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	2.5 (2)	0.00049	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Dissolved	mg/L	-	-	-	<0.00030	<0.00030	<0.00030	<0.00030
Tungston (W)- Dissolved	mg/L	0.003 (2)	-	-	<0.00010	<0.00010	<0.00010	<0.00010
Uranium (U)-Dissolved	mg/L	0.020	0.00005	0.000059	0.00004	0.00004	0.00004	0.00004
Vanadium (V)-Dissolved	mg/L	0.020 (2)	<0.0010	<0.0010	0.00057	0.00061	0.00069	0.00062
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	0.0157	<0.0040	<0.0010	0.00110	<0.0010	<0.0010
Zirconium - Dissolved	mg/L	-	<0.00010	<0.00010	<0.000060	<0.000060	<0.000060	<0.000060
Volatile Organic Compounds (Water)				-				
Benzene	mg/L	0.005 (2)	-	-	<0.00050	-	-	-
Bromodichloromethane	mg/L	0.1(2)	-	-	<0.0010	-	-	-
Bromoform	mg/L	0.1(2)	-	-	<0.0010	-	-	-
Carbon Tetrachloride	mg/L	0.002(2)	-	-	<0.00050	-	-	-
Chlorobenzene	mg/L	0.08(2)	-	-	<0.0010	-	-	-
Dibromochloromethane	mg/L	0.1(2)	-	-	<0.0010	-	-	-
Chloroethane	mg/L	-	-	-	<0.0010	-	-	-
Chloroform	mg/L	0.1(2)	-	-	<0.0010	-	-	-
Chloromethane	mg/L	-	-	-	<0.0050	-	-	-
1,2-Dichlorobenzene	mg/L	0.2(2)	-	-	<0.00050	-	-	-
1,3-Dichlorobenzene	mg/L	-	-	-	<0.0010	-	-	-
1,4-Dichlorobenzene	mg/L	0.005(2)	-	-	<0.0010	-	-	-
1,1-Dichloroethane	mg/L	0.03(2)	-	-	<0.0010	-	-	-
1,2-Dichloroethane	mg/L	0.005(2)	-	-	<0.0010	-	-	-
1,1-Dichloroethylene	mg/L	0.014(2)	-	-	<0.0010	-	-	-
cis-1,2-Dichloroethylene	mg/L	0.008(2)	-	-	<0.0010	-	-	-
trans-1,2-Dichloroethylene	mg/L	0.08(2)	-	-	<0.0010	-	-	-
Dichloromethane	mg/L	0.05(2)	-	-	<0.0050	-	-	-
1,2-Dichloropropane	mg/L	0.0045(2)	-	-	<0.0010	-	-	-
cis-1,3-Dichloropropylene	mg/L	-	-	-	<0.00050	-	-	-
trans-1,3-Dichloropropylene	mg/L	-	-	-	<0.00050	-	-	-
1,3-Dichloropropene (cis & trans)	mg/L	0.0015(2)	-	-	<0.0010	-	-	-
Ethylbenzene	mg/L	0.14(2)	-	-	<0.00050	-	-	-
Methyl t-butyl ether (MTBE)	mg/L	0.095(2)	-	-	<0.00050	-	-	-
Styrene	mg/L	0.8(2)	-	-	<0.00050	-	-	-
1,1,1,2-Tetrachloroethane	mg/L	0.006(2)	-	-	<0.0010	-	-	-
1,1,2,2-Tetrachloroethane	mg/L	0.008(2)	-	-	<0.00020	-	-	-
Tetrachloroethylene	mg/L	0.03(2)	-	-	<0.0010	-	-	-
Toluene	mg/L	0.06(2)	-	-	0.00189	-	-	-
1,1,1-Trichloroethane	mg/L	8(2)	-	-	<0.0010	-	-	-
1,1,2-Trichloroethane	mg/L	0.003(2)	-	-	<0.00050	-	-	-
Trichloroethylene	mg/L	0.005(2)	-	-	<0.0010	-	-	-
Trichlorofluoromethane	mg/L	1(2)	-	-	<0.0010	-	-	-
Vinyl Chloride	mg/L	0.002(2)	-	-	<0.00040	-	-	-
ortho-Xylene	mg/L	-	-	-	<0.00050	-	-	-
meta- & para-Xylene	mg/L	-	-	-	<0.00050	-	-	-
Xylenes	mg/L	0.09(2)	-	-	<0.00075	-	-	-

NOTES

(1) BC MoE Approved and Working Water Quality Guidelines, last updated March 2018
(2) BC Contaminated Sites Regulation (CSR) for drinking water, Schedule 3.2, last updated January 2019
(3) All criteria limits for BCWQG - Drinking Quality Guidelines based on Total Metal Concentration except Aluminum (Dissolved)
(4) BC MoE Water Quality Guidelines for Protection of Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 8: Groundwater Quality Results Sampling Location MW-4 (E251533)

		BC MoE Guidelines	22-Oct-12	2-Apr-13	13-Jun-13	6-Apr-17	7-Jul-17	3-Oct-17	15-Nov-17	11-Apr-18	18-Jul-18	20-Nov-18
Field	**Units**	**CSR-DW (2)**										
Conductivity	uS/cm	-	-	-	-	57	61	33.5	33.3	40.8	66	68
pH	pH	-	-	-	-	7.8	7.9	8.2	8.04	7.96	7.33	6.6
Dissolved Oxygen	mg/L	-	-	-	-	-	1.5	8.9	6.4	5.9	5.5	8.6
Temperature	°C	-	-	-	-	6.3	5.6	6.1	5	5.3	5.5	5.5
Water elevation	m	-	-	-	-	-	-		24.4	24.62	24.19	24.99
Analyte	Units											
Conductivity	uS/cm	-	47.5	-	-	59.5		-				
Hardness (as CaCO3)	mg/L	-	-	22.9	-	-	22.5	22.1	19.1	26.9	31.1	28.2
pH	pH	-	8.5	7.4	-	8.3	8.2	8.1	7.62	7.65		
Alkalinity, Total (as CaCO3)	mg/L	-	24.3	28.7	-	-	34	28	27.7	33.2	39	32.9
Ammonia, Total (as N)	mg/L	-	0.06	-	-	<0.03	0.05	0.03	0.0229	0.0295	0.0266	0.0102
Chloride (Cl)	mg/L	250 (2)	ND	ND	-	<1.0	1.8	1.1	1.61	0.54	<0.50	<0.50
Fluoride (F)	mg/L	1.5 (2)	0.16	0.2	-	-	<0.10	0.11	0.09	0.076	0.048	0.045
Nitrate (as N)	mg/L	10 (2)	ND	ND	-	<0.01	0.071	<0.0100	0.0139	0.129	0.0618	0.0466
Nitrite (as N)	mg/L	1.0 (2)	ND	ND	-	-	<0.01	<0.01	<0.001	<0.0010	<0.0010	<0.0010
Sulfate (SO4)	mg/L	500 (2)	-	0.81	-	<1.0	<1.0	<1.0	<0.30	0.34	0.75	<0.30
Total Organic Carbon	mg/L	-	-	0.75	-	-	1.41	<0.50	3.45	0.54	1.42	4.9
BOD	mg/L	-	-	-	-	-		4.4				
COD	mg/L	-	-	-	-	-	-	<20	<20	<20	21	43
Dissolved Metals												
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	ND	0.0055	<0.0050	<0.0050	<0.0050	0.0178	0.0049	0.0012	0.0251	0.0036
Antimony (Sb)-Dissolved	mg/L	0.006(2)	ND	ND	<0.00050	<0.00010	<0.00010	<0.00020	0.00082	<0.00010	<0.00010	<0.00010
Arsenic (As)-Dissolved	mg/L	0.01(2)	ND	0.000076	-	<0.00050	<0.00050	<0.00050	0.00094	<0.00010	0.00011	<0.00010
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.0060	0.0052	-	0.0375	0.0098	0.0079	0.00681	0.00503	0.00998	0.00994
Beryllium (Be)-Dissolved	mg/L	0.008(2)	ND	ND	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	-	<0.00010	<0.00010	<0.00010	0.000601	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	mg/L	5.0(2)	ND	ND	-	0.006	<0.0050	<0.0050	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	ND	0.00002	-	<0.00001	<0.000010	0.000482	0.000484	<0.0000050	0.0000125	0.0000446
Calcium (Ca)-Dissolved	mg/L	-	-	-	-	-	7.46	6.4	6.16	9.37	10.9	9.86
Cesium (Cs) - Dissolved	mg/L	-	-	-	-	-	-	-	0.000042	<0.000010	<0.000010	<0.000010
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	ND	ND	-	<0.0005	<0.00050	<0.00050	0.00021	<0.00010	<0.00010	<0.00010
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	ND	0.0076	-	<0.00005	<0.00010	<0.00010	0.00025	<0.00010	<0.00010	<0.00010
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.00066	ND	-	0.0077	0.00035	0.0021	0.00372	<0.00020	0.0066	0.00177
Iron (Fe)-Dissolved	mg/L	6.5(2)	ND	0.0338	-	0.011	<0.010	<0.010	0.018	<0.010	0.536	0.022
Lead (Pb)-Dissolved	mg/L	0.01(2)	ND	ND	-	<0.0001	<0.00010	<0.00020	0.000450	<0.000050	0.000302	<0.000050
Lithium (Li)-Dissolved	mg/L	0.008 (2)	ND	ND	-	0.0004	0.00072	0.00054	<0.0010	<0.0010	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	0.729	0.68	-	0.742	0.938	0.921	0.895	0.837	0.964	0.874
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	0.0963	0.348	-	0.0237	<0.00020	0.0558	0.0674	0.0067	0.0152	0.0647
Mercury (Hg)-Dissolved	mg/L	0.001(2)	ND	ND	-	<0.00002	<0.000020	<0.000010	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	ND	0.000116	-	0.00014	<0.00010	0.00014	0.000355	0.000122	0.000136	0.000085
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-	-	0.0005	0.00022	0.00071	0.00122	<0.00050	<0.00050	<0.00050
Phosphorus - Dissolved	mg/L	-	-	-	-	<0.05	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	-	-	-	-	1.17	0.93	1.16	0.757	0.759	0.79
Rubidium (Rd) - Dissolved	mg/L	-	-	-	-	-	-	-	0.00061	0.00025	0.00027	0.00023
Selenium (Se)-Dissolved	mg/L	0.01 (2)	ND	ND	-	<0.00050	<0.00050	<0.00050	0.000866	<0.000050	<0.000050	<0.000050
Silicon - Dissolved	mg/L	-	ND	ND	-	0.9	<1.0	<1.0	0.718	1.33	2.08	1.33
Silver (Ag)-Dissolved	mg/L	0.02 (2)	ND	ND	-	<0.00005	<0.000050	<0.000050	0.000017	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	200(2)	1.81	1.52	-	2.34	2.71	2.46	3.13	2.04	1.9	1.93
Strontium - Dissolved	mg/L	-	0.0484	0.0503	-	0.0502	0.0614	0.0573	0.0536	0.0591	0.0635	0.0604
Sulfur- Dissolved	mg/L	-	-	-	-	<3.0	<3.0	<3.0	<0.50	<0.50	<0.50	<0.50
Tellurium - Dissolved	mg/L	-	-	-	-	<0.00020	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	-	-	-	<0.00002	<0.000020	<0.000020	0.000851	<0.000010	<0.000010	<0.000010
Thorium - Dissolved	mg/L	-	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	2.5 (2)	ND	ND	-	<0.00020	<0.00020	<0.00020	0.00235	<0.00010	<0.00010	0.0009
Titanium (Ti)-Dissolved	mg/L	-	-	-	-	-	<0.0050	<0.0050	<0.00030	<0.00030	0.00056	<0.00030
Tungston (W) - Dissolved	mg/L	0.003 (2)	-	-	-	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010
Uranium (U)-Dissolved	mg/L	0.020	ND	ND	-	<0.00002	<0.000020	-	<0.000010	<0.000010	0.000011	<0.000010
Vanadium (V)-Dissolved	mg/L	0.020 (2)	ND	ND	-	<0.0010	<0.0010	-	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	ND	ND	-	0.008	<0.0040	-	0.0038	<0.0010	0.0058	<0.0010
Zirconium - Dissolved	mg/L	-	ND	ND	-	<0.00010	<0.00010	-	<0.000060	<0.000060	<0.000060	<0.000060
Volatile Organic Compounds (Water)				-								
Benzene	mg/L	0.005 (2)	-	-	<0.00050	-	-	-	<0.00050	-	-	-
Bromodichloromethane	mg/L	0.1(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
Bromoform	mg/L	0.1(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
Carbon Tetrachloride	mg/L	0.002(2)	-	-	<0.00050	-	-	-	<0.00050	-	-	-
Chlorobenzene	mg/L	0.08(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
Dibromochloromethane	mg/L	0.1(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
Chloroethane	mg/L	-	-	-	<0.0010	-	-	-	<0.0010	-	-	-
Chloroform	mg/L	0.1(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
Chloromethane	mg/L	-	-	-	<0.0050	-	-	-	<0.0050	-	-	-
1,2-Dichlorobenzene	mg/L	0.2(2)	-	-	<0.00070	-	-	-	<0.00050	-	-	-
1,3-Dichlorobenzene	mg/L	-	-	-	<0.0010	-	-	-	<0.0010	-	-	-
1,4-Dichlorobenzene	mg/L	0.005(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
1,1-Dichloroethane	mg/L	0.03(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
1,2-Dichloroethane	mg/L	0.005(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
1,1-Dichloroethylene	mg/L	0.014(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
cis-1,2-Dichloroethylene	mg/L	0.008(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
trans-1,2-Dichloroethylene	mg/L	0.08(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
Dichloromethane	mg/L	0.05(2)	-	-	<0.0050	-	-	-	<0.0050	-	-	-
1,2-Dichloropropane	mg/L	0.0045(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
cis-1,3-Dichloropropylene	mg/L	-	-	-	<0.0010	-	-	-	<0.00050	-	-	-
trans-1,3-Dichloropropylene	mg/L	-	-	-	<0.0010	-	-	-	<0.00050	-	-	-
1,3-Dichloropropene (cis & trans)	mg/L	0.0015(2)	-	-	<0.0014	-	-	-	<0.0010	-	-	-
Ethylbenzene	mg/L	0.14(2)	-	-	<0.0050	-	-	-	<0.00050	-	-	-
Methyl t-butyl ether (MTBE)	mg/L	0.095(2)	-	-	<0.00050	-	-	-	<0.00050	-	-	-
Styrene	mg/L	0.8(2)	-	-	<0.00050	-	-	-	<0.00050	-	-	-
1,1,1,2-Tetrachloroethane	mg/L	0.006(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
1,1,2,2-Tetrachloroethane	mg/L	0.008(2)	-	-	<0.0010	-	-	-	<0.00020	-	-	-
Tetrachloroethylene	mg/L	0.03(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
Toluene	mg/L	0.06(2)	-	-	<0.00050	-	-	-	0.00280	-	-	-
1,1,1-Trichloroethane	mg/L	8(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
1,1,2-Trichloroethane	mg/L	0.003(2)	-	-	<0.0010	-	-	-	<0.00050	-	-	-
Trichloroethylene	mg/L	0.005(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
Trichlorofluoromethane	mg/L	1(2)	-	-	<0.0010	-	-	-	<0.0010	-	-	-
Vinyl Chloride	mg/L	0.002(2)	-	-	<0.0010	-	-	-	<0.00040	-	-	-
ortho-Xylene	mg/L	-	-	-	<0.00050	-	-	-	0.00054	-	-	-
meta- & para-Xylene	mg/L	-	-	-	<0.00050	-	-	-	0.00115	-	-	-
Xylenes	mg/L	0.09(2)	-	-	<0.00075	-	-	-	0.00169	-	-	-

NOTES

(1) BC MoE Approved and Working Water Quality Guidelines, last updated March 2018
(2) BC Contaminated Sites Regulation (CSR) for drinking water, Schedule 3.2, last updated January 2019
(3) All criteria limits for BCWQG - Drinking Quality Guidelines based on Total Metal Concentration except Aluminum (Dissolved)
(4) BC MoE Water Quality Guidelines for Protection of Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 9: Groundwater Quality Results Sampling Location MW-7 (E287379)

		BC MoE Guidelines	22-Oct-12	3-Apr-13	6-Apr-17	6-Jul-17
Field	**Units**	**CSR-DW (2)**				
Conductivity	uS/cm	-	-	-	124	77
pH	pH	-	-	-	7.8	8.2
Dissolved Oxygen	mg/L	-	-	-	-	78.3
Temperature	°C	-	-	-	-	5.6
Water elevation	m	-	-	-	-	-
Analyte	Units					
Conductivity	uS/cm	-	59.2	-	-	
Hardness (as CaCO3)	mg/L	-	-	67.3	53.2	40.1
pH	pH	-	8.5	8.6	8.1	8.4
Alkalinity, Total (as CaCO3)	mg/L	-	29.6	38.1	57	58
Ammonia, Total (as N)	mg/L	-	ND	-	<0.03	<0.03
Chloride (Cl)	mg/L	250 (2)	1.3	ND	<1.0	1.3
Fluoride (F)	mg/L	1.5 (2)	ND	ND	<0.10	0.1
Nitrate (as N)	mg/L	10 (2)	ND	ND	0.061	0.055
Nitrite (as N)	mg/L	1.0 (2)	ND	ND	<0.01	<0.01
Sulfate (SO4)	mg/L	500 (2)	-	1.68	1.4	1.4
Total Organic Carbon	mg/L	-	-	4.89	0.68	0.79
BOD	mg/L	-	-	-	-	-
COD	mg/L	-	-	-	-	-
Dissolved Metals						
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	0.0183	0.0198	0.012	0.0143
Antimony (Sb)-Dissolved	mg/L	0.006(2)	ND	0.000158	<0.00010	0.00039
Arsenic (As)-Dissolved	mg/L	0.01(2)	0.00090	0.00060	<0.00050	<0.00050
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.0056	0.00609	0.0139	0.0129
Beryllium (Be)-Dissolved	mg/L	0.008(2)	ND	ND	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010
Boron (B)-Dissolved	mg/L	5.0(2)	ND	ND	0.005	<0.0050
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	0.000017	0.000012	0.00023	0.000011
Calcium (Ca)-Dissolved	mg/L	-	-	-	18.8	15.2
Cesium (Cs)- Dissolved	mg/L	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	ND	ND	<0.0005	<0.00050
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	ND	0.0001	0.00006	<0.00010
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.00118	0.00049	0.0032	0.00055
Iron (Fe)-Dissolved	mg/L	6.5(2)	ND	0.0069	<0.010	<0.010
Lead (Pb)-Dissolved	mg/L	0.01(2)	ND	ND	<0.0001	<0.00010
Lithium (Li)-Dissolved	mg/L	0.008 (2)	ND	ND	0.0007	0.00085
Magnesium (Mg)-Dissolved	mg/L	-	0.452	0.47	0.92	0.502
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	ND	0.00082	0.00323	0.00025
Mercury (Hg)-Dissolved	mg/L	0.001(2)	ND	ND	<0.00002	<0.000020
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	ND	0.00015	0.0009	0.00015
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-	0.0024	<0.00020
Phosphorus - Dissolved	mg/L	-	-	-	<0.05	<0.050
Potassium (K)-Dissolved	mg/L	-	-	-	0.66	0.57
Rubidium (Rb) - Dissolved	mg/L	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	0.01 (2)	ND	0.000051	<0.00050	<0.00050
Silicon - Dissolved	mg/L	-	4.24	3.79	4.7	4.3
Silver (Ag)-Dissolved	mg/L	0.02 (2)	ND	ND	<0.00005	<0.000050
Sodium (Na)-Dissolved	mg/L	200(2)	1.55	1.26	1.5	1.48
Strontium - Dissolved	mg/L	-	0.0325	0.0361	0.0668	0.0542
Sulfur- Dissolved	mg/L	-	-	-	<3.0	<3.0
Tellurium - Dissolved	mg/L	-	-	-	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	-	-	<0.00002	<0.000020
Thorium - Dissolved	mg/L	-	-	-	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	2.5 (2)	ND	ND	<0.00020	<0.00020
Titanium (Ti)-Dissolved	mg/L	-	-	-	<0.0050	<0.0050
Tungston (W) - Dissolved	mg/L	0.003 (2)	-	-	-	-
Uranium (U)-Dissolved	mg/L	0.020	ND	0.00002	0.00004	0.000023
Vanadium (V)-Dissolved	mg/L	0.020 (2)	ND	0.00093	<0.0010	<0.0010
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	ND	0.0019	0.0126	<0.0040
Zirconium - Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010

NOTES

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(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 10: Groundwater Quality Results Sampling Location MW-8 (E287380)

		BC MoE Guidelines	22-Oct-12	3-Apr-13	13-Jun-13	6-Jul-17	3-Oct-17	15-Nov-17	10-Apr-18	18-Jul-18	21-Nov-18
Field	**Units**	**CSR-DW (2)**									
Conductivity	uS/cm	-	-	-	-	34	22.4	22.6	22.4	34	34
pH	pH	-	-	-	-	8.2	6.45	6.43	5.98	6.49	7.49
Dissolved Oxygen	mg/L	-	-	-	-	6.6	-	9.6	11.6	8.1	0.3
Temperature	°C	-	-	-	-	6.5	5.9	5.5	5.8	6.3	6.1
Water elevation	m	-	-	-	-	-	-		10.31	9.95	10.94
Analyte	Units										
Conductivity	uS/cm	-	27.5	-	-	-	24.8	-	-	-	-
Hardness (as CaCO3)	mg/L	-	-	14.1	-	10.6	-	12	11.4	12.5	12.2
pH	pH	-	6.5	6.3	-	6.1	6.2	6.94	7.37	-	-
Total Suspended Solids	mg/L	-	-	-		-	190	-	-	-	-
Total Dissolved Solids	mg/L	-	13	-	-	-	12	-	-	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	16	16.5	-	16	-	16.3	16.9	17.8	15.1
Ammonia, Total (as N)	mg/L	-	ND	-	-	<0.03	<0.03	<0.005	0.0056	0.0089	<0.0050
Total Nitrogen as N	mg/L	-	0.311	-	-	-	0.168	-	-	-	<0.050
Bromide (Br)	mg/L	-	-	-	-	-	-	-	<0.050	<0.050	<0.50
Chloride (Cl)	mg/L	250 (2)	ND	ND	-	2.7	2.2	1.13	1.13	1.4	1.4
Fluoride (F)	mg/L	1.5 (2)	ND	ND	-	<0.10	-	0.024	0.023	0.022	0.021
Nitrate (as N)	mg/L	10 (2)	ND	ND	-	0.17	<0.100	0.016	0.0153	0.0233	0.0225
Nitrite (as N)	mg/L	1.0 (2)	ND	ND	-	<0.01	-	<0.001	<0.0010	<0.0010	<0.0010
Sulfate (SO4)	mg/L	500 (2)	-	1.31	-	<1.0	<1.0	<0.3	<0.30	<0.30	<0.30
Total Organic Carbon	mg/L	-	-	2.67	-	<0.50	-	<0.50	0.6	3.31	1.28
BOD	mg/L	-	-	-	-	-	-	-	-	-	-
COD	mg/L	-	-	-	-	-	-	<20	<20	25	<20
Dissolved Metals											
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	ND	0.0033	<0.0050	<0.0050	0.0067	0.0024	0.0036	0.0144	0.004
Antimony (Sb)-Dissolved	mg/L	0.006(2)	ND	ND	<0.00050	0.00018	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)-Dissolved	mg/L	0.01(2)	0.00019	0.000172	-	<0.00050	<0.00050	0.00010	<0.00010	0.00015	0.00011
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.0044	0.00416	-	0.0051	<0.0050	0.0103	0.00516	0.00549	0.00508
Beryllium (Be)-Dissolved	mg/L	0.008(2)	ND	ND	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	-	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	mg/L	5.0(2)	ND	ND	-	<0.0050	0.0063	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	0.000011	0.000012	-	0.000213	0.000029	0.0000439	0.000186	0.000123	0.0000829
Calcium (Ca)-Dissolved	mg/L	-	-	-	-	3.15	-	4.09	3.98	4.33	4.28
Cessium (Cs) -Dissolved	mg/L	-	-	-	-	-	-	-	<0.000010	<0.000010	<0.000010
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	ND	ND	-	<0.00050	<0.00050	0.00021	0.00025	0.00021	0.00018
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	ND	0.000011	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.00058	ND	-	0.00194	<0.00040	<0.00020	0.00097	0.00037	<0.00020
Iron (Fe)-Dissolved	mg/L	6.5(2)	ND	ND	-	<0.010	<0.010	<0.010	<0.010	0.016	<0.010
Lead (Pb)-Dissolved	mg/L	0.01(2)	ND	ND	-	<0.00010	<0.00020	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Dissolved	mg/L	0.008 (2)	ND	ND	-	0.00025	0.00018	<0.0010	<0.0010	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	0.416	0.37	-	0.27	0.363	0.445	0.366	0.407	0.377
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	ND	0.0098	-	<0.00020	0.0011	0.00117	0.00204	0.0101	0.00233
Mercury (Hg)-Dissolved	mg/L	0.001(2)	ND	ND	-	<0.000020	<0.000010	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	ND	0.000054	-	<0.00010	0.00022	<0.000050	<0.000050	<0.000050	<0.000050
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-	-	0.00049	<0.00040	<0.00050	0.0005	<0.00050	0.00052
Phosphorus - Dissolved	mg/L	-	-	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	-	-	-	0.48	-	0.254	0.316	0.335	0.274
Rubidium (Rb) - Dissolved	mg/L	-	-	-	-	-	-	-	0.00045	0.00043	0.00035
Selenium (Se)-Dissolved	mg/L	0.01 (2)	ND	0.000059	-	<0.00050	<0.00050	<0.000050	<0.000050	<0.000050	<0.000050
Silicon - Dissolved	mg/L	-	5.93	5.44	-	5.9	6.4	6.27	6.09	5.91	6.32
Silver (Ag)-Dissolved	mg/L	0.02 (2)	ND	ND	-	<0.000050	<0.000050	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	200(2)	1.68	1.58	-	3.07	2.19	2.33	2.39	2.44	2.4
Strontium - Dissolved	mg/L	-	0.0368	0.0423	-	0.0425	0.0472	0.0516	0.0525	0.047	0.0513
Sulfur- Dissolved	mg/L	-	-	-	-	<3.0	<3.0	<0.50	<0.50	<0.50	<0.50
Tellurium - Dissolved	mg/L	-	-	-	-	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	-	-	-	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010	<0.000010
Thorium- Dissolved	mg/L	-	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	2.5 (2)	ND	ND	-	<0.00020	<0.00020	<0.00010	0.00065	<0.00010	<0.00010
Titanium (Ti)-Dissolved	mg/L	-	-	-	-	<0.0050	-	<0.00030	<0.00030	0.00066	<0.00030
Tungston (W) - Dissolved	mg/L	0.003 (2)	-	-	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010
Uranium (U)-Dissolved	mg/L	0.020	ND	ND	-	<0.000020	<0.000020	-	<0.000010	<0.000010	<0.000010
Vanadium (V)-Dissolved	mg/L	0.020 (2)	ND	ND	-	<0.0010	<0.0010	-	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	ND	0.0014	-	0.0064	<0.0040	-	0.0041	<0.0010	<0.0010
Zirconium - Dissolved	mg/L	-	ND	ND	-	<0.00010	<0.00010	-	<0.000060	<0.000060	<0.000060
Volatile Organic Compounds (Water)				-							
Benzene	mg/L	0.005 (2)	-	-	<0.00050	-	-	-	-	-	-
Bromodichloromethane	mg/L	0.1(2)	-	-	<0.0010	-	-	-	-	-	-
Bromoform	mg/L	0.1(2)	-	-	<0.0010	-	-	-	-	-	-
Carbon Tetrachloride	mg/L	0.002(2)	-	-	<0.00050	-	-	-	-	-	-
Chlorobenzene	mg/L	0.08(2)	-	-	<0.0010	-	-	-	-	-	-
Dibromochloromethane	mg/L	0.1(2)	-	-	<0.0010	-	-	-	-	-	-
Chloroethane	mg/L	-	-	-	<0.0010	-	-	-	-	-	-
Chloroform	mg/L	0.1(2)	-	-	<0.0010	-	-	-	-	-	-
Chloromethane	mg/L	-	-	-	<0.0050	-	-	-	-	-	-
1,2-Dichlorobenzene	mg/L	0.2(2)	-	-	<0.00070	-	-	-	-	-	-
1,3-Dichlorobenzene	mg/L	-	-	-	<0.0010	-	-	-	-	-	-
1,4-Dichlorobenzene	mg/L	0.005(2)	-	-	<0.0010	-	-	-	-	-	-
1,1-Dichloroethane	mg/L	0.03(2)	-	-	<0.0010	-	-	-	-	-	-
1,2-Dichloroethane	mg/L	0.005(2)	-	-	<0.0010	-	-	-	-	-	-
1,1-Dichloroethylene	mg/L	0.014(2)	-	-	<0.0010	-	-	-	-	-	-
cis-1,2-Dichloroethylene	mg/L	0.008(2)	-	-	<0.0010	-	-	-	-	-	-
trans-1,2-Dichloroethylene	mg/L	0.08(2)	-	-	<0.0010	-	-	-	-	-	-
Dichloromethane	mg/L	0.05(2)	-	-	<0.0050	-	-	-	-	-	-
1,2-Dichloropropane	mg/L	0.0045(2)	-	-	<0.0010	-	-	-	-	-	-
cis-1,3-Dichloropropylene	mg/L	-	-	-	<0.0010	-	-	-	-	-	-
trans-1,3-Dichloropropylene	mg/L	-	-	-	<0.0010	-	-	-	-	-	-
1,3-Dichloropropene (cis & trans)	mg/L	0.0015(2)	-	-	<0.0014	-	-	-	-	-	-
Ethylbenzene	mg/L	0.14(2)	-	-	<0.0050	-	-	-	-	-	-
Methyl t-butyl ether (MTBE)	mg/L	0.095(2)	-	-	<0.00050	-	-	-	-	-	-
Styrene	mg/L	0.8(2)	-	-	<0.00050	-	-	-	-	-	-
1,1,1,2-Tetrachloroethane	mg/L	0.006(2)	-	-	<0.0010	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	mg/L	0.008(2)	-	-	<0.0010	-	-	-	-	-	-
Tetrachloroethylene	mg/L	0.03(2)	-	-	<0.0010	-	-	-	-	-	-
Toluene	mg/L	0.06(2)	-	-	<0.00050	-	-	-	-	-	-
1,1,1-Trichloroethane	mg/L	8(2)	-	-	<0.0010	-	-	-	-	-	-
1,1,2-Trichloroethane	mg/L	0.003(2)	-	-	<0.0010	-	-	-	-	-	-
Trichloroethylene	mg/L	0.005(2)	-	-	<0.0010	-	-	-	-	-	-
Trichlorofluoromethane	mg/L	1(2)	-	-	<0.0010	-	-	-	-	-	-
Vinyl Chloride	mg/L	0.002(2)	-	-	<0.0010	-	-	-	-	-	-
ortho-Xylene	mg/L	-	-	-	<0.00050	-	-	-	-	-	-
meta- & para-Xylene	mg/L	-	-	-	<0.00050	-	-	-	-	-	-
Xylenes	mg/L	0.09(2)	-	-	<0.00075	-	-	-	-	-	-

NOTES

(1) BC MoE Approved and Working Water Quality Guidelines, last updated March 2018
(2) BC Contaminated Sites Regulation (CSR) for drinking water, Schedule 3.2, last updated January 2019
(3) All criteria limits for BCWQG - Drinking Quality Guidelines based on Total Metal Concentration except Aluminum (Dissolved)
(4) BC MoE Water Quality Guidelines for Protection of Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 11: Groundwater Quality Results Sampling Location MW-9 (E287381)

		BC MoE Guidelines	22-Oct-12	2-Apr-13	6-Jul-17	15-Nov-17	19-Jul-18	20-Nov-18
Field	**Units**	**CSR-DW (2)**						
Conductivity	uS/cm	-	-	-	43	24.7	28.8	42
pH	pH	-	-	-	7.7	7.4	5.99	6.83
Dissolved Oxygen	mg/L	-	-	-	8.0	9.0	6.9	3.1
Temperature	°C	-	-	-	6.0	4.8	5.5	5.4
Water elevation	m	-	-	-		50.41	50.58	51.15
Analyte	Units							
Conductivity	uS/cm	-	63.7	-	42	-	-	-
Hardness (as CaCO3)	mg/L	-	-	20.4	14.6	13	16	16.9
pH	pH	-	6.7	6.9	6.6	7.08	-	-
Total Suspended Solids	mg/L	-	-	-	-	-	-	-
Total Dissolved Solids	mg/L	-	30	-	22	-	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	30.6	24.5	20	16.4	25.4	20.9
Ammonia, Total (as N)	mg/L	-	ND	-	<0.03	-	0.0162	<0.0050
Total Nitrogen as N	mg/L	-	0.213	-	0.149	-	-	-
Bromide (Br)	mg/L	-	-	-	-	-	-	<0.050
Chloride (Cl)	mg/L	250 (2)	ND	2.4	<1.0	0.5	<0.50	<0.50
Fluoride (F)	mg/L	1.5 (2)	ND	ND	<0.10	0.031	0.032	0.026
Nitrate (as N)	mg/L	10 (2)	0.022	0.039	0.046	0.0343	0.0205	0.0215
Nitrite (as N)	mg/L	1.0 (2)	ND	ND	<0.01	<0.001	<0.0010	<0.0010
Sulfate (SO4)	mg/L	500 (2)	-	1.83	1.3	0.98	1.07	0.93
Total Organic Carbon	mg/L	-	-	2.67	<0.50	3.06	8.36	2.14
BOD	mg/L	-	-	-	-	-	-	-
COD	mg/L	-	-	-	-	<20	45	<20
Dissolved Metals								
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	ND	0.0033	<0.0050	0.0037	0.0427	0.0069
Antimony (Sb)-Dissolved	mg/L	0.006(2)	ND	0.000137	0.00014	<0.00010	0.00011	0.00013
Arsenic (As)-Dissolved	mg/L	0.01(2)	0.00023	0.000286	<0.00050	0.00022	0.0009	0.00038
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.0074	0.00512	<0.0050	0.0149	0.00818	0.00573
Beryllium (Be)-Dissolved	mg/L	0.008(2)	ND	ND	<0.00010	<0.00010	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	<0.00010	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	mg/L	5.0(2)	ND	ND	<0.0050	<0.010	<0.010	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	0.000065	0.00015	0.000022	0.0003550	0.000178	0.000771
Calcium (Ca)-Dissolved	mg/L	-	-	-	5.04	4.34	5.35	5.7
Cessium (Cs) -Dissolved	mg/L	-	-	-	-	<0.000010	0.000012	<0.000010
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	ND	0.000029	<0.00050	0.00021	0.0002	0.00019
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	ND	0.00047	<0.00010	<0.00010	0.00075	0.00015
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.00086	ND	0.00025	0.00064	0.00081	0.00202
Iron (Fe)-Dissolved	mg/L	6.5(2)	ND	ND	<0.010	<0.010	0.312	0.021
Lead (Pb)-Dissolved	mg/L	0.01(2)	ND	ND	<0.00010	<0.000050	0.00012	<0.000050
Lithium (Li)-Dissolved	mg/L	0.008 (2)	ND	ND	0.00051	<0.0010	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	0.924	0.55	0.496	0.532	0.651	0.652
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	0.0048	0.0038	<0.00020	0.01530	0.234	0.0258
Mercury (Hg)-Dissolved	mg/L	0.001(2)	ND	ND	<0.000020	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	ND	0.000096	<0.00010	0.000084	0.000156	0.000057
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-	0.00046	<0.00050	0.00056	<0.00050
Phosphorus (P)- Dissovled	mg/L	-	-	-	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	-	-	0.33	0.285	0.323	0.371
Rubidium (Rb) -Dissolved	mg/L	-	-	-	-	<0.00020	0.00032	0.00025
Selenium (Se)-Dissolved	mg/L	0.01 (2)	ND	0.000053	<0.00050	<0.000050	<0.000050	<0.000050
Silicon - Dissolved	mg/L	-	4.10	4.74	6.00	5.89	5.94	5.98
Silver (Ag)-Dissolved	mg/L	0.02 (2)	ND	ND	<0.000050	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	200(2)	2.21	1.95	1.76	1.670	1.77	1.84
Strontium - Dissolved	mg/L	-	0.0480	0.0328	0.0244	0.0235	0.0303	0.0335
Sulfur- Dissolved	mg/L	-	-	-	<3.0	<0.50	<0.50	<0.50
Tellium (Te) - Dissolved	mg/L	-	-	-	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	-	-	<0.000020	<0.000010	<0.000010	<0.000010
Thorium (Th)- Dissolved	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	2.5 (2)	ND	ND	<0.00020	<0.00010	<0.00010	0.00091
Titanium (Ti)-Dissolved	mg/L	-	-	-	<0.0050	<0.00030	0.00305	<0.00030
Tungston (W) - Dissolved	mg/L	0.003 (2)	-	-	-	<0.00010	<0.00010	<0.00010
Uranium (U)-Dissolved	mg/L	0.020	ND	ND	<0.000020	<0.000010	<0.000010	<0.000010
Vanadium (V)-Dissolved	mg/L	0.020 (2)	ND	0.00072	<0.0010	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	ND	0.0022	<0.0040	0.0013	0.0018	0.0032
Zirconium - Dissolved	mg/L	-	ND	ND	<0.00010	<0.000060	<0.000060	<0.000060
Volatile Organic Compounds (Water)				-				
Benzene	mg/L	0.005 (2)	-	-	-	<0.00050	-	-
Bromodichloromethane	mg/L	0.1(2)	-	-	-	<0.0010	-	-
Bromoform	mg/L	0.1(2)	-	-	-	<0.0010	-	-
Carbon Tetrachloride	mg/L	0.002(2)	-	-	-	<0.00050	-	-
Chlorobenzene	mg/L	0.08(2)	-	-	-	<0.0010	-	-
Dibromochloromethane	mg/L	0.1(2)	-	-	-	<0.0010	-	-
Chloroethane	mg/L	-	-	-	-	<0.0010	-	-
Chloroform	mg/L	0.1(2)	-	-	-	<0.0010	-	-
Chloromethane	mg/L	-	-	-	-	<0.0050	-	-
1,2-Dichlorobenzene	mg/L	0.2(2)	-	-	-	<0.00050	-	-
1,3-Dichlorobenzene	mg/L	-	-	-	-	<0.0010	-	-
1,4-Dichlorobenzene	mg/L	0.005(2)	-	-	-	<0.0010	-	-
1,1-Dichloroethane	mg/L	0.03(2)	-	-	-	<0.0010	-	-
1,2-Dichloroethane	mg/L	0.005(2)	-	-	-	<0.0010	-	-
1,1-Dichloroethylene	mg/L	0.014(2)	-	-	-	<0.0010	-	-
cis-1,2-Dichloroethylene	mg/L	0.008(2)	-	-	-	<0.0010	-	-
trans-1,2-Dichloroethylene	mg/L	0.08(2)	-	-	-	<0.0010	-	-
Dichloromethane	mg/L	0.05(2)	-	-	-	<0.0050	-	-
1,2-Dichloropropane	mg/L	0.0045(2)	-	-	-	<0.0010	-	-
cis-1,3-Dichloropropylene	mg/L	-	-	-	-	<0.00050	-	-
trans-1,3-Dichloropropylene	mg/L	-	-	-	-	<0.00050	-	-
1,3-Dichloropropene (cis & trans)	mg/L	0.0015(2)	-	-	-	<0.0010	-	-
Ethylbenzene	mg/L	0.14(2)	-	-	-	<0.00050	-	-
Methyl t-butyl ether (MTBE)	mg/L	0.095(2)	-	-	-	<0.00050	-	-
Styrene	mg/L	0.8(2)	-	-	-	<0.00050	-	-
1,1,1,2-Tetrachloroethane	mg/L	0.006(2)	-	-	-	<0.0010	-	-
1,1,2,2-Tetrachloroethane	mg/L	0.008(2)	-	-	-	<0.00020	-	-
Tetrachloroethylene	mg/L	0.03(2)	-	-	-	<0.0010	-	-
Toluene	mg/L	0.06(2)	-	-	-	0.00646	-	-
1,1,1-Trichloroethane	mg/L	8(2)	-	-	-	<0.0010	-	-
1,1,2-Trichloroethane	mg/L	0.003(2)	-	-	-	<0.00050	-	-
Trichloroethylene	mg/L	0.005(2)	-	-	-	<0.0010	-	-
Trichlorofluoromethane	mg/L	1(2)	-	-	-	<0.0010	-	-
Vinyl Chloride	mg/L	0.002(2)	-	-	-	<0.00040	-	-
ortho-Xylene	mg/L	-	-	-	-	<0.00050	-	-
meta- & para-Xylene	mg/L	-	-	-	-	<0.00050	-	-
Xylenes	mg/L	0.09(2)	-	-	-	<0.00075	-	-

NOTES

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(3) All criteria limits for BCWQG - Drinking Quality Guidelines based on Total Metal Concentration except Aluminum (Dissolved)
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(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
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(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 12: Groundwater Quality Results Sampling Location MW-5 (E251534)

		BC MoE Guidelines	22-Oct-12	3-Apr-13	13-Jun-13	5-Apr-17
Field	**Units**	**CSR-DW (2)**				
Conductivity	uS/cm	-	-	-	-	116
pH	pH	-	-	-	-	7.4
Dissolved Oxygen	mg/L	-	-	-	-	-
Temperature	°C	-	-	-	-	-
Water elevation	m	-	-	-	-	-
Analyte	Units					
Conductivity	uS/cm	-	102	-	-	116
Hardness (as CaCO3)	mg/L	-	-	52.3	-	-
pH	pH	-	7.5	7.3	-	7.4
Total Suspended Solids	mg/L	-	-	-		7.7
Total Dissolved Solids	mg/L	-	48	-	-	70
Alkalinity, Total (as CaCO3)	mg/L	-	53.1	57.8	-	-
Ammonia, Total (as N)	mg/L	-	ND	-	-	<0.03
Chloride (Cl)	mg/L	-	ND	ND	<0.50	<1.0
Fluoride (F)	mg/L	250 (2)	ND	ND	-	<0.1
Nitrate (as N)	mg/L	1.5 (2)	ND	0.021	-	-
Nitrite (as N)	mg/L	10 (2)	ND	ND	-	<0.01
Sulfate (SO4)	mg/L	1.0 (2)	ND	2.03	-	-
Total Organic Carbon	mg/L	500 (2)	-	ND	-	<0.50
BOD	mg/L	-	-		-	-
COD	mg/L	-	-	-	-	-
Dissolved Metals						
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	ND	0.0036	<0.0050	<0.0050
Antimony (Sb)-Dissolved	mg/L	0.006(2)	ND	0.000106	<0.00050	<0.00010
Arsenic (As)-Dissolved	mg/L	0.01(2)	ND	0.000074	<0.00050	<0.00050
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.0060	0.0044	-	<0.0050
Beryllium (Be)-Dissolved	mg/L	0.008(2)	ND	ND	-	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	-	<0.00010
Boron (B)-Dissolved	mg/L	5.0(2)	ND	ND	-	0.004
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	ND	0.000016	-	<0.00001
Calcium (Ca)-Dissolved	mg/L	-	6.40	18.20	-	18.8
Cesium (Cs)- Dissolved	mg/L	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	-	-	-	-
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	ND	ND	-	<0.00005
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.00066	0.00678	-	0.0034
Iron (Fe)-Dissolved	mg/L	6.5(2)	ND	ND	-	0.01
Lead (Pb)-Dissolved	mg/L	0.01(2)	ND	ND	-	<0.0001
Lithium (Li)-Dissolved	mg/L	0.008 (2)	ND	0.0008	-	0.0009
Magnesium (Mg)-Dissolved	mg/L	-	0.729	1.29	-	1.35
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	0.0963	0.0115	-	0.0757
Mercury (Hg)-Dissolved	mg/L	0.001(2)	ND	ND	-	<0.00002
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	ND	ND	-	<0.00010
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	ND	0.0129	-	0.005
Phosphorus - Dissolved	mg/L	-	-	-	-	<0.05
Potassium (K)-Dissolved	mg/L	-	-	-	-	0.46
Rubidium (Rb) - Dissolved	mg/L	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	0.01 (2)	-	-	-	-
Silicon - Dissolved	mg/L	-	ND	3.9	-	4.1
Silver (Ag)-Dissolved	mg/L	0.02 (2)	ND	ND	-	<0.00005
Sodium (Na)-Dissolved	mg/L	200(2)	1.81	1.51	-	1.62
Strontium - Dissolved	mg/L	-	0.0484	0.0705	-	0.0694
Sulfur- Dissolved	mg/L	-	ND	ND	-	<3.0
Tellurium - Dissolved	mg/L	-	-	-	-	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	-	-	-	<0.00002
Thorium - Dissovled	mg/L	-	-	-	-	<0.00010
Tin (Sn)-Dissolved	mg/L	2.5 (2)	-	-	-	<0.00020
Titanium (Ti)-Dissolved	mg/L	-	ND	ND	-	<0.0050
Tungston (W) - Dissolved	mg/L	0.003 (2)	-	-	-	-
Uranium (U)-Dissolved	mg/L	0.020	-	-	-	-
Vanadium (V)-Dissolved	mg/L	0.020 (2)	ND	ND	-	<0.0010
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	ND	0.0703	-	0.0426
Zirconium - Dissolved	mg/L	-	ND	ND	-	<0.00010
Volatile Organic Compounds (Water)						
Benzene	mg/L	0.005 (2)	-	-	<0.00050	
Bromodichloromethane	mg/L	0.1(2)	-	-	<0.0010	-
Bromoform	mg/L	0.1(2)	-	-	<0.0010	-
Carbon Tetrachloride	mg/L	0.002(2)	-	-	<0.00050	-
Chlorobenzene	mg/L	0.08(2)	-	-	<0.0010	-
Dibromochloromethane	mg/L	0.1(2)	-	-	<0.0010	-
Chloroethane	mg/L	-	-	-	<0.0010	-
Chloroform	mg/L	0.1(2)	-	-	<0.0010	-
Chloromethane	mg/L	-	-	-	<0.0050	-
1,2-Dichlorobenzene	mg/L	0.2(2)	-	-	<0.00070	-
1,3-Dichlorobenzene	mg/L	-	-	-	<0.0010	-
1,4-Dichlorobenzene	mg/L	0.005(2)	-	-	<0.0010	-
1,1-Dichloroethane	mg/L	0.03(2)	-	-	<0.0010	-
1,2-Dichloroethane	mg/L	0.005(2)	-	-	<0.0010	-
1,1-Dichloroethylene	mg/L	0.014(2)	-	-	<0.0010	-
cis-1,2-Dichloroethylene	mg/L	0.008(2)	-	-	<0.0010	-
trans-1,2-Dichloroethylene	mg/L	0.08(2)	-	-	<0.0010	-
Dichloromethane	mg/L	0.05(2)	-	-	<0.0050	-
1,2-Dichloropropane	mg/L	0.0045(2)	-	-	<0.0010	-
cis-1,3-Dichloropropylene	mg/L	-	-	-	<0.0010	-
trans-1,3-Dichloropropylene	mg/L	-	-	-	<0.0010	-
1,3-Dichloropropene (cis & trans)	mg/L	0.0015(2)	-	-	<0.0014	-
Ethylbenzene	mg/L	0.14(2)	-	-	<0.0050	-
Methyl t-butyl ether (MTBE)	mg/L	0.095(2)	-	-	<0.00050	-
Styrene	mg/L	0.8(2)	-	-	<0.00050	-
1,1,1,2-Tetrachloroethane	mg/L	0.006(2)	-	-	<0.0010	-
1,1,2,2-Tetrachloroethane	mg/L	0.008(2)	-	-	<0.0010	-
Tetrachloroethylene	mg/L	0.03(2)	-	-	<0.0010	-
Toluene	mg/L	0.06(2)	-	-	<0.00050	-
1,1,1-Trichloroethane	mg/L	8(2)	-	-	<0.0010	-
1,1,2-Trichloroethane	mg/L	0.003(2)	-	-	<0.0010	-
Trichloroethylene	mg/L	0.005(2)	-	-	<0.0010	-
Trichlorofluoromethane	mg/L	1(2)	-	-	<0.0010	-
Vinyl Chloride	mg/L	0.002(2)	-	-	<0.0010	-
ortho-Xylene	mg/L	-	-	-	<0.00050	-
meta- & para-Xylene	mg/L	-	-	-	<0.00050	-
Xylenes	mg/L	0.09(2)	-	-	<0.00075	-

NOTES

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(4) BC MoE Water Quality Guidelines for Protection of Wildlife
(5) BC Contaminated Sites Regulation (CSR) for drinking water, Schedule 3.2
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 13: Groundwater Quality Results Sampling Location MW-10 (E287382)

		BC MoE Guidelines	22-Oct-12	2-Apr-13
Field	**Units**	**CSR-DW (2)**		
Conductivity	uS/cm	-	-	-
pH	pH	-	-	-
Dissolved Oxygen	mg/L	-	-	-
Temperature	°C	-	-	-
Water elevation	m	-	-	-
Analyte	Units			
Conductivity	uS/cm	-	37.1	-
Hardness (as CaCO3)	mg/L	-	-	90.4
pH	pH	-	6.9	7
Total Suspended Solids	mg/L	-	-	-
Total Dissolved Solids	mg/L	-	17	-
Alkalinity, Total (as CaCO3)	mg/L	-	17.6	21.7
Ammonia, Total (as N)	mg/L	-	ND	-
Total Nitrogen as N	mg/L	-	0.622	-
Bromide (Br)	mg/L	-	-	-
Chloride (Cl)	mg/L	250 (2)	ND	ND
Fluoride (F)	mg/L	1.5 (2)	ND	ND
Nitrate (as N)	mg/L	10 (2)	0.023	0.038
Nitrite (as N)	mg/L	1.0 (2)	ND	ND
Sulfate (SO4)	mg/L	500 (2)	-	1.59
Total Organic Carbon	mg/L	-	-	1.53
BOD	mg/L	-	-	-
COD	mg/L	-	-	-
Dissolved Metals				
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	0.0058	0.0138
Antimony (Sb)-Dissolved	mg/L	0.006(2)	ND	ND
Arsenic (As)-Dissolved	mg/L	0.01(2)	0.00021	0.000167
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.0069	0.00541
Beryllium (Be)-Dissolved	mg/L	0.008(2)	ND	ND
Bisumuth - Dissolved	mg/L	-	ND	ND
Boron (B)-Dissolved	mg/L	5.0(2)	ND	ND
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	0.00114	0.000021
Calcium (Ca)-Dissolved	mg/L	-	-	-
Cesium (Cs)- Dissolved	mg/L	-	-	-
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	ND	0.00061
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	ND	0.000018
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.00267	0.00028
Iron (Fe)-Dissolved	mg/L	6.5(2)	0.0107	0.0263
Lead (Pb)-Dissolved	mg/L	0.01(2)	ND	ND
Lithium (Li)-Dissolved	mg/L	0.008 (2)	ND	ND
Magnesium (Mg)-Dissolved	mg/L	-	0.956	0.77
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	0.0036	0.00104
Mercury (Hg)-Dissolved	mg/L	0.001(2)	ND	ND
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	ND	0.000135
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-
Phosphorus - Dissolved	mg/L	-	-	-
Potassium (K)-Dissolved	mg/L	-	-	-
Rubidium (Rb) - Dissolved	mg/L	-	-	-
Selenium (Se)-Dissolved	mg/L	0.01 (2)	0.00016	0.00004
Silicon - Dissolved	mg/L	-	5.70	5.20
Silver (Ag)-Dissolved	mg/L	0.02 (2)	ND	ND
Sodium (Na)-Dissolved	mg/L	200(2)	3.65	1.68
Strontium - Dissolved	mg/L	-	0.0390	0.0295
Sulfur- Dissolved	mg/L	-	-	-
Tellurium - Dissolved	mg/L	-	-	-
Thallium (Tl)-Dissolved	mg/L	-	-	-
Thorium - Dissolved	mg/L	-	-	-
Tin (Sn)-Dissolved	mg/L	2.5 (2)	ND	0.00029
Titanium (Ti)-Dissolved	mg/L	-	-	-
Tungston (W) - Dissolved	mg/L	0.003 (2)	-	-
Uranium (U)-Dissolved	mg/L	0.020	0.00046	0.000009
Vanadium (V)-Dissolved	mg/L	0.020 (2)	ND	0.00075
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	0.0065	ND
Zirconium - Dissolved	mg/L	-	ND	ND

NOTES

(1) BC MoE Approved and Working Water Quality Guidelines, last updated March 2018
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(5) BC Contaminated Sites Regulation (CSR) for drinking water, Schedule 3.2
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
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(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 14: Groundwater Quality Results Sampling Location MW-12 (E287384)

		BC MoE Guidelines	22-Oct-12	3-Apr-13	19-Jul-18
Field	**Units**	**CSR-DW (2)**			
Conductivity	uS/cm	-	-	-	-
pH	pH	-	-	-	-
Dissolved Oxygen	mg/L	-	-	-	-
Temperature	°C	-	-	-	-
Water elevation	m	-	-	-	-
Analyte	Units				
Hardness (as CaCO3)	mg/L	-	-	76.5	50.9
pH	pH	-	8	7.9	-
Alkalinity, Total (as CaCO3)	mg/L	-	72.3	75.5	70.5
Ammonia, Total (as N)	mg/L	-	ND	-	<0.0050
Chloride (Cl)	mg/L	250 (2)	1	1.3	<0.50
Fluoride (F)	mg/L	1.5 (2)	ND	ND	0.059
Nitrate (as N)	mg/L	10 (2)	0.026	0.041	0.0271
Nitrite (as N)	mg/L	1.0 (2)	ND	ND	<0.0010
Sulfate (SO4)	mg/L	500 (2)	-	2.24	1.02
Total Organic Carbon	mg/L	-	-	4.01	1.7
COD	mg/L	-	-	-	<20
Dissolved Metals					
Aluminum (Al)-Dissolved	mg/L	9.5 (2)	0.0043	0.0074	0.0072
Antimony (Sb)-Dissolved	mg/L	0.006(2)	ND	0.000334	<0.00010
Arsenic (As)-Dissolved	mg/L	0.01(2)	ND	0.000142	<0.00010
Barium (Ba)-Dissolved	mg/L	1.0(2)	0.0143	0.0155	0.0156
Beryllium (Be)-Dissolved	mg/L	0.008(2)	ND	ND	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	<0.000050
Boron (B)-Dissolved	mg/L	5.0(2)	ND	ND	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.005(2)	0.000020	0.000054	0.000144
Calcium (Ca)-Dissolved	mg/L	-	-	-	18
Cesium (Cs)- Dissolved	mg/L	-	-	-	<0.000010
Chromium (Cr)-Dissolved	mg/L	0.05 - 6.0 (2)	ND	0.00139	0.00045
Cobalt (Co)-Dissolved	mg/L	0.001 (2)	ND	0.000037	<0.00010
Copper (Cu)-Dissolved	mg/L	1.5 (2) AO	0.00085	0.0013	0.00044
Iron (Fe)-Dissolved	mg/L	6.5(2)	ND	0.0148	0.011
Lead (Pb)-Dissolved	mg/L	0.01(2)	ND	ND	<0.000050
Lithium (Li)-Dissolved	mg/L	0.008 (2)	ND	0.00066	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	2.00	1.74	1.45
Manganese (Mn)-Dissolved	mg/L	1.5 (2)	0.0016	0.00378	0.00205
Mercury (Hg)-Dissolved	mg/L	0.001(2)	ND	ND	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	0.25(2)	ND	0.0002	0.00009
Nickel (Ni)-Dissolved	mg/L	0.08 (2)	-	-	<0.00050
Phosphorus - Dissolved	mg/L	-	-	-	<0.050
Potassium (K)-Dissolved	mg/L	-	-	-	0.42
Rubidium (Rb) - Dissolved	mg/L	-	-	-	0.00036
Selenium (Se)-Dissolved	mg/L	0.01 (2)	ND	0.000061	<0.000050
Silicon - Dissolved	mg/L	-	5.91	5.17	5.29
Silver (Ag)-Dissolved	mg/L	0.02 (2)	ND	ND	<0.000010
Sodium (Na)-Dissolved	mg/L	200(2)	2.11	1.92	1.65
Strontium - Dissolved	mg/L	-	0.0758	0.0782	0.0757
Sulfur- Dissolved	mg/L	-	-	-	<0.50
Tellurium - Dissolved	mg/L	-	-	-	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	-	-	<0.000010
Thorium - Dissolved	mg/L	-	-	-	<0.00010
Tin (Sn)-Dissolved	mg/L	2.5 (2)	ND	ND	0.00054
Titanium (Ti)-Dissolved	mg/L	-	-	-	<0.00030
Tungston (W) - Dissolved	mg/L	0.003 (2)	-	-	<0.00010
Uranium (U)-Dissolved	mg/L	0.020	ND	0.000018	<0.000010
Vanadium (V)-Dissolved	mg/L	0.020 (2)	ND	0.00068	<0.00050
Zinc (Zn)-Dissolved	mg/L	3.0 (2)	ND	ND	0.0015
Zirconium - Dissolved	mg/L	-	ND	ND	<0.000060

NOTES

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(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows

** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

CSR-DW *BC Contaminated Sites Regulation Water Quality Guidelines for Drinking Water*

Table 15: Surface Water Quality Results Sampling Location SW-01 (Onion Lake)

		BC MoE Guidelines	22-Oct-12	2-Apr-17	5-Jul-17	26-Sep-17	26-Sep-17		8-Nov-17	17-Jul-18	17-Jul-18		19-Nov-18
		BCWQG-AW (1)											
Field	**Units**					Sample	Duplicate	RPD		Sample	Duplicate	RPD	
Conductivity	uS/cm	-	-	-	28.5	25.7	25.7	0.00%	19.9	25.9	-	-	18.7
pH	pH	-	-	-	6.3	8.1	8.1	0.00%	7.9	7.5	-	-	7.8
Temperature	°C	-	-	-	20	15.7	15.7	0.00%	5.4	20.2	-	-	7
Dissolved Oxygen	mg/L	-	-	-	6.49	11.6	11.6	0.00%	9.7	0.6	-	-	7.1
Analyte	Units												
Conductivity	uS/cm	-	33.7	14.1	30.3	30.8	30.5	0.98%	-	-	-	-	-
Hardness (as CaCO3)	mg/L	-	3.9	1.4	2.95	3.55	3.55	0.00%	2.81	2.48	2.46	0.40%	2.67
pH	pH	6.5-9.0	6.3	6.6	6.8	6.7	6.6	1.50%	6.8	6.9	6.6	2.16%	6.7
Total Suspended Solids	mg/L	25 mg/L (backgr. 25-250 mg/l)) (i)	-	-	2	2.3	<1.0	-	-	-	-	-	-
Total Dissolved Solids	mg/L	-	16	21	20	50	27	59.74%	-	-	-	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	3.9	2.3	4	3	3	0.00%	-	-	-	-	-
Ammonia, Total (as N)	mg/L	0.681-28.7 (a)	ND	0.03	<0.03	<0.03	<0.03	-	<0.0050	0.006	0.0092	21.05%	<0.0050
Total Nitrogen as N	mg/L	-	-	0.108	0.051	0.161	0.15	7.07%	-	-	-	-	-
Bromide (Br)	mg/L	-	-	-	-	-	-	-	<0.050	-	-	-	<0.050
Chloride (Cl)	mg/L	600	10.3	3.9	6.9	7.1	6.9	2.86%	6.85	6.22	6.64	3.27%	6.14
Fluoride (F)	mg/L	0.4-1.87 (d)	ND	ND	<0.10	<0.1	<0.10	-	0.027	0.023	0.022	2.22%	0.025
Nitrate (as N)	mg/L	32.8	ND	ND	<0.01	0.017	0.014	19.35%	<0.0050	<0.0050	<0.0050	-	<0.0050
Nitrite (as N)	mg/L	0.06-0.6 (h)	ND	ND	<0.01	<0.01	<0.01	-	<0.0010	<0.0010	<0.0010	-	<0.0010
Sulfate (SO4)	mg/L	128-429 (d)	0.62	1.1	<1.0	<1.0	<1.0	-	0.31	<0.30	<0.30	-	<0.30
Total Organic Carbon	mg/L	+/- 20% of background	2.15	0.65	<0.50	1.68	1.76	4.65%	-	-	-	-	-
BOD	mg/L	-	-	ND	<4.0	<4.0	<4.0	-	<2.0	<2.0	<2.0	-	<2.0
COD	mg/L	-	-	-	-	-	-	-	<20	<20	<20	-	<20
Total Metals													
Aluminum (Al)-Total	mg/L	-	0.0065	0.0058	0.0142	0.021	0.0068	102.16%	0.0489	0.0105	0.0085	10.53%	0.0067
Antimony (Sb)-Total	mg/L	0.009	ND	ND	<0.00010	<0.00020	<0.00020	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Arsenic (As)-Total	mg/L	0.005	ND	ND	<0.00050	<0.00050	<0.00050	-	0.00010	0.00012	0.00012	0.00%	<0.00010
Barium (Ba)-Total	mg/L	1	0.0127	0.0041	<0.0050	0.0051	<0.0050	-	0.00647	0.00533	0.00508	2.40%	0.00559
Beryllium (Be)-Total	mg/L	0.00013	ND	ND	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Bismuth	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	-	<0.000050	<0.000050	<0.000050	-	<0.000050
Boron (B)-Total	mg/L	1.2	ND	ND	0.007	0.0059	0.0053	10.71%	<0.010	<0.010	<0.010	-	<0.010
Cadmium (Cd)-Total	mg/L	-	0.000056	0.000014	<0.000010	<0.000010	<0.000010	-	0.0000209	<0.0000050	<0.0000050	-	<0.0000050
Calcium (Ca)-Total	mg/L	<4 sensitive to acid input	1.22	0.434	1	1.16	1.16	0.00%	0.912	0.824	0.823	0.06%	0.905
Cessium (Cs) - Total	mg/L	-	-	ND	-	-	-	-	0.000011	<0.000010	<0.000010	-	<0.000010
Chromium (Cr)-Total	mg/L	0.001 (e)	ND	ND	<0.00050	<0.00050	<0.00050	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Cobalt (Co)-Total	mg/L	0.11	ND	0.00025	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Copper (Cu)-Total	mg/L	0.0032-0.0396 (d,f)	0.00106	0.00025	<0.00020	<0.00040	<0.00040	-	<0.00050	<0.00050	<0.00050	-	0.00069
Iron (Fe)-Total	mg/L	1	0.0304	0.0165	0.011	0.022	0.015	37.84%	0.089	0.010	<0.010	-	0.028
Lead (Pb)-Total	mg/L	0.011-0.402 (d,f)	ND	ND	<0.00010	<0.00020	<0.00020	-	0.000108	<0.000050	<0.000050	-	<0.000050
Lithium (Li)-Total	mg/L	-	ND	ND	0.0001	0.00012	0.0001	18.18%	<0.0010	<0.0010	<0.0010	-	<0.0010
Magnesium (Mg)-Total	mg/L	-	0.209	0.076	0.144	0.161	0.155	3.80%	0.149	0.135	0.127	3.05%	0.130
Manganese (Mn)-Total	mg/L	0.8-3.4 (d,f)	0.0211	0.0078	0.00787	0.0147	0.0135	8.51%	0.0602	0.0116	0.0107	4.04%	0.0394
Mercury (Hg)-Total	mg/L	0.0001	ND	ND	<0.000020	<0.000010	<0.000010	-	<0.000025	<0.0000050	<0.0000050	-	<0.0000050
Molybdenum (Mo)-Total	mg/L	2	ND	ND	<0.00010	<0.00010	<0.00010	-	<0.000050	<0.000050	<0.000050	-	<0.000050
Nickel (Ni)-Total	mg/L	0.025-0.15 (d,f)	ND	ND	<0.00020	<0.00040	<0.00040	-	<0.00050	<0.00050	<0.00050	-	<0.00050
Phosphorus - Total	mg/L	0.005-0.015 (lakes only)	ND	-	<0.050	<0.050	<0.050	-	<0.050	<0.050	<0.050	-	<0.050
Potassium (K)-Total	mg/L	-	0.270	0.128	0.17	0.19	0.19	0.00%	0.228	0.154	0.144	3.36%	0.146
Rubidium (Rb) - Total	mg/L	-	-	-	-	-	-	-	0.00035	0.00026	0.00023	6.12%	0.00030
Selenium (Se)-Total	mg/L	0.002	ND	ND	<0.00050	<0.00050	<0.00050	-	<0.000050	<0.000050	<0.000050	-	<0.000050
Silicon - Total	mg/L	-	0.486	ND	<1.0	<1.0	<1.0	-	0.13	<0.10	<0.10	-	0.19
Silver (Ag)-Total	mg/L	0.0001-0.003 (d)	ND	ND	0.000055	<0.000050	<0.000050	-	<0.000010	<0.000010	<0.000010	-	<0.000010
Sodium (Na)-Total	mg/L	-	5.53	2	4.16	4.63	4.49	3.07%	4.32	3.83	3.72	1.46%	3.89
Strontium - Total	mg/L	-	0.0116	0.0034	0.0075	0.0076	0.0073	4.03%	0.00777	0.00669	0.00655	1.06%	0.00755
Sulfur - Total	mg/L	-	ND	ND	<3.0	<3.0	<3.0	-	<0.50	<0.50	<0.50	-	<0.50
Tellurium - Total	mg/L	-	-	-	<0.00020	<0.00050	<0.00050	-	<0.00020	<0.00020	<0.00020	-	<0.00020
Thallium (Tl)-Total	mg/L	0.0008	ND	ND	<0.000020	<0.000020	<0.000020	-	<0.000010	<0.000010	<0.000010	-	<0.000010
Thorium - Total	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Tin (Sn)-Total	mg/L	-	ND	ND	<0.00020	<0.00020	<0.00020	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Titanium (Ti)-Total	mg/L	-	ND	ND	<0.0050	<0.0050	<0.0050	-	0.00177	0.00031	<0.00030	-	<0.00030
Tungsten (W) - Total	mg/L	-	-	-	-	-	-	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Uranium (U)-Total	mg/L	0.0085	ND	ND	<0.000020	<0.000020	<0.000020	-	<0.000010	<0.000010	<0.000010	-	<0.000010
Vanadium (V)-Total	mg/L	-	ND	ND	<0.0010	<0.0010	<0.0010	-	<0.00050	<0.00050	<0.00050	-	<0.00050
Zinc (Zn)-Total	mg/L	0.033-0.34 (d,f)	ND	ND	<0.0040	0.005	<0.0040	-	<0.0030	<0.0030	<0.0030	-	<0.0030
Zirconium - Total	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	-	<0.000060	<0.000060	<0.000060	-	<0.000060
Dissolved Metals													
Aluminum (Al)-Dissolved	mg/L	0.023-0.1 (b,c)	0.0034	0.0038	<0.0050	<0.0050	<0.0050	-	<0.0010	0.0037	0.0036	1.37%	0.0015
Antimony (Sb)-Dissolved	mg/L	-	ND	ND	<0.00010	<0.00020	<0.00020	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Arsenic (As)-Dissolved	mg/L	-	ND	0.00005	<0.00050	<0.00050	<0.00050	-	0.00014	<0.00010	<0.00010	-	<0.00010
Barium (Ba)-Dissolved	mg/L	-	0.0128	0.0045	<0.0050	<0.0050	<0.0050	-	0.00515	0.00475	0.00466	0.96%	0.00553
Beryllium (Be)-Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	-	<0.000050	<0.000050	<0.000050	-	<0.000050
Boron (B)-Dissolved	mg/L	-	ND	ND	<0.0050	<0.0050	<0.0050	-	<0.010	<0.010	<0.010	-	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.000027 - 0.00280 (d, f)	0.00110	0.00001	<0.000010	<0.000010	<0.000010	-	0.0000051	<0.0000050	<0.0000050	-	<0.0000050
Cessium (Cs) - Dissovled	mg/L	-	-	-	-	-	-	-	0.887	0.791	0.792	0.06%	0.854
Calcium (Ca)-Dissolved	mg/L	-	1.22	0.43	0.98	1.09	1.06	2.79%	<0.000010	<0.000010	<0.000010	-	<0.000010
Chromium (Cr)-Dissolved	mg/L	-	ND	ND	<0.00050	<0.00050	<0.00050	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Cobalt (Co)-Dissolved	mg/L	-	ND	0.00001	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Copper (Cu)-Dissolved	mg/L	-	0.00098	ND	<0.00020	<0.00040	<0.00040	-	<0.00020	<0.00020	<0.00020	-	<0.00020
Iron (Fe)-Dissolved	mg/L	0.35	0.0101	ND	0.01	<0.010	<0.010	-	<0.010	<0.010	<0.010	-	<0.010
Lead (Pb)-Dissolved	mg/L	-	ND	ND	<0.00010	<0.00020	<0.00020	-	<0.000050	<0.000050	<0.000050	-	<0.000050
Lithium (Li)-Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	-	<0.0010	<0.0010	<0.0010	-	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	0.207	ND	0.124	0.153	0.146	4.68%	0.145	0.122	0.118	1.67%	0.131
Manganese (Mn)-Dissolved	mg/L	-	0.0157	ND	0.00533	0.00377	0.00355	6.01%	0.00767	0.00730	0.00673	4.06%	0.02730
Mercury (Hg)-Dissolved	mg/L	-	ND	ND	-	<0.000010	<0.000010	-	<0.0000050	<0.0000050	<0.0000050	-	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	-	<0.000050	<0.000050	<0.000050	-	<0.000050
Nickel (Ni)-Dissolved	mg/L	-	ND	ND	<0.00020	<0.00040	<0.00040	-	<0.00050	<0.00050	<0.00050	-	<0.00050
Phosphorus - Dissovled	mg/L	-	-	ND	<0.050	<0.050	<0.050	-	<0.050	<0.050	<0.050	-	<0.050
Potassium (K)-Dissolved	mg/L	-	0.243	-	0.12	0.19	0.19	0.00%	0.187	0.131	0.143	4.38%	0.154
Rubidum (Rb) - Dissolved	mg/L	-	-	ND	-	-	-	-	0.00027	0.00025	0.00023	4.17%	0.00025
Selenium (Se)-Dissolved	mg/L	-	ND	ND	<0.00050	<0.00050	<0.00050	-	<0.000050	<0.000050	<0.000050	-	<0.000050
Silicon - Dissolved	mg/L	-	0.478	ND	<1.0	<1.0	<1.0	-	0.066	<0.050	<0.050	-	0.110
Silver (Ag)-Dissolved	mg/L	-	ND	ND	<0.000050	<0.000050	<0.000050	-	<0.000010	<0.000010	<0.000010	-	<0.000010
Sodium (Na)-Dissolved	mg/L	-	5.48	1.99	3.75	4.5	4.33	3.85%	4.44	3.67	3.62	0.69%	3.83
Strontium - Dissolved	mg/L	-	0.0115	0.0039	0.0064	0.0073	0.0072	1.38%	0.00759	0.00637	0.00645	0.62%	0.00762
Sulfur- Dissolved	mg/L	-	ND	ND	<3.0	<3.0	<3.0	-	<0.50	<0.50	<0.50	-	<0.50
Tellurium - Dissolved	mg/L	-	-	ND	<0.00020	<0.00050	<0.00050	-	<0.00020	<0.00020	<0.00020	-	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	ND	ND	<0.000020	<0.000020	<0.000020	-	<0.000010	<0.000010	<0.000010	-	<0.000010
Thorium - Dissovled	mg/L	-	-	ND	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Tin (Sn)-Dissolved	mg/L	-	ND	ND	<0.00020	<0.00020	<0.00020	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Titanium (Ti)-Dissolved	mg/L	-	ND	ND	<0.0050	<0.0050	<0.0050	-	<0.00030	<0.00030	<0.00030	-	<0.00030
Tungsten (W) - Dissolved	mg/L	-	-	-	-	-	-	-	<0.00010	<0.00010	<0.00010	-	<0.00010
Uranium (U)-Dissolved	mg/L	-	ND	ND	<0.000020	<0.000020	<0.000020	-	<0.000010	<0.000010	<0.000010	-	<0.000010
Vanadium (V)-Dissolved	mg/L	-	ND	ND	<0.0010	<0.0010	<0.0010	-	<0.00050	<0.00050	<0.00050	-	<0.00050
Zinc (Zn)-Dissolved	mg/L	-	0.0067	0.0047	0.0041	0.0054	<0.0040	-	<0.0010	<0.0010	<0.0010	-	<0.0010
Zirconium - Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	-	<0.000060	<0.000060	<0.000060	-	<0.000060

NOTES

(1) BC MoE Approved and Working Water Quality Guidelines, last updated March 2018
(2) BC Contaminated Sites Regulation (CSR) for protection of aquatic life or drinking water, Schedule 3.2, last updated July 2018
(3) All criteria limits for BCWQG - Aquatic Life Guidelines based on Total Metal Concentration except Aluminum (Dissolved) and Cadmium (Dissolved)
(4) BC MoE Water Quality Guidelines for Protectionof Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows
** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

BCWQG-AW *BC MoE Quality Guidelines for Protection of Aquatic Life*

Table 16: Surface Water Quality Results Sampling Location SW-02 (Upper Clearwater Lake)

		BC MoE Guidelines BCWQG-AW (1)	22-Oct-12	2-Apr-13	6-Apr-17	5-Jul-17	26-Sep-17	8-Nov-17	17-Jul-18	19-Nov-18
Field	**Units**									
Conductivity	uS/cm	-	-	-	137.5	28.8	113	97.9	124.1	98.3
pH	pH	-	-	-	7.7	8.3	8.3	8.1	7.9	7.3
Temperature	°C	-	-	-	5.2	6.8	11.4	5.3	14.5	5.8
Dissolved Oxygen	mg/L	-	-	-	-	2.5	13.6	9.4	4.2	6.1
Analyte	Units									
Conductivity	uS/cm	-	154	154	148	164	161	-	-	-
Hardness (as CaCO3)	mg/L	-	74.8	75.6	69.4	76.6	77.8	78	75.3	74.4
pH	pH	6.5-9.0	7.8	8	7.9	8.1	8.1	8.2	8.3	8.2
Total Suspended Solids	mg/L	25 mg/L (backgr. 25-250 mg/l)) (i)	-	ND	<1.0	<1.0	<1.0	-	-	-
Total Dissolved Solids	mg/L	-	73	105	89	79	93	-	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	77	75.7	73	80	79	-	-	-
Ammonia, Total (as N)	mg/L	2.0-26.5 (a)	ND	ND	<0.03	<0.03	<0.03	<0.0050	0.0053	0.0097
Total Nitrogen as N	mg/L	-	-	0.048	0.094	<0.0500	0.0715	-	-	-
Bromide (Br)	mg/L	-	-	-	-	-	-	<0.050	-	<0.050
Chloride (Cl)	mg/L	600, MAC	1.8	1.1	<1.0	1.2	1	1.2	0.84	0.84
Fluoride (F)	mg/L	0.7-1.9 (d)	ND	ND	<0.1	<0.10	<0.10	0.052	0.049	0.049
Nitrate (as N)	mg/L	32.8	ND	ND	<0.01	<0.010	0.012	0.0133	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06-0.6 (h)	ND	ND	<0.01	<0.01	<0.01	<0.0010	<0.0010	<0.0010
Sulfate (SO4)	mg/L	128-429 (d)	2.57	4.25	2.5	2.8	2.3	2.56	2.23	2.1
Total Organic Carbon	mg/L	+/- 20% of background	ND	ND	<0.5	<0.50	0.89	-	-	-
BOD	mg/L	-	ND	ND	<4.0	<4.0	<4.0	<2.0	<2.0	<2.0
COD	mg/L	-	-	-	-	-	-	<20	<20	<20
Total Metals										
Aluminum (Al)-Total	mg/L	-	ND	0.0052	<0.0050	<0.0050	<0.0050	<0.0030	0.0033	0.0069
Antimony (Sb)-Total	mg/L	0.009	ND	ND	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010
Arsenic (As)-Total	mg/L	0.005	0.00191	0.00182	0.00167	0.00193	0.00193	0.00193	0.00209	0.00205
Barium (Ba)-Total	mg/L	1	0.0219	0.0198	0.0217	0.0238	0.0213	0.0224	0.02480	0.02350
Beryllium (Be)-Total	mg/L	0.00013	ND	ND	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050
Boron (B)-Total	mg/L	1.2	ND	ND	0.006	0.0115	0.0087	<0.010	<0.010	<0.010
Cadmium (Cd)-Total	mg/L	-	0.000025	0.000011	<0.00001	<0.000010	<0.000010	<0.0000050	<0.0000050	0.0000614
Calcium (Ca)-Total	mg/L	<4 sensitive to acid input	26.2	26	24.8	27.1	28	27.9	26.7	26.0
Cessium (Cs) - Total	mg/L	-	-	-	-	-	-	<0.000010	<0.000010	<0.000010
Chromium (Cr)-Total	mg/L	0.001 (e)	ND	ND	<0.0005	<0.00050	0.00069	0.00032	0.00041	0.00035
Cobalt (Co)-Total	mg/L	0.11	ND	ND	<0.00005	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)-Total	mg/L	0.0032-0.0396 (d,f)	0.00093	ND	<0.0002	<0.00020	<0.00040	<0.00050	<0.00050	0.00072
Iron (Fe)-Total	mg/L	1	ND	0.0171	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Lead (Pb)-Total	mg/L	0.011-0.402 (d,f)	ND	ND	<0.0001	<0.00010	<0.00020	<0.000050	<0.000050	<0.000050
Lithium (Li)-Total	mg/L	-	ND	ND	0.0011	0.00123	0.00118	0.0011	0.0011	0.0011
Magnesium (Mg)-Total	mg/L	-	2.25	0.0012	1.88	2.14	2.25	2.32	2.200	2.040
Manganese (Mn)-Total	mg/L	0.8-3.4 (d,f)	ND	2.06	0.00048	0.00038	0.00044	0.00077	0.0013	0.0013
Mercury (Hg)-Total	mg/L	0.0001	ND	ND	<0.00002	<0.000020	<0.000010	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	2	ND	ND	0.00028	0.00031	0.00029	0.000283	0.000292	0.000295
Nickel (Ni)-Total	mg/L	0.025-0.15 (d,f)	ND	ND	<0.0002	<0.00020	<0.00040	<0.00050	<0.00050	<0.00050
Phosphorus - Total	mg/L	0.005-0.015 (lakes only)	-	-	<0.05	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Total	mg/L	-	0.886	0.783	0.72	0.83	0.86	0.819	0.824	1.110
Rubidium (Rb) -Total	mg/L	-	-	-	-	-	-	0.00036	0.00034	0.00061
Selenium (Se)-Total	mg/L	0.002	0.00013	ND	<0.00050	<0.00050	<0.00050	0.000143	0.000126	0.000129
Silicon - Total	mg/L	-	4.58	4.98	4.9	5	5	5.02	4.78	4.94
Silver (Ag)-Total	mg/L	0.0001-0.003 (d)	ND	ND	<0.00005	0.000066	<0.000050	<0.000010	<0.000010	<0.000010
Sodium (Na)-Total	mg/L	-	1.89	1.88	1.71	1.92	2.01	1.91	2.15	2.04
Strontium - Total	mg/L	-	0.0992	0.0946	0.0912	0.105	0.0928	0.0993	0.09970	0.10300
Sulfur - Total	mg/L	-	ND	ND	<3.0	<3.0	<3.0	0.87	0.67	0.61
Tellurium - Total	mg/L	-	-	-	<0.00020	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Total	mg/L	0.0008	ND	ND	<0.00002	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010
Thorium - Total	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Total	mg/L	-	ND	ND	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Total	mg/L	-	ND	ND	<0.0050	<0.0050	<0.0050	<0.00030	<0.00030	<0.00030
Tungsten (W) - Total	mg/L	-	-	-	-	-	-	<0.00010	<0.00010	<0.00010
Uranium (U)-Total	mg/L	0.0085	0.00011	0.00011	0.00009	0.000122	0.000104	0.000094	0.000104	0.000113
Vanadium (V)-Total	mg/L	-	ND	ND	<0.0010	0.0012	0.0011	0.00095	0.00126	0.00112
Zinc (Zn)-Total	mg/L	0.033-0.34 (d,f)	ND	ND	<0.0040	<0.0040	<0.0040	<0.0030	<0.0030	0.004
Zirconium - Total	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	<0.000060	<0.000060	<0.000060
Dissolved Metals										
Aluminum (Al)-Dissolved	mg/L	0.023-0.1 (b,c)	0.0445	ND	<0.0050	<0.0050	<0.0050	<0.0010	<0.0010	0.0011
Antimony (Sb)-Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010
Arsenic (As)-Dissolved	mg/L	-	0.00198	0.00156	0.00173	0.00184	0.00198	0.00186	0.00194	0.00211
Barium (Ba)-Dissolved	mg/L	-	0.0221	0.0189	0.0203	0.021	0.0212	0.0231	0.02290	0.02280
Beryllium (Be)-Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	mg/L	-	ND	ND	<0.004	0.0056	0.0064	<0.010	<0.010	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.000027 - 0.00280 (d, f)	ND	0.000007	<0.00001	<0.000010	<0.000010	0.0000273	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	mg/L	-	26.0	24.9	24.7	24.1	27.4	27.6	26.700	26.200
Cessium (Cs) - Dissolved	mg/L	-	-	ND	-	-	-	<0.000010	<0.000010	<0.000010
Chromium (Cr)-Dissolved	mg/L	-	ND	ND	<0.0005	<0.00050	<0.00050	0.00032	0.0004	0.0003
Cobalt (Co)-Dissolved	mg/L	-	ND	ND	<0.00005	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)-Dissolved	mg/L	-	0.00157	ND	<0.0002	<0.00020	<0.00040	<0.00020	<0.00020	<0.00020
Iron (Fe)-Dissolved	mg/L	0.35	ND	ND	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Lead (Pb)-Dissolved	mg/L	-	ND	ND	<0.0001	<0.00010	<0.00020	<0.000050	<0.000050	<0.000050
Lithium (Li)-Dissolved	mg/L	-	ND	0.00097	0.001	0.00102	0.00114	<0.0010	0.001	0.001
Magnesium (Mg)-Dissolved	mg/L	-	2.30	1.92	1.86	1.9	2.28	2.21	2.070	2.170
Manganese (Mn)-Dissolved	mg/L	-	ND	0.00041	<0.00020	<0.00020	0.00031	<0.00010	0.00028	0.00069
Mercury (Hg)-Dissolved	mg/L	-	ND	ND	<0.00002	-	<0.000010	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	-	ND	0.000282	0.00027	0.00028	0.00029	0.000284	0.00028	0.000283
Nickel (Ni)-Dissolved	mg/L	-	ND	ND	<0.0002	<0.00020	<0.00040	<0.00050	<0.00050	<0.00050
Phosphorus - Dissolved	mg/L	-	-	-	<0.05	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	0.899	0.77	0.73	0.71	0.85	0.893	0.796	0.838
Rubidium (Rb) -Dissolved	mg/L	-	-	-	-	-	-	0.00037	0.00032	0.00037
Selenium (Se)-Dissolved	mg/L	-	0.00015	0.000111	<0.00050	<0.00050	<0.00050	0.000114	0.000098	0.000115
Silicon - Dissolved	mg/L	-	4.49	4.28	5	4.6	5.1	4.67	4.500	4.780
Silver (Ag)-Dissolved	mg/L	-	ND	ND	<0.00005	<0.000050	<0.000050	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	-	1.93	1.68	1.68	1.71	2.02	2.21	1.85	2.04
Strontium - Dissolved	mg/L	-	0.0988	0.0946	0.0881	0.0907	0.0957	0.106	0.09870	0.10200
Sulfur- Dissolved	mg/L	-	ND	ND	<3.0	<3.0	<3.0	0.59	0.63	0.71
Tellurium - Dissolved	mg/L	-	-	ND	<0.00020	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	ND	ND	<0.00002	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010
Thorium - Dissovled	mg/L	-	-	ND	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	-	ND	ND	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Dissolved	mg/L	-	ND	ND	<0.0050	<0.0050	<0.0050	<0.00030	<0.00030	<0.00030
Tungsten (W) - Dissolved	mg/L	-	-	-	-	-	-	<0.00010	<0.00010	<0.00010
Uranium (U)-Dissolved	mg/L	-	0.00012	ND	0.00009	0.000109	0.0001	0.000104	0.000102	0.000108
Vanadium (V)-Dissolved	mg/L	-	ND	0.00116	<0.0010	<0.0010	<0.0010	0.00097	0.00099	0.001
Zinc (Zn)-Dissolved	mg/L	-	ND	0.002	<0.0040	<0.0040	<0.0040	0.0010	<0.0010	<0.0010
Zirconium - Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	<0.000060	<0.000060	<0.000060

NOTES

(1) BC MoE Approved and Working Water Quality Guidelines, last updated March 2018
(2) BC Contaminated Sites Regulation (CSR) for protection of aquatic life or drinking water, Schedule 3.2, last updated July 2018
(3) All criteria limits for BCWQG - Aquatic Life Guidelines based on Total Metal Concentration except Aluminum (Dissolved) and Cadmium (Dissolved)
(4) BC MoE Water Quality Guidelines for Protectionof Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows
** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

BCWQG-AW *BC MoE Quality Guidelines for Protection of Aquatic Life*

Table 17: Surface Water Quality Results Sampling Location SW-03 (Lower Clearwater Lake)

		BC MoE Guidelines	22-Oct-12	2-Apr-13	6-Apr-17	5-Jul-17	26-Sep-17	8-Nov-17	12-Apr-18	12-Apr-18		17-Jul-18	19-Nov-18
		BCWQG-AW (1)											
Field	**Units**								Sample	Duplicate	RPD		
Conductivity	uS/cm	-	-	-	140	141	111	92	91	-	-	126	95
pH	pH	-	-	-	7.6	7.5	8.2	8.0	7.6	-	-	7.9	7.6
Temperature	°C	-	-	-	7	14.1	11	4.2	5.2	-	-	15.4	5.3
Dissolved Oxygen	mg/L	-	-	-	-	-	14.2	12	16.3	-	-	1	5.4
Analyte	Units												
Conductivity	uS/cm	-	149	151	145	161	158	-	-	-	-	-	-
Hardness (as CaCO3)	mg/L	-	72.8	73.3	68	75.4	73.1	78.7	70.2	71.4	0.85%	73.9	72.4
pH	pH	6.5-9.0	7.48	7.9	8	8.1	7.9	8.2	8.2	8.3	0.79%	8.2	8.2
Total Suspended Solids	mg/L	25 mg/L (backgr. 25-250 mg/l)) (i)	-	ND	1.1	1.8	<1.0	-	-	-	-	-	-
Total Dissolved Solids	mg/L	-	71	104	82	78	91	-	-	-	-	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	-	75.2	71	78	76	-	-	-	-	-	-
Ammonia, Total (as N)	mg/L	2.0-26.5 (a)	ND	ND	<0.03	<0.03	<0.03	<0.0050	0.0063	0.0054	7.69%	<0.0050	<0.0050
Total Nitrogen as N	mg/L	-	-	0.049	<0.0200	0.121	<0.0500	-	-	-	-	-	-
Bromide (Br)	mg/L	-	-	-	-	-	-	<0.050	<0.050	<0.050	-	-	<0.050
Chloride (Cl)	mg/L	600, MAC	1.7	1.3	1.1	1.4	1.1	0.97	0.86	0.88	1.15%	0.87	0.90
Fluoride (F)	mg/L	0.7-1.9 (d)	ND	ND	<0.1	<0.10	<0.10	0.05	0.047	0.048	1.05%	0.047	0.047
Nitrate (as N)	mg/L	32.8	0.036	0.032	<0.01	<0.010	0.012	0.0164	0.0089	0.0081	4.71%	<0.0050	0.0069
Nitrite (as N)	mg/L	0.06-0.6 (h)	ND	ND	<0.01	<0.01	<0.01	<0.0010	<0.0010	<0.0010	-	<0.0010	<0.0010
Sulfate (SO4)	mg/L	128-429 (d)	2.63	3.38	2.6	2.8	2.4	2.5	2.21	2.22	0.23%	2.25	2.12
Total Organic Carbon	mg/L	+/- 20% of background	1.09	ND	<0.50	<0.50	0.65	-	<0.50	<0.50	-	-	-
BOD	mg/L	-	ND	ND	<4.0	<4.0	<4.0	<2.0	<2.0	<2.0	-	2.5	<2.0
COD	mg/L	-	-	-	-	-	-	<20	<20	<20	-	<20	<20
Total Metals													
Aluminum (Al)-Total	mg/L	-	0.0032	0.0043	0.0056	0.0146	<0.0050	<0.0030	0.0051	0.0037	15.91%	0.0040	0.0039
Antimony (Sb)-Total	mg/L	0.009	ND	ND	<0.00010	0.0001	<0.00020	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Arsenic (As)-Total	mg/L	0.005	0.00179	0.00185	0.00155	0.00186	0.00195	0.00184	0.00165	0.00169	1.20%	0.00196	0.00181
Barium (Ba)-Total	mg/L	1	0.0219	0.0225	0.0187	0.0218	0.0215	0.0215	0.01990	0.01910	2.05%	0.02110	0.02160
Beryllium (Be)-Total	mg/L	0.00013	ND	ND	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Bismuth - Total	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050	-	<0.000050	<0.000050
Boron (B)-Total	mg/L	1.2	ND	ND	0.007	0.0072	0.0083	<0.010	<0.010	<0.010	-	<0.010	<0.010
Cadmium (Cd)-Total	mg/L	-	ND	ND	<0.00001	<0.000010	<0.000010	<0.0000050	<0.0000050	<0.0000050	-	<0.0000050	<0.0000050
Calcium (Ca)-Total	mg/L	<4 sensitive to acid input	25.5	26.7	24.2	26.7	30.3	27.5	23.8	24.2	0.83%	26.2	24.8
Cesium (Cs) - Total	mg/L	-	-	-	-	-	-	<0.000010	<0.000010	<0.000010	-	<0.000010	<0.000010
Chromium (Cr)-Total	mg/L	0.001 (e)	ND	ND	<0.0005	<0.00050	0.00066	0.00034	0.00045	0.00044	1.12%	0.00044	0.0003
Cobalt (Co)-Total	mg/L	0.11	ND	ND	<0.00005	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Copper (Cu)-Total	mg/L	0.0032-0.0396 (d,f)	0.00074	ND	<0.0002	<0.00020	<0.00040	<0.00050	<0.00050	<0.00050	-	<0.00050	<0.00050
Iron (Fe)-Total	mg/L	1	0.0069	0.0091	0.011	0.023	<0.010	<0.010	<0.010	<0.010	-	<0.010	<0.010
Lead (Pb)-Total	mg/L	0.011-0.402 (d,f)	ND	ND	<0.0001	<0.00010	<0.00020	<0.000050	<0.000050	<0.000050	-	<0.000050	<0.000050
Lithium (Li)-Total	mg/L	-	ND	ND	0.001	0.00122	0.00125	<0.0010	0.0012	0.0013	4.00%	0.0011	0.0011
Magnesium (Mg)-Total	mg/L	-	2.21	2.15	1.85	2.09	2.4	2.34	1.840	1.830	0.27%	2.110	2.010
Manganese (Mn)-Total	mg/L	0.8-3.4 (d,f)	ND	ND	0.00075	0.00113	0.00105	0.00051	0.0007	0.0006	2.29%	0.0010	0.0007
Mercury (Hg)-Total	mg/L	0.0001	ND	ND	<0.00002	<0.000020	<0.000010	<0.0000050	<0.0000050	<0.0000050	-	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	2	ND	ND	0.00029	0.00032	0.00032	0.000275	0.000283	0.000285	0.35%	0.000287	0.00031
Nickel (Ni)-Total	mg/L	0.025-0.15 (d,f)	ND	ND	<0.0002	<0.00020	<0.00040	<0.00050	<0.00050	<0.00050	-	<0.00050	<0.00050
Phosphorus - Total	mg/L	0.005-0.015 (lakes only)	-	-	<0.05	<0.050	<0.050	<0.050	<0.050	<0.050	-	<0.050	<0.050
Potassium (K)-Total	mg/L	-	0.880	0.814	0.71	0.84	0.93	0.813	0.724	0.716	0.56%	0.800	0.824
Rubidium (Rb) - Total	mg/L	-	-	ND	-	-	-	0.00033	0.00033	0.00031	3.13%	0.00029	0.00031
Selenium (Se)-Total	mg/L	0.002	0.00013	ND	<0.00050	<0.00050	<0.00050	0.000133	0.000136	0.000068	33.33%	0.000095	0.000091
Silicon - Total	mg/L	-	4.70	5.13	4.8	5	5.2	5.07	4.64	4.67	0.32%	4.60	4.96
Silver (Ag)-Total	mg/L	0.0001-0.003 (d)	ND	ND	<0.00005	<0.000050	<0.000050	<0.000010	<0.000010	<0.000010	-	<0.000010	<0.000010
Sodium (Na)-Total	mg/L	-	1.91	1.89	1.73	2.01	2.23	1.95	1.73	1.67	1.76%	1.89	1.86
Strontium - Total	mg/L	-	0.0961	0.0983	0.0894	0.101	0.1	0.0962	0.09330	0.09330	0.00%	0.09780	0.10300
Sulfur - Total	mg/L	-	ND	ND	<3.0	<3.0	<3.0	0.87	1.07	0.88	9.74%	0.87	0.76
Tellurium - Total	mg/L	-	-	-	<0.00020	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020	-	<0.00020	<0.00020
Thallium (Tl)-Total	mg/L	0.0008	ND	ND	<0.00002	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010	-	<0.000010	<0.000010
Thorium - Total	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Tin (Sn)-Total	mg/L	-	ND	ND	<0.00020	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Titanium (Ti)-Total	mg/L	-	ND	ND	<0.0050	<0.0050	<0.0050	<0.00030	<0.00030	<0.00030	-	<0.00030	<0.00030
Tungsten (W) - Total	mg/L	-	-	-	-	-	-	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Uranium (U)-Total	mg/L	0.0085	0.00011	ND	0.0001	0.000128	0.000113	0.000099	0.000112	0.000106	2.75%	0.000108	0.000116
Vanadium (V)-Total	mg/L	-	ND	ND	<0.0010	0.0012	0.0011	0.00092	0.00104	0.001	1.96%	0.00125	0.00103
Zinc (Zn)-Total	mg/L	0.033-0.34 (d,f)	ND	ND	<0.0040	<0.0040	0.0046	<0.0030	<0.0030	<0.0030	-	<0.0030	<0.0030
Zirconium - Total	mg/L	-	ND	ND	<0.00010	0.00058	<0.00010	<0.000060	<0.000060	<0.000060	-	0.000077	<0.000060
Dissolved Metals													
Aluminum (Al)-Dissolved	mg/L	0.023-0.1 (b,c)	ND	ND	<0.0050	<0.0050	<0.0050	<0.0010	0.0024	0.0022	4.35%	0.002	0.0022
Antimony (Sb)-Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Arsenic (As)-Dissolved	mg/L	-	0.00185	0.00159	0.00159	0.00174	0.00174	0.00182	0.00167	0.00173	1.76%	0.00188	0.00190
Barium (Ba)-Dissolved	mg/L	-	0.0215	0.0208	0.018	0.0197	0.0195	0.0228	0.02010	0.02050	0.99%	0.02050	0.02060
Beryllium (Be)-Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	ND	ND	<0.00010	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050	-	<0.000050	<0.000050
Boron (B)-Dissolved	mg/L	-	ND	ND	<0.004	<0.0050	0.0058	<0.010	<0.010	<0.010	-	<0.010	0.011
Cadmium (Cd)-Dissolved	mg/L	0.000027 - 0.00280 (d, f)	ND	ND	<0.00001	<0.000010	<0.000010	<0.0000050	<0.0000050	<0.0000050	-	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	mg/L	-	24.9	24.1	23.4	23.8	25.7	28.0	24.900	25.400	0.99%	26.200	25.700
Cesium (Cs) - Dissolved	mg/L	-	-	-	-	-	-	<0.000010	<0.000010	<0.000010	-	<0.000010	<0.000010
Chromium (Cr)-Dissolved	mg/L	-	ND	ND	<0.0005	0.00062	<0.00050	0.00028	0.00031	0.00031	0.00%	0.0004	0.00034
Cobalt (Co)-Dissolved	mg/L	-	ND	ND	<0.00005	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Copper (Cu)-Dissolved	mg/L	-	0.00083	0.00073	<0.0002	<0.00020	<0.00040	<0.00020	<0.00020	<0.00020	-	<0.00020	<0.00020
Iron (Fe)-Dissolved	mg/L	0.35	0.0060	ND	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010	<0.010
Lead (Pb)-Dissolved	mg/L	-	ND	0.000395	<0.0001	<0.00010	<0.00020	<0.000050	<0.000050	<0.000050	-	<0.000050	<0.000050
Lithium (Li)-Dissolved	mg/L	-	ND	0.00102	0.001	0.00104	0.00107	<0.0010	0.001	0.001	0.00%	<0.0010	0.0011
Magnesium (Mg)-Dissolved	mg/L	-	2.22	1.92	1.82	1.87	2.15	2.15	1.950	1.930	0.52%	2.030	2.030
Manganese (Mn)-Dissolved	mg/L	-	ND	0.00014	0.00026	0.00022	0.00034	<0.00010	0.00053	0.00052	0.95%	0.00054	0.00066
Mercury (Hg)-Dissolved	mg/L	-	ND	ND	<0.00002	-	<0.000010	<0.0000050	<0.0000050	<0.0000050	-	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	-	ND	0.000282	0.0003	0.00031	0.00027	0.000303	0.000296	0.000282	2.42%	0.000273	0.000301
Nickel (Ni)-Dissolved	mg/L	-	ND	ND	<0.0002	<0.00020	<0.00040	<0.00050	<0.00050	<0.00050	-	<0.00050	<0.00050
Phosphorus - Dissolved	mg/L	-	-	-	<0.05	<0.050	<0.050	<0.050	<0.050	<0.050	-	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	0.875	0.770	0.7	0.72	0.82	0.798	0.765	0.756	0.59%	0.790	0.792
Rubidium (Rb) - Dissolved	mg/L	-	-	-	-	-	-	0.00028	0.00027	0.00035	12.90%	0.00029	0.00028
Selenium (Se)-Dissolved	mg/L	-	0.00014	0.000111	<0.00050	<0.00050	<0.00050	0.000134	0.000127	0.000111	6.72%	0.00015	0.000114
Silicon - Dissolved	mg/L	-	4.58	4.28	4.8	4.6	4.9	4.55	4.680	4.630	0.54%	4.630	4.580
Silver (Ag)-Dissolved	mg/L	-	ND	ND	<0.00005	<0.000050	<0.000050	<0.000010	<0.000010	<0.000010	-	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	-	1.92	1.68	1.69	1.79	2	2.06	1.74	1.76	0.57%	1.87	1.96
Strontium - Dissolved	mg/L	-	0.0950	0.0946	0.0864	0.0896	0.0922	0.102	0.09360	0.09480	0.64%	0.09770	0.10200
Sulfur- Dissolved	mg/L	-	ND	ND	<3.0	<3.0	<3.0	0.54	0.84	0.78	3.70%	0.62	0.84
Tellurium - Dissolved	mg/L	-	-	-	<0.00020	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020	-	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	ND	ND	<0.00002	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010	-	<0.000010	<0.000010
Thorium - Dissolved	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	-	ND	ND	<0.00011	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Titanium (Ti)-Dissolved	mg/L	-	ND	ND	<0.00012	<0.0050	<0.0050	<0.00030	<0.00030	<0.00030	-	<0.00030	<0.00030
Tungsten (W) - Dissovled	mg/L	-	-	-	-	-	-	<0.00010	<0.00010	<0.00010	-	<0.00010	<0.00010
Uranium (U)-Dissolved	mg/L	-	0.00011	0.000108	<0.00013	0.000117	0.000099	0.000111	0.000107	0.000105	0.94%	0.000103	0.00011
Vanadium (V)-Dissolved	mg/L	-	ND	0.00116	<0.00014	<0.0010	<0.0010	0.00092	0.00094	0.00095	0.53%	0.00096	0.00091
Zinc (Zn)-Dissolved	mg/L	-	ND	0.0016	<0.00015	<0.0040	<0.0040	<0.0010	<0.0010	<0.0010	-	<0.0010	<0.0010
Zirconium - Dissolved	mg/L	-	ND	ND	<0.00016	<0.00010	<0.00010	<0.000060	<0.000060	<0.000060	-	<0.000060	<0.000060

NOTES

(1) BC MoE Approved and Working Water Quality Guidelines, last updated March 2018
(2) BC Contaminated Sites Regulation (CSR) for protection of aquatic life or drinking water, Schedule 3.2, last updated July 2018
(3) All criteria limits for BCWQG - Aquatic Life Guidelines based on Total Metal Concentration except Aluminum (Dissolved) and Cadmium (Dissolved)
(4) BC MoE Water Quality Guidelines for Protectionof Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows
** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

BCWQG-AW *BC MoE Quality Guidelines for Protection of Aquatic Life*

Table 18: Surface Water Quality Results Sampling Location SW-04 (Creek from Onion Lake at FSR)

		BC MoE Guidelines BCWQG-AW (1)	5-Jul-17	26-Sep-17	8-Nov-17	12-Apr-18	17-Jul-18	19-Nov-18
Field	**Units**							
Conductivity	uS/cm	-	97	70	44	56	85	50
pH	pH	-	6.5	7.6	7.8	7.5	7.2	7.8
Temperature	°C	-	11.8	10	2.3	2.5	16.8	4.4
Dissolved Oxygen	mg/L	-	9.41	14.1	13.7	13.4	1.9	10.8
Analyte	Units							
Conductivity	uS/cm	-	105	104	-	-	-	-
Hardness (as CaCO3)	mg/L	-	42.3	42.3	28.1	26.4	39.4	27.7
pH	pH	6.5-9.0	7.5	7.6	7.9	7.7	7.9	7.8
Total Suspended Solids	mg/L	25 mg/L (backgr. 25-250 mg/l)) (i)	<1.0	<1.0	-	-	-	-
Total Dissolved Solids	mg/L	-	53	76	-	-	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	42	40	-	-	-	-
Ammonia, Total (as N)	mg/L	2.0-26.5 (a)	<0.03	<0.03	<0.0050	0.0058	<0.0050	<0.0050
Total Nitrogen as N	mg/L	-	<0.0500	0.066	<0.050	-	-	-
Bromide (Br)	mg/L	-	-	-	-	<0.050	-	<0.050
Chloride (Cl)	mg/L	600, MAC	6.1	6.1	4.13	13.8	10.8	7.02
Fluoride (F)	mg/L	0.7-1.9 (d)	<0.10	<0.10	0.038	0.035	0.039	0.038
Nitrate (as N)	mg/L	32.8	<0.01	<0.01	<0.0050	0.0054	0.0842	<0.0050
Nitrite (as N)	mg/L	0.06-0.6 (h)	<0.01	<0.01	<0.0010	<0.0010	<0.0010	<0.0010
Sulfate (SO4)	mg/L	128-429 (d)	1.7	1.4	1.22	0.87	<0.30	0.9
Total Organic Carbon	mg/L	+/- 20% of background	<0.50	1.53	-	1.94	-	-
BOD	mg/L	-	<4.0	<4.0	<2.0	<2.0	<2.0	<2.0
COD	mg/L	-	-	-	<20	<20	<20	<20
Total Metals								
Aluminum (Al)-Total	mg/L	-	0.0061	0.0166	0.0140	0.0353	0.3660	0.0257
Antimony (Sb)-Total	mg/L	0.009	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)-Total	mg/L	0.005	0.00184	0.00192	0.00135	0.00104	0.00461	0.00133
Barium (Ba)-Total	mg/L	1	0.0121	0.0129	0.00997	0.01060	0.02680	0.01040
Beryllium (Be)-Total	mg/L	0.00013	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth	mg/L	-	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Total	mg/L	1.2	<0.0050	0.0117	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)-Total	mg/L	-	<0.000010	<0.000010	<0.0000050	<0.0000050	0.0000151	<0.0000050
Calcium (Ca)-Total	mg/L	<4 sensitive to acid input	12.6	15.1	11.3	8.4	14.8	10.0
Cesium (Cs) - Total	mg/L	-	-	-	<0.000010	<0.000010	0.000022	<0.000010
Chromium (Cr)-Total	mg/L	0.001 (e)	<0.00050	0.00053	0.00015	0.00018	0.00073	0.00019
Cobalt (Co)-Total	mg/L	0.11	<0.00010	<0.00010	<0.00010	<0.00010	0.00037	<0.00010
Copper (Cu)-Total	mg/L	0.0032-0.0396 (d,f)	<0.00020	<0.00040	<0.00050	<0.00050	0.00073	<0.00050
Iron (Fe)-Total	mg/L	1	<0.010	0.064	0.025	0.055	0.795	0.068
Lead (Pb)-Total	mg/L	0.011-0.402 (d,f)	<0.00010	<0.00020	<0.000050	<0.000050	0.000325	<0.000050
Lithium (Li)-Total	mg/L	-	0.00039	0.00047	<0.0010	<0.0010	<0.0010	<0.0010
Magnesium (Mg)-Total	mg/L	-	0.934	1.12	0.853	0.714	1.210	0.856
Manganese (Mn)-Total	mg/L	0.8-3.4 (d,f)	0.00109	0.0154	0.00606	0.0094	0.2440	0.0174
Mercury (Hg)-Total	mg/L	0.0001	-	<0.000010	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Total	mg/L	2	0.00021	0.00023	0.000163	0.000141	0.000242	0.000121
Nickel (Ni)-Total	mg/L	0.025-0.15 (d,f)	<0.00020	<0.00040	<0.00050	<0.00050	0.00059	<0.00050
Phosphorus - Total	mg/L	0.005-0.015 (lakes only)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Total	mg/L	-	0.43	0.72	0.509	0.520	0.544	0.511
Rubidium (Rb) - Total	mg/L	-	-	-	0.00043	0.00048	0.00064	0.00051
Selenium (Se)-Total	mg/L	0.002	<0.00050	<0.00050	0.000055	0.00005	0.000169	<0.000050
Silicon - Total	mg/L	-	4.2	4.6	4.19	3.34	4.65	4.17
Silver (Ag)-Total	mg/L	0.0001-0.003 (d)	<0.000050	<0.000050	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Total	mg/L	-	4.17	4.57	3.58	7.70	6.97	4.29
Strontium - Total	mg/L	-	0.0542	0.0594	0.0461	0.04320	0.06900	0.04820
Sulfur - Total	mg/L	-	<3.0	<3.0	0.51	0.5	<0.50	<0.50
Tellurium - Total	mg/L	-	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Total	mg/L	0.0008	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010	<0.000010
Thorium - Total	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Total	mg/L	-	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Total	mg/L	-	<0.0050	<0.0050	<0.00030	0.00062	0.00970	0.00047
Tungsten (W) - Total	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010
Uranium (U)-Total	mg/L	0.0085	0.000047	0.000033	0.000025	0.000023	0.000195	0.000021
Vanadium (V)-Total	mg/L	-	<0.0010	<0.0010	<0.00050	0.00054	0.00263	0.00052
Zinc (Zn)-Total	mg/L	0.033-0.34 (d,f)	<0.0040	<0.0040	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium - Total	mg/L	-	<0.00010	<0.00010	<0.000060	<0.000060	<0.000060	<0.000060
Dissolved Metals								
Aluminum (Al)-Dissolved	mg/L	0.023-0.1 (b,c)	0.0168	0.0071	0.0123	0.0261	0.0061	0.0134
Antimony (Sb)-Dissolved	mg/L	-	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)-Dissolved	mg/L	-	0.0021	0.00181	0.00129	0.00095	0.00163	0.00124
Barium (Ba)-Dissolved	mg/L	-	0.0136	0.0117	0.0103	0.01190	0.01540	0.01030
Beryllium (Be)-Dissolved	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bisumuth - Dissolved	mg/L	-	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	mg/L	-	0.0058	0.0067	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)-Dissolved	mg/L	0.000027 - 0.00280 (d, f)	<0.000010	<0.000010	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)-Dissolved	mg/L	-	15.2	13.4	9.80	9.310	14.100	9.650
Cesium (Cs) -Dissolved	mg/L	-	-	-	<0.000010	<0.000010	<0.000010	<0.000010
Chromium (Cr)-Dissolved	mg/L	-	<0.00050	<0.00050	0.00013	0.00011	0.00014	0.00015
Cobalt (Co)-Dissolved	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)-Dissolved	mg/L	-	<0.00020	<0.00040	<0.00020	<0.00020	<0.00020	<0.00020
Iron (Fe)-Dissolved	mg/L	0.35	0.045	0.032	0.013	0.022	0.018	0.032
Lead (Pb)-Dissolved	mg/L	-	<0.00010	<0.00020	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Dissolved	mg/L	-	0.00051	0.0004	<0.0010	<0.0010	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	1.06	1.05	0.893	0.775	1.020	0.879
Manganese (Mn)-Dissolved	mg/L	-	0.0119	0.00588	0.00247	0.00378	0.00734	0.00841
Mercury (Hg)-Dissolved	mg/L	-	<0.000020	<0.000010	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	mg/L	-	0.00023	0.00022	0.000153	0.000112	0.000197	0.000144
Nickel (Ni)-Dissolved	mg/L	-	<0.00020	<0.00040	<0.00050	<0.00050	<0.00050	<0.00050
Phosphorus - Dissolved	mg/L	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	0.51	0.66	0.487	0.571	0.498	0.514
Rubidium (Rb) - Dissolved	mg/L	-	-	-	0.00038	0.00045	0.00044	0.00047
Selenium (Se)-Dissolved	mg/L	-	<0.00050	<0.00050	<0.000050	<0.000050	0.000057	<0.000050
Silicon - Dissolved	mg/L	-	4.6	4.4	4.01	3.430	4.280	4.170
Silver (Ag)-Dissolved	mg/L	-	<0.000050	<0.000050	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	mg/L	-	4.7	4.34	3.82	8.00	6.55	4.40
Strontium - Dissolved	mg/L	-	0.0627	0.0567	0.0474	0.04400	0.06490	0.04840
Sulfur- Dissolved	mg/L	-	<3.0	<3.0	<0.50	<0.50	<0.50	<0.50
Tellurium - Dissolved	mg/L	-	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Dissolved	mg/L	-	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010	<0.000010
Thorium - Dissovled	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Dissolved	mg/L	-	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Dissolved	mg/L	-	<0.0050	<0.0050	<0.00030	<0.00030	<0.00030	<0.00030
Tungsten (W) - Dissolved	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010
Uranium (U)-Dissolved	mg/L	-	0.000062	0.000027	0.000026	0.000017	0.000031	0.00002
Vanadium (V)-Dissolved	mg/L	-	<0.0010	<0.0010	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved	mg/L	-	<0.0040	<0.0040	<0.0010	<0.0010	0.001	<0.0010
Zirconium - Dissolved	mg/L	-	<0.00010	<0.00010	<0.000060	<0.000060	<0.000060	<0.000060

NOTES

(1) BC MoE Approved and Working Water Quality Guidelines, last updated March 2018
(2) BC Contaminated Sites Regulation (CSR) for protection of aquatic life or drinking water, Schedule 3.2, last updated July 2018
(3) All criteria limits for BCWQG - Aquatic Life Guidelines based on Total Metal Concentration except Aluminum (Dissolved) and Cadmium (Dissolved)
(4) BC MoE Water Quality Guidelines for Protectionof Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows
** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

BCWQG-AW *BC MoE Quality Guidelines for Protection of Aquatic Life*

Table 19: Surface Water Quality Results Sampling Location SW-05 (Clearwater Creek at FSR)

		BC MoE Guidelines BCWQG-AW (1)	5-Jul-17	26-Sep-17	8-Nov-17	12-Apr-18	17-Jul-18	19-Nov-18	19-Nov-18	
Field	**Units**							Sample	Duplicate	RPD
Conductivity	uS/cm	-	148	106	93	91	117	97	-	-
pH	pH	-	6	8.1	8.0	7.5	7.7	6.8	-	-
Temperature	°C	-	11.8	9.1	4.1	4.6	12.1	5.2	-	-
Dissolved Oxygen	mg/L	-	9.41	15.5	13.5	13.1	5.3	9.3	-	-
Analyte	Units									
Conductivity	uS/cm	-	162	162	-	-	-	-	-	-
Hardness (as CaCO3)	mg/L	-	73.9	82.7	72.8	74.8	73.6	72.1	72.1	0.00%
pH	pH	6.5-9.0	7.9	8	8.2	7.9	6.6	8.1	8.2	0.37%
Total Suspended Solids	mg/L	25 mg/L (backgr. 25-250 mg/l)) (i)	3.3	2.4	-	-	-	-	-	-
Total Dissolved Solids	mg/L	-	78	94	-	-	-	-	-	-
Alkalinity, Bicarbonate (as CaCO3)	mg/L	-	-	-	-	-	-	-	-	-
Alkalinity, Carbonate (as CaCO3)	mg/L	-	-	-	-	-	-	-	-	-
Alkalinity, Hydroxide (as CaCO3)	mg/L	-	-	-	-	-	-	-	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	78	78	-	-	-	-	-	-
Ammonia, Total (as N)	mg/L	2.0-26.5 (a)	<0.03	<0.03	<0.0050	0.0057	<0.0050	<0.0050	<0.0050	-
Total Nitrogen as N	mg/L	-	-	-	-	-	-	-	-	-
Bromide (Br)	mg/L	-	-	-	<0.050	<0.050		<0.050	<0.050	-
Chloride (Cl)	mg/L	600, MAC	1.5	1.4	1.37	1.05	1.05	1.12	1.12	0.00%
Fluoride (F)	mg/L	0.7-1.9 (d)	<0.10	<0.1	0.056	0.052	0.051	0.053	0.05	2.91%
Nitrate (as N)	mg/L	32.8	<0.010	0.014	0.0179	0.0129	<0.0050	0.0188	0.0161	7.74%
Nitrite (as N)	mg/L	0.06-0.6 (h)	<0.01	<0.01	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-
Sulfate (SO4)	mg/L	128-429 (d)	3.1	2.7	2.86	2.66	2.54	2.48	2.39	1.85%
Total Organic Carbon	mg/L	+/- 20% of background	<0.50	0.88	-	0.54		-	-	-
BOD	mg/L	-	<4.0	<4.0	<2.0	<2.0	<2.0	<2.0	<2.0	-
COD	mg/L	-	-	-	<20	<20	<20	<20	<20	-
Total Metals										
Aluminum (Al)-Total	mg/L	-	0.0104	0.0076	0.0607	0.0067	0.0064	0.0073	0.0070	2.10%
Antimony (Sb)-Total	mg/L	0.009	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Arsenic (As)-Total	mg/L	0.005	0.00184	0.00181	0.00197	0.00173	0.00202	0.00178	0.00186	2.20%
Barium (Ba)-Total	mg/L	1	0.0213	0.0205	0.0213	0.01890	0.02130	0.02120	0.02050	1.68%
Beryllium (Be)-Total	mg/L	0.00013	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Bismuth	mg/L	-	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	-
Boron (B)-Total	mg/L	1.2	0.0104	0.0099	<0.010	<0.010	<0.010	<0.010	<0.010	-
Cadmium (Cd)-Total	mg/L	-	<0.000010	<0.000010	0.0000294	<0.0000050	<0.0000050	<0.0000050	<0.0000050	-
Calcium (Ca)-Total	mg/L	<4 sensitive to acid input	25.8	28.9	27.5	23.1	25.8	24.7	26.2	2.95%
Cessium (Cs) - Total	mg/L	-	-	-	0.000011	<0.000010	<0.000010	<0.000010	<0.000010	-
Chromium (Cr)-Total	mg/L	0.001 (e)	<0.00050	0.00068	0.00046	0.00034	0.00046	0.00036	0.00037	1.37%
Cobalt (Co)-Total	mg/L	0.11	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Copper (Cu)-Total	mg/L	0.0032-0.0396 (d,f)	<0.00020	<0.00040	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-
Iron (Fe)-Total	mg/L	1	0.01	0.01	0.086	<0.010	0.010	<0.010	<0.010	-
Lead (Pb)-Total	mg/L	0.011-0.402 (d,f)	<0.00010	<0.00020	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	-
Lithium (Li)-Total	mg/L	-	0.00122	0.00122	0.0011	0.0011	0.0011	0.0011	0.001	4.76%
Magnesium (Mg)-Total	mg/L	-	2.28	2.55	2.65	2.190	2.440	2.280	2.200	1.79%
Manganese (Mn)-Total	mg/L	0.8-3.4 (d,f)	0.00133	0.00146	0.00659	0.0006	0.0015	0.0012	0.0014	6.42%
Mercury (Hg)-Total	mg/L	0.0001	<0.000020	<0.000010	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	-
Molybdenum (Mo)-Total	mg/L	2	0.0004	0.00038	0.000336	0.000354	0.000393	0.00038	0.000372	1.06%
Nickel (Ni)-Total	mg/L	0.025-0.15 (d,f)	<0.00020	<0.00040	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-
Phosphorus - Total	mg/L	0.005-0.015 (lakes only)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-
Potassium (K)-Total	mg/L	-	0.89	0.99	0.981	0.859	0.920	0.936	0.896	2.18%
Rubidium (Rb)- Total	mg/L	-	-	-	0.00040	0.00029	0.00033	0.00034	0.00038	5.56%
Selenium (Se)-Total	mg/L	0.002	<0.00050	<0.00050	0.000151	0.000102	0.000151	0.000118	0.000124	2.48%
Silicon - Total	mg/L	-	4.9	5	4.81	4.65	4.73	4.78	4.69	0.95%
Silver (Ag)-Total	mg/L	0.0001-0.003 (d)	0.000062	<0.000050	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Sodium (Na)-Total	mg/L	-	2.07	2.31	2.32	2.11	2.16	2.15	2.19	0.92%
Strontium - Total	mg/L	-	0.104	0.0995	0.101	0.09660	0.10300	0.10200	0.09940	1.29%
Sulfur - Total	mg/L	-	3.2	<3.0	1.05	0.71	0.81	0.78	0.55	17.29%
Tellurium - Total	mg/L	-	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	-
Thallium (Tl)-Total	mg/L	0.0008	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Thorium - Total	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Tin (Sn)-Total	mg/L	-	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Titanium (Ti)-Total	mg/L	-	<0.0050	<0.0050	<0.0021	<0.00030	<0.00030	<0.00030	<0.00030	-
Tungsten (W) - Total	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Uranium (U)-Total	mg/L	0.0085	0.000164	0.000147	0.000148	0.000138	0.000156	0.000166	0.000155	3.43%
Vanadium (V)-Total	mg/L	-	0.0012	0.001	0.00106	0.00109	0.00118	0.00097	0.00095	1.04%
Zinc (Zn)-Total	mg/L	0.033-0.34 (d,f)	<0.0040	<0.0040	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	-
Zirconium - Total	mg/L	-	<0.00010	<0.00010	<0.000060	<0.000060	<0.000060	<0.000060	<0.000060	-
Dissolved Metals										
Aluminum (Al)-Dissolved	mg/L	0.023-0.1 (b,c)	<0.0050	<0.0050	0.0044	0.0056	0.0026	0.0032	0.00310	1.59%
Antimony (Sb)-Dissolved	mg/L	-	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Arsenic (As)-Dissolved	mg/L	-	0.00172	0.00183	0.00181	0.00176	0.00185	0.00185	0.00199	3.65%
Barium (Ba)-Dissolved	mg/L	-	0.0194	0.0199	0.0219	0.02130	0.02000	0.02100	0.0201	2.19%
Beryllium (Be)-Dissolved	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Bisumuth - Dissolved	mg/L	-	<0.00010	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	-
Boron (B)-Dissolved	mg/L	-	0.0052	0.0073	<0.010	<0.010	<0.010	<0.010	<0.010	-
Cadmium (Cd)-Dissolved	mg/L	0.000027 - 0.00280 (d, f)	<0.000010	<0.000010	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	-
Calcium (Ca)-Dissolved	mg/L	-	23	26.5	25.2	26.200	25.800	25.100	25.1	0.00%
Cessium (Cs) - Dissolved	mg/L	-	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Chromium (Cr)-Dissolved	mg/L	-	<0.00050	<0.00050	0.00035	0.00051	0.00033	0.00036	0.00031	7.46%
Cobalt (Co)-Dissolved	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Copper (Cu)-Dissolved	mg/L	-	<0.00020	<0.00040	0.00033	<0.00020	0.00025	<0.00020	<0.00020	-
Iron (Fe)-Dissolved	mg/L	0.35	<0.010	<0.010	<0.010	<0.010	<0.010	0.012	<0.010	-
Lead (Pb)-Dissolved	mg/L	-	<0.00010	<0.00020	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	-
Lithium (Li)-Dissolved	mg/L	-	0.00101	0.00114	<0.0010	0.0011	0.001	0.001	0.001	0.00%
Magnesium (Mg)-Dissolved	mg/L	-	2	2.54	2.38	2.250	2.210	2.270	2.27	0.00%
Manganese (Mn)-Dissolved	mg/L	-	<0.00020	0.00038	<0.00010	0.00033	0.00073	0.00221	0.00056	59.57%
Mercury (Hg)-Dissolved	mg/L	-	-	<0.000010	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	-
Molybdenum (Mo)-Dissolved	mg/L	-	0.00038	0.00039	0.000395	0.000367	0.00036	0.000379	0.000	0.66%
Nickel (Ni)-Dissolved	mg/L	-	<0.00020	<0.00040	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	-
Phosphorus - Dissolved	mg/L	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-
Potassium (K)-Dissolved	mg/L	-	0.78	0.96	0.925	0.893	0.881	0.906	0.893	0.72%
Rubidium (Rb)-Dissovled	mg/L	-	-	-	0.00040	0.00034	0.00034	0.00029	0.00032	4.92%
Selenium (Se)-Dissolved	mg/L	-	<0.00050	<0.00050	0.000120	0.000138	0.000158	0.000141	0.00	7.63%
Silicon - Dissolved	mg/L	-	4.6	5	4.60	4.640	4.540	4.570	4.68000	1.19%
Silver (Ag)-Dissolved	mg/L	-	<0.000050	<0.000050	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Sodium (Na)-Dissolved	mg/L	-	1.86	2.32	2.41	2.01	2.05	2.17	2.11	1.40%
Strontium - Dissolved	mg/L	-	0.091	0.101	0.103	0.10000	0.10000	0.10200	0.101	0.49%
Sulfur- Dissolved	mg/L	-	<3.0	<3.0	0.79	0.83	0.85	0.85	0.79	3.66%
Tellurium - Dissolved	mg/L	-	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	-
Thallium (Tl)-Dissolved	mg/L	-	<0.000020	<0.000020	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Thorium - Dissovled	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Tin (Sn)-Dissolved	mg/L	-	<0.00020	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Titanium (Ti)-Dissolved	mg/L	-	<0.0050	<0.0050	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	-
Tungsten (W) -Dissovled	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	-
Uranium (U)-Dissolved	mg/L	-	0.00015	0.000135	0.000149	0.000148	0.000144	0.000144	0.000144	0.00%
Vanadium (V)-Dissolved	mg/L	-	<0.0010	<0.0010	0.00088	0.00091	0.00086	0.00087	0.00088	0.57%
Zinc (Zn)-Dissolved	mg/L	-	<0.0040	0.0043	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	-
Zirconium - Dissolved	mg/L	-	<0.00010	<0.00010	<0.000060	<0.000060	<0.000060	<0.000060	<0.000060	-

NOTES

(1) BC MoE Approved and Working Water Quality Guidelines, last updated March 2018
(2) BC Contaminated Sites Regulation (CSR) for protection of aquatic life or drinking water, Schedule 3.2, last updated July 2018
(3) All criteria limits for BCWQG - Aquatic Life Guidelines based on Total Metal Concentration except Aluminum (Dissolved) and Cadmium (Dissolved)
(4) BC MoE Water Quality Guidelines for Protectionof Wildlife
(a) Range based on max pH 8.5 to min pH 6.5 at temperature of 6.0 'C
(b) at pH less than 6.5, limit is determined by regression equation, else limit is 0.1 mg/L.
(c) Limit for dissolved metals, not total metals
(d) Limit dependent upon hardness.
(e) Limit for chromium(VI) - data reported by lab as total chromium - limit assumes 100% chromium VI in sample
(f) Where hardness data was unavailable, 50 mg/L was assumed
(g) Maximum value
(h) Limit dependent upon chloride concentration
(i) Change of 25 mg/L from background for a duration of 24 hours during clear flows. Change of 10% of background during turbid flows
** Criteria exceeds detection limit*
MAC = Maximum Acceptable Concentration
AO = Aesthetic Objective

BCWQG-AW *BC MoE Quality Guidelines for Protection of Aquatic Life*

Table 20: Forceman Ridge Precipitation and Leachate Generation Rates

Design Precipitation		
Global Warming Factor	15%	
Design Average Precipitation	1986	mm/year
Design Extreme Ratio	1.4	
Design Extreme Precipitation	2781	mm/year
Leachate Production (HELP)		
Average Condition		
Active Areas	1413	mm/year
Temporary Closed Areas	353	mm/year
Geomembrane Capped Areas	0.43	mm/year
Extreme Condition		
Active Areas	1957	mm/year
Temporary Closed Areas	489	mm/year
Geomembrane Capped Areas	0.86	mm/year

Table 21: Leachate Water Quality Results Sampling Location F1, Raw Leachate

		BC MOE				
Field	**Units**	**OC Criteria**	**6-Jun-17**	**5-Jul-17**	**18-May-18**	**16-Jul-18**
Conductivity	uS/cm	-	283	3050	3,750	-
pH	pH	-	5.4	5.7	5.6	-
Temperature	°C	-	14.1	13.2	9.6	-
Dissolved Oxygen	mg/L	-	-	2.4	-	-
Turbidity	NTU	-	-	-	-	-
Analyte	Units					
Conductivity	uS/cm	-	3,040	3,250	-	-
Hardness (as CaCO3)	mg/L	-	920	990	-	2020
pH	pH	6.5 - 8.5	5.6	5.6	-	6.16
Total Suspended Solids	mg/L	-	8.7	7	-	-
Total Dissolved Solids	mg/L	-	1500	1600	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	860	950	-	2160
Ammonia, Total (as N)	mg/L	214	51.8	54.1	-	160
Total Nitrogen as N	mg/L	-	60.9	49.6	-	-
Bromide (Br)	mg/L	-	-	-	-	3.8
Chloride (Cl)	mg/L	5000	238	242	-	408
Fluoride (F)	mg/L	-	<0.10	<0.10	-	<0.40
Nitrate (as N)	mg/L	-	<0.01	<0.010	-	<0.10
Nitrite (as N)	mg/L	-	<0.01	0.02	-	0.042
Sulfate (SO4)	mg/L	-	80	48.2	-	<6.0
Orthophosphorus (P)	mg/L	-	-	-	-	<0.020
Total Organic Carbon	mg/L	-	1290	1310	-	2100
BOD	mg/L	-	>540	>1120	-	3840
COD	mg/L	-	-	-	-	6290
Total Metals						
Aluminum (Al)-Total	mg/L	-	3.89	1.35	-	0.279
Antimony (Sb)-Total	mg/L	-	0.00252	0.00159	-	0.003
Arsenic (As)-Total	mg/L	-	0.00535	0.00605	-	0.0122
Barium (Ba)-Total	mg/L	-	0.781	1.49	-	2.86
Beryllium (Be)-Total	mg/L	-	0.00027	0.00024	-	<0.0020
Bismuth	mg/L	-	<0.00010	<0.00010	-	<0.0010
Boron (B)-Total	mg/L	-	0.833	0.731	-	2.1
Cadmium (Cd)-Total	mg/L	0.1	0.000327	0.000133	-	<0.00010
Calcium (Ca)-Total	mg/L	-	309	334	-	699
Cessium (Cs) - Total	mg/L	-	-	-	-	0.00069
Chromium (Cr)-Total	mg/L	-	0.0353	0.0266	-	0.0288
Cobalt (Co)-Total	mg/L	-	0.164	0.131	-	0.0318
Copper (Cu)-Total	mg/L	-	0.0028	0.00123	-	<0.010
Iron (Fe)-Total	mg/L	6	49.5	62.4	118	161
Lead (Pb)-Total	mg/L	-	0.00094	0.00052	-	<0.0010
Lithium (Li)-Total	mg/L	-	0.00157	0.00123	-	<0.020
Magnesium (Mg)-Total	mg/L	-	36	37.5	-	68.1
Manganese (Mn)-Total	mg/L	-	44.5	119	-	83.7
Mercury (Hg)-Total	mg/L	-	<0.00002	<0.000020	-	<0.0000050
Molybdenum (Mo)-Total	mg/L	-	0.00199	0.00055	-	<0.0010
Nickel (Ni)-Total	mg/L	-	0.0575	0.0392	-	0.024
Phosphorus - Total	mg/L	-	0.701	0.35	-	<1.0
Potassium (K)-Total	mg/L	-	64.7	65.5	-	130
Rubidium (Rb) - Total	mg/L	-	-	-	-	0.147
Selenium (Se)-Total	mg/L	-	<0.00050	0.00076	-	<0.0010
Silicon - Total	mg/L	-	9.4	9.9	-	10.5
Silver (Ag)-Total	mg/L	-	<0.000050	0.000063	-	<0.00020
Sodium (Na)-Total	mg/L	-	217	215	-	414
Strontium - Total	mg/L	-	0.897	1.05	-	2.63
Sulfur - Total	mg/L	-	37.8	13	-	<10
Tellurium - Total	mg/L	-	<0.00020	<0.00020	-	<0.0040
Thallium (Tl)-Total	mg/L	-	0.000062	0.000023	-	<0.00020
Thorium - Total	mg/L	-	0.00018	<0.00010	-	<0.0020
Tin (Sn)-Total	mg/L	-	0.00046	0.00024	-	<0.0020
Titanium (Ti)-Total	mg/L	-	0.104	0.025	-	<0.013
Tungston (W) - Total	mg/L	-	-	-	-	<0.0020
Uranium (U)-Total	mg/L	-	0.000191	0.000079	-	<0.00020
Vanadium (V)-Total	mg/L	-	0.02	0.0204	-	0.025
Zinc (Zn)-Total	mg/L	100	0.202	0.0814	-	<0.060
Zirconium - Total	mg/L	-	0.00153	0.00114	-	<0.0012
Dissolved Metals						
Aluminum (Al)-Dissolved	mg/L	-	3.24	0.222	-	-
Antimony (Sb)-Dissolved	mg/L	-	0.00173	0.00094	-	-
Arsenic (As)-Dissolved	mg/L	-	0.00352	0.00293	-	-
Barium (Ba)-Dissolved	mg/L	-	0.7340	1.3300	-	-
Beryllium (Be)-Dissolved	mg/L	-	0.00025	0.00015	-	-
Bisumuth - Dissolved	mg/L	-	<0.00010	<0.00010	-	-
Boron (B)-Dissolved	mg/L	-	0.734	0.647	-	-
Cadmium (Cd)-Dissolved	mg/L	-	0.000041	<0.000010	-	-
Calcium (Ca)-Dissolved	mg/L	-	285.00	291.00	-	-
Cesium (Cs) - Dissolved	mg/L	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	-	0.0334	0.01	-	-
Cobalt (Co)-Dissolved	mg/L	-	0.155	0.122	-	-
Copper (Cu)-Dissolved	mg/L	-	0.00083	<0.00020	-	-
Iron (Fe)-Dissolved	mg/L	-	47.1	30.7	106	-
Lead (Pb)-Dissolved	mg/L	-	0.0002	<0.00010	-	-
Lithium (Li)-Dissolved	mg/L	-	0.00137	0.00314	-	-
Magnesium (Mg)-Dissolved	mg/L	-	33.3	33.1	-	-
Manganese (Mn)-Dissolved	mg/L	-	40.2	99.4	-	-
Mercury (Hg)-Dissolved	mg/L	-	<0.00002	-	-	-
Molybdenum (Mo)-Dissolved	mg/L	-	0.00092	<0.00010	-	-
Nickel (Ni)-Dissolved	mg/L	-	0.0538	0.0362	-	-
Phosphorus - Dissolved	mg/L	-	0.48	0.16	-	-
Potassium (K)-Dissolved	mg/L	-	62.400	62.000	-	-
Rubidium (Rd) - Dissolved	mg/L	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	-	<0.00050	0.00076	-	-
Silicon - Dissolved	mg/L	-	8.8	8.6	-	-
Silver (Ag)-Dissolved	mg/L	-	<0.000050	<0.000050	-	-
Sodium (Na)-Dissolved	mg/L	-	203	193	-	-
Strontium - Dissolved	mg/L	-	0.87	0.899	-	-
Sulfur- Dissolved	mg/L	-	35.3	9.7	-	-
Tellurium - Dissolved	mg/L	-	<0.00020	<0.00020	-	-
Thallium (Tl)-Dissolved	mg/L	-	<0.000020	0.000021	-	-
Thorium - Dissolved	mg/L	-	0.00013	<0.00010	-	-
Tin (Sn)-Dissolved	mg/L	-	<0.00020	<0.00020	-	-
Titanium (Ti)-Dissolved	mg/L	-	0.072	<0.0050	-	-
Tungston (W) - Dissolved	mg/L	-	-	-	-	-
Uranium (U)-Dissolved	mg/L	-	0.000166	0.000031	-	-
Vanadium (V)-Dissolved	mg/L	-	0.018	<0.0010	-	-
Zinc (Zn)-Dissolved	mg/L	-	0.0234	0.0459	-	-
Zirconium - Dissolved	mg/L		0.00114	0.00018	-	-

OC Criteria — Shaded Value Means Exceeded Discharge Criteria (OC)

Table 22: Leachate Water Quality Results Sampling Location F2, Raw Septage

		MC MOE				
Field	**Units**	**OC Criteria**	**5-Jul-17**	**15-Aug-17**	**18-May-18**	**16-Jul-18**
Conductivity	uS/cm	-	-	26600	250	-
pH	pH	-	4.7	4.8	6.9	-
Temperature	°C	-	14.3	14.5	18.1	-
Dissolved Oxygen	mg/L	-	1.5	12.9	-	-
Turbidity	NTU	-	-	-	-	-
Analyte	Units					
Conductivity	uS/cm	-	23000	26400	-	-
Hardness (as CaCO3)	mg/L	-	7210	8330	-	8420
pH	pH	6.5 - 8.5	4.8	4.6	-	4.9
Total Suspended Solids	mg/L	-	1400	580	-	-
Total Dissolved Solids	mg/L	-	11000	13000	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	1500	780	-	2330
Ammonia, Total (as N)	mg/L	214	1,420	1,640	-	922
Total Nitrogen as N	mg/L	-	3210	3890	-	-
Bromide (Br)	mg/L	-	-	-	-	13.2
Chloride (Cl)	mg/L	5000	2740	3010	-	1430
Fluoride (F)	mg/L	-	0.19	0.12	-	1.1
Nitrate (as N)	mg/L	-	<0.50	0.38	-	0.26
Nitrite (as N)	mg/L	-	<0.50	<0.20	-	<0.050
Sulfate (SO4)	mg/L	-	1030	471	-	560
Orthophosphorus (P)	mg/L	-	-	-	-	236
Total Organic Carbon	mg/L	-	36600	42000	-	20100
BOD	mg/L	-	>2230	>2270	-	32300
COD	mg/L	-	-	-	-	54700
Total Metals						
Aluminum (Al)-Total	mg/L	-	31.3	32.4	-	25.7
Antimony (Sb)-Total	mg/L	-	0.0207	0.0121	-	0.0176
Arsenic (As)-Total	mg/L	-	0.184	0.144	-	0.144
Barium (Ba)-Total	mg/L	-	1.33	1.14	-	0.942
Beryllium (Be)-Total	mg/L	-	0.00069	<0.00100	-	<0.0020
Bismuth	mg/L	-	0.00026	<0.00100	-	<0.0010
Boron (B)-Total	mg/L	-	5.51	3.01	-	1.56
Cadmium (Cd)-Total	mg/L	0.1	0.0282	0.0174	-	0.0109
Calcium (Ca)-Total	mg/L	-	2390	2630	-	2620
Cessium (Cs) - Total	mg/L	-	-	-	-	0.00731
Chromium (Cr)-Total	mg/L	-	0.151	0.143	-	0.171
Cobalt (Co)-Total	mg/L	-	0.146	0.166	-	0.141
Copper (Cu)-Total	mg/L	-	0.262	0.214	-	0.293
Iron (Fe)-Total	mg/L	6	172	221	1.82	226
Lead (Pb)-Total	mg/L	-	0.0245	0.0153	-	0.0267
Lithium (Li)-Total	mg/L	-	0.0596	0.0715	-	0.054
Magnesium (Mg)-Total	mg/L	-	401	464	-	454
Manganese (Mn)-Total	mg/L	-	41.7	41.8	-	33
Mercury (Hg)-Total	mg/L	-	0.000157	<0.000010	-	<0.00050
Molybdenum (Mo)-Total	mg/L	-	0.0738	0.0845	-	0.103
Nickel (Ni)-Total	mg/L	-	0.409	0.403	-	0.361
Phosphorus - Total	mg/L	-	489	582	-	549
Potassium (K)-Total	mg/L	-	3000	4220	-	3270
Rubidium (Rb) - Total	mg/L	-	-	-	-	2.14
Selenium (Se)-Total	mg/L	-	0.0133	0.0173	-	0.0193
Silicon - Total	mg/L	-	88.2	79.2	-	63.1
Silver (Ag)-Total	mg/L	-	<0.000050	<0.000500	-	0.00061
Sodium (Na)-Total	mg/L	-	1530	1580	-	1330
Strontium - Total	mg/L	-	7.01	5.72	-	5.35
Sulfur - Total	mg/L	-	335	303	-	284
Tellurium - Total	mg/L	-	<0.00020	<0.00500	-	<0.0040
Thallium (Tl)-Total	mg/L	-	0.00132	0.00104	-	0.00053
Thorium - Total	mg/L	-	0.0008	<0.00100	-	<0.0020
Tin (Sn)-Total	mg/L	-	0.00628	0.0122	-	0.011
Titanium (Ti)-Total	mg/L	-	1.48	1.86	-	1.82
Tungston (W) - Total	mg/L	-	-	-	-	0.0139
Uranium (U)-Total	mg/L	-	0.00291	0.00196	-	0.00135
Vanadium (V)-Total	mg/L	-	0.148	0.124	-	0.116
Zinc (Zn)-Total	mg/L	100	6.94	9.13	-	7.53
Zirconium - Total	mg/L	-	0.022	0.0206	-	0.0178
Dissolved Metals						
Aluminum (Al)-Dissolved	mg/L	-	9.51	14.7	-	-
Antimony (Sb)-Dissolved	mg/L	-	0.0216	0.0272	-	-
Arsenic (As)-Dissolved	mg/L	-	0.175	0.135	-	-
Barium (Ba)-Dissolved	mg/L	-	0.1680	0.2460	-	-
Beryllium (Be)-Dissolved	mg/L	-	0.0001	<0.00100	-	-
Bisumuth - Dissolved	mg/L	-	<0.00010	<0.00100	-	-
Boron (B)-Dissolved	mg/L	-	5.32	2.72	-	-
Cadmium (Cd)-Dissolved	mg/L	-	0.0245	0.0143	-	-
Calcium (Ca)-Dissolved	mg/L	-	2120.00	2590.00	-	-
Cesium (Cs) - Dissolved	mg/L	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	-	0.11	0.11	-	-
Cobalt (Co)-Dissolved	mg/L	-	0.139	0.159	-	-
Copper (Cu)-Dissolved	mg/L	-	0.201	0.151	-	-
Iron (Fe)-Dissolved	mg/L	-	47.6	91.2	1.11	-
Lead (Pb)-Dissolved	mg/L	-	0.00282	<0.00100	-	-
Lithium (Li)-Dissolved	mg/L	-	0.0512	0.058	-	-
Magnesium (Mg)-Dissolved	mg/L	-	463	448	-	-
Manganese (Mn)-Dissolved	mg/L	-	37.9	39.4	-	-
Mercury (Hg)-Dissolved	mg/L	-	-	0.000052	-	-
Molybdenum (Mo)-Dissolved	mg/L	-	0.0885	0.12	-	-
Nickel (Ni)-Dissolved	mg/L	-	0.395	0.382	-	-
Phosphorus - Dissolved	mg/L	-	375	461	-	-
Potassium (K)-Dissolved	mg/L	-	2690.000	3450.000	-	-
Rubidium (Rd) - Dissolved	mg/L	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	-	0.0147	0.0232	-	-
Silicon - Dissolved	mg/L	-	88.3	75.4	-	-
Silver (Ag)-Dissolved	mg/L	-	0.00006	<0.000500	-	-
Sodium (Na)-Dissolved	mg/L	-	1690	1560	-	-
Strontium - Dissolved	mg/L	-	5.58	4.81	-	-
Sulfur- Dissolved	mg/L	-	431	299	-	-
Tellurium - Dissolved	mg/L	-	<0.00020	<0.00500	-	-
Thallium (Tl)-Dissolved	mg/L	-	0.000913	0.000793	-	-
Thorium - Dissolved	mg/L	-	0.00019	<0.00100	-	-
Tin (Sn)-Dissolved	mg/L	-	0.00578	0.0174	-	-
Titanium (Ti)-Dissolved	mg/L	-	2.67	2.72	-	-
Tungston (W) - Dissolved	mg/L	-	-	-	-	-
Uranium (U)-Dissolved	mg/L	-	0.00047	0.000525	-	-
Vanadium (V)-Dissolved	mg/L	-	0.118	0.109	-	-
Zinc (Zn)-Dissolved	mg/L	-	6.72	8.54	-	-
Zirconium - Dissolved	mg/L	-	0.0073	0.0105	-	-

OC Criteria Shaded Value Means Exceeded Discharge Criteria (OC)

Table 23: Leachate Water Quality Results Sampling Location F3, Pond - Outflow

		MC MOE					
Field	**Units**	**OC Criteria**	**6-Jun-17**	**5-Jul-17**	**15-Aug-17**	**7-Nov-17**	**16-Jul-18**
Conductivity	uS/cm	-	472	720	701	-	-
pH	pH	-	5.1	6.4	5.9	-	-
Temperature	°C	-	13.8	10.6	14.1	-	-
Dissolved Oxygen	mg/L	-	-	2.8	12.2	-	-
Turbidity	NTU	-	-	-	-	-	-
Analyte	Units						
Conductivity	uS/cm	-	456	680	578	-	-
Hardness (as CaCO3)	mg/L	-	96	175	102	777	370
pH	pH	6.5 - 8.5	5.4	6.3	5.5	6.4	7.21
Total Suspended Solids	mg/L	-	20	59	17	-	-
Total Dissolved Solids	mg/L	-	220	300	480	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	110	240	140	757	605
Ammonia, Total (as N)	mg/L	214	16.7	21.8	22.8	65.2	41.9
Total Nitrogen as N	mg/L	-	14.7	28.8	25.3	-	-
Bromide (Br)	mg/L	-	-	-	-	<5.0	<0.50
Chloride (Cl)	mg/L	5000	27.7	38.3	30.9	165	81.2
Fluoride (F)	mg/L	-	<0.10	<0.10	<0.10	<2.0	<0.10
Nitrate (as N)	mg/L	-	0.012	0.011	<0.01	<0.50	<0.025
Nitrite (as N)	mg/L	-	<0.01	<0.01	<0.01	<0.10	0.0209
Sulfate (SO4)	mg/L	-	8.7	40.5	10.1	0.72	<1.5
Orthophosphorus (P)	mg/L	-	-	-	-	69	0.89
Total Organic Carbon	mg/L	-	171	223	294	779	200
BOD	mg/L	-	>210	320	430	-	294
COD	mg/L	-	-	-	-	2420	690
Total Metals							
Aluminum (Al)-Total	mg/L	-	0.318	0.245	0.203	0.1960	0.1680
Antimony (Sb)-Total	mg/L	-	0.0004	0.00072	0.00032	0.00240	0.00081
Arsenic (As)-Total	mg/L	-	0.00074	0.00107	0.00083	0.00882	0.00221
Barium (Ba)-Total	mg/L	-	0.0762	0.0603	0.0765	0.419	0.270
Beryllium (Be)-Total	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00020	<0.00050
Bismuth	mg/L	-	0.00024	0.00026	0.00014	<0.00010	<0.00025
Boron (B)-Total	mg/L	-	0.186	0.18	0.144	1.280	0.503
Cadmium (Cd)-Total	mg/L	0.1	0.000361	0.000356	0.000114	0.0004160	0.0000750
Calcium (Ca)-Total	mg/L	-	31.6	84.5	34.4	272.0	128.0
Cessium (Cs) - Total	mg/L	-	-	-	-	0.001740	0.000615
Chromium (Cr)-Total	mg/L	-	0.00346	0.00271	0.00359	0.02060	0.00496
Cobalt (Co)-Total	mg/L	-	0.0107	0.00522	0.0118	0.02220	0.00347
Copper (Cu)-Total	mg/L	-	0.00422	0.00431	0.00328	0.00300	<0.0025
Iron (Fe)-Total	mg/L	6	2.65	4.88	5.49	24.50	11.30
Lead (Pb)-Total	mg/L	-	0.00028	0.00033	<0.00020	0.000840	0.00035
Lithium (Li)-Total	mg/L	-	0.00078	0.00153	0.00084	0.0052	<0.0050
Magnesium (Mg)-Total	mg/L	-	4.11	6.24	4.73	23.50	12.10
Manganese (Mn)-Total	mg/L	-	3.72	2.9	4.33	34.8	15.6
Mercury (Hg)-Total	mg/L	-	<0.00002	<0.000020	<0.000010	0.000027	<0.000050
Molybdenum (Mo)-Total	mg/L	-	0.00072	0.00076	0.00054	0.000850	0.000570
Nickel (Ni)-Total	mg/L	-	0.00581	0.00491	0.00564	0.01900	0.00710
Phosphorus - Total	mg/L	-	4.14	4.2	4.36	2.08	2.87
Potassium (K)-Total	mg/L	-	17.1	17.8	18.6	69.9	41.1
Rubidium (Rb) - Total	mg/L	-	-	-	-	0.0832	0.0422
Selenium (Se)-Total	mg/L	-	<0.00050	<0.00050	<0.00050	0.000320	<0.00025
Silicon - Total	mg/L	-	1.9	8.6	2.3	6.83	3.78
Silver (Ag)-Total	mg/L	-	<0.000050	0.000083	<0.000050	<0.000020	<0.000050
Sodium (Na)-Total	mg/L	-	23.9	23.2	24.9	150.0	73.8
Strontium - Total	mg/L	-	0.104	0.185	0.109	0.974	0.441
Sulfur - Total	mg/L	-	5.4	5.1	<3.0	31.20	<2.5
Tellurium - Total	mg/L	-	<0.00020	<0.00020	<0.00050	<0.00040	<0.0010
Thallium (Tl)-Total	mg/L	-	<0.000020	<0.000020	<0.000020	<0.000020	<0.000050
Thorium - Total	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00020	<0.00050
Tin (Sn)-Total	mg/L	-	0.00034	0.00038	0.00026	0.00068	<0.00050
Titanium (Ti)-Total	mg/L	-	0.0096	0.0116	0.0108	0.00917	0.00810
Tungston (W) - Total	mg/L	-	-	-	-	0.00023	<0.00050
Uranium (U)-Total	mg/L	-	0.000066	0.000064	0.000041	0.000042	<0.000050
Vanadium (V)-Total	mg/L	-	0.0015	0.0026	0.0013	0.00940	0.00250
Zinc (Zn)-Total	mg/L	100	0.107	0.595	0.054	0.4030	0.0530
Zirconium - Total	mg/L	-	0.00025	0.00033	0.00018	0.000230	<0.00030
Dissolved Metals							
Aluminum (Al)-Dissolved	mg/L	-	0.117	0.0419	0.0834	-	-
Antimony (Sb)-Dissolved	mg/L	-	0.0004	0.00014	0.00038	-	-
Arsenic (As)-Dissolved	mg/L	-	<0.00050	<0.00050	0.00053	-	-
Barium (Ba)-Dissolved	mg/L	-	0.0628	0.0417	0.0603	-	-
Beryllium (Be)-Dissolved	mg/L	-	<0.00010	<0.00010	<0.00010	-	-
Bisumuth - Dissolved	mg/L	-	<0.00010	<0.00010	<0.00010	-	-
Boron (B)-Dissolved	mg/L	-	0.166	0.155	0.136	-	-
Cadmium (Cd)-Dissolved	mg/L	-	0.000098	0.000023	<0.000010	-	-
Calcium (Ca)-Dissolved	mg/L	-	29.00	62.10	33.30	-	-
Cesium (Cs) - Dissolved	mg/L	-	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	-	0.00262	0.00	0.00	-	-
Cobalt (Co)-Dissolved	mg/L	-	0.00852	0.00311	0.0101	-	-
Copper (Cu)-Dissolved	mg/L	-	0.00086	0.0004	0.00097	-	-
Iron (Fe)-Dissolved	mg/L	-	2.42	3.35	5.06	-	-
Lead (Pb)-Dissolved	mg/L	-	<0.00010	<0.00010	<0.00020	-	-
Lithium (Li)-Dissolved	mg/L	-	0.00069	0.00146	0.00082	-	-
Magnesium (Mg)-Dissolved	mg/L	-	3.83	4.7	4.43	-	-
Manganese (Mn)-Dissolved	mg/L	-	3.52	2.85	3.91	-	-
Mercury (Hg)-Dissolved	mg/L	-	<0.00002	-	<0.000010	-	-
Molybdenum (Mo)-Dissolved	mg/L	-	0.00015	<0.00010	0.00018	-	-
Nickel (Ni)-Dissolved	mg/L	-	0.00491	0.00348	0.00493	-	-
Phosphorus - Dissolved	mg/L	-	3.53	0.466	3.74	-	-
Potassium (K)-Dissolved	mg/L	-	16.500	14.900	17.200	-	-
Rubidium (Rd) - Dissolved	mg/L	-	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	-	<0.00050	<0.00050	<0.00050	-	-
Silicon - Dissolved	mg/L	-	1.8	6.7	1.9	-	-
Silver (Ag)-Dissolved	mg/L	-	<0.000050	<0.000050	<0.000050	-	-
Sodium (Na)-Dissolved	mg/L	-	22.6	21.2	23.8	-	-
Strontium - Dissolved	mg/L	-	0.0985	0.141	0.0977	-	-
Sulfur- Dissolved	mg/L	-	17	5.9	<3.0	-	-
Tellurium - Dissolved	mg/L	-	<0.00020	<0.00020	<0.00050	-	-
Thallium (Tl)-Dissolved	mg/L	-	<0.000020	<0.000020	<0.000020	-	-
Thorium - Dissolved	mg/L	-	<0.00010	<0.00010	<0.00010	-	-
Tin (Sn)-Dissolved	mg/L	-	<0.00020	<0.00020	<0.00020	-	-
Titanium (Ti)-Dissolved	mg/L	-	0.0067	<0.0050	0.0051	-	-
Tungston (W) - Dissolved	mg/L	-	-	-	-	-	-
Uranium (U)-Dissolved	mg/L	-	<0.000020	0.000021	<0.000020	-	-
Vanadium (V)-Dissolved	mg/L	-	<0.0010	<0.0010	0.0011	-	-
Zinc (Zn)-Dissolved	mg/L	-	0.0228	0.0261	0.0149	-	-
Zirconium - Dissolved	mg/L	-	0.0002	0.00012	0.00016	-	-

OC Criteria Shaded Value Means Exceeded Discharge Criteria (OC)

Table 24: Leachate Water Quality Results Sampling Location F4, Aeration Pond - Outflow

		MC MOE						
Field	**Units**	**OC Criteria**	**6-Jun-17**	**5-Jul-17**	**15-Aug-17**	**7-Nov-17**	**18-May-18**	**16-Jul-18**
Conductivity	uS/cm	-	21.9	48.6	162	-	377	-
pH	pH	-	8.8	7.6	7.5	-	7.5	-
Temperature	°C	-	18.4	16.1	15.3	-	18.3	-
Dissolved Oxygen	mg/L	-	-	7.6	13.2	-	-	-
Turbidity	NTU	-	-	-	-	-	-	-
Analyte	Units							
Conductivity	uS/cm	-	15.1	45.4	70.6	-	-	-
Hardness (as CaCO3)	mg/L	-	8.48	14.3	19.5	336	-	305
pH	pH	6.5 - 8.5	8.1	7.3	8.3	7.6	-	7.46
Total Suspended Solids	mg/L	-	9.4	13	13	-	-	-
Total Dissolved Solids	mg/L	-	7	24	47	-	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	8	14	22	464	-	489
Ammonia, Total (as N)	mg/L	214	<0.03	<0.03	<0.03	22.6	-	24.6
Total Nitrogen as N	mg/L	-	0.288	0.544	1.25	-	-	-
Bromide (Br)	mg/L	-	-	-	-	0.74	-	<0.25
Chloride (Cl)	mg/L	5000	1	3.3	6	77.2	-	71.5
Fluoride (F)	mg/L	-	<0.10	<0.10	<0.10	<0.20	-	<0.10
Nitrate (as N)	mg/L	-	<0.01	<0.010	<0.01	<0.050	-	<0.025
Nitrite (as N)	mg/L	-	<0.01	<0.01	<0.01	<0.010	-	0.0079
Sulfate (SO4)	mg/L	-	1.8	3.3	4.4	<0.0050	-	<1.5
Orthophosphorus (P)	mg/L	-	-	-	-	33.4	-	0.0048
Total Organic Carbon	mg/L	-	5.34	5.33	8.32	192	-	78.7
BOD	mg/L	-	<5.0	<4.0	5.3	-	-	124
COD	mg/L	-	-	-	-	676	-	276
Total Metals								
Aluminum (Al)-Total	mg/L	-	0.0614	0.0192	0.0337	0.1290	-	0.017
Antimony (Sb)-Total	mg/L	-	<0.00010	<0.00010	<0.00020	0.00103	-	<0.00050
Arsenic (As)-Total	mg/L	-	<0.00050	<0.00050	<0.00050	0.00299	-	0.00517
Barium (Ba)-Total	mg/L	-	0.0057	0.0083	0.0056	0.184	-	0.498
Beryllium (Be)-Total	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00050	-	<0.00050
Bismuth	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00025	-	<0.00025
Boron (B)-Total	mg/L	-	0.04	0.0293	0.0268	0.497	-	0.438
Cadmium (Cd)-Total	mg/L	0.1	0.000015	0.000013	<0.000010	0.0001920	-	0.000092
Calcium (Ca)-Total	mg/L	-	2.98	4.95	7.08	116.0	-	105
Cessium (Cs) - Total	mg/L	-	-	-	-	0.000884	-	0.000827
Chromium (Cr)-Total	mg/L	-	<0.00050	<0.00050	<0.00050	0.00722	-	0.00133
Cobalt (Co)-Total	mg/L	-	<0.00010	0.00025	0.00052	0.01130	-	0.00253
Copper (Cu)-Total	mg/L	-	0.00095	0.00106	0.00112	<0.0025	-	0.0097
Iron (Fe)-Total	mg/L	6	0.027	0.02	0.089	9.45	0.072	12.10
Lead (Pb)-Total	mg/L	-	<0.00010	<0.00010	<0.00020	0.000540	-	0.00052
Lithium (Li)-Total	mg/L	-	<0.00010	0.00011	0.00014	<0.0050	-	<0.0050
Magnesium (Mg)-Total	mg/L	-	0.251	0.467	0.794	11.40	-	10.6
Manganese (Mn)-Total	mg/L	-	0.0388	0.104	0.256	16.7	-	20.5
Mercury (Hg)-Total	mg/L	-	<0.00002	<0.000020	<0.000010	<0.000025	-	<0.000050
Molybdenum (Mo)-Total	mg/L	-	0.00013	0.0002	0.00025	0.000510	-	0.00031
Nickel (Ni)-Total	mg/L	-	0.00024	0.00033	0.00072	0.01130	-	0.0047
Phosphorus - Total	mg/L	-	<0.050	0.068	0.144	1.65	-	0.36
Potassium (K)-Total	mg/L	-	0.39	1.33	2.73	35.3	-	29.2
Rubidium (Rb) - Total	mg/L	-	-	-	-	0.0403	-	0.0355
Selenium (Se)-Total	mg/L	-	<0.00050	<0.00050	<0.00050	0.002420	-	<0.00025
Silicon - Total	mg/L	-	<1.0	<1.0	<1.0	3.21	-	3.84
Silver (Ag)-Total	mg/L	-	<0.000050	0.000055	<0.000050	<0.000050	-	<0.000050
Sodium (Na)-Total	mg/L	-	0.83	2.32	4.46	73.3	-	62.1
Strontium - Total	mg/L	-	0.023	0.0293	0.0332	0.385	-	0.513
Sulfur - Total	mg/L	-	<3.0	3.4	<3.0	15.50	-	<2.5
Tellurium - Total	mg/L	-	<0.00020	<0.00020	<0.00050	<0.0010	-	<0.0010
Thallium (Tl)-Total	mg/L	-	<0.000020	<0.000020	<0.000020	<0.000050	-	<0.000050
Thorium - Total	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00050	-	<0.00050
Tin (Sn)-Total	mg/L	-	<0.00020	<0.00020	<0.00020	<0.00050	-	<0.00050
Titanium (Ti)-Total	mg/L	-	<0.0050	<0.0050	<0.0050	0.00700	-	<0.0015
Tungston (W) - Total	mg/L	-	-	-	-	<0.00050	-	<0.00050
Uranium (U)-Total	mg/L	-	<0.000020	<0.000020	<0.000020	<0.000050	-	<0.000050
Vanadium (V)-Total	mg/L	-	<0.0010	<0.0010	<0.0010	0.00330	-	<0.0025
Zinc (Zn)-Total	mg/L	100	0.09	0.0308	0.0248	0.1640	-	0.06
Zirconium - Total	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00030	-	<0.00030
Dissolved Metals								
Aluminum (Al)-Dissolved	mg/L	-	0.0328	<0.0050	0.0141	-	-	-
Antimony (Sb)-Dissolved	mg/L	-	<0.00010	0.00012	<0.00020	-	-	-
Arsenic (As)-Dissolved	mg/L	-	<0.00050	<0.00050	<0.00050	-	-	-
Barium (Ba)-Dissolved	mg/L	-	<0.0050	0.0064	<0.0050	-	-	-
Beryllium (Be)-Dissolved	mg/L	-	<0.00010	<0.00010	<0.00010	-	-	-
Bisumuth - Dissolved	mg/L	-	<0.00010	<0.00010	<0.00010	-	-	-
Boron (B)-Dissolved	mg/L	-	0.039	0.0182	0.0264	-	-	-
Cadmium (Cd)-Dissolved	mg/L	-	<0.000010	<0.000010	<0.000010	-	-	-
Calcium (Ca)-Dissolved	mg/L	-	2.83	4.33	6.67	-	-	-
Cesium (Cs) - Dissolved	mg/L	-	-	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	-	<0.00050	<0.00050	<0.00050	-	-	-
Cobalt (Co)-Dissolved	mg/L	-	<0.00010	<0.00010	0.00025	-	-	-
Copper (Cu)-Dissolved	mg/L	-	0.00063	0.00083	0.00097	-	-	-
Iron (Fe)-Dissolved	mg/L	-	<0.010	<0.010	<0.010	-	0.197	-
Lead (Pb)-Dissolved	mg/L	-	<0.00010	<0.00010	<0.00020	-	-	-
Lithium (Li)-Dissolved	mg/L	-	<0.00010	0.0002	0.00027	-	-	-
Magnesium (Mg)-Dissolved	mg/L	-	0.234	0.422	0.693	-	-	-
Manganese (Mn)-Dissolved	mg/L	-	0.00935	<0.00020	0.00857	-	-	-
Mercury (Hg)-Dissolved	mg/L	-	<0.00002	-	<0.000010	-	-	-
Molybdenum (Mo)-Dissolved	mg/L	-	0.00014	0.00019	0.0002	-	-	-
Nickel (Ni)-Dissolved	mg/L	-	<0.00020	0.00026	0.00067	-	-	-
Phosphorus - Dissolved	mg/L	-	<0.050	<0.050	<0.050	-	-	-
Potassium (K)-Dissolved	mg/L	-	0.370	1.320	2.370	-	-	-
Rubidium (Rd) - Dissolved	mg/L	-	-	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	-	<0.00050	<0.00050	<0.00050	-	-	-
Silicon - Dissolved	mg/L	-	<1.0	<1.0	<1.0	-	-	-
Silver (Ag)-Dissolved	mg/L	-	<0.000050	0.000107	<0.000050	-	-	-
Sodium (Na)-Dissolved	mg/L	-	0.83	2.25	4.04	-	-	-
Strontium - Dissolved	mg/L	-	0.0223	0.0262	0.0284	-	-	-
Sulfur- Dissolved	mg/L	-	<3.0	<3.0	<3.0	-	-	-
Tellurium - Dissolved	mg/L	-	<0.00020	<0.00020	<0.00050	-	-	-
Thallium (Tl)-Dissolved	mg/L	-	<0.000020	<0.000020	<0.000020	-	-	-
Thorium - Dissolved	mg/L	-	<0.00010	<0.00010	<0.00010	-	-	-
Tin (Sn)-Dissolved	mg/L	-	<0.00020	<0.00020	<0.00020	-	-	-
Titanium (Ti)-Dissolved	mg/L	-	<0.0050	<0.0050	<0.0050	-	-	-
Tungston (W) - Dissolved	mg/L	-	-	-	-	-	-	-
Uranium (U)-Dissolved	mg/L	-	<0.000020	<0.000020	<0.000020	-	-	-
Vanadium (V)-Dissolved	mg/L	-	<0.0010	<0.0010	<0.0010	-	-	-
Zinc (Zn)-Dissolved	mg/L	-	0.0329	<0.0040	<0.0040	-	-	-
Zirconium - Dissolved	mg/L	-	<0.00010	<0.00010	<0.00010	-	-	-

OC Criteria Shaded Value Means Exceeded Discharge Criteria (OC)

Table 25: Leachate Water Quality Results Sampling Location F5, Sand Cyclone

		MC MOE							
Field	**Units**	**OC Criteria**	**6-Jun-17**	**5-Jul-17**	**15-Aug-17**	**7-Nov-17**	**25-Apr-18**	**18-May-18**	**27-Aug-18**
Conductivity	uS/cm	-	83.5	96.4	352	566	532	239	1019
pH	pH	-	8.4	7.4	6.8	7.08	6.46	7.07	6.96
Temperature	°C	-	16.2	13.3	14.2	3.5	5.0	16.2	18.4
Dissolved Oxygen	mg/L	-	-	6.4	12.7	7.7	5.7	-	1
Turbidity	NTU	-	-	-	-	-	-	-	-
ORP	mV	-	-	-	-	-	105.6	-	-
Analyte	Units								
Conductivity	uS/cm	-	-	-	-	-	-	-	-
Hardness (as CaCO3)	mg/L	-	43.2	39.8	59.3	244	213	-	227
pH	pH	6.5 - 8.5	7.4	7.4	7.6	7.57	-	-	8.02
Total Suspended Solids	mg/L		-	-	-	-	-	-	-
Total Dissolved Solids	mg/L		-	-	-	-	-	-	-
Alkalinity, Bicarbonate (as CaCO3)	mg/L		-	-	-	-	-	-	-
Alkalinity, Carbonate (as CaCO3)	mg/L		-	-	-	-	-	-	-
Alkalinity, Hydroxide (as CaCO3)	mg/L		-	-	-	-	-	-	-
Alkalinity, Total (as CaCO3)	mg/L	-	36	41	59	348	110	-	466
Ammonia, Total (as N)	mg/L	214	<0.03	<0.03	<0.03	15.5	18.5	-	30.8
Total Nitrogen as N	mg/L		-	-	-	-	15.3	-	-
Bromide (Br)	mg/L		-	-	-	-	0.071	-	-
Chloride (Cl)	mg/L	5000	<1.0	2.4	2.7	58.4	15.3	-	<0.25
Fluoride (F)	mg/L	-	<0.10	<0.10	<0.10	<0.20	0.071	-	<0.10
Nitrate (as N)	mg/L	-	<0.01	0.023	0.031	<0.050	0.071	-	0.044
Nitrite (as N)	mg/L	-	<0.01	<0.01	<0.01	<0.010	<0.0050	-	<0.0050
Sulfate (SO4)	mg/L	-	3.4	5.5	5.3	13.1	<0.0010	-	<1.5
Orthophosphorus (P)	mg/L	-	-	-	-	<0.0010	<0.0010	-	<0.0010
Total Organic Carbon	mg/L	-	2.14	1.39	1.57	146	42.4	-	3.2
BOD	mg/L	-	<3.0	<4.0	<4.0	-	11.8	-	24.4
COD	mg/L	-	-	-	-	466	167	-	178
Total Metals									
Aluminum (Al)-Total	mg/L	-	0.054	0.0497	0.0183	0.0388	0.0290	-	0.0268
Antimony (Sb)-Total	mg/L	-	0.00021	0.00027	0.00022	0.00059	0.00041	-	0.00045
Arsenic (As)-Total	mg/L	-	<0.00050	<0.00050	<0.00050	0.00250	0.00529	-	0.00367
Barium (Ba)-Total	mg/L	-	0.0513	0.0341	0.0432	0.241	0.320	-	0.254
Beryllium (Be)-Total	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	-	<0.00010
Bismuth	mg/L	-	<0.00010	<0.00010	<0.00010	<0.000050	<0.00010	-	<0.000050
Boron (B)-Total	mg/L	-	0.009	0.0165	0.0111	0.355	0.217	-	0.508
Cadmium (Cd)-Total	mg/L	0.1	<0.000010	0.000019	<0.000010	0.0000618	0.0005260	-	0.000051
Calcium (Ca)-Total	mg/L	-	15.9	14.6	22	83.6	72.9	-	68.6
Cessium (Cs) - Total	mg/L	-	-	-	-	0.000630	0.000529	-	0.000876
Chromium (Cr)-Total	mg/L	-	<0.00050	<0.00050	<0.00050	0.00453	0.00093	-	0.00146
Cobalt (Co)-Total	mg/L	-	<0.00010	<0.00010	<0.00010	0.00823	0.00965	-	0.00226
Copper (Cu)-Total	mg/L	-	0.00155	0.00203	0.00177	0.00650	0.02150	-	0.0032
Iron (Fe)-Total	mg/L	6	0.086	0.093	0.052	5.64	14.90	2.21	2.5
Lead (Pb)-Total	mg/L	-	0.00077	0.00085	<0.00020	0.000572	0.004330	-	0.00030
Lithium (Li)-Total	mg/L	-	<0.00010	<0.00010	<0.00010	<0.0010	<0.0020	-	<0.0010
Magnesium (Mg)-Total	mg/L	-	0.841	0.806	1.05	8.63	7.56	-	13.60
Manganese (Mn)-Total	mg/L	-	0.00355	0.00483	0.012	16.7	25.0	-	7.6
Mercury (Hg)-Total	mg/L	-	<0.00002	<0.000020	<0.000010	<0.000025	<0.0000050	-	0.0000087
Molybdenum (Mo)-Total	mg/L	-	0.00058	0.00068	0.00074	0.000640	0.000700	-	0.00040
Nickel (Ni)-Total	mg/L	-	<0.00020	<0.00020	<0.00040	0.00667	0.00540	-	0.0054
Phosphorus - Total	mg/L	-	<0.050	<0.050	<0.050	1.32	0.13	-	0.74
Potassium (K)-Total	mg/L	-	0.89	0.93	1.17	28.5	16.4	-	44.6
Rubidium (Rb) - Total	mg/L	-	-	-	-	0.0326	0.0257	-	0.0506
Selenium (Se)-Total	mg/L	-	<0.00050	<0.00050	<0.00050	0.000108	<0.00010	-	0.00009
Silicon - Total	mg/L	-	2.3	2.1	2.5	2.72	3.43	-	2.42
Silver (Ag)-Total	mg/L	-	<0.000050	0.000073	<0.000050	<0.000010	<0.000020	-	<0.000010
Sodium (Na)-Total	mg/L	-	1.28	1.4	2.13	54.1	36.1	-	84.4
Strontium - Total	mg/L	-	0.183	0.204	0.271	0.297	0.401	-	0.347
Sulfur - Total	mg/L	-	4	3.9	<3.0	6.94	<1.0	-	1.27
Tellurium - Total	mg/L	-	<0.00020	<0.00020	<0.00050	<0.00020	<0.00040	-	<0.00020
Thallium (Tl)-Total	mg/L	-	<0.000020	<0.000020	<0.000020	0.000018	<0.000020	-	0.000011
Thorium - Total	mg/L	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020	-	<0.00010
Tin (Sn)-Total	mg/L	-	<0.00020	<0.00020	<0.00020	0.00013	0.00037	-	<0.00010
Titanium (Ti)-Total	mg/L	-	<0.0050	<0.0050	<0.0050	0.00274	0.00203	-	0.00134
Tungsten (W) - Total	mg/L	-	-	-	-	0.00010	<0.00020	-	<0.00010
Uranium (U)-Total	mg/L	-	<0.000020	<0.000020	0.00003	0.000045	0.000083	-	0.000056
Vanadium (V)-Total	mg/L	-	<0.0010	<0.0010	<0.0010	0.00186	0.00170	-	0.0014
Zinc (Zn)-Total	mg/L	100	0.0315	0.0249	<0.0040	0.0428	0.0616	-	<0.0030
Zirconium - Total	mg/L	-	<0.00010	<0.00010	<0.00010	0.000063	<0.00012	-	0.000103
Dissolved Metals									
Aluminum (Al)-Dissolved	mg/L	-	-	0.0084	0.0066	-	-	-	-
Antimony (Sb)-Dissolved	mg/L	-	-	0.00026	0.00033	-	-	-	-
Arsenic (As)-Dissolved	mg/L	-	-	<0.00050	<0.00050	-	-	-	-
Barium (Ba)-Dissolved	mg/L	-	-	0.0291	0.0409	-	-	-	-
Beryllium (Be)-Dissolved	mg/L	-	-	<0.00010	<0.00010	-	-	-	-
Bisumuth - Dissolved	mg/L	-	-	<0.00010	<0.00010	-	-	-	-
Boron (B)-Dissolved	mg/L	-	-	0.0094	0.012	-	-	-	-
Cadmium (Cd)-Dissolved	mg/L	-	-	0.000011	<0.000010	-	-	-	-
Calcium (Ca)-Dissolved	mg/L	-	-	14.10	21.00	-	-	-	-
Cesium (Cs) - Dissolved	mg/L	-	-	-	-	-	-	-	-
Chromium (Cr)-Dissolved	mg/L	-	-	<0.00050	<0.00050	-	-	-	-
Cobalt (Co)-Dissolved	mg/L	-	-	<0.00010	<0.00010	-	-	-	-
Copper (Cu)-Dissolved	mg/L	-	-	0.00074	0.00227	-	-	-	-
Iron (Fe)-Dissolved	mg/L	-	-	<0.010	<0.010	-	-	1.18	-
Lead (Pb)-Dissolved	mg/L	-	-	<0.00010	<0.00020	-	-	-	-
Lithium (Li)-Dissolved	mg/L	-	-	0.00022	0.00039	-	-	-	-
Magnesium (Mg)-Dissolved	mg/L	-	-	0.77	1.03	-	-	-	-
Manganese (Mn)-Dissolved	mg/L	-	-	<0.00020	0.0627	-	-	-	-
Mercury (Hg)-Dissolved	mg/L	-	-	0.00067	<0.000010	-	-	-	-
Molybdenum (Mo)-Dissolved	mg/L	-	-	<0.00020	0.00073	-	-	-	-
Nickel (Ni)-Dissolved	mg/L	-	-	<0.050	<0.00040	-	-	-	-
Phosphorus - Dissolved	mg/L	-	-	0.86	<0.050	-	-	-	-
Potassium (K)-Dissolved	mg/L	-	-	<0.00050	1.230	-	-	-	-
Rubidium (Rd) - Dissolved	mg/L	-	-	-	-	-	-	-	-
Selenium (Se)-Dissolved	mg/L	-	-	1.7	<0.00050	-	-	-	-
Silicon - Dissolved	mg/L	-	-	0.000072	2.4	-	-	-	-
Silver (Ag)-Dissolved	mg/L	-	-	1.34	<0.000050	-	-	-	-
Sodium (Na)-Dissolved	mg/L	-	-	0.19	2.25	-	-	-	-
Strontium - Dissolved	mg/L	-	-	<3.0	0.241	-	-	-	-
Sulfur- Dissolved	mg/L	-	-	<0.00020	<3.0	-	-	-	-
Tellurium - Dissolved	mg/L	-	-	<0.000020	<0.00050	-	-	-	-
Thallium (Tl)-Dissolved	mg/L	-	-	<0.00010	<0.000020	-	-	-	-
Thorium - Dissolved	mg/L	-	-	<0.00020	<0.00010	-	-	-	-
Tin (Sn)-Dissolved	mg/L	-	-	<0.0050	<0.00020	-	-	-	-
Titanium (Ti)-Dissolved	mg/L	-	-	<0.000020	<0.0050	-	-	-	-
Tungston (W) - Dissolved	mg/L	-	-	-	-	-	-	-	-
Uranium (U)-Dissolved	mg/L	-	-	<0.0010	0.000024	-	-	-	-
Vanadium (V)-Dissolved	mg/L	-	-	0.0179	<0.0010	-	-	-	-
Zinc (Zn)-Dissolved	mg/L	-	-	<0.00010	0.0074	-	-	-	-
Zirconium - Dissolved	mg/L	-	-	0.0497	<0.00010	-	-	-	-

OC Criteria Shaded Value Means Exceeded Discharge Criteria (OC)

Table 26: Leachate Water Quality Results, F6, Compost

		MC MOE		
Field	**Units**	**OC Criteria**	**7-Nov-17**	**18-May-18**
Conductivity	uS/cm	-	-	15,220
pH	pH	-	-	4.8
Temperature	°C	-	-	8.0
Dissolved Oxygen	mg/kg	-	-	-
Turbidity	NTU	-	-	-
Analyte	Units			
Conductivity	uS/cm	-	-	-
Hardness (as CaCO3)	mg/L	-	4550	-
pH	pH	6.5 - 8.5	4.6	-
Alkalinity, Total (as CaCO3)	mg/L		483	-
Ammonia, Total (as N)	mg/L	214	586	-
Chloride (Cl)	mg/L	5000	1470	-
Fluoride (F)	mg/L	-	<23	-
Nitrate (as N)	mg/L	-	<0.50	-
Nitrite (as N)	mg/L	-	<0.10	-
Sulfate (SO4)	mg/L	-	0.0039	-
Orthophosphorus (P)	mg/L	-	247	-
Total Organic Carbon	mg/L	-	15100	-
BOD	mg/L	-	-	-
COD	mg/L	-	42800	-
Total Metals				
Aluminum (Al)-Total	mg/L	-	11.6	-
Antimony (Sb)-Total	mg/L	-	0.00700	-
Arsenic (As)-Total	mg/L	-	0.06130	-
Barium (Ba)-Total	mg/L	-	0.582	-
Beryllium (Be)-Total	mg/L	-	<0.0010	-
Bismuth	mg/L	-	<0.00050	-
Boron (B)-Total	mg/L	-	0.900	-
Cadmium (Cd)-Total	mg/L	0.1	0.0054400	-
Calcium (Ca)-Total	mg/L	-	1420.0	-
Cessium (Cs) - Total	mg/L	-	0.007600	-
Chromium (Cr)-Total	mg/L	-	0.06080	-
Cobalt (Co)-Total	mg/L	-	0.05350	-
Copper (Cu)-Total	mg/L	-	0.11000	-
Iron (Fe)-Total	mg/L	6	86.1	109.0
Lead (Pb)-Total	mg/L	-	0.007850	-
Lithium (Li)-Total	mg/L	-	0.043	-
Magnesium (Mg)-Total	mg/L	-	243.00	-
Manganese (Mn)-Total	mg/L	-	25.0	-
Mercury (Hg)-Total	mg/L	-	<0.00050	-
Molybdenum (Mo)-Total	mg/L	-	0.028000	-
Nickel (Ni)-Total	mg/L	-	0.17200	-
Phosphorus - Total	mg/L	-	387.00	-
Potassium (K)-Total	mg/L	-	2190.0	-
Rubidium (Rb) - Total	mg/L	-	1.5200	-
Selenium (Se)-Total	mg/L	-	0.008670	-
Silicon - Total	mg/L	-	40.40	-
Silver (Ag)-Total	mg/L	-	0.00015	-
Sodium (Na)-Total	mg/L	-	918.0	-
Strontium - Total	mg/L	-	3.170	-
Sulfur - Total	mg/L	-	175.00	-
Tellurium - Total	mg/L	-	<0.0020	-
Thallium (Tl)-Total	mg/L	-	0.000410	-
Thorium - Total	mg/L	-	<0.0010	-
Tin (Sn)-Total	mg/L	-	0.00290	-
Titanium (Ti)-Total	mg/L	-	0.34100	-
Tungston (W) - Total	mg/L	-	0.00430	-
Uranium (U)-Total	mg/L	-	0.000560	-
Vanadium (V)-Total	mg/L	-	0.06660	-
Zinc (Zn)-Total	mg/L	100	3.2600	-
Zirconium - Total	mg/L	-	0.004530	-

OC Criteria RDKS - Discharge Criteria (OC)

Table 27: Phytoremediation Soil Sample Results

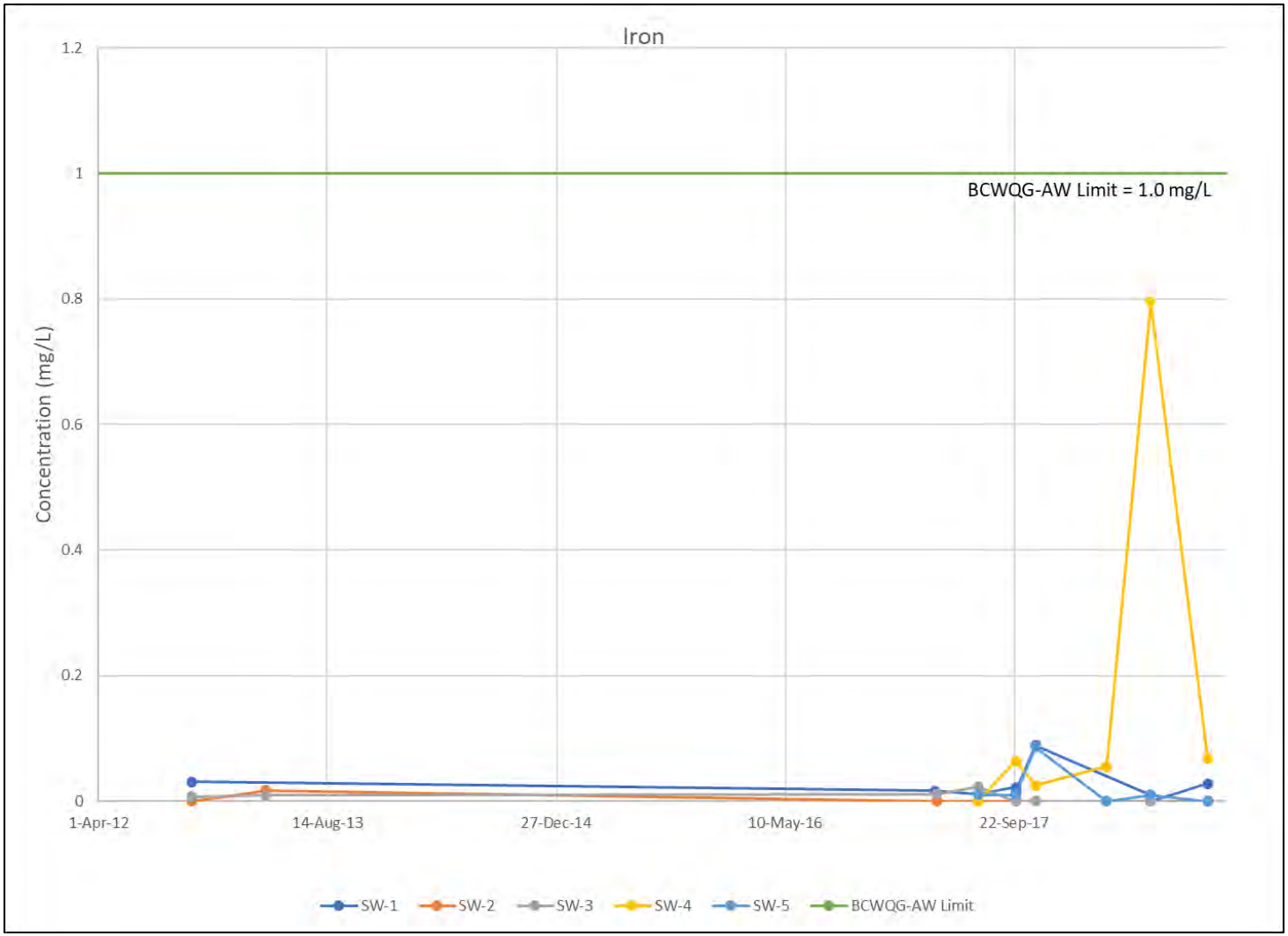
		BC MoE Guidelines	BC MoE Guidelines	22-Aug-17				
Physical Tests (Soil)	**Units**	**CSR-DW (1)**	**CSR-AW (2)**	Site A	Site B	Site C	Site D	**25-Apr-18**
pH (1:2 soil:water)	pH	-	-	5.74	5.35	5.16	5.13	5.24
Saturated Paste Extractables (Soil)	Units							
Chloride (Cl)	mg/kg	100	600	1.57	1.44	3.0	2.8	1.4
% Saturation	%	-	-	35.5	39	54.2	53.8	50.6
Sodium (Na)	mg/kg	15,000	-	<1.0	<1.0	<1.0	1.00	<1.0
Metals (Soil)								
Aluminum (Al)	mg/kg	250,000	-	-	-	-	-	25,500
Antimony (Sb)	mg/kg	40,000	40	0.50	0.40	0.41	0.41	0.37
Arsenic (As)	mg/kg	10	10	7.98	6.71	6.51	5.86	5.67
Barium (Ba)	mg/kg	350	3,500	71.9	54.6	43.8	43.7	51.1
Beryllium (Be)	mg/kg	1 - 2,500 (3)	1 - 500 (4)	0.40	0.37	0.36	0.36	0.29
Bismuth (Bi)	mg/kg	-	-	-	-	-	-	<0.20
Boron (B)	mg/kg	1,000,000	-	-	-	-	-	<5.0
Cadmium (Cd)	mg/kg	1 - 70 (5)	1 - 50 (5)	0.108	0.067	0.058	<0.050	0.067
Calcium (Ca)	mg/kg	-	-	-	-	-	-	1,620
Chromium (Cr)	mg/kg	60	60	33.1	29.1	29.6	27.6	27.1
Cobalt (Co)	mg/kg	25	25	14.2	11.0	9.2	7.7	8.7
Copper (Cu)	mg/kg	500	75	41.7	29.5	26.4	18.2	23.1
Iron (Fe)	mg/kg	150,000	-	-	-	-	-	34,400
Lead (Pb)	mg/kg	120 - 8,500 (6)	200 - 90,000 (7)	7.09	6.61	7.14	8.16	6.15
Lithium (Li)	mg/kg	450	-	-	-	-	-	13
Magnesium (Mg)	mg/kg	-	-	-	-	-	-	6,200
Manganese (Mn)	mg/kg	2,000	-	-	-	-	-	564
Mercury (Hg)	mg/kg	-	75	<0.050	<0.050	<0.050	<0.050	<0.050
Molybdenum (Mo)	mg/kg	15	650	0.61	0.62	0.79	0.77	0.67
Nickel (Ni)	mg/kg	70 - 500 (8)	90 - 9,500 (7)	31.5	24.6	18.8	16.5	18.2
Phosphorus (P)	mg/kg	-	-	-	-	-	-	1,020
Potassium (K)	mg/kg	-	-	-	-	-	-	610
Selenium (Se)	mg/kg	1	1	<0.20	0.23	0.32	0.29	0.27
Silver (Ag)	mg/kg	35,000	40	<0.10	<0.10	0.14	0.13	0.11
Sodium (Na)	mg/kg	-	-	-	-	-	-	93
Strontium (Sr)	mg/kg	-	-	-	-	-	-	15
Sulfur (S)	mg/kg	-	-	-	-	-	-	<1000
Thallium (Tl)	mg/kg	-	25	0.065	0.066	0.066	0.076	0.063
Tin (Sn)	mg/kg	1,000,000	300	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	mg/kg	-	-	-	-	-	-	1,090
Tungsten (W)	mg/kg	-	-	-	-	-	-	<0.50
Uranium (U)	mg/kg	30	150	0.622	0.574	0.492	0.529	0.423
Vanadium (V)	mg/kg	100	-	83.5	76.1	83.2	81.3	77.3
Zinc (Zn)	mg/kg	200 - 5,500 (7)	150 - 3,000 (7)	92.0	78.2	70.4	66.4	71.8
Zirconium (Zr)	mg/kg	-	-	-	-	-	-	10

NOTES

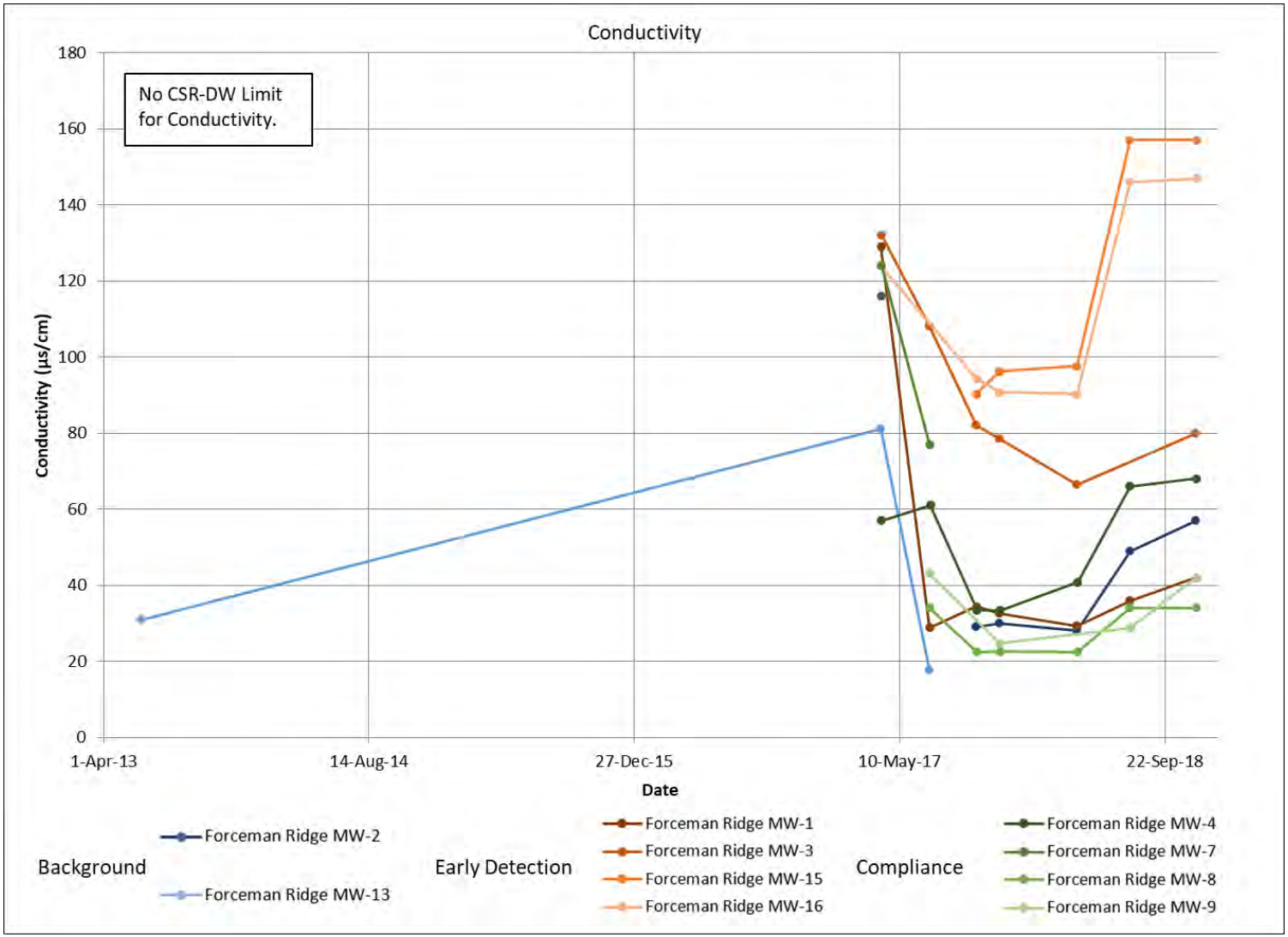
(1) BC Contaminated Sites Regulation (CSR) Soil Standards for Drinking Water, Schedule 3.1, 1997 (Amended June 2018)
(2) BC Contaminated Sites Regulation (CSR)Soil Standards for Aquatic Life, Schedule 3.1, 1997 (Amended June 2018)
(3)Limit dependent on pH. At pH less than 5.5, limit is 1 mg/kg.
(4)Limit dependent on pH. At pH less than 6.5, limit is 1 mg/kg.
(5)Limit dependent on pH. At pH less than 7, limit is 1 mg/kg.
(6)Limit dependent on pH. At pH less than 5.5, limit is 120 mg/kg.
(7Limit dependent on pH.
(8)Limit dependent on pH. At pH less than 7.5, limit is 70 mg/kg.

CSR-DW	*BC Contaminated Sites Regulation Soil Standards for Drinking Water, Schedule 3.1*
CSR-AW	*BC Contaminated Sites Regulation Soil Standards for Aquatic Life, Schedule 3.1*

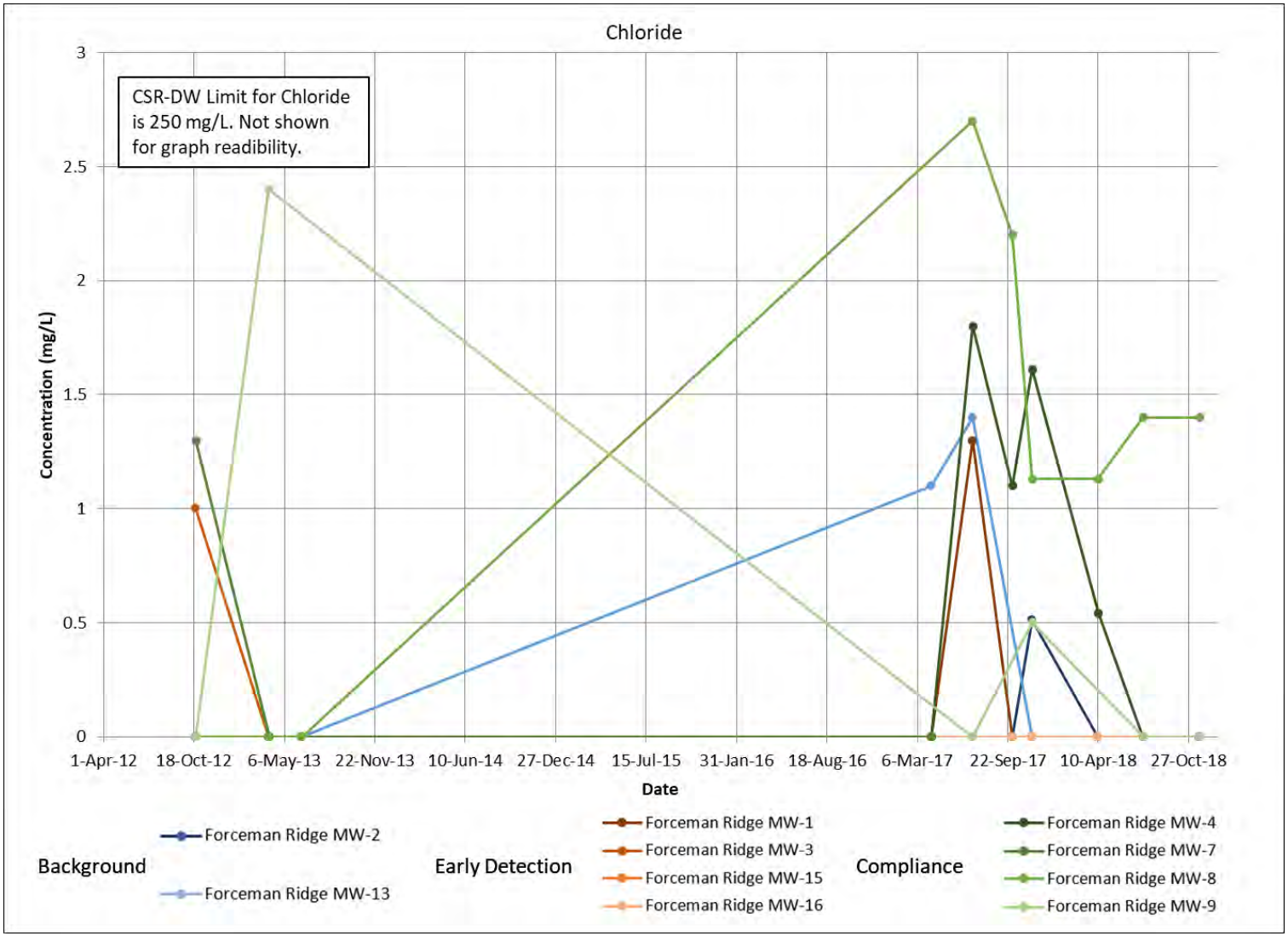
Appendix C: Charts



Sperling Hansen Associates	Regional District of Kitimat-Stikine	PROJECT: Forceman Ridge WMF 2018 Annual Monitoring Report	TITLE: Surface Water Total Iron	SCALE: N/A; DATE: 2019/02/21 yyyy/mm/dd; PROJECT NO: PRJ19008; DESIGNED: AM; DRAWN: AM; CHECKED: IB; DRAWING NO: Chart 8



Sperling Hansen Associates	Regional District of Kitimat-Stikine	PROJECT: **Forceman Ridge WMF 2018 Annual Monitoring Report**	TITLE: **Groundwater Conductivity**	SCALE: N/A; DATE: 2019/02/21 yyyy/mm/dd; PROJECT NO: **PRJ19008**; DESIGNED: AM; DRAWN: AM; CHECKED: IB; DRAWING NO: **Chart 1**



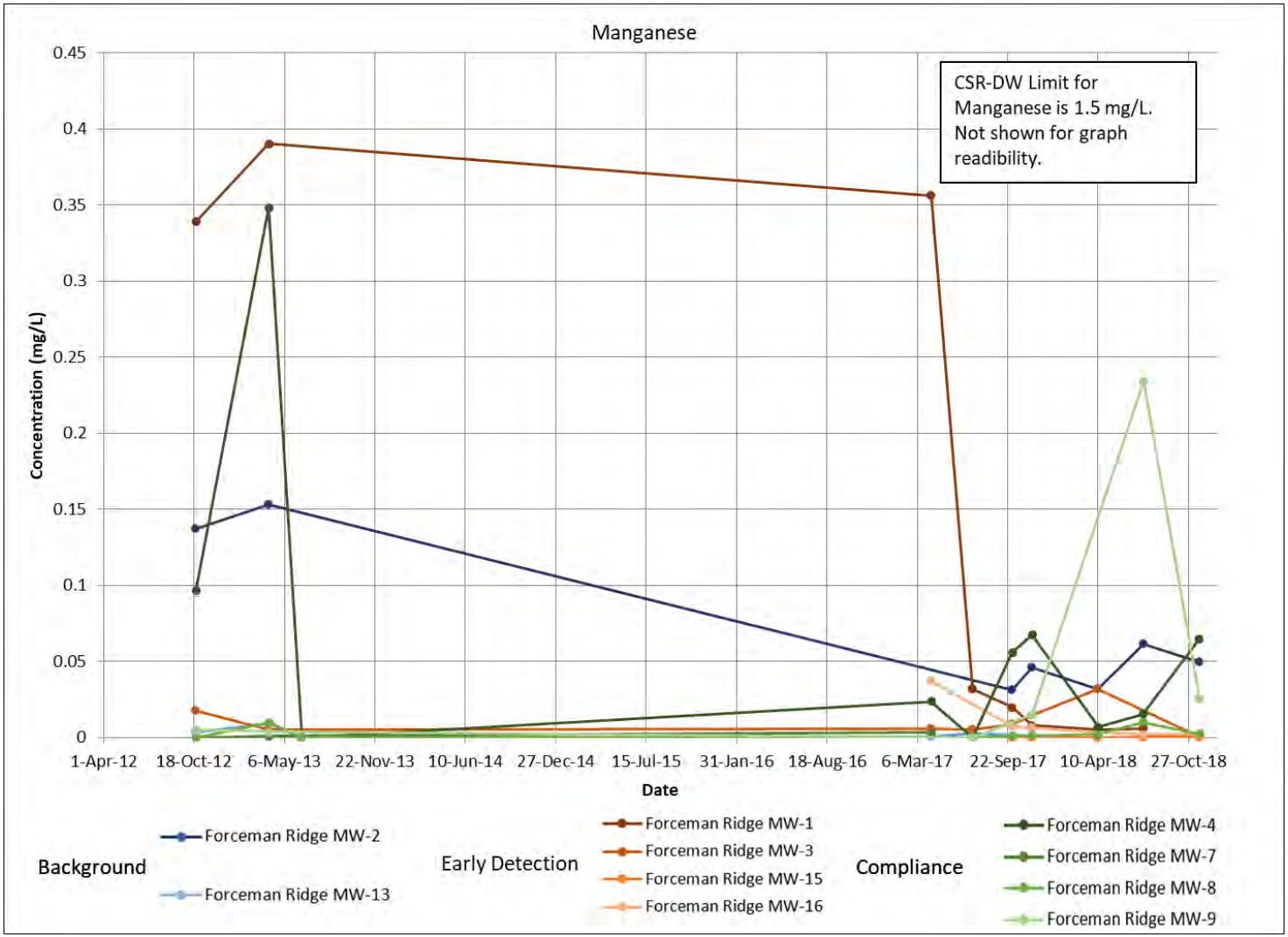
Sperling Hansen Associates

Regional District of Kitimat-Stikine

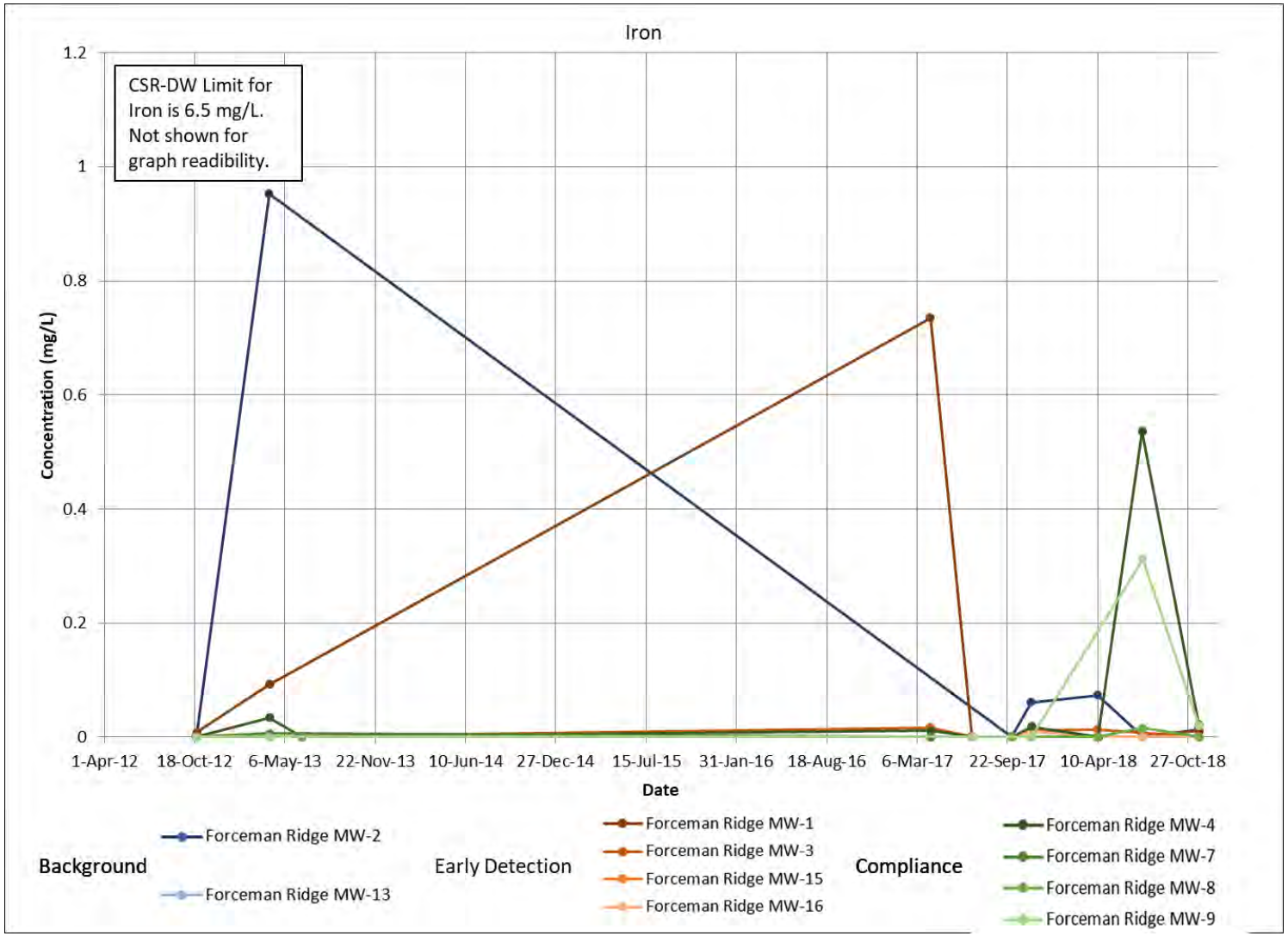
PROJECT:
Forceman Ridge WMF 2018 Annual Monitoring Report

TITLE:
Groundwater Chloride

SCALE:	DATE:	PROJECT NO:
N/A	2019/02/21 yyyy/mm/dd	PRJ19008
DESIGNED	AM	DRAWING NO:
DRAWN	AM	**Chart 2**
CHECKED	IB	



Sperling Hansen Associates	Regional District of Kitimat-Stikine	PROJECT: **Forceman Ridge WMF 2018 Annual Monitoring Report**	TITLE: **Groundwater Dissolved Manganese**	SCALE: N/A; DATE: 2019/02/21 yyyy/mm/dd; PROJECT NO: PRJ19008; DESIGNED: AM; DRAWN: AM; CHECKED: IB; DRAWING NO: **Chart 3**



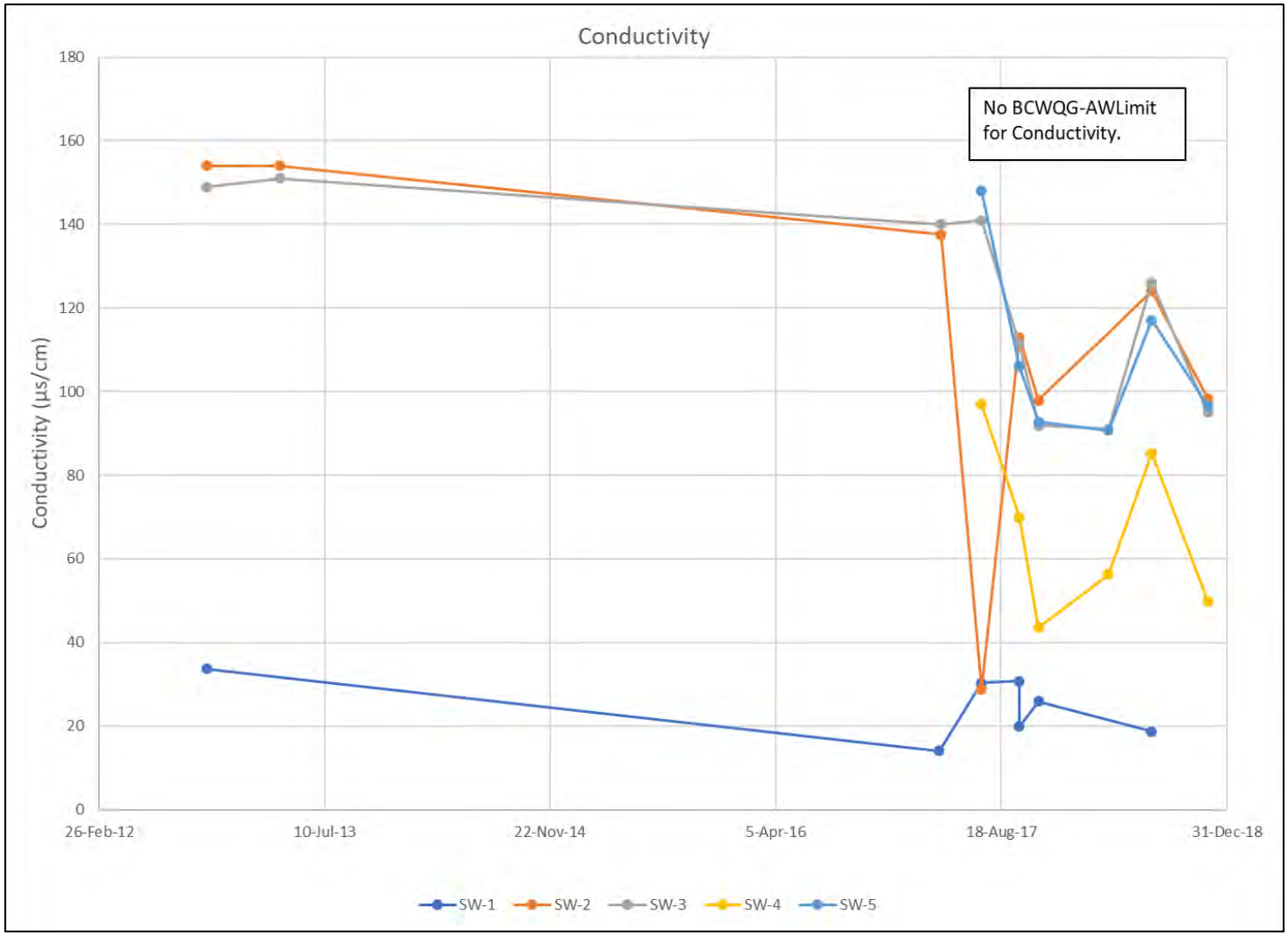
Sperling Hansen Associates

Regional District of Kitimat-Stikine

PROJECT:
Forceman Ridge WMF 2018 Annual Monitoring Report

TITLE:
Groundwater Dissolved Iron

SCALE:	DATE:	PROJECT NO:
N/A	2019/02/21 yyyy/mm/dd	PRJ19008
DESIGNED	AM	DRAWING NO:
DRAWN	AM	**Chart 4**
CHECKED	IB	



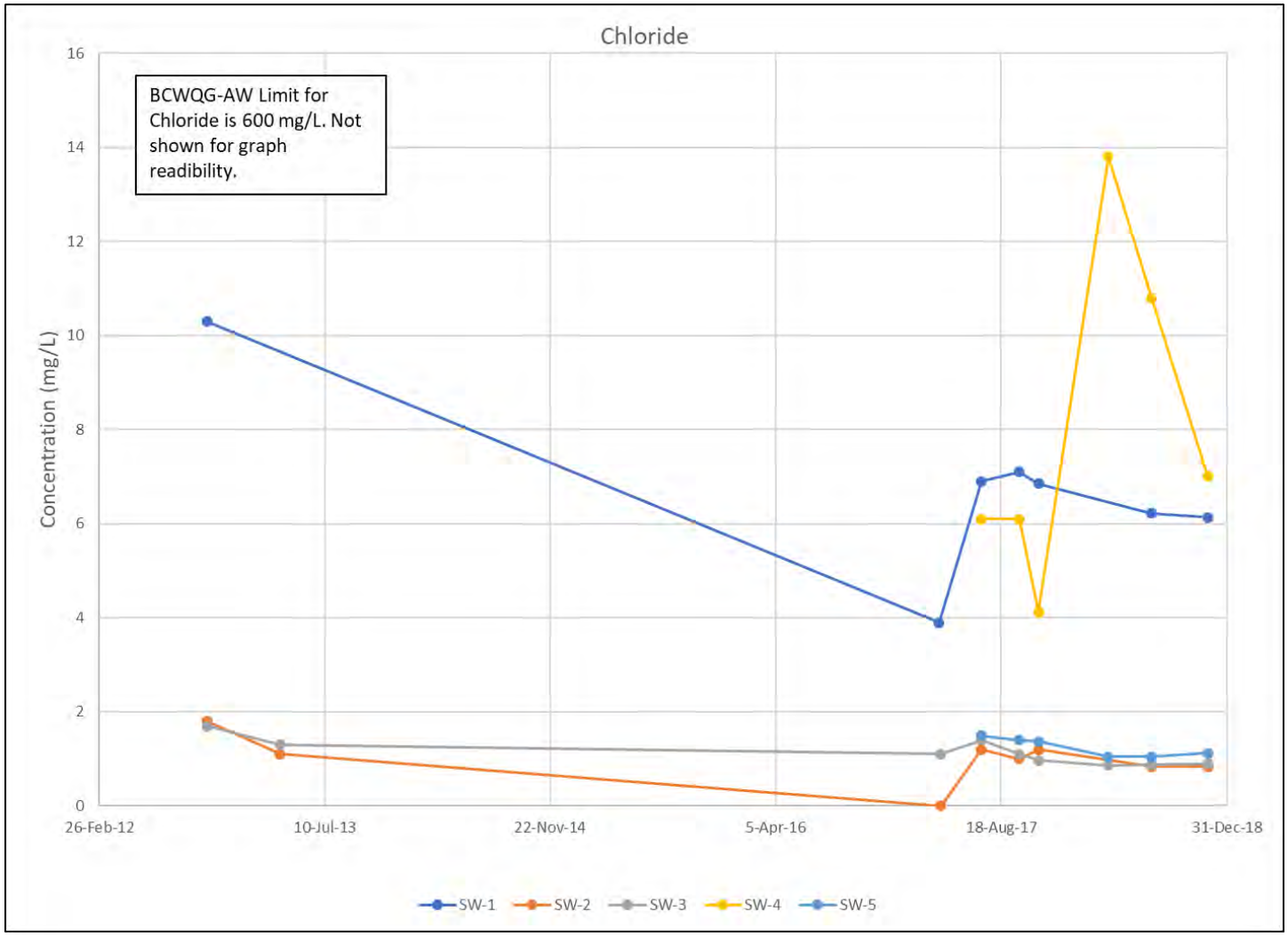
Sperling Hansen Associates

Regional District of Kitimat-Stikine

PROJECT:
Forceman Ridge WMF 2018 Annual Monitoring Report

TITLE:
Surface Water Conductivity

SCALE:	DATE:	PROJECT NO:
N/A	2019/02/21 yyyy/mm/dd	PRJ19008
DESIGNED	AM	DRAWING NO:
DRAWN	AM	**Chart 5**
CHECKED	IB	



Sperling Hansen Associates	Regional District of Kitimat-Stikine	PROJECT: Forceman Ridge WMF 2018 Annual Monitoring Report	TITLE: Surface Water Chloride	SCALE: N/A	DATE: 2019/02/21
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				DESIGNED AM	DRAWING NO: Chart 6
				DRAWN AM	
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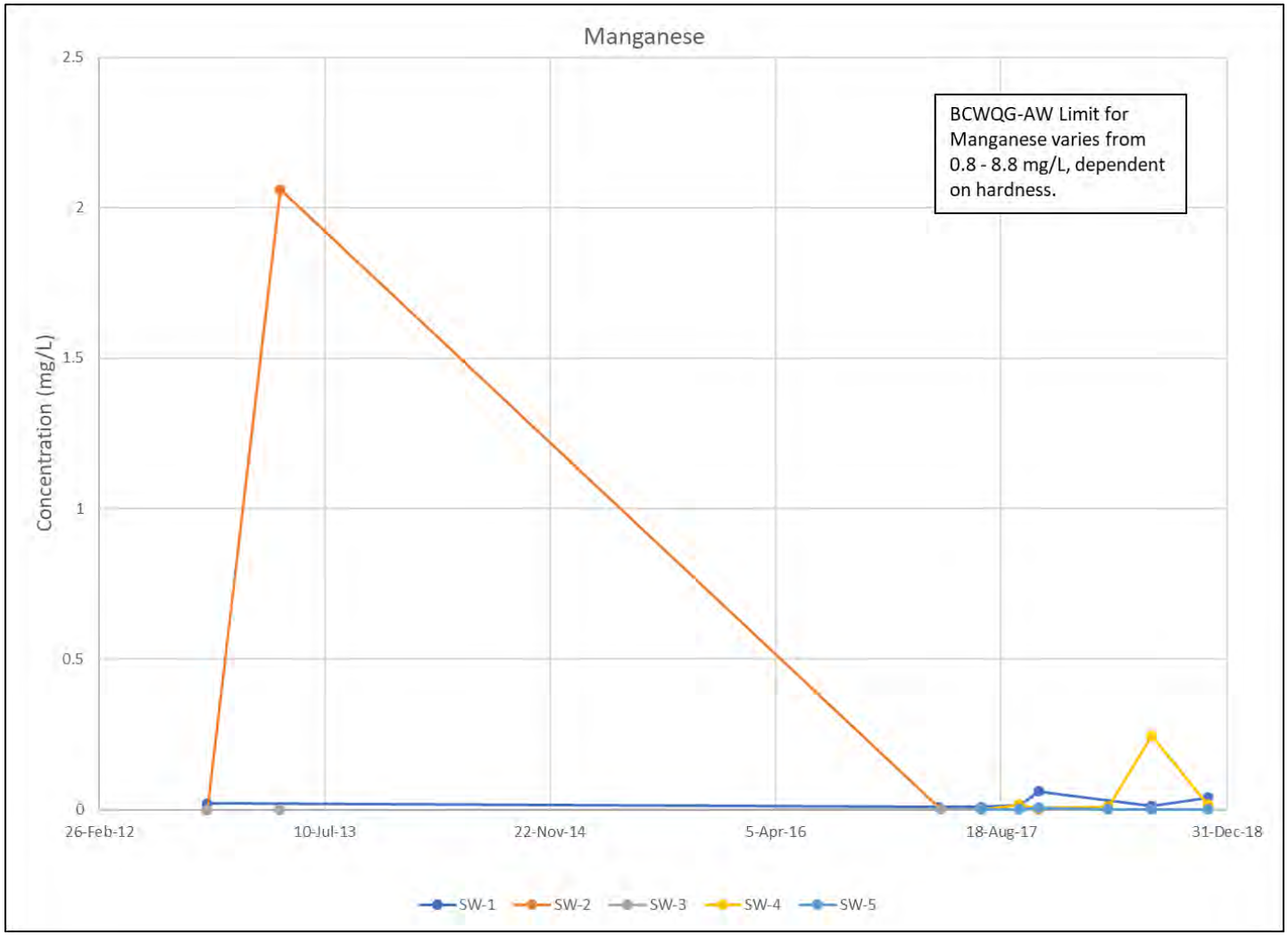
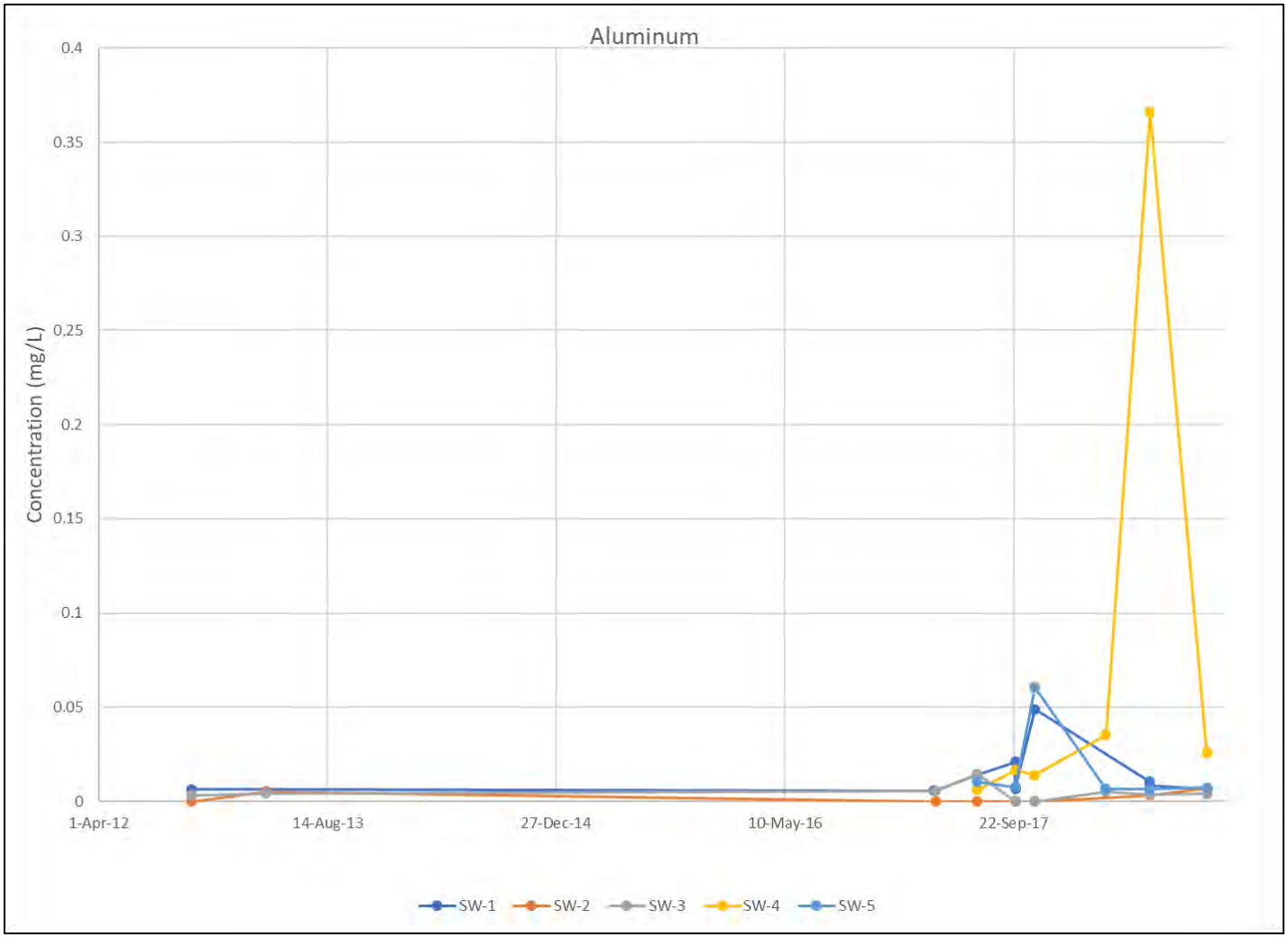


Sperling Hansen Associates	Regional District of Kitimat-Stikine	PROJECT: Forceman Ridge WMF 2018 Annual Monitoring Report	TITLE: Surface Water Total Manganese	SCALE: N/A; DATE: 2019/02/21 yyyy/mm/dd; PROJECT NO: PRJ19008; DESIGNED: AM; DRAWN: AM; CHECKED: IB; DRAWING NO: Chart 7



Sperling Hansen Associates

Regional District of Kitimat-Stikine

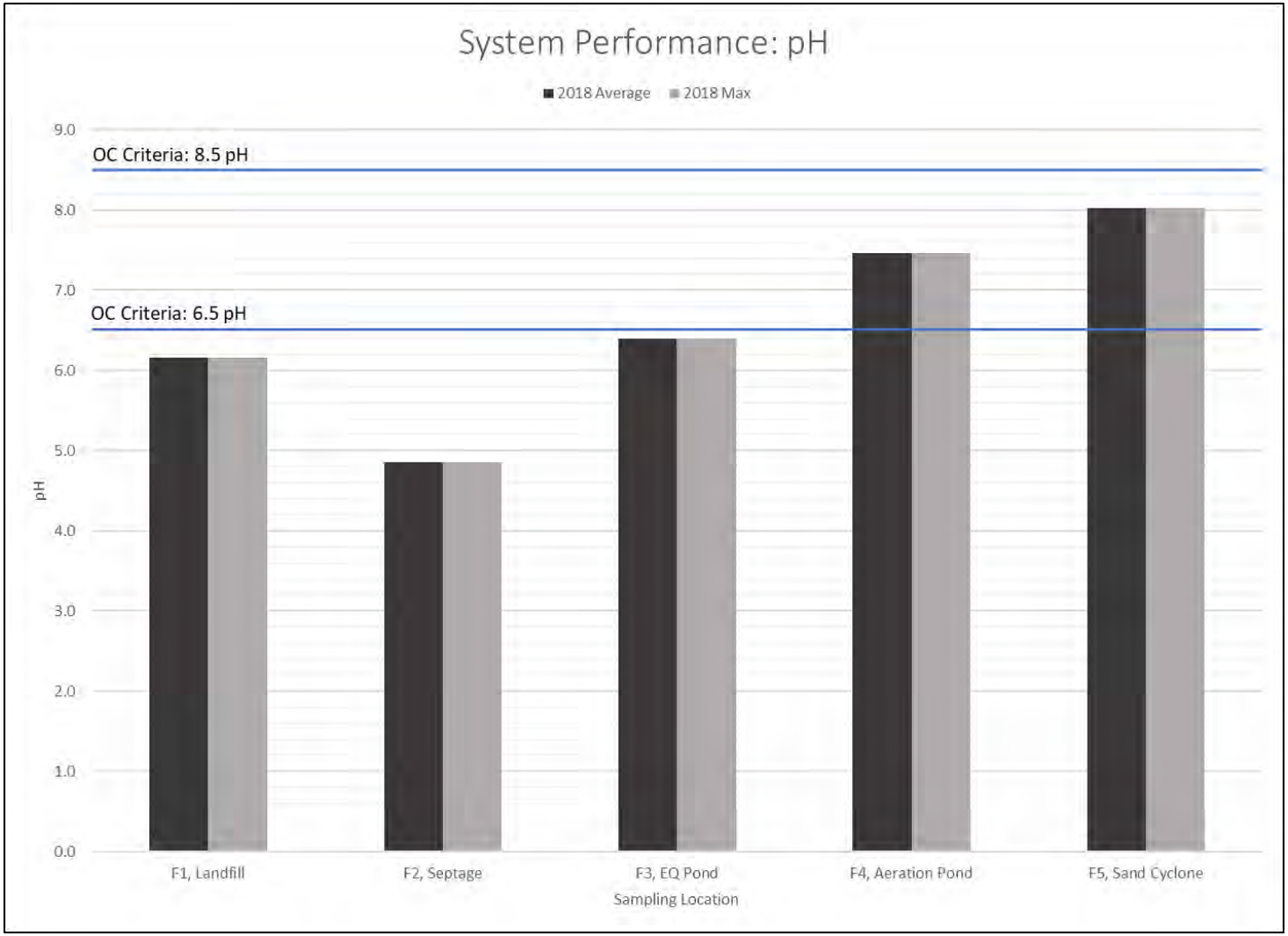
PROJECT:

Forceman Ridge WMF 2018 Annual Monitoring Report

TITLE:

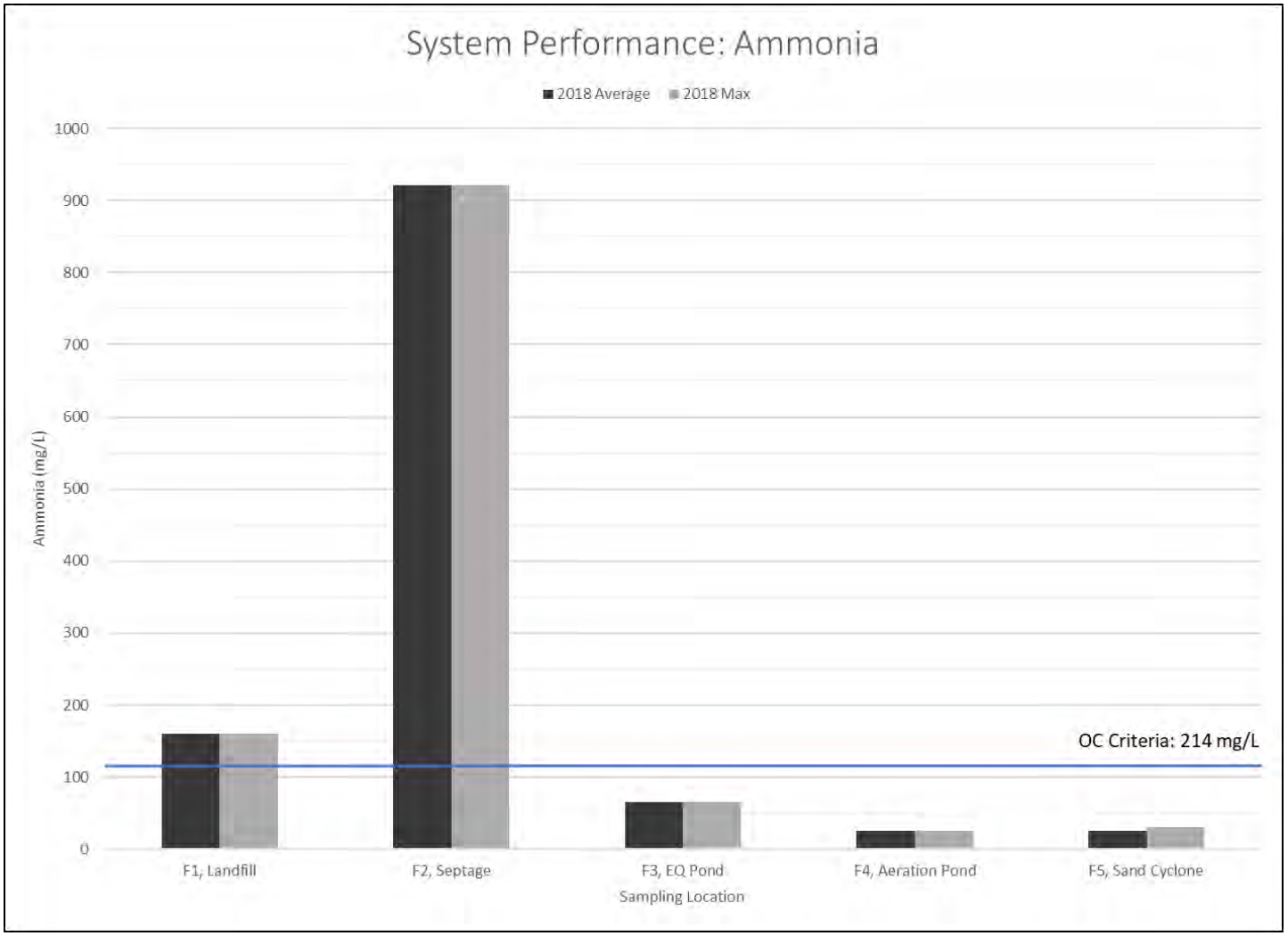
Surface Water Total Aluminum

SCALE:	DATE:	PROJECT NO:
N/A	2019/02/21 yyyy/mm/dd	PRJ19008
DESIGNED	AM	DRAWING NO:
DRAWN	AM	**Chart 9**
CHECKED	IB	

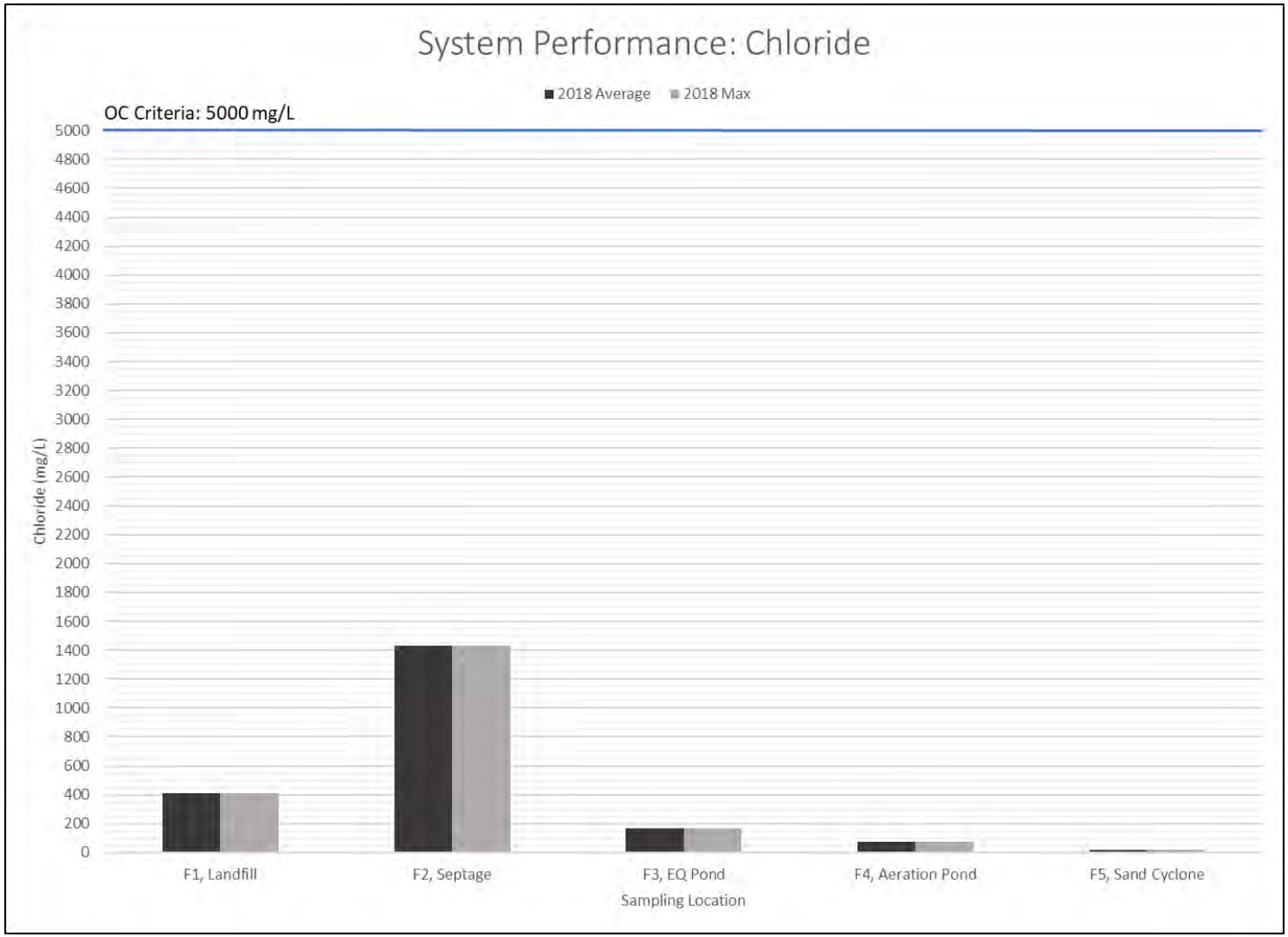


Sperling Hansen Associates	Regional District of Kitimat-Stikine	PROJECT: Forceman Ridge WMF 2018 Annual Monitoring Report	TITLE: System Performance: pH

SCALE: N/A	DATE: 2019/02/21 yyyy/mm/dd	PROJECT NO: PRJ19008	
DESIGNED	AM	DRAWING NO: Chart 10	
DRAWN	AM		
CHECKED	IB		

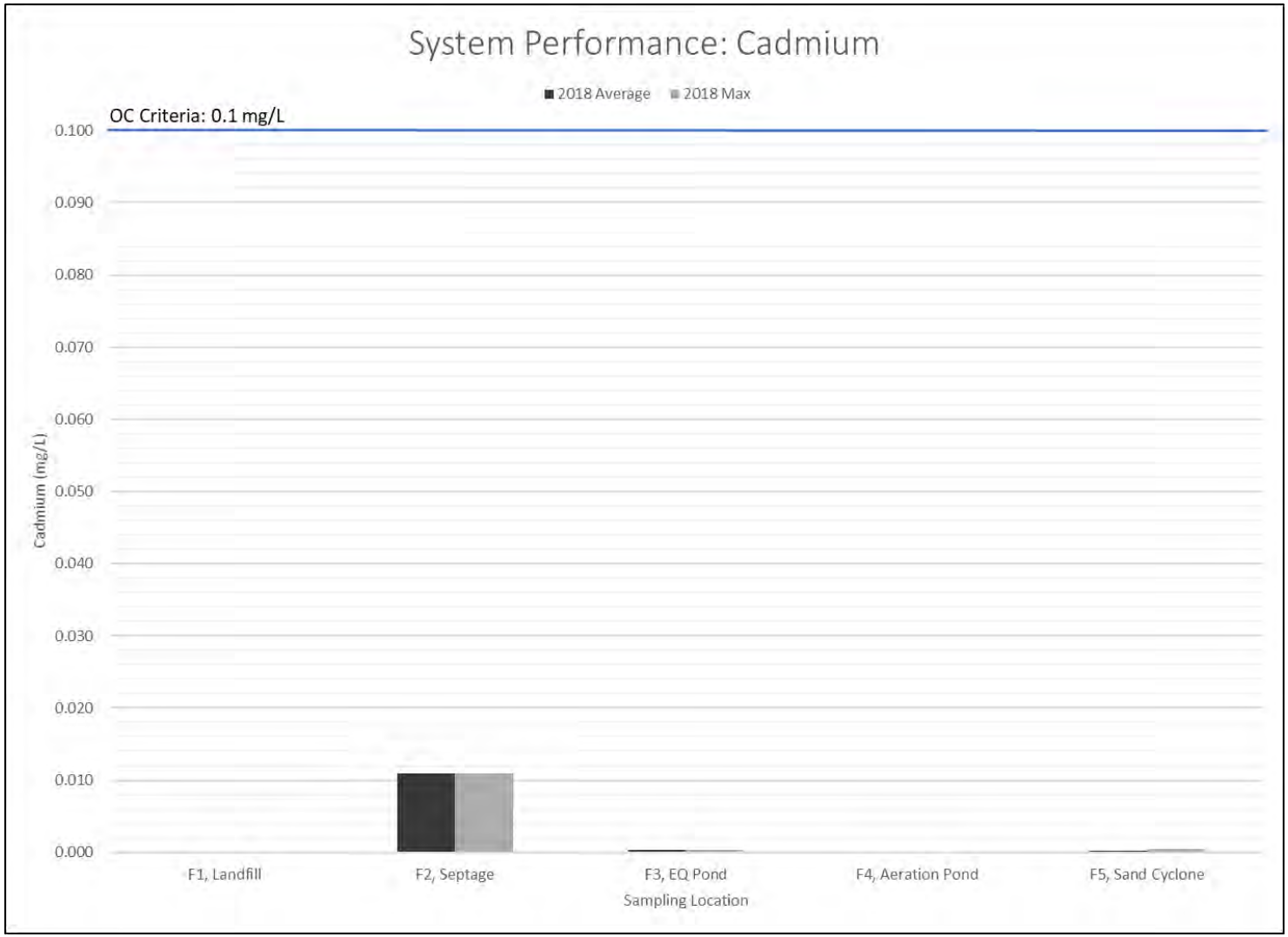


Sperling Hansen Associates	Regional District of Kitimat-Stikine	PROJECT: **Forceman Ridge WMF 2018 Annual Monitoring Report**	TITLE: **System Performance: Ammonia**	SCALE: N/A; DATE: **2019/02/21** yyyy/mm/dd; PROJECT NO: **PRJ19008**; DESIGNED AM; DRAWN AM; CHECKED IB; DRAWING NO: **Chart 11**



Sperling Hansen Associates	Regional District of Kitimat-Stikine	PROJECT: Forceman Ridge WMF 2018 Annual Monitoring Report	TITLE: System Performance: Chloride

SCALE: N/A	DATE: 2019/02/21 yyyy/mm/dd		PROJECT NO: PRJ19008
DESIGNED	AM	DRAWING NO: Chart 12	
DRAWN	AM		
CHECKED	IB		



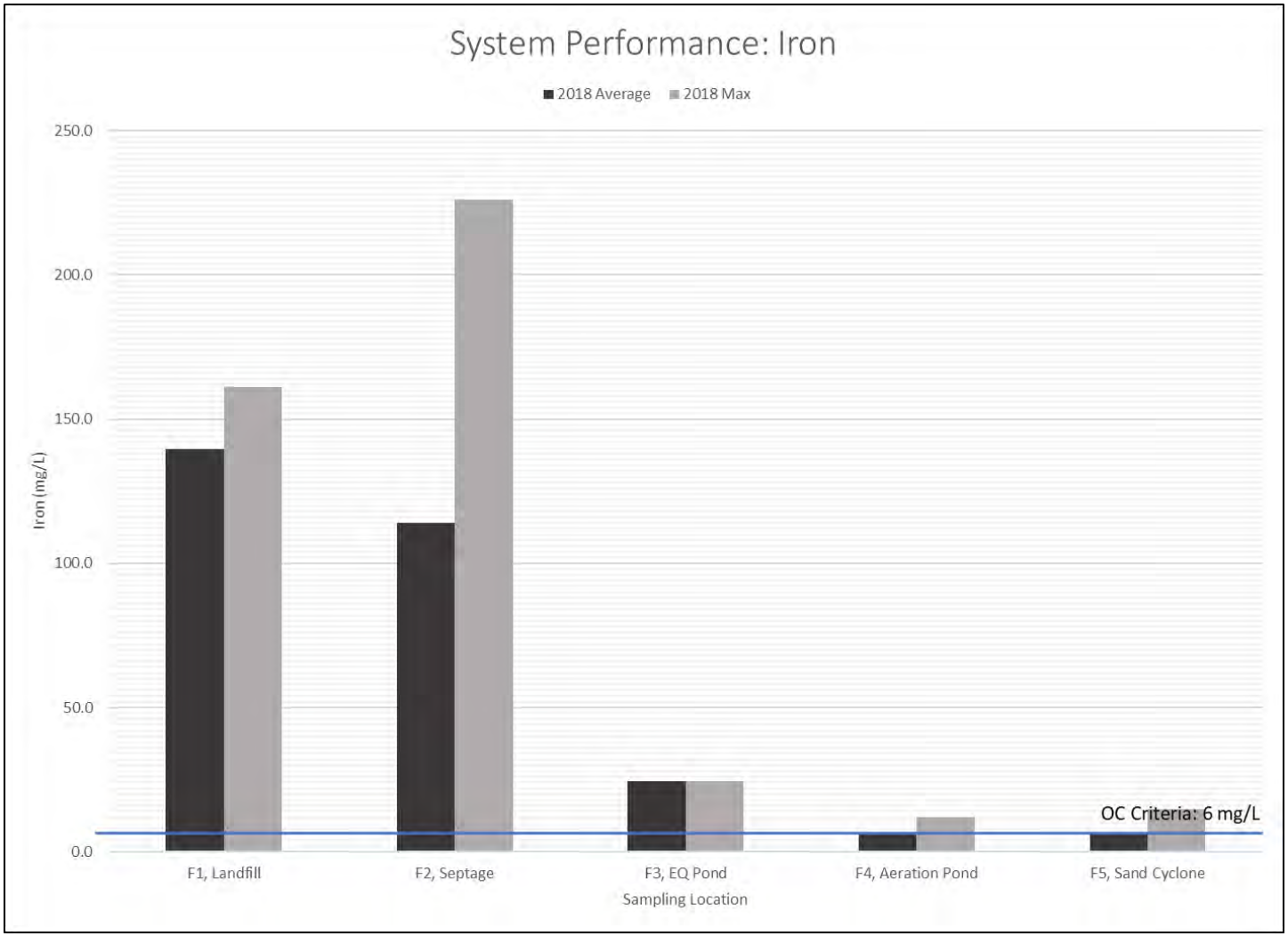
Sperling Hansen Associates

Regional District of Kitimat-Stikine

PROJECT:
Forceman Ridge WMF 2018 Annual Monitoring Report

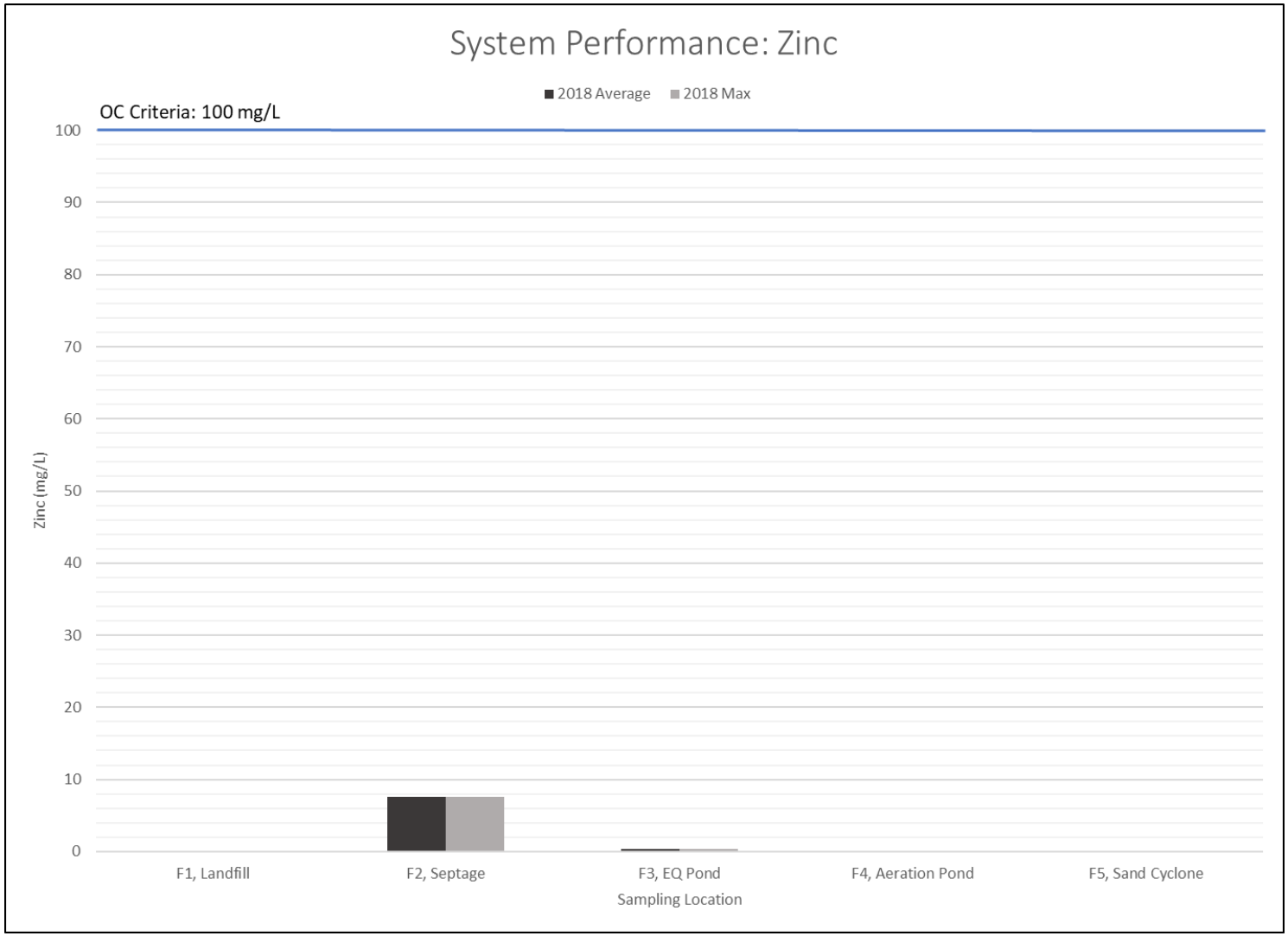
TITLE:
System Performance: Cadmium

SCALE:	DATE:	PROJECT NO:
N/A	2019/02/21 yyyy/mm/dd	PRJ19008
DESIGNED	AM	DRAWING NO:
DRAWN	AM	Chart 13
CHECKED	IB	



Sperling Hansen Associates	Regional District of Kitimat-Stikine	PROJECT: Forceman Ridge WMF 2018 Annual Monitoring Report	TITLE: System Performance: Iron

SCALE: N/A	DATE: 2019/02/21 yyyy/mm/dd		PROJECT NO: PRJ19008
DESIGNED	AM	DRAWING NO: Chart 14	
DRAWN	AM		
CHECKED	IB		



Sperling Hansen Associates	Regional District of Kitimat-Stikine	PROJECT: Forceman Ridge WMF 2018 Annual Monitoring Report	TITLE: System Performance: Zinc

SCALE: N/A	DATE: 2019/02/21 yyyy/mm/dd		PROJECT NO: PRJ19008
DESIGNED	AM	DRAWING NO: Chart 15	
DRAWN	AM		
CHECKED	IB		

Appendix D: Amended Operational Certificate 17227

April 20, 2017

Tracking Number: 333328
Authorization Number: 17227

REGISTERED MAIL

REGIONAL DISTRICT OF KITIMAT-STIKINE
300 4545 LAZELLE AVENUE
TERRACE BC V8G 4E1

Dear Operational Certificate Holder:

Enclosed is Amended Operational Certificate 17227 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the operational certificate.

This operational certificate 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 rests with the operational certificate holder. It is also the responsibility of the operational certificate holder to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464.

Administration of this permit will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. Plans, data and reports pertinent to the permit are to be submitted by email or electronic transfer to the Director, designated Officer, or as further instructed.

Yours truly,

for Director, *Environmental Management Act*
Authorizations - North

Enclosure

cc: Environment Canada

Ministry of Environment Environmental Protection Division Bag 5000 Smithers, BC V0J 2N0 Authorizations - North Telephone: (250) 847-7260 Facsimile: (250) 847-7591

MINISTRY OF ENVIRONMENT

OPERATIONAL CERTIFICATE
17227

for the

FORCEMAN RIDGE REGIONAL LANDFILL

Under the Provisions of the Environmental Management Act
and in Accordance with the
Regional District of Kitimat-Stikine's Solid Waste Management Plan

REGIONAL DISTRICT OF KITIMAT-STIKINE

Suite 300 – 4545 Lazelle Avenue

Terrace, British Columbia

V8J 4E1

is authorized to store, handle, treat and discharge municipal waste at a sanitary landfill facility located near Forceman Ridge approximately 30 km south of Terrace, British Columbia, subject to the terms and conditions listed below. Contravention of any of these conditions is a violation of the *Environmental Management Act* and may result in prosecution.

Date Issued: November 7, 2008
Date Amended: April 20, 2017
(most recent)

for Director, *Environmental Management Act*
Authorizations - North
Operational Certificate Number: 17227

1. LOCATION OF LANDFILL PROPERTY

The location of the property where discharges are authorized to occur is described as District Lot 8128, Range 5, Coast District.

2. AUTHORIZED DISCHARGES

2.1. Municipal Solid Waste

This section applies to the discharge of municipal solid waste to ground. The site reference number for this discharge is E249849.

2.1.1. Quantity of Discharge

The quantity of solid wastes discharged to ground shall not exceed the design capacity of the landfill facility specified as follows: (1) by an engineered final design footprint (see section 3.3); and (2) by engineered excavation and final grade contours (see section 3.4).

2.1.2. Characteristics of the Discharge

Subject to sections 6.2, 6.3 and 6.4, the characteristics of the discharge shall be typical of municipal solid waste.

2.1.3. Authorized Works

The authorized works are a separate municipal solid waste disposal area and related appurtenances located approximately as shown on the attached site plan.

2.2. Open Burning Air Contaminants

This section applies to the discharge of air contaminants to the atmosphere from the regulated open burning of selected combustibles. The site reference number for this discharge is E249850.

2.2.1. Quantity of Discharge

The maximum authorized quantity of discharge of air contaminants is indeterminate.

2.2.2. Characteristics of the Discharge

The characteristics of the discharge shall be typical of those resulting from the regulated open burning of selected combustibles as per section 11.3.

2.2.3. Authorized Works

The authorized works are a separate burn area associated with a landfill operation and related appurtenances located approximately as shown on the attached Site Plan.

2.3. Liquid Wastes

This section applies to the discharge of selected liquid wastes to the ground. The site reference number for this discharge is E249851.

2.3.1. Quantity of Discharge

The maximum authorized quantity of discharge is indeterminate.

2.3.2. Characteristics of the Discharge

The characteristics of the discharge shall be those typical of septic tank pumpage, holding tank effluent, sewage treatment plant sludges, and wash water and grit from drain sumps at car and light truck wash facilities and parking lots.

2.3.3. Authorized Works

The authorized works are liquid waste storage and treatment lagoons and related appurtenances located approximately as shown on the attached Site Plan.

2.4. Leachate

This section applies to the discharge of leachate to a phytoremediation area. The site reference number for this discharge is E249852.

2.4.1. Quantity of Discharge

The maximum authorized rate of discharge is 609 m^3/day and the average rate of discharge is 400 m^3/day. The discharge may occur

24 hours/day, 7 days/week during the months of April to October inclusive.

2.4.2. Characteristics of the Discharge

The characteristics of treated leachate shall not exceed the following limits:

Total Nitrogen	300 mg/L
Ammonia	214 mg/L
pH	6.5 to 8.5
Chloride	5000 mg/L
Total iron	6 mg/L
Total zinc	100 mg/L
Total cadmium	0.1 mg/L

2.4.3. Authorized Works

The authorized works are leachate collection and treatment facilities including an equalization basin, aeration lagoon, sedimentation pond, sand filter and hybrid poplar plantation and related appurtenances located approximately as shown on the attached Site Plan.

3. LANDFILL DESIGN

3.1. Design by Qualified Professional(s)

The landfill and associated works [including but not limited to the size(s) and location(s) of disposal area(s), maximum allowable slopes of disposal area(s), leachate management system, progressive and final closure details, etc.] shall be designed by qualified professionals [such as engineer(s) and/or geoscientist(s)] registered in the Province of British Columbia who have expertise in the field of landfill design. Where a

design feature prepared by a qualified professional is in conflict with any requirement of this operational certificate, it shall be brought to the attention of the Director who shall determine a resolution to the conflict.

3.2. Construction

The landfill and associated works shall be constructed in accordance with the design prepared by qualified professionals.

3.3. Engineered Footprint

The landfill design shall include preparation of an engineered final design footprint delineating the maximum extent of solid waste disposal allowable at the facility horizontally (in plan view). The engineered final design footprint shall be clearly shown on a scaled plan of the site and the plan shall be made available in an electronic format as a computer aided design (CAD) drawing.

3.4. Engineered Excavation and Final Grade Contours

The landfill design shall include preparation of engineered excavation grade (if below grade landfilling is to occur) and final grade contours delineating the maximum extent of solid waste disposal allowable at the facility vertically (in cross-sectional view). The engineered excavation and final grade contours shall be clearly shown on scaled drawings (accompanied with typical cross sections to aid in depicting the landfill profile) and the drawings shall be made available in an electronic format as computer aided design (CAD) drawings.

4. LANDFILL GAS MANAGEMENT

4.1. Lower Explosive Limit

The landfill shall be operated such that combustible gas concentrations do not exceed the lower explosive limit in soils at the property boundary or 25% of the lower explosive limit in any on-site or off-site structure or facility, including any services (water, sewer, electrical, etc.).

5. LEACHATE MANAGEMENT REQUIREMENTS

5.1. Leachate Containment

The operational certificate holder shall ensure that leachate is contained through the use of a barrier system. The barrier system shall consist of a minimum of 2 metres of natural, *in-situ* clay with a hydraulic conductivity of 1 x 10^{-6} cm/s or less. Alternatively, an engineered barrier may be used provided it is equivalent to or better than the natural clay barrier specified above. The actual specifications of the leachate containment system shall be set out in the detailed engineering design.

5.2. Leachate Collection

A continuous drainage blanket shall be established beneath all landfill phases. The drainage blanket shall consist of, or be equivalent to, a minimum 300 mm thick layer of clean gravel with an effective hydraulic conductivity exceeding 1 x 10^{-1} cm/s. The leachate collection system shall be designed such that the hydraulic head on top of the barrier layer does not exceed 300 mm at any time.

5.3. Protection Against Clogging

The drainage layer shall be protected against sedimentation and bio-chemical clogging. Under no circumstances shall leachate piping or leachate collectors be wrapped in geotextile.

6. GENERAL REQUIREMENTS

6.1. Site Identification

A sign shall be erected at the main entrance to the site which identifies the following: site name, owner and operator, contact phone number and address, tipping fees (if applicable) and prohibited wastes. The lettering on the sign shall be such that it is clearly readable upon approach.

6.2. Prohibited Wastes

No wastes as defined by the *Hazardous Waste Regulation* shall be received, stored or disposed of at this site except as authorized by the Director. Lead-acid batteries shall not be landfilled but may be salvaged/recycled provided they are stored, handled and shipped in compliance with the *Hazardous Waste Regulation* and with section 10 of

this operational certificate. Tires equal to or less than 43.2 centimetres (17") in rim size and autohulks shall not be landfilled.

6.3. Waste Asbestos

Notwithstanding section 6.2 of this operational certificate, the disposal of waste asbestos under section 2.1 of this operational certificate and in compliance with the requirements of the *Hazardous Waste Regulation* is hereby authorized.

6.4. Contaminated Soil

Soil that contains contaminants in concentrations less than "hazardous waste" as defined by the *Hazardous Waste Regulation* may be disposed at the landfill site. Disposal includes monofilling, co-disposal with other wastes, use as a refuse cell berm material and use as a refuse cell cover material. Disposal must occur within a disposal area as authorized by sections 7 and 8 of this operational certificate. Disposal does not include use as final cover material.

6.5. Waste Measurement

The quantity of waste material landfilled at the site shall be measured using a weigh scale or by volume or estimated by means suitable to the Director. The results shall be submitted once per year on or before June 30 for the previous year expressed in tonnes/yr and/or m^3/yr.

6.6. Ozone Depleting Substances

Release of ozone depleting substances from the storage, handling and disposal of used refrigerator equipment, freezers, motor vehicle air conditioners and other air conditioning equipment, fire extinguishers or other equipment containing ozone depleting substances is strictly forbidden as per the requirements of the *Ozone Depleting Substances and other Halocarbons Regulation*.

6.7. Fire Prevention

The operational certificate holder shall make all reasonable efforts to prevent unauthorized fires from occurring at the landfill site. As a minimum, a fire break clear of all combustible materials at least 15 metres wide shall surround all disposal, treatment and individual storage areas

which have received or are receiving combustible materials. Disposal areas that have had 30 cm of compacted mineral soil cell cover or final cover applied are exempt. Water supply and pumping capabilities and/or soil and earth moving equipment shall be maintained at a sufficient level to extinguish fires. In addition, reasonable efforts shall include, but are not necessarily limited to, the preparation of a fire prevention and response plan.

6.8. Extinguishment of Fires

In the event of an unauthorized fire (including any smouldering fire), the operational certificate holder shall immediately make all reasonable efforts to extinguish the fire. Any fire which poses a threat to public health or to neighbouring property shall be reported to Emergency Management BC at 1-800-663-3456, the local fire authority, and/or the BC Wildfire Service at 1-800-663-5555.

6.9. Buffer Zone

No material shall be landfilled within 50 metres of the property boundary.

6.10. Litter Control

The operational certificate holder shall make all reasonable efforts to prevent litter from scattering. Any litter scattered on neighbouring property shall be cleaned up as soon as practicable.

6.11. Water Table Restriction

Wastes shall not be deposited or stored less than 1.2 metres above the highest groundwater level.

6.12. Inert Materials

Specific inert materials may be exempted from the requirements of section 6.11 by the Director. The permission of the Director must be obtained in writing prior to any disposal or handling of inert materials on an exemption basis.

6.13. Bear-Proof Containment of Putrescibles

All putrescible wastes that arrive at the landfill facility must be immediately contained within a bear-proof bin (i.e. on-site transfer station of bear-proof design and construction) or within an area enclosed by an electric fence. Grass, leaves, weeds, branches and ground woodwaste are not considered putrescible for the purposes of this operational certificate.

6.14. Electric Fencing

6.14.1. Design, Construction and Maintenance

Wherever required, electric fencing and gate systems at the landfill shall be designed, constructed, and maintained such that bears are prevented from entering into the landfill through any portion of the fence or gates at any time of the day.

6.14.2. Fence Type

Fencing may be either high tensile smooth wire or fence fabric (e.g., mesh-wire, page-wire or chainlink). The configuration of a high tensile smooth wire fence shall consist of a minimum of eight strands, with four energized strands alternating with four grounded strands as follows: the bottom strand shall be a grounded or (-) strand and shall not be more than 10 cm from the ground (soil) at any location; and thence starting from the bottom strand, the other seven strands shall be spaced 15 ± 2 cm, 15 ± 2 cm, 15 ± 2 cm, 20 ± 2 cm, 20 ± 2 cm, 20 ± 2 cm, and 25 ± 2 cm. Additional strands to this minimum configuration may be used.

A fence fabric may be used instead of high tensile smooth wire. The fence fabric shall: be a minimum of 1.22 metre high; be constructed of a minimum wire thickness of 11 gauge, and have a maximum mesh size of 15 cm. The bottom of the fabric shall not be more than 10 cm from the ground (soil) at any location. Any uncharged fence fabric must have a minimum of four strands of charged wires on an outrigger system, spaced as follows: the first strand shall not be higher than 25 cm from the ground; and each of the remaining three strands shall be spaced approximately 25 cm apart from adjacent charged strands.

6.14.3. Wire Tension

For a high tensile smooth wire fence construction, all strands shall be tightened to a minimum of 125 lbs tension at 20°C. The required tension is to be corrected for temperature by use of the following formula for 12-½ gauge high tensile steel wire:

$$Tension = 125 - 2.5(Temperature - 20)$$

where: *Tension* is in lbs force

Temperature is in °C

6.14.4. Post Spacing

Fence posts shall be spaced a maximum of 7.5 metres apart.

6.14.5. Grounding System

A grounding system shall be installed consisting of solid grounding rods (i.e., not pipe) with a minimum diameter of 16 mm (5/8 inch) that have a buried length of at least 2 metres. A minimum of three grounding rods (spaced at least 3 metres apart) shall be installed and connected to the energizer. Alternative energizer grounding systems (e.g., grounding plates, or a deep-driven grounding system) may be used provided the grounding is equivalent to or better than three grounding rods. A grounding rod (or equivalent) shall be installed at least once every 450 metres along the fence and connected to the grounded wire strands or uncharged fence fabric. Additional grounding may be required for dry sites or if other conditions affect proper grounding.

6.14.6. Period of Operation

Electric fencing shall be fully operational during the period of April 1 to October 31 inclusive each year and at any other time of year when there is bear activity in the immediate surrounding area. If snow is present during this period, any electrified strands above snow line shall be isolated from the remainder of the system and energized.

6.14.7. Minimum Voltage

Electric fencing shall be operated with a minimum voltage of 6,000 volts.

6.14.8. Gate(s)

Any access through electric fencing for vehicles, equipment and personnel shall consist of an electrified gate system that is closed during non-operating hours. The gate system shall be electrified to a minimum voltage of 6,000 volts at all times except when being opened or closed. Any gate that is open during operating hours shall be periodically checked by the attendant for bear activity during hours of operation. Gaps between the gate and the fence and ground, and between gate panels (for a double-hung gate), shall not exceed 10 cm.

6.14.9. Fence Inspections

The entire perimeter of the electric fencing shall be inspected at least once every seven days and the voltage of the fencing measured at several points along the fencing and at each gate using a proper electric fence voltmeter matched to the brand of the fence charging unit. The results of voltage testing shall be recorded in a log book or electronic record. Any results less than the minimum 6,000 volts shall be immediately investigated for the cause of the low voltage (e.g., low battery, litter, vegetation, loose or crossed wires, broken insulators, breaks in the grounding system, etc.). Corrective actions to restore proper voltage shall be immediately undertaken.

Signs of digging or other attempts by bears to penetrate electric fencing shall be recorded in a log book or electronic record. Any penetrations through electric fencing by bears shall be immediately reported to the Conservation Officer Service at 1-877-952-7277.

In cases of low voltage or signs of penetration attempts, inspections shall be increased from once per week to once per day until proper voltage is fully restored and until there are no new signs of penetration attempts, respectively.

6.15. Municipal Solid Waste Separation

Municipal solid waste may be separated into the following streams: (1) a mixed waste stream including putrescibles for disposal; (2) a mixed waste

stream not including any putrescibles for disposal; (3) an organic waste stream, including untreated wood wastes, for composting; (4) a selected waste stream for salvage and recycling; and (5) a selected combustibles waste stream for open burning or air-curtain burning. Each of these waste streams is subject to all of the general requirements contained in sections 6.1 through 6.14 above, as well as being subject to specific requirements as outlined in a separate section for each below.

6.16 Groundwater Quality

The characteristics of the groundwater at the property boundary shall not exceed drinking water standards in Schedule 6 of the Contaminated Sites Regulation. Where natural background water quality concentrations exceed the aforementioned standard, the characteristics of the groundwater at the property boundary must not exceed background concentrations.

Where monitoring shows contaminant concentrations exceed the applicable water use, or other standards, the operational certificate holder shall notify the Director and take one of the following corrective actions:

- Mitigation to meet standards or

- Based on the results of a risk assessment carried out in accordance with Contaminated Sites Regulation guidance (i.e. Technical Guidance 7), undertake the warranted mitigation measures to achieve acceptable risk.

7. OPERATIONAL REQUIREMENTS FOR DISPOSAL OF SOLID WASTES CONTAINING PUTRESCIBLES

7.1. Location

The operational certificate holder shall identify an area for disposal of putrescible refuse (herein referred to as the putrescible disposal area) that is within the authorized municipal solid waste disposal footprint (see section 2.1.1). Disposal of any solid wastes consisting of or mixed with putrescibles shall be restricted to the designated putrescible disposal area.

7.2. Nature of Wastes

Wastes disposed at the active face of the putrescible disposal area may include any municipal solid waste except liquid wastes and hot ashes or as otherwise restricted by section 6.2.

7.3. Bear-Proofing

The putrescible waste disposal area shall be maintained inside an electric fence. The electric fence shall comply with all requirements of section 6.14.

7.4. Waste Compaction

Wastes at the active face of the putrescible disposal area shall be spread in layers of 60 centimetres or less on the active face and then compacted with a minimum of three (3) passes with heavy equipment.

7.5. Maximum Lift Height

The maximum height of any lift of compacted refuse in the putrescible disposal area shall be 5 metres.

7.6. Waste Cover

Cover shall be applied to refuse in the putrescible disposal area as specified below. The operational certificate holder shall maintain a log book or electronic record with all dates of cover application.

7.6.1. Active Face Cover

Except as otherwise stated in sub-section 7.6.2, the active face of the putrescible disposal area does not normally require cover. Based on information concerning environmental or public health concerns related to exposed refuse at the active face, however, the Director may require that the active face be covered completely at a specified frequency with 0.15 m of soil (or functional equivalent) for a specified period.

7.6.2. Cell Cover

A uniform cover of 30 cm compacted soil shall be applied to all sides of the active refuse cell in the putrescible disposal area such

that no more than 500 m^2 of refuse are exposed at the active face at any time and such that the volume of refuse in the cell does not exceed 5,000 m^3. Once the maximum volume of refuse has been reached in a cell, the active face shall be covered with 30 cm of compacted soil and a new refuse cell begun.

7.6.3. Final Cover

Completed portions of the putrescible disposal area shall progressively receive final cover during the active life of the landfill (see section 15.5).

7.7. Dead Animal Disposal

Dead animals and animal parts shall be disposed of in the putrescible disposal area and covered as soon as practicable with a minimum of 60 centimetres of soil and/or refuse material such that flies and scavenging animals are prevented from accessing the carrion.

8. OPERATIONAL REQUIREMENTS FOR DISPOSAL OF NON-PUTRESCIBLE SOLID WASTES

8.1. Location

The operational certificate holder may identify an area for the disposal of non-putrescible wastes (herein referred to as the non-putrescible disposal area) that is within the authorized municipal solid waste disposal footprint (see sub-section 2.1.1).

8.2. Nature of Wastes

Wastes disposed at the active face of the non-putrescible disposal area may include any municipal solid waste except putrescibles, liquid wastes and hot ashes or materials otherwise restricted by section 6.2.

8.3. Waste Compaction

Wastes at the active face of the non-putrescible disposal area shall be spread in layers of 60 centimetres or less on the active face and then compacted with a minimum of three (3) passes with heavy equipment.

8.4. Maximum Lift Height

The maximum height of any lift of compacted refuse in the non-putrescible disposal area shall be 5 metres.

8.5. Waste Cover

Cover shall be applied to refuse in the non-pustrescible disposal area as specified below. The operational certificate holder shall maintain a log book or electronic record with all dates of cover application.

8.5.1. Active Face Cover

Except as otherwise stated in sub-section 8.5.2, the active face of the non-putrescible disposal area does not normally require cover. Based on information concerning environmental or public health concerns related to exposed refuse at the active face, however, the Director may require that the active face be covered completely at a specified frequency with 0.15 m of soil (or functional equivalent) for a specified period.

8.5.2. Cell Cover

A uniform cover of 30 cm compacted soil shall be applied to all sides of the active refuse cell in the non-pustrescible disposal area such that no more than 500 m^2 of refuse are exposed at the active face at any time and such that the volume of refuse in the cell does not exceed 5,000 m^3. Once the maximum volume of refuse has been reached in a cell, the active face shall be covered with 30 cm of compacted soil and a new refuse cell begun.

8.5.3. Final Cover

Completed portions of the non-putrescible disposal area shall progressively receive final cover during the active life of the landfill (see section 15.5).

9. OPERATIONAL REQUIREMENTS FOR COMPOSTING

9.1. Location

The operational certificate holder may identify an area for composting (herein referred to as the composting area). Any composting shall be restricted to the designated composting area. This area shall be clearly identified at the landfill site.

9.2. On-Site Usage of Compost Product

Composting may be conducted passively by static pile (i.e., no aeration, etc.) provided the compost product is used on-site at the landfill for cover, reclamation or landscaping purposes. The compost piles must be rested at least one year after the last addition of organic waste prior to use.

9.3. Use of Sewage Sludge

Dewatered sludge from the liquid waste disposal lagoons authorized by section 2.3 may be included in static compost piles provided: the sludge is first blended with carbonaceous material (e.g., sawdust and/or wood shavings); and the public is prohibited from accessing any composting area that includes sludge.

9.4. Off-site Usage of Compost Product

If compost product is to be made available to the public or otherwise used offsite, composting operations shall comply with the requirements of the *Organic Matter Recycling Regulation* and any other relevant composting legislation.

9.5. Bear-Proofing

If the composting operation is to receive any organic wastes that are potential attractants to bears, then composting shall be completely enclosed by an electric fence or contained in a bear-proof structure (building or composting vessel). The electric fence shall comply with all requirements of section 6.14.

10. OPERATIONAL REQUIREMENTS FOR STORAGE OF SELECTED WASTES FOR SALVAGE AND RECYCLING

10.1. Location

The operational certificate holder may identify an area for the storage of selected wastes for salvage and recycling (herein referred to as the salvage/recycling area). Any salvage/recycling shall be restricted to the designated salvage/recycling area.

10.2. Nature of Wastes

Wastes to be salvaged/recycled may be any items with potential salvage or recycling value but shall not include any refuse consisting of or containing putrescibles, any liquid wastes, hot ashes or materials otherwise restricted by section 6.2.

10.3. Contamination

Contamination of any of the designated salvage/recycling storage piles with putrescible wastes shall be cleaned up immediately. Contamination of any of the storage piles with materials other than the intended salvageable/recyclable material (e.g., scrap metal with wood waste, or white goods with demolition debris, etc.) may result in a requirement to clean up the contamination or to landfill the contaminated material.

11. OPERATIONAL REQUIREMENTS FOR REGULATED OPEN BURNING

11.1. Location

The operational certificate holder may identify an area for the use of open burning to treat selected combustibles (herein referred to as the open burning area). Any open burning of selected wastes shall be restricted to the designated open burning area.

11.2. Quantity, Timing and Duration of Discharge

The maximum authorized quantity of wood residue to be open burned during each event is that which has accumulated at the time of burn initiation.

The maximum authorized duration of each burn shall be limited to the period between two hours after sunrise on the day of ignition, and sunset on the following day. Each open burn shall be completely extinguished at the end of the authorized burn duration.

Should a condition arise which prevents the burn pile(s) from being burned within this period, the Director shall be notified in accordance with this authorization.

11.3. Nature of Wastes

Acceptable materials for burning may only include dry, unpainted, untreated demolition, construction and packing-related wood residue, clean stumps and brush, but shall exclude nuisance-causing combustibles such as glue-containing wood, painted and treated wood, sawdust, yard wastes, mulch, wood chips, rubber, plastics, tars, insulation, roofing material, asphalt shingles, etc.

11.4. Favourable Weather for Smoke Dispersion

Open burning shall not proceed unless the recorded Environment Canada Ventilation Index Forecast for Terrace is good for the first day and good or fair for the second day.

The contact number for the forecast is 1-888-281-2992. Ventilation index forecasts can also be obtained after 7:00 a.m. from the following Environment Canada website:
http://www.env.gov.bc.ca/epd/epdpa/venting/venting.html

A burn registration number shall be obtained from the Ministry of Forests (1-888-797-1717) prior to ignition.

Open burning of wood residue shall not be initiated or continued if the local air flow will cause the smoke to negatively impact a nearby population or cause pollution. No burning shall occur during periods of fire hazard or when burning is prohibited by other agencies.

11.5. Fire Accelerant

An approved fire accelerant such as diesel fuel or commercial fire starter gel or a flame-thrower shall be used to ensure efficient and rapid ignition of the waste material.

11.6. Minimization of Smoke

Each burn shall be tended in a manner that ensures minimization of smoke emissions. Measures to minimize smoke shall include, but not necessarily be limited to: stacking of waste in a manner that eliminates inclusion of dirt; waiting to burn until wastes are reasonably dry after any significant precipitation event; and using adequate equipment and staff.

11.7. Extinguishment Contingency Plan

Prior to burning, a contingency plan shall be in place detailing how the open burn will be extinguished in the event of any of the following occurring:

i) Inadequate smoke dispersion in the surrounding environment;

ii) wood continues to smoulder after the authorized burn period;

iii) the Director requires that the open burn be extinguished for environmental protection reasons

11.8. Extinguishment

All combustion shall be completely extinguished at the end of the authorized period as set out in Section 6.2.

12. OPERATIONAL REQUIREMENTS FOR DISPOSAL OF LIQUID WASTES

12.1. Location

The operational certificate holder may identify an area for the controlled disposal of selected liquid wastes (herein referred to as the liquid waste disposal area). Disposal of any liquid wastes from pumper trucks or the like shall be restricted to the designated liquid waste disposal area.

12.2. Liquid Waste Disposal Lagoons

Disposal of any liquid wastes shall be to properly designed and constructed lagoon(s) located in the liquid waste disposal area. The lagoon(s) shall function as decant lagoons (with decant discharged to an authorized liquid waste handling system such as a leachate treatment system) and/or as part of an organic matter composting system. The

lagoons shall be of an impervious design that prevents the escapement of liquid to the ground. In all cases, design and construction of the liquid waste disposal lagoon(s) shall be such that seepage through the berms shall not occur.

12.3. Signage and Fencing

The liquid waste disposal area shall be fenced with chainlink or steel woven-wire (e.g., page wire) a minimum of 1.2 metres high. Signs identifying the nature of the lagoon disposal area shall be erected on all sides of the fence such that the lagoons are easily identifiable from any approach.

12.4. Freeboard

A minimum freeboard of 50 centimetres shall be maintained at all times. The lagoon berms shall be maintained in good working order and the Director shall be notified immediately of any failure or overflow.

12.5. Nature of Wastes

The nature of wastes which may be discharged to a designated lagoon is that of typical septic tank pumpage, sewage holding tank waste, sewage treatment plant sludge, and wash water and grit from drain sumps at automobile wash facilities (intended primarily for cars and light trucks) and parking lots. Industrial liquid wastes and sludges shall be excluded.

12.6. Off-Loading Chute

An off-loading chute shall be provided to ensure that all effluent enters the lagoon and does not spill on the ground in the unloading area.

12.7. Sludge Removal

If the sludge is to be removed from a lagoon for final disposal at an active face of a designated solid waste disposal area (under section 7) or for composting (under section 9), then the lagoon must be rested for a sufficient amount of time to allow the wastes to dewater. Semi-solid sludge may be removed and stockpiled above ground for further dewatering provided: the sludge stockpile is located on impervious ground; drainage from the stockpile area is directed into the lagoon or other approved liquid waste disposal system (e.g., a leachate collection

and treatment system) and provided the sludge stockpile is contained within a signed and fenced area as per section 12.3. Once the solidified sludge is deposited at an active face of a designated solid waste disposal area, it must be covered immediately with a minimum of 30 centimetres of cover material and then the area of sludge disposal compacted immediately after cover is applied.

12.8. Lagoon Closure

If a lagoon is to be closed without removal of sludge as per section 12.7, the sludge must be allowed to dewater to a moisture content that will support final cover. The lagoon must then be covered with a minimum of 1 metre of compacted soil and sloped to promote runoff.

12.9. Volume Measurement

The operational certificate holder shall maintain a log book or electronic record with quantities of sewage wastes discharged to the lagoons.

13. MONITORING REQUIREMENTS

The operational certificate holder shall carry out an environmental monitoring program as follows:

13.1 Treated Leachate/Phytoremediation Area

Location	Parameters	Frequency
E249852 Treated Leachate Prior to Discharge to Phytoremediation Area	Lab: total metals, alkalinity, chloride, fluoride, sulphate, hardness, ammonia, nitrate, nitrite, total organic carbon, orthophosphorus, COD, BOD, VOCs[1], pH	Quarterly→Annually*
	Field: conductivity, temperature, DO and turbidity	Monthly→Quarterly*
	Volume	Continuous during seasonal discharge

E306624 Composite Soil Sample[2] from Phytoremediation Area	Lab: metals, salinity	Annually, prior to discharge each season.

[1]One-time sample of VOCs for background levels
[2]Composite sample assembled from 4 locations from a pre-established list of 12 locations
* quarterly reduced to annually and monthly reduced to quarterly following two complete years of sampling.

13.2 Groundwater

Location	Parameters	Frequency
Background E251531 MW-02 E287385 MW-13 Early Detection E251530 MW-01 E251532 MW-03 E251533 MW-04 E287379 MW-07 E287380 MW-08 E287381 MW-09 E302210 MW-15 E302211 MW-16	Lab: dissolved metals, alkalinity, chloride, fluoride, sulphate, hardness, ammonia, nitrate, nitrite, TOC, COD, VOCs[1], pH	Quarterly→Annually*
	Field: conductivity, temperature	Monthly→Quarterly*
All of the above wells and: E251534 MW-05 E251535 MW-06 E287382 MW-10 E287383 MW-11 E287384 MW-12 E287386 MW-14	Water elevation	quarterly

[1]One-time sample of VOCs for background levels
* quarterly reduced to annually and monthly reduced to quarterly following two complete years of sampling.

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13.3 Surface Water

Location	Parameters	Frequency
E273828 SW-01 (Onion Lake) E273829 SW-02 (Upper Clearwater Lake at outlet) E273831 SW-03 (Lower Clearwater Lake at outlet) E306587 SW-04 (Creek from Onion Lake at FSR) E296117 SW-05 (Clearwater Creek at FSR)	Lab: total metals, dissolved metals, chloride, fluoride, sulphate, hardness, ammonia, nitrate, nitrite, COD, BOD, pH	Quarterly→Annually*
	Field: conductivity, temperature, turbidity, water level, flow rate	Monthly→Quarterly*

* quarterly reduced to annually and monthly reduced to quarterly following two complete years of sampling. Once sampling on an annual basis commences, it shall occur during the season with lowest stream flows

13.4 Leachate and Water Monitoring Procedures

13.4.1 Sampling Procedures

Sampling is to be carried out in accordance with the procedures described in the most recent edition of the "British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples", or by suitable alternative procedures as authorized by the Director.

13.4.2 Analytical Procedures

Analyses are to be carried out in accordance with procedures described in the most recent edition of the "British Columbia Environmental Laboratory Methods Manual for the Analysis of Water, Wastewater, Sediment, Biological Materials and Discrete Ambient Air Samples" or by suitable alternative procedures as authorized by the Director.

13.4.3 Quality Assurance and Quality Control

The operational certificate holder is required to conduct the following Quality Assurance and Control Program to determine the acceptability of data required by this operational certificate and Section 2(d) of the Environmental Data Quality Assurance Regulation:

a) Obtain and keep current, the laboratory precision, accuracy and blank quality control criteria for each laboratory analyzed parameter from the analytical laboratory(ies)

b) Collect one duplicate sample during each sampling session from one of the discharge points.

c) Each duplicate sample shall be submitted to the laboratory; one of the pair identified as the regular sample, and the other, as a blind sample identified by a fictitious site-name established solely to identify the duplicate sample.

d) For each parameter, report the results of the field duplicates in terms of the degree of variation as the relative percent difference

e) A sample collection blank shall be prepared, containing distilled water, and preservative if required, and submitted as a blank sample with one sample set per session. If any result for any parameter indicates detectable concentrations, then efforts shall be made to determine and control the source of contamination.

14. DATA ANALYSES AND REPORTING

14.1. Log Book

As required by sections 6.14.9, 7.6, 8.5, and 12.9 the operational certificate holder shall maintain a log book or electronic record. The log book or electronic record shall be made available for inspection upon request by Ministry staff or Kitselas First Nation.

14.2. Reporting

Whenever required, the operational certificate holder shall submit data, studies and reports to the Director by email or electronic transfer or as otherwise instructed.

An annual report shall be submitted to the Director and posted on the Regional District of Kitimat-Stikine website on or before June 30 each year for the previous calendar year.

The annual report shall contain at minimum:

i) The type and tonnage or volume of waste received, recycled, composted and landfilled for the year;

ii) Occurrences or observations of wildlife attempting to access the facility;

iii) The results of all required monitoring programs undertaken by the operational certificate holder for the site. Trend analysis, as well as an evaluation of any identified impacts of the discharges on the receiving environment in the previous year shall be carried out by a qualified professional.

14.3. Groundwater Model

The operational certificate holder shall have a qualified professional maintain the existing groundwater model of the landfill site and immediate downstream receiving environment using all available, relevant groundwater and surface water monitoring, stream flow, and precipitation data. Development of the groundwater model shall include a water balance assessment for the drainage area in which the landfill site is situated. The groundwater model shall define, where possible, the groundwater regime (flow directions, flow rates, groundwater divide, any evidence of a leachate plume, extent of plume, etc.) at and in the immediate surrounding area of the landfill site. Based on monitoring data and inferred groundwater flow direction from each previous year, the annual report as required in Section 14.2 shall contain a preliminary assessment of any recommended changes to the model. Based on this assessment and any other information available, the Director may require that a formal update to the model be undertaken.

15. CLOSURE REQUIREMENTS

15.1. Notification of Closure

The operational certificate holder shall notify the Director and Kitselas First Nation in writing of intentions to close the landfill site.

15.2. Closure Plan

A closure plan shall be submitted to the Director upon request. Upon issuance of the draft closure plan, the Kitselas First Nation shall also be provided with a copy. The closure plan shall, as a minimum, include the following:

- proposed end-use of the landfill property after closure;
- anticipated total waste volume and tonnage, and life of the landfill (i.e., closure date);
- a topographic plan showing the final elevation contours of the landfill and surface water diversion and drainage controls;
- design of the final cover suited to the intended end-use of the site, including the thickness and permeability of barrier layers and drainage layers, and information on topsoil, vegetative cover and erosion prevention controls;
- procedures for notifying the public about the closure and about alternative waste disposal facilities;
- rodent and nuisance wildlife control procedures;
- a comprehensive monitoring plan, including groundwater monitoring, surface water monitoring, landfill gas monitoring, leachate monitoring, final cover monitoring, and erosion and settlement monitoring, for a minimum post-closure period of 25 years;
- a plan and accompanying design for the collection, storage and treatment/use of landfill gas for a minimum 25 year post-closure period (if required);
- a plan for operation of any required pollution abatement engineering works such as leachate collection and treatment systems, for a minimum post-closure period of 25 years; and
- an estimated cost, updated annually, to carry out closure and post-closure activities for a minimum period of 25 years.

15.3. Closure Funding

The operational certificate holder shall ensure that sufficient funds will be available to provide for all closure and post-closure requirements as outlined in the closure plan required by section 15.2, plus a reasonable contingency for any remediation which may be required.

15.4. Final Cover

The final cover system shall be designed by a qualified professional to match the intended end-use of the landfill site and to match the needs of any required environmental management systems (leachate minimization or recirculation, as the case may be, landfill gas collection and treatment, etc.). Generally, the final cover shall consist of a layer of 1 metre of low permeability ($<1 \times 10^{-5}$ cm/s) compacted soil followed by a layer of topsoil suitable for establishment of vegetation. Use of higher permeability soil must first be approved by the Director. The final cover shall be constructed with minimum and maximum slopes as specified by a qualified professional (see section 3.4) to promote runoff and minimize erosion, with appropriate runon/runoff drainage controls, erosion controls, and gas venting controls. The site shall be seeded with a grass/legume mixture suited to the local climate.

15.5. Progressive Application of Final Cover

Completed portions of the landfill shall progressively receive final cover during the active life of the landfill. The maximum area of disposed refuse that has not yet received final cover shall not exceed 25% of the total final footprint area. Final cover is to be applied according to the specifications identified in section 15.4.

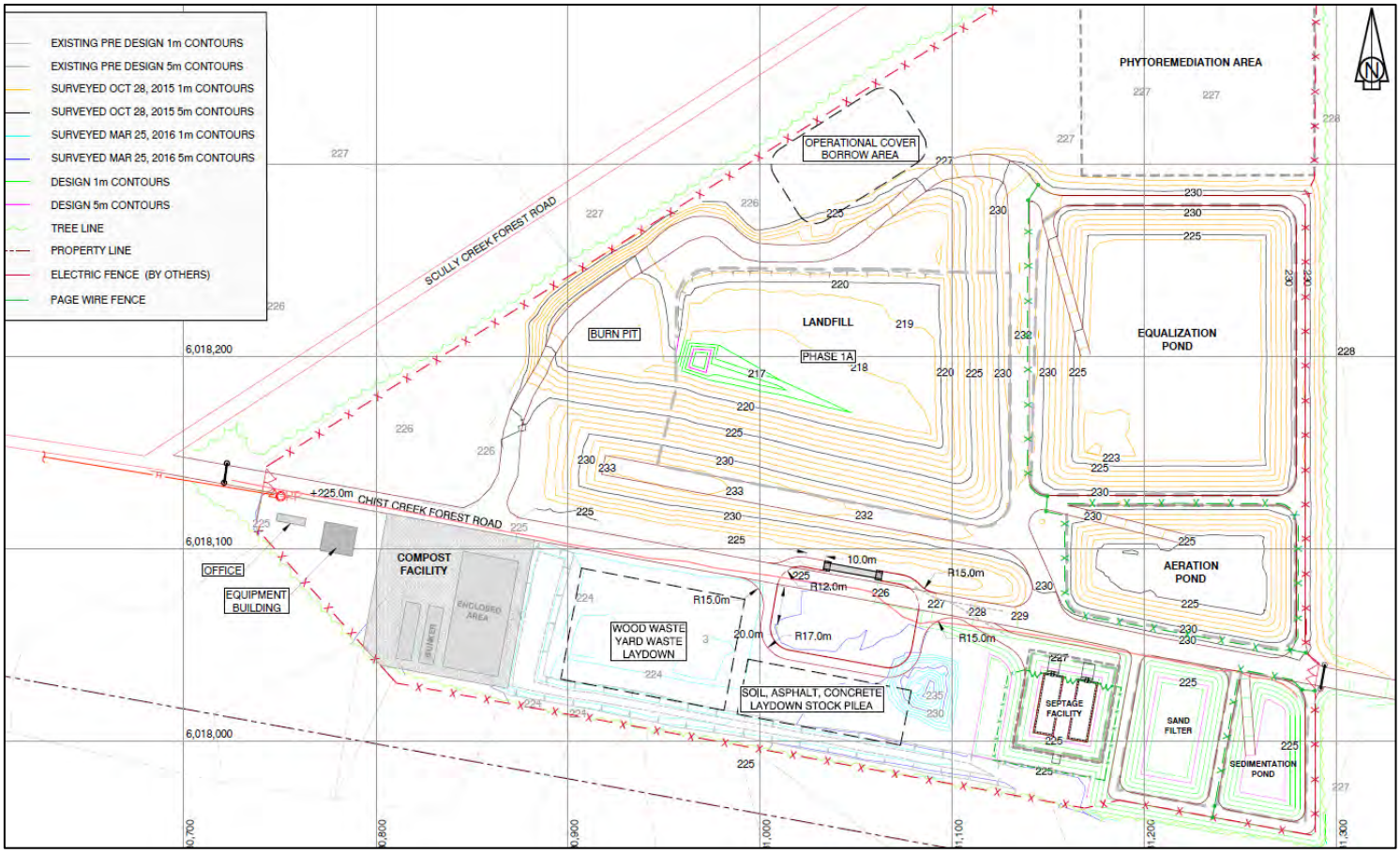
16. ENVIRONMENTAL IMPACT

Inspections of the discharge will be carried out by Environmental Protection personnel as a part of the routine operational certificate inspection procedure. Based on these inspections and any other information available to the Director on the effect of the discharge on the receiving environment, the operational certificate holder may be required to undertake additional monitoring, install additional pollution control works, or change the method of operation.

17. MAINTENANCE OF WORKS, EMERGENCY PROCEDURES AND NON-COMPLIANCE REPORTING

The operational certificate holder shall inspect the operation regularly and maintain it in good order. The operational certificate holder shall immediately notify the Director or designate as well as the Kitselas First Nation of any circumstance which prevents continuing operation in the approved manner or results in noncompliance with the requirements of this operational certificate.

SITE PLAN



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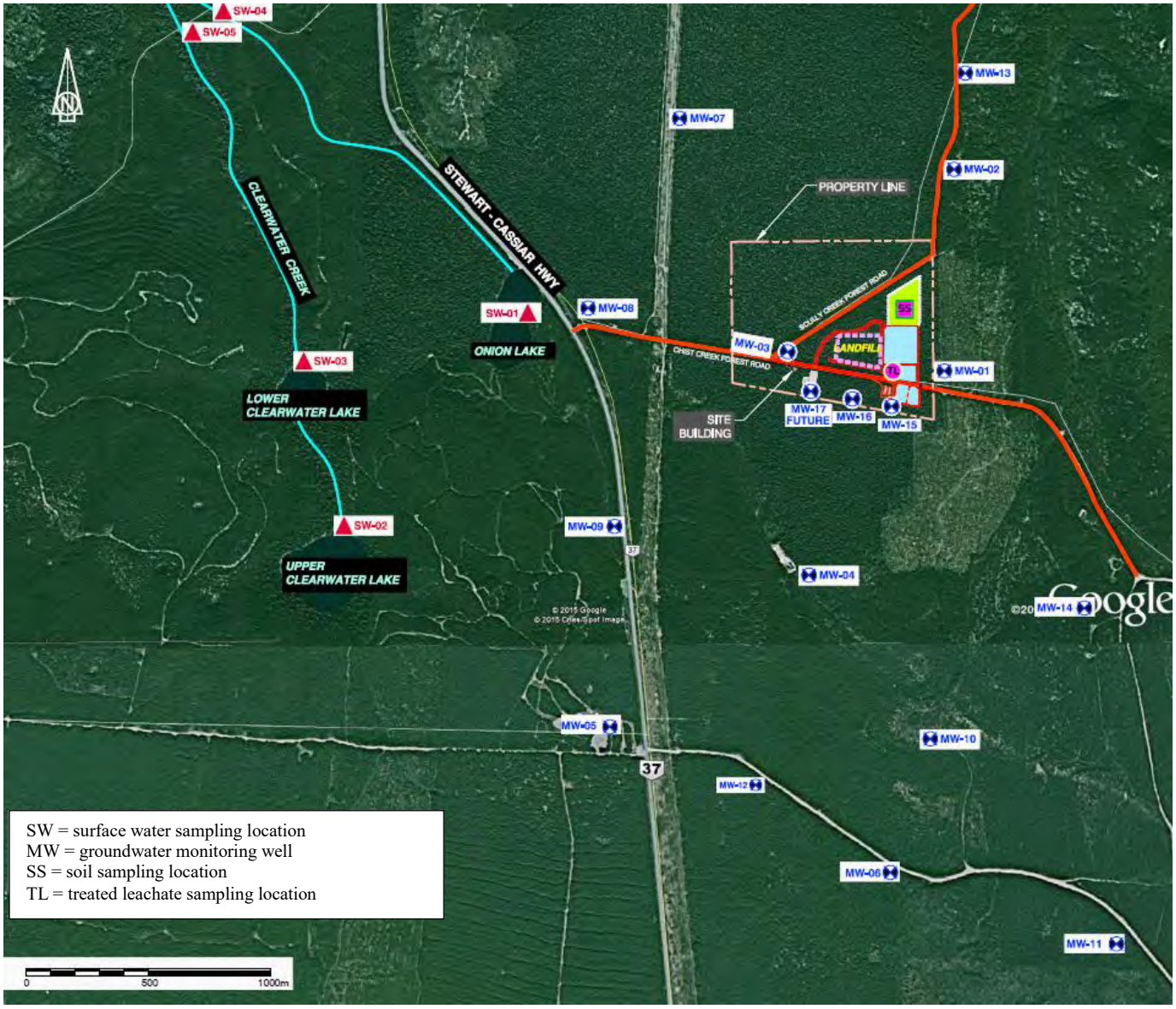
Operational Certificate Number: 17227

MONITORING LOCATIONS



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for Director, *Environmental Management Act*
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Appendix E: Borehole Logs

APPENDIX C

Record of Previous Monitoring Well Installations AGRA (1997) and Golder (2006)

Golder Associates

Regional District of Kitimat-Stikine	Double D Drilling	BOREHOLE NO: BH-1
Proposed Landfill Siting Investigation	Air Rotary	PROJECT NO: VE50789
Terrace, British Columbia		ELEVATION: 227.63 (m)

SAMPLE TYPE: DISTURBED | CORE BARREL RUN | SPLIT SPOON | AUGER FLYTES | AIR RETURN

DEPTH (m)	SAMPLE TYPE	SAMPLE NO	SOIL SYMBOL	Soil Description	WELL INSTALLATION	Installation Details	ELEVATION(m)
0.0				SAND, medium, some fine, with GRAVEL, some wood bits (roots?), dry-moist, greyish-brown.		Stick-up casing at surface, locked.	227.0
				SAND, medium to fine, some GRAVEL, dry to moist, greyish-brown.			
				SAND, fine with medium, some GRAVEL, dry to moist, light brown.			
5.0		1-1		SAND, medium to fine, some GRAVEL, dry to moist, greyish-brown. -moist to damp -rock at 21-22.5'			222.0
		1-2		-becomes GRAVELLY			
				SAND and GRAVEL, medium to fine sand, rounded to subangular gravel, moist, greyish-brown. -rock at 33-34'			
10.0							217.0
		1-3		SAND, medium to fine, trace GRAVEL, moist to damp, greyish-brown.		Steel casing, 6".	
15.0				-damp to wet			212.0
				SAND and GRAVEL, medium to fine, subrounded to subangular, damp, greyish-brown. -dry to moist -dense, slower drilling			
20.0		1-4					207.0
		1-5		SAND, medium to fine, damp to wet, grey-green. -trace GRAVEL			
25.0				-some GRAVEL			202.0
				SAND, fine to medium, some GRAVEL, light grey, dry			
		1-6		SAND, medium to fine, trace to some GRAVEL grey-green, moist			
30.0				-damp			197.0
				-wet			
		1-7		-GRAVELLY, damp to wet			
35.0							

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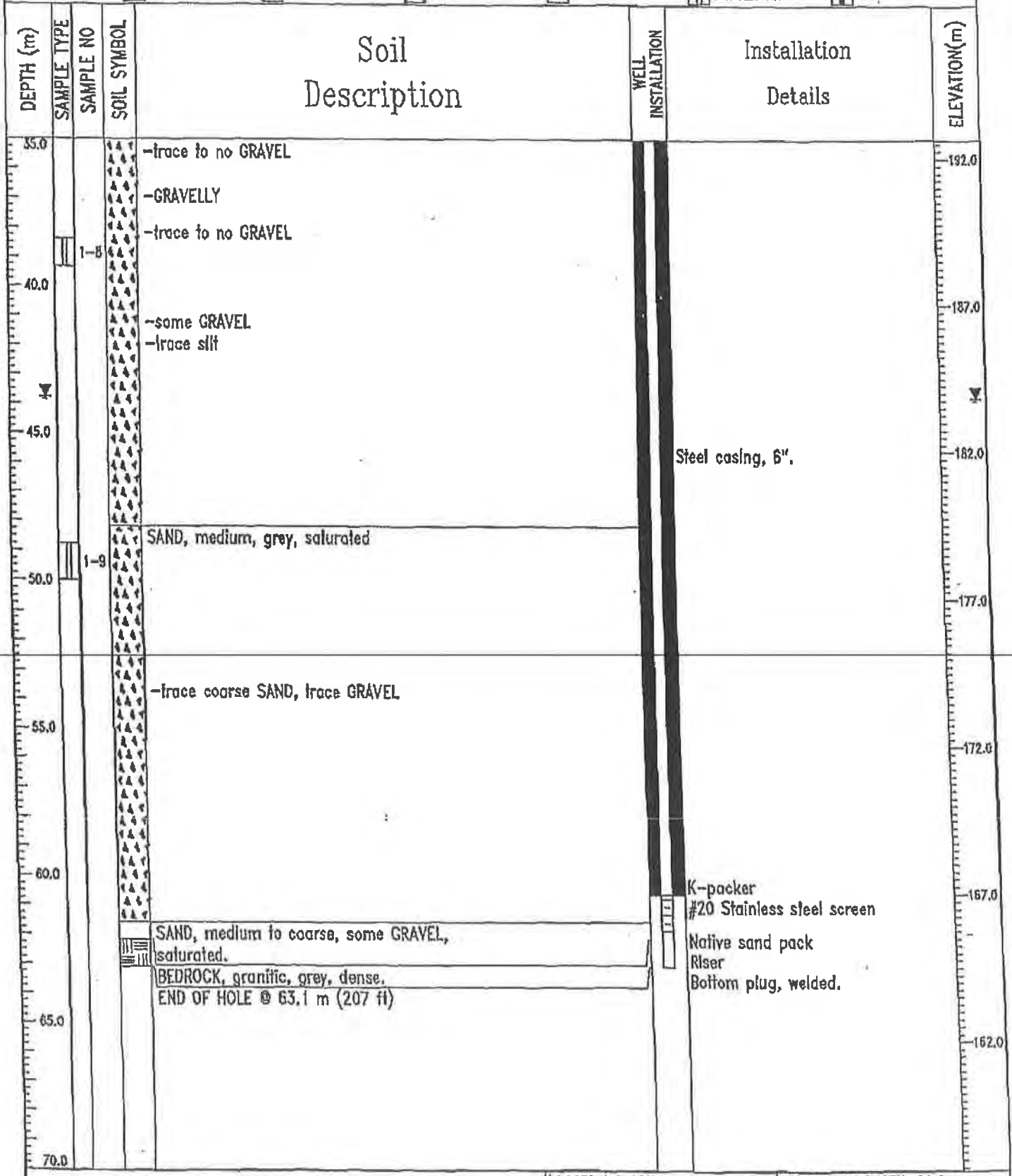
Burnaby, B.C.

LOGGED BY: GRE	COMPLETION DEPTH: 61.0 m
REVIEWED BY: GEB	COMPLETE: 02/12/97
Fig. No: BH-1	Page 1 of 2

97/12/18 01:49AM

Regional District of Kitimat-Stikine	Double D Drilling	BOREHOLE NO: BH-1
Proposed Landfill Siting Investigation	Air Rotary	PROJECT NO: VE50789
Terrace, British Columbia		ELEVATION: 227.63 (m)

SAMPLE TYPE: DISTURBED | CORE BARREL RUN | SPLIT SPOON | AUGER FLYTES | AIR RETURN



AGRA Earth & Environmental Limited Burnaby, B.C.	LOGGED BY: GRE REVIEWED BY: GEB Fig. No: BH-1	COMPLETION DEPTH: 61.0 m COMPLETE: 02/12/97 Page 2 of 2

97/12/16 01:32AM

Regional District of Kitimat–Stikine	Double D Drilling	BOREHOLE NO: BH–2
Proposed Landfill Siting Investigation	Air Rotary	PROJECT NO: VE50789
Terrace, British Columbia		ELEVATION: 231.43 (m)

SAMPLE TYPE ■ DISTURBED ☒ CORE BARREL RUN ☒ SPLIT SPOON ☰ AUGER FLYTES ▥ AIR RETURN

DEPTH (m)	SAMPLE TYPE	SAMPLE NO	SOIL SYMBOL	Soil Description	WELL INSTALLATION	Installation Details	ELEVATION(m)
0.0				GRAVEL, with SAND, angular, medium gravel, coarse to medium sand, greyish–brown, moist.		Stick–up casing at surface, locked.	231.0
		2–1		SAND, medium, some coarse, trace medium grovel, greyish–brown, moist. –GRAVELLY –and GRAVEL, medium, angular			
5.0							226.0
				–GRAVELLY, medium			
		2–2		–and GRAVEL, medium			
10.0							221.0
		2–3		SAND, medium, trace medium GRAVEL, grey–brown, moist to damp. –some GRAVEL, medium, damp –trace fine SAND			
15.0				–GRAVELLY, medium, damp		Steel casing, 6".	216.0
		2–4		SAND, medium to fine, trace to no gravel, damp			
				SAND, medium, GRAVELLY, medium, grey–brown damp. –grey–green –medium to fine gravel, rounded to subrounded –SAND, medium, and GRAVEL, medium to fine			
20.0							211.0
		2–5		–GRAVEL, medium and SAND, medium –cobbles to coarse gravel, 76'– 82'			
25.0							206.0
		2–6		SAND, medium to fine, trace GRAVEL, medium rounded to subrounded, grey–green, damp. –some GRAVEL, medium to fine –trace GRAVEL, fine to medium –some GRAVEL			
30.0		2–7		–GRAVELLY, rounded to subrounded, medium			201.0
				–SAND, trace to no GRAVEL			
35.0							

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Burnaby, B.C.

LOGGED BY: GRE
REVIEWED BY: GEB
Fig. No: BH–2

COMPLETION DEPTH: 58.2 m
COMPLETE: 03/12/97

97/12/18 01:55AM

Regional District of Kitimat-Stikine	Double D Drilling	BOREHOLE NO: BH-2
Proposed Landfill Siting Investigation	Air Rotary	PROJECT NO: VE50789
Terrace, British Columbia		ELEVATION: 231.43 (m)

SAMPLE TYPE: DISTURBED | CORE BARREL RUN | SPLIT SPOON | AUGER FLYTES | AIR RETURN

DEPTH (m)	SAMPLE TYPE	SAMPLE NO	SOIL SYMBOL	Soil Description	WELL INSTALLATION	Installation Details	ELEVATION(m)
35.0							
		2-8		-GRAVELLY, medium to fine, rounded to subrounded, trace SILT			196.0
				-no SILT			
				-some GRAVEL			
				-some to trace GRAVEL, medium, subrounded to rounded			
40.0				-trace GRAVEL, trace SILT			
		2-9		-fine to medium SAND			191.0
				-no SILT			
				-some GRAVEL			
				-GRAVELLY, damp			
		2-10		-trace SILT, some GRAVEL			
45.0				-some SILT			
				-SILTY			
				-some SILT, some GRAVEL		Steel casing, 6".	186.0
				-no SILT, GRAVELLY			
				-some GRAVEL			
		2-11		-wet to saturated, water in air return			
50.0				GRAVEL, angular and SAND, coarse, greyish brown, saturated.			181.0
				-medium to fine SAND, angular to subangular GRAVEL			
				SAND, medium to fine, some GRAVEL, trace SILT, greyish brown, wet.			
						K-packer	
55.0						#25 Stainless steel screen	
						Native sand pack	
		2-12		-trace gravel, flowing SAND		Bottom plug, welded.	176.0
				END OF HOLE @ 58.2 m (191 ft)			
60.0							
							171.0
65.0							
							166.0
70.0							

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Burnaby, B.C.

LOGGED BY: GRE
REVIEWED BY: GEB
Fig. No: BH-2

COMPLETION DEPTH: 58.2 m
COMPLETE: 03/12/97

97/12/18 01:56AM

Regional District of Kitimat-Stikine	Double D Drilling	BOREHOLE NO: BH-3
Proposed Landfill Siting Investigation	Air Rotary	PROJECT NO: VE50789
Terrace, British Columbia		ELEVATION: 226.68 (m)

SAMPLE TYPE: DISTURBED | CORE BARREL RUN | SPLIT SPOON | AUGER FLYTES | AIR RETURN

DEPTH (m)	SAMPLE TYPE	SAMPLE NO	SOIL SYMBOL	Soil Description	WELL INSTALLATION	Installation Details	ELEVATION (m)
0.0				SAND, coarse to medium, and GRAVEL, angular to subrounded, medium brown, moist		Stick-up casing at surface, locked.	226.0
		3-1					
5.0				SAND, medium to fine, some GRAVEL, brown, moist to damp. -GRAVELLY -cobble at 19' -medium-coarse SAND -some fine SAND			221.0
		3-2		SAND, medium to fine, some GRAVEL, brownish grey, moist -medium to coarse SAND -GRAVELLY			
10.0				SAND, medium to coarse, and GRAVEL, rounded to subrounded, medium brown, damp -trace SILT, GRAVELLY -dark brown			216.0
15.0		3-3				Steel casing, 6".	211.0
20.0				-medium SAND, trace GRAVEL -medium to coarse SAND, and GRAVEL -medium SAND, trace GRAVEL -medium to coarse SAND, and GRAVEL			206.0
25.0		3-4		-GRAVEL and SAND -SAND, medium, GRAVELLY			201.0
30.0				SAND, medium, trace fine, and GRAVEL, rounded, greyish brown			196.0
35.0							

AGRA Earth & Environmental Limited
Burnaby, B.C.

LOGGED BY: GRE	COMPLETION DEPTH: 59.7 m
REVIEWED BY: GEB	COMPLETE: 04/12/97
Fig. No: BH-3	Page 1 of 2

97/12/18 02:02AM

Regional District of Kitimat-Stikine	Double D Drilling	BOREHOLE NO: BH-3
Proposed Landfill Siting Investigation	Air Rotary	PROJECT NO: VE50789
Terrace, British Columbia		ELEVATION: 226.68 (m)

SAMPLE TYPE: DISTURBED | CORE BARREL RUN | SPLIT SPOON | AUGER FLYTES | AIR RETURN

DEPTH (m)	SAMPLE TYPE	SAMPLE NO	SOIL SYMBOL	Soil Description	WELL INSTALLATION	Installation Details	ELEVATION (m)
35.0							191.0
		3-5					
40.0							186.0
				SAND, medium to coarse, trace GRAVEL, brownish grey, wet			
45.0				-water in air return		Steel casing, 6".	181.0
		3-6					
50.0							176.0
		3-7		GRAVEL, rounded, some coarse SAND, saturated.		K-packer	
55.0						#25 Stainless steel screen Native sand pack Bottom plug, welded.	171.0
60.0				END OF HOLE @ 59.7 m (196 ft)			166.0
65.0							161.0
70.0							

AGRA Earth & Environmental Limited
Burnaby, B.C.

LOGGED BY: GRE	COMPLETION DEPTH: 59.7 m
REVIEWED BY: GEB	COMPLETE: 04/12/97
Fig. No: BH-3	Page 2 of 2

97/12/18 02:05AM

PROJECT No.: 03-1412-140 (5000)

RECORD OF BOREHOLE: MW-07

SHEET 1 OF 3

LOCATION: Terrace, B.C.

BORING DATE: August 24, 2006

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	CORE No.	CORE RECOVERY %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		229.93 0.00							Top of Casing at Elev. 230.82m
0	Double D Drilling Ltd. Barber Air Rotary	Loose, dry, grey, fine SAND and subangular GRAVEL.			1	CS					Bentonite Seal
2				227.80 2.13							
		Loose GRAVEL, trace to some sand from 3.05m - 6.1m depth.			2	CS					
4					3	CS					
6				223.83 6.10	4	CS					
		Loose, dry, grey, fine to coarse SAND and subangular to subrounded GRAVEL.									
				222.31 7.62	5	CS					
8											
					6	CS					
10					7	CS					Slough
12					8	CS					
		Loose, dry, light brown, fine to coarse SAND, some gravel. - grey-brown from 10.7m - 12.2m depth - trace fine gravel at 15.2m depth. - trace gravel at 16.8m depth. - some gravel at 18.3m depth.			9	CS					
14											
					10	CS					
16											
					11	CS					
18					12	CS					
20					13	CS					
		CONTINUED NEXT PAGE									

DEPTH SCALE

1 : 100

Golder Associates

LOGGED: L.W.

CHECKED: G.P.

ENVIROLOG 03-1412-140.GPJ GLDR_CAN.GDT 10/26/06

PROJECT No: 03-1412-140 (5000)

RECORD OF BOREHOLE: MW-07

SHEET 2 OF 3

LOCATION: Terrace, B.C.

BORING DATE: August 24, 2006

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	CORE No.	CORE RECOVERY %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20	Double D Drilling Ltd. Barber Air Rotary			209.51 / 20.42							
22		Loose, dry, grey, gravelly fine SAND. - fine to coarse sand at 24.4m depth. - grey-brown, fine sand, some gravel at 27.4m depth. - moist at 29.0m depth.			14	CS					
24					15	CS					
26					16	CS					
28					17	CS					
30					18	CS					
32					19	CS					Slough
34					20	CS					
36				198.53 / 31.39	21	CS					
38		Loose, moist, brown, fine to coarse SAND and GRAVEL.			22	CS					
40					23	CS					
					24	CS					
					25	CS					
					26	CS					Bentonite Seal
		CONTINUED NEXT PAGE									

ENVIROLOG 03-1412-140.GPJ GLDR_CAN.GDT 10/26/06

DEPTH SCALE

1 : 100

Golder Associates

LOGGED: L.W.

CHECKED: G.P.

PROJECT No.: 03-1412-140 (5000)

RECORD OF BOREHOLE: MW-07

SHEET 3 OF 3

LOCATION: Terrace, B.C.

BORING DATE: August 24, 2006

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	CORE No.	CORE RECOVERY %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
40	Double D Drilling Ltd. Barber Air Rotary	Loose, moist, brown, fine to coarse SAND and GRAVEL. *(continued)*			27	CS					Filter Sand
42				187.26 / 42.67	28	CS					Slotted PVC Pipe Sept.13/06 ▽
44					29	CS					
46		Loose, moist, brown, medium SAND, trace gravel.			30	CS					
48					31	CS					Slough
50					32	CS					
		End of BOREHOLE		179.64 / 50.29	33	CS					
52											
54											
56											
58											
60											

ENVIROLOG 03-1412-140.GPJ GLDR_CAN.GDT 10/26/06

DEPTH SCALE

1 : 100

Golder Associates

LOGGED: L.W.

CHECKED: G.P.

PROJECT No.: 03-1412-140 (5000)

RECORD OF BOREHOLE: MW-08

SHEET 1 OF 2

LOCATION: Terrace, B.C.

BORING DATE: August 25, 2006

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	CORE No.	CORE RECOVERY %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		194.62							Top of Casing at Elev. 195.62m
0	Double D Drilling Ltd. Barber Air Rotary			0.00							Bentonite Seal
		Loose, moist, brown, medium to coarse SAND, trace subangular to subrounded gravel.			1	CS					
2					2	CS					
4					3	CS					Slough
6				188.52							
		Loose, moist, brown, fine SAND. - fine to medium sand at 9.1m depth.		6.10	4	CS					
8					5	CS					▽
10											Bentonite Seal
				183.95	6	CS					
				10.67							Filter Sand
12					7	CS					
					8	CS					Slotted PVC Pipe
14		Loose, moist to wet, dark grey-brown, medium SAND. - wet at 12.2m depth. - fine to medium sand at 15 2m depth.									
16					9	CS					
											Slough
18				176.33	10	CS					
		Loose, wet, grey-brown, fine SAND, some silt.		18.29							
20					11	CS					

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 100

Golder Associates

LOGGED: L.W.

CHECKED: G.P.

ENVIROLOG 03-1412-140.GPJ GLDR_CAN.GDT 10/26/06

PROJECT No : 03-1412-140 (5000)

RECORD OF BOREHOLE: MW-08

SHEET 2 OF 2

LOCATION: Terrace, B.C.

BORING DATE: August 25, 2006

DATUM:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	CORE No.	CORE RECOVERY %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20	Double D Drilling Ltd. Barber Air Rotary	Loose, wet, grey-brown, fine SAND, some silt. *(continued)*		173.28 / 21.34							
22		Loose, wet, brown-grey SILT, trace clay.			12	CS					
24				170.24 / 24.38	13	CS					
26					14	CS					
28					15	CS					Slough
30		Loose, wet, dark grey-brown, silty SAND			16	CS					
32											
34											
36				158.04 / 36.58	17	CS					
		End of BOREHOLE.									
38											
40											

DEPTH SCALE

1 : 100

Golder Associates

LOGGED: L.W.

CHECKED: G.P.

ENVIROLOG 03-1412-140.GPJ GLDR_CAN.GDT 10/26/06

Appendix F: SHA Leachate Discharge Estimate Calculations

Darcy's Law:

$$Q = kAi$$
$$Q = Flowrate, m^3/s$$
$$k = Hydraulic\ Conductivity, m/s$$
$$A = Area, m^2$$
$$i = Hydraulic\ Gradient$$

Hydraulic Gradient:

$$i = \frac{\Delta H}{\Delta L}$$
$$i = Hydraulic\ Gradient, unitless$$
$$\Delta H = Change\ in\ Hydraulic\ Head, m$$
$$\Delta L = Change\ in\ Length, m$$

Transmissivity:

$$T = \frac{Q}{W} = kbi$$
$$T = Transmissivity, m^2/s$$
$$Q = Flowrate, m^3/s$$
$$w = Width\ of\ Groundwater, m$$
$$k = Hydraulic\ Conductivity, m/s$$
$$b = Aquifer\ Thickness, m$$
$$i = Hydraulic\ Gradient, unitless$$

Transmissivity below Landfill:

$$T = 1.5 \times 10^{-4}\,\frac{m}{s} \cdot 20\ m \cdot \left(\frac{5\ m}{50\ m}\right) = 2 \times 10^{-4}\,\frac{m^2}{s} = 25.92\,\frac{m^2}{d}$$
$$T = Transmissivity, m^2/s$$
$$k = Hydraulic\ Conductivity, m/s$$
$$b = Aquifer\ Thickness, m$$
$$i = Hydraulic\ Gradient, unitless$$