Sparwood Landfill
2020 Groundwater Monitoring Annual Report

PREPARED FOR:REGIONAL DISTRICT OF EAST KOOTENAY

PREPARED BY: SPERLING HANSEN ASSOCIATES

February, 2021

PRJ20050

SPERLING HANSEN ASSOCIATES

Regional District of East Kootenay

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

1. INTRODUCTION

Sperling Hansen Associates (SHA) was retained by the Regional District of East Kootenay (RDEK) in 2020 to develop an updated Groundwater Monitoring Program (GMP) for seven (7) Solid Waste Management facilities located withing the RDEK. As part of this GMP update SHA, along with Subconsultant Bear Environmental Limited (BEAR), will conduct four (4) groundwater sampling events per year, and provide one interim report per event for each site. The goal of this program is to provide the RDEK with valuable information regarding the groundwater quality at disposal sites and to assist in developing appropriate monitoring and management measures for the next five years.

SHA was awarded this contract with the RDEK in April, 2020. The first two quarterly sampling events were completed by the previous consultant EcoLogic in January and April 2020. As SHA was brought on halfway through the year, the results of the first two sampling events were shared with SHA so that a complete data set for 2020 could be compiled, and that the complete data from all four events could be reviewed and included in this Annual report.

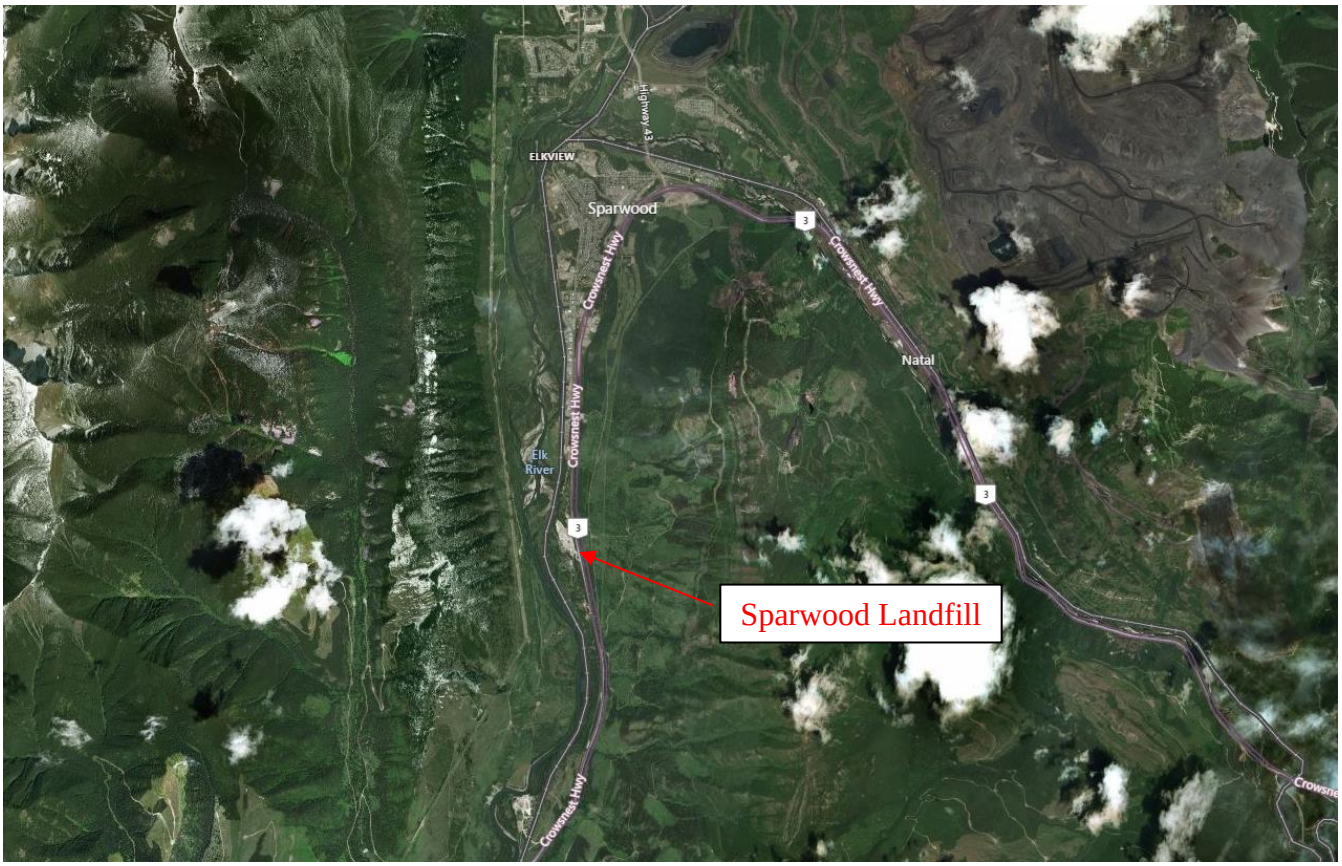

Photo 1-1. Sparwood Landfill Site Location.

1.1 Location and Setting

The Sparwood Transfer Station and Landfill is located in the District of Sparwood within the Elk Valley Subregion. The site is at 1001 off Hwy 3. The longitude and latitude are 49º69'592" N and 114º89'499" W respectively.

Photo 1-2. Sparwood Site Layout.

1.2 Site Operations

The facility has been operating for 50 years since it opened in the early 1970's. The site has operated as a construction and demolition waste center since 2000. The site operates Monday to Saturday, from 9:00 am to 5:00 pm. The site accepts MSW, recycling, yard and garden waste, and some commercial waste.

Due to the nature of waste when it comes into contact with water, it is required to monitor the groundwater on and surrounding the site to observe impacts from the landfill. In compliance with Landfill Criteria for Municipal Solid Waste, Sperling Hansen Associates (SHA) was retained to conduct the groundwater monitoring for seven (7) of the solid waste management facilities within the RDEK. The wells identified on Figure 1 are sampled quarterly in January, April, July, and October.

The site is approximately 15 hectares in size and services a population of approximately 12,500. The Operating Permit issued by the Ministry of Environment is attached to this report as Appendix A.

2. MONITORING PROGRAM

Site monitoring requirements are outlined in Operational Certificate 107745 (OC). The requirements include development of a monitoring plan by a Qualified Professional per guidance set out in the Landfill Criteria for Municipal Solid Waste and the Guideline for Environmental Monitoring at Municipal Solid Waste Landfills.

Per the Site's DOCP from 2017, the monitoring program consists of quarterly sampling of six (6) groundwater monitoring wells which include upgradient and downgradient wells as shown on Figure 1.

The following wells were sampled in 2020, as outlined in Table 2-1 below.

Table 2-1: Groundwater Monitoring Plan Wells

Monitoring Well	Notes
MW14-1	Sampled
MW14-4	Sampled
MW15-2	Sampled
MW14-3	Sampled
MW14-2	Damaged*
MW15-1	Dry

"*" SHA to confirm the condition of monitoring well MW14-2 during Spring 2021 site inspection.

2.1 Methodology

Sampling in Q1/Q2 2020 was conducted by Ecologic. Subconsultant BEAR was hired to implement the monitoring program and conduct field sampling in Q3/Q4 2020. Each well sampled is tested for a set of parameters. These differ from site to site and some are only tested quarterly while others are only tested annually. Table 2-2 shows which parameters are tested Quarterly and Yearly.

Table 2-2. Groundwater Monitoring Parameters.

Site	Quarterly Params	Yearly Params
Sparwood Landfill	Temperature	Temperature
	Conductivity	Conductivity
	pH	pH
	Nitrite (N)	Nitrite (N)
	Nitrate (N)	Nitrate (N)
	Ammonia Nitrogen (NH3)	Ammonia Nitrogen (NH3)
	Fluoride (F)	Fluoride (F)
	Dissolved Sulphate (SO4)	Dissolved Sulphate (SO4)
	Dissolved Chloride (Cl)	Dissolved Chloride (Cl)
	Dissolved Hardness	Dissolved Hardness
	Total Alkalinity	Total Alkalinity
	Total Suspended Solids	Total Suspended Solids
	Dissolved Metals	Dissolved Metals
		PAH/VOC in wells that show the greatest impacts

Note that Ecologic did not complete the entire suite of parameters as per the GMP in the Spring 2020. SHA will ensure PAH and VOC sampling and analysis is completed in Spring 2021.

In 2020, sampling was conducted in accordance to the BC Field Sampling Manual. Laboratory Certificates of Analysis are shown in Appendix B. COAs for Q1 and Q2 were not available to SHA by former consultants. SHA reviewed available COAs for Q3 and Q4. Based on internal laboratory QA/QC, the results are considered reliable.

2.2 Groundwater Flow

The Sparwood Landfill is located approximately 120 m directly east of the Elk River. Per the 2017 DOCP, the site is situated on glaciofluvial sand and gravel deposits as well as fine grained silt and clay.

The BC Water Resources Atlas shows no mapped aquifers below the site; however, Aquifer 1078 is located to the north underlying the Municipality of Sparwood and is described as confined with low vulnerability and domestic and commercial water uses. The area's topography shows elevation decreases toward Elk River and the site naturally slopes to the west. The regional groundwater flow is expected to be west or southwest in tandem with the Elk River. Locally, groundwater flow can be affected by building foundations, recharge areas, drainage and subsurface utilities. Depending on their depth, underground structures may significantly influence shallow groundwater flow in the vicinity of the Site. Locally, groundwater is assumed to flow west. Well details are shown in Table 2-3 below.

Table 2-3. Well Details and Water Level

Well ID	Well Construction	Water Level (from EcoLogic Reports)	Water Level (from EcoLogic Reports)	Q3 Depth to Water BGS (m)	Q4 Depth to Water BGS (m)
MW15-2	2" PVC	32.89	32.74	23.405	23.81
MW14-3	2" PVC	24.38	25.61	31.045	31.895
MW14-1	2" PVC	DRY	41.1	39.52	39.175
MW14-4	2" PVC	34.02	33.55	30.205	32.48

Note that MW15-1 was dry and field notes indicate that MW14-2 was previously damaged. SHA will inspect MW14-2 as part of the Spring 2021 site investigation works and provide feedback to the RDEK whether the well is salvageable or needs to be replaced.

2.3 Nomenclature

The reporting of monitoring wells at the RDEK sites has previously been a combination of Environmental Monitoring System Numbers (EMSN) and site number names that are the more common naming convention (MW-1). Sparwood does not have EMSN nomenclature, but rather the site number names. For this site these number names will be used unless EMS numbers are identified, in which case they will be the default.

2.4 Regulatory Criteria

Per the OC published in 2016, ground and surface water quality should be assessed using the most recent Approved and Working Criteria for Water Quality prepared by the Water Management Division of the Ministry of Environment, Lands, and Parks at or beyond the landfill property boundary.

The BC Contaminated Sites Regulation (CSR) Protocol 21 indicates that Aquatic Life Standards (AW) generally apply to all groundwater located within 500 m of a surface water body containing aquatic life. The Site is located approximately 120m east of Elk River, therefore the Aquatic Life for Freshwater (AW) standards will apply.

The CSR Protocol 21 indicates that Drinking Water (DW) Standards generally apply to groundwater and surface water where drinking water sources are within 500m of a site, or if a property is situated on an aquifer that could be used in the future for Drinking Water. A search for water wells revealed that there are no domestic use water wells within 500m of the Site (WTN 22959 exists on the Site to a depth of approximately 18mbgs). Information from the BC Water Atlas indicates that there are no mapped aquifers underlying the Site. Although current DW use appears to not apply to the site, without further investigation, future DW standards are assumed to apply. Note that future drinking water use applies

where information is unavailable or inadequate to demonstrate an absence of drinking water aquifers below a site.

Recent standards and guidelines have been applied by SHA to include:

- The Schedule 3.2 of the BC CSR with consideration to Aquatic Life (AW) and Drinking Water (DW);

These standards and guidelines are the most recent published by BC ENV used to assess groundwater at contaminated sites and the quality of drinking water. These standards are also the most recent iteration of the criteria to be used for the Sparwood site as per Section 2.8 of the 2017 DOCP for the site.

3. RESULTS

The parameters tested during 2020 include:

- Temperature, conductivity, pH, nitrite, nitrate, ammonia nitrogen, fluoride, dissolved sulphate, dissolved chloride, dissolved hardness, total alkalinity, total suspended solids, and dissolved metals.

Appendix B, Table B-1 outlines the water quality analysis alongside the applicable water standards.

All parameters tested were below applicable BC CSR AW standards.

One parameter was detected above BC CSR DW standards:

- Lithium

Details are provided in the Sections below.

3.1 Exceedances

Lithium above the BC CSR DW standard was detected at MW14-1, MW14-2, MW15-2, and MW14-3. This single exceedance was observed across all four sampling periods. The maximum concentration is shown in Table 3-1 below:

Table 3-1. Observed Exceedances in Parameters by Sampled Wells

Parameter	BC CSR DW Standard	Maximum Concentration (mg/L)	Well Name
Lithium (Li)	0.008 mg/L	**0.0218**	MW15-2

Green shading with bold font indicates the maximum concentration observed above BC CSR DW standards.

3.2 Notes on Regional Background Concentrations

As per the British Columbia Contaminated Sites Regulation (CSR) Schedule 3.2, 2019, the drinking water limit for Lithium (Li) is 8 µg/L or 0.008 mg/L. Many regions in B.C. have background concentrations of lithium that exceed this limit, which poses a complication for monitored sites that are required under Operation Certificates or Permits to avoid exceedances of harmful parameters. In response, the B.C. Ministry of Environment and Climate Change (BC ENV) published a document in 2018 qualifying the limit and providing background concentrations for three regions in the province for five metals, including lithium. The limits published in the *Technical Bulletin 3: Regional Background Concentrations for Select Inorganic Substances in Groundwater* account for naturally occurring levels of the five metals, and are therefore higher than the limit within the CSR currently.

However, these three regions only comprise the Lower Mainland, South Vancouver Island, and Thompson-Okanagan. SHA believes the exceedances in lithium observed at the RDEK sites are attributable to natural background concentrations that are not accounted for in the CSR Schedule 3.2 or *Technical Bulletin 3*. It should be noted that Eco/Logic did not have a limit for lithium, which explains the discrepancy in exceedances despite there being little difference between 2019 and 2020 results.

Thompson-Okanagan, the nearest region to the RDEK with a back ground concentration qualifier for lithium, has a qualified concentration in the Bulletin of 96 µg/L, or 0.096 mg/L. None of the wells monitored in July, 2020 would exceed a limit of 0.096 mg/L, so SHA recommends keeping a note of this and a close eye on this parameter in ongoing monitoring. SHA does not believe the RD needs to look into remediation measures at this point, but recommends the RD flag this exceedance history in the case that the Ministry publishes a background concentration for the Kootenay region.

4. DISCUSSION

All parameters tested were below applicable standards BC CSR AW and DW standards with the exception of the following parameters:

- Lithium

Lithium was detected in concentrations above the BC CSR DW standard with a maximum concentration approximately 2.7 times the applicable standard. The maximum concentration of lithium was found at MW15-2 at 0.0218 mg/L versus the BC CSR DW standard of 0.008 mg/L. Based on the surrounding water use, i.e groundwater at a radial distance of 500m from the site is not currently used as a drinking water source, and concentrations for all parameters were below applicable BC CSR AW standards, SHA considers the impacts from the landfill on the surrounding environment to be low. Note that elevated metals parameters were not accompanied by other typical elevated landfill leachate parameters such as sulphate, chloride, and nitrate.

As metals parameters, specifically, lithium is detected in slightly elevated concentrations, SHA recommends that low flow sampling be conducted to minimized the resuspension of colloidal material that can occur when using Waterra or bailer sampling methods.

4.1 Trend Analysis

To illustrate the trends observed in key parameters at the wells sampled, SHA has prepared figures that combine the 2020 analytical results with the applicable criteria limits.

- Figure 2 – Lithium concentrations
- Figure 3 – Sulfate concentrations
- Figure 4 – Sodium concentrations
- Figure 5 – Chloride concentrations
- Figure 6 – Nitrate Concentrations
- Figure 7 – Specific Conductance (Conductivity)

The red line on each figure represents the limit for that parameter according to the criteria, to show if wells are under or exceeding the maximum allowable concentration at the time of each quarterly sampling event.

Lithium is the parameter with an observable consistent trend above the CSR DW limit. Sulfate, sodium, chloride, nitrate, and conductivity are graphed because they are typical landfill indicators. As shown in the graphs, these parameters are below allowable limits and show the landfill is not impacting groundwater chemistry beyond regulatory standards.
Please note that the graphs provided are for observing trends, and data less than or equal to the detection limit for a parameter appears on graphs as trace concentrations. If a well shows to have no data on the graph, please refer to the master data table for the exact parameter concentration.

5. CONCLUSIONS AND RECOMMENDATIONS

In 2020, sampling at the Site occurred in accordance with the OC. Note that annual sampling for PAH/VOCs was not conducted in 2020. SHA has scheduled the subsequent annual sampling event for Q2 2021 and will ensure that all Annual sampling parameters are included.

Parameters sampled in 2020 generally associated with landfill leachate including, but not limited to, chloride, nitrate, and sulfate were all below applicable standards.. All parameters were detected below BC CSR AW standards. However, some metals parameters, lithium specifically, was detected slightly above BC CSR DW standards. SHA reviewed surrounding water use per BC Protocol 21 and has determined that although current drinking water use does not appear to apply to the Site, without further investigation into the underlying unmapped aquifer, future drinking water is assumed to apply.

As elevated lithium was not accompanied by other typically elevated landfill leachate parameters such as sulphate, chloride, and nitrate, and all parameters were below applicable BC CSR AW standards, SHA considers the impacts from the landfill on the surrounding environment to be low.

Note that in conducting analyses for seven different sites within the RDEK with similar exceedances of lithium under the CSR DW limit, SHA believes these elevated concentrations are a region-wide

occurrence caused by existing background concentrations rather than impacts caused by activities at the solid waste sites.

SHA recommends the following:

Slight metals parameter concentrations of lithium above applicable standards were detected in the landfill and domestic wells, although, these were not accompanied with other elevated landfill contaminants such as chloride, sulfate, nitrate. SHA recommends that a future groundwater sampling event be conducted using a low flow method to minimize the re-suspension of colloidal materials that can be caused during sampling with bailers and/or Waterra inertia pumps. If this sampling method is effective in providing a more accurate interpretation of groundwater data and able to show the groundwater exceedances are a result of suspended materials from bailer sampling, then SHA could make a recommendation to the RDEK to implement this sampling method for the monitoring going forward.

The next sampling event, scheduled in Q2 in April 2021, will also be the annual sampling and analysis event. This follows the same schedule of 2020 that EcoLogic followed. SHA believes this makes the most sense as spring is the most likely time of year that all wells are accessible and have adequate water flow for sampling.

Finally, SHA will inspect MW14-2 in the Spring of 2021 for damages, as noted in 2020 field notes, and will provide a recommendation to the RDEK whether the location is salvageable or needs replacing.

6. STATEMENT OF LIMITATIONS

This report has been prepared by Sperling Hansen Associates. (SHA) on behalf of the Regional District of East Kootenay (RDEK) 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.

The report is based on site visits, project experience, and analysis by SHA staff of data compiled during the preparation of this report from a number of sources. 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 SHA to determine its accuracy and completeness. SHA 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 RDEK. Any use which other parties makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such other parties. SHA 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 SHA during the course of this project. Should additional new data become available in the future, SHA should be requested to re-evaluate the findings of this report and modify the conclusions and recommendations drawn, as required.

Should you have any questions on this report or require further assistance or information, please feel free to contact the undersigned at 778-471-7088 or 604-986-7723.

Report prepared by:

Chloe Hetherington
Environmental Analyst Assistant

Rahim Gaidhar
GIT, Project Geoscientist

Report reviewed by:

Scott Garthwaite
Sr. Civil Technologist

7. REFERENCES

Eco/Logic Environmental, Sparwood Post-Closure Groundwater Monitoring 2019, prepared for the Regional District of East Kootenay.

Environmental Management Act, BC Contaminated Sites Regulation Schedule 3.2, 2019.

Ministry of Environment, BC Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Summary Report, August 2019.

RDEK Public Web Map 2020, retrieved from https://www.rdek.bc.ca/departments/mapping

GROUNDWATER MONITORING LOCATIONS

* No Environmental Monitoring System (EMS) Numbers for this site.

Sperling Hansen Associates

Regional District of East Kootenay

PROJECT:

SOLID WASTE FACILITY MONITORING PROGRAM 2020-2025

TITLE:

SPARWOODLANDFILL MONITORING LOCATIONS

SCALE:	DATE:	PROJECT NO:
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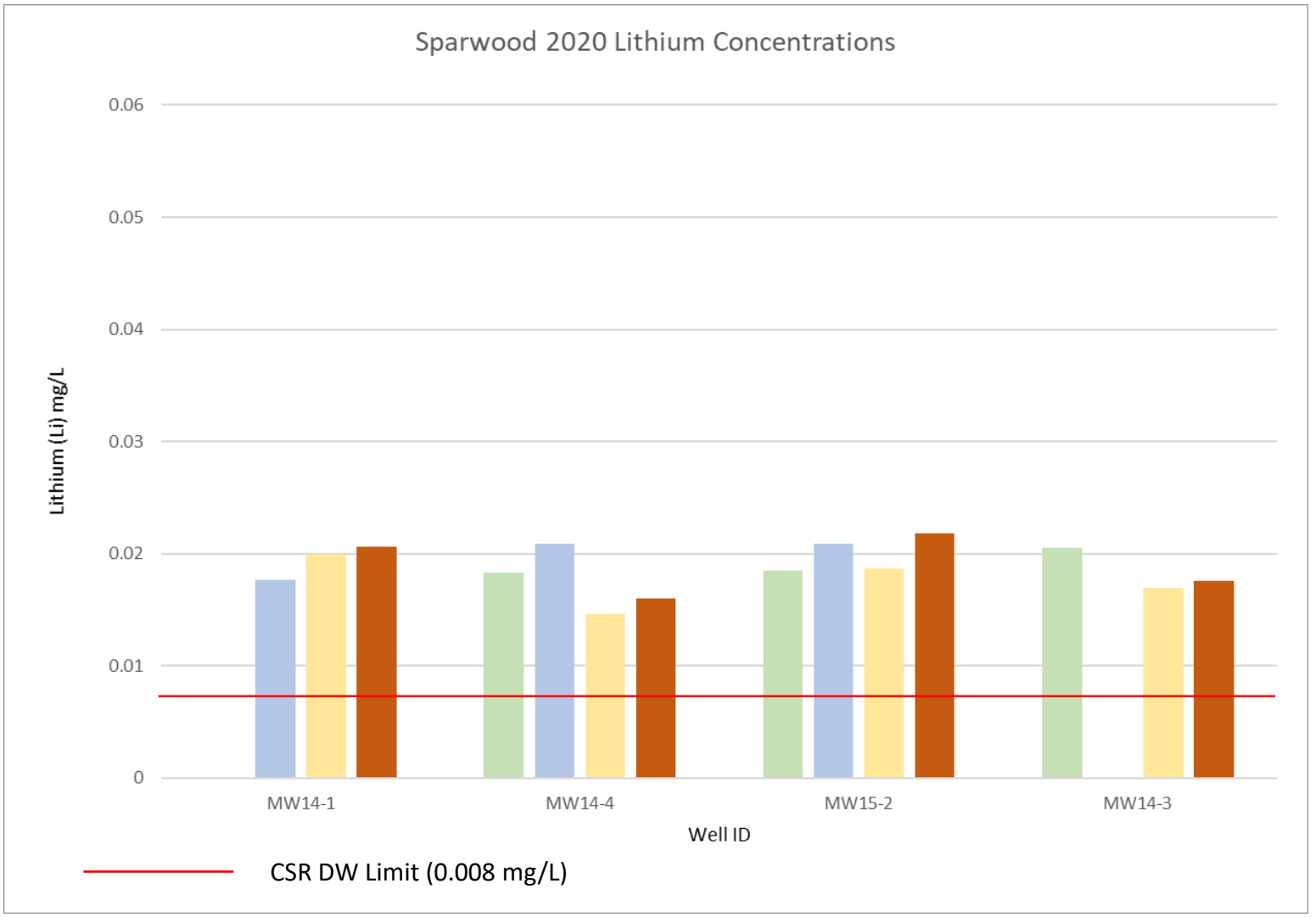
DESIGNED	-	DRAWING NO:
DRAWN	MG	**Figure 1**
CHECKED		



Sperling Hansen Associates	Regional District of East Kootenay	PROJECT: SOLID WASTE FACILITY MONITORING PROGRAM 2020-2025	TITLE: 2020 Lithium Concentrations

SCALE: N/A	DATE: 28/01/2021 yyyy/mm/dd	PROJECT NO: 20050	
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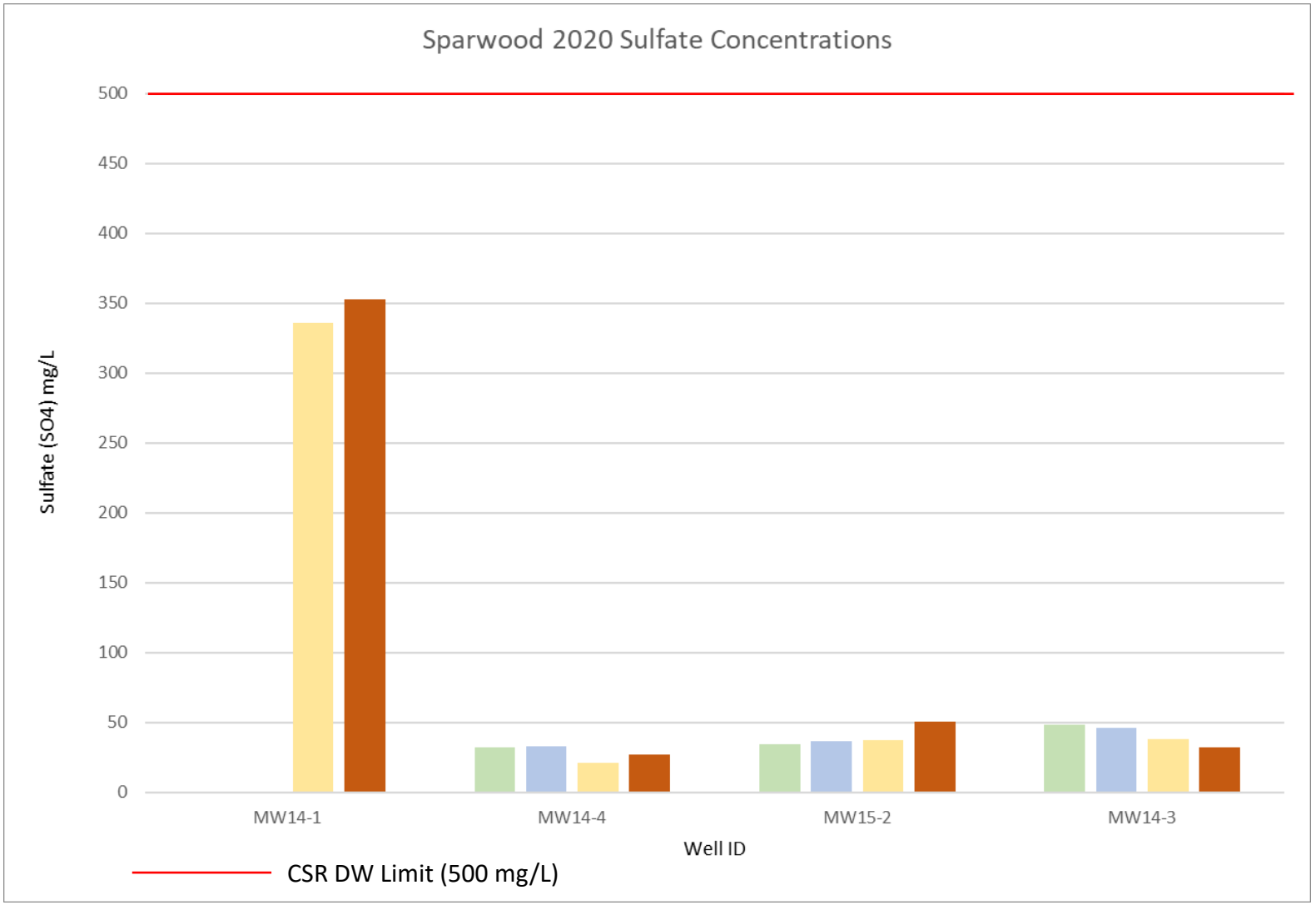
DRAWN	CH		
CHECKED	SG		



Sperling Hansen Associates	Regional District of East Kootenay	PROJECT: SOLID WASTE FACILITY MONITORING PROGRAM 2020-2025	TITLE: 2020 Sulfate Concentrations

SCALE:	DATE:	PROJECT NO:
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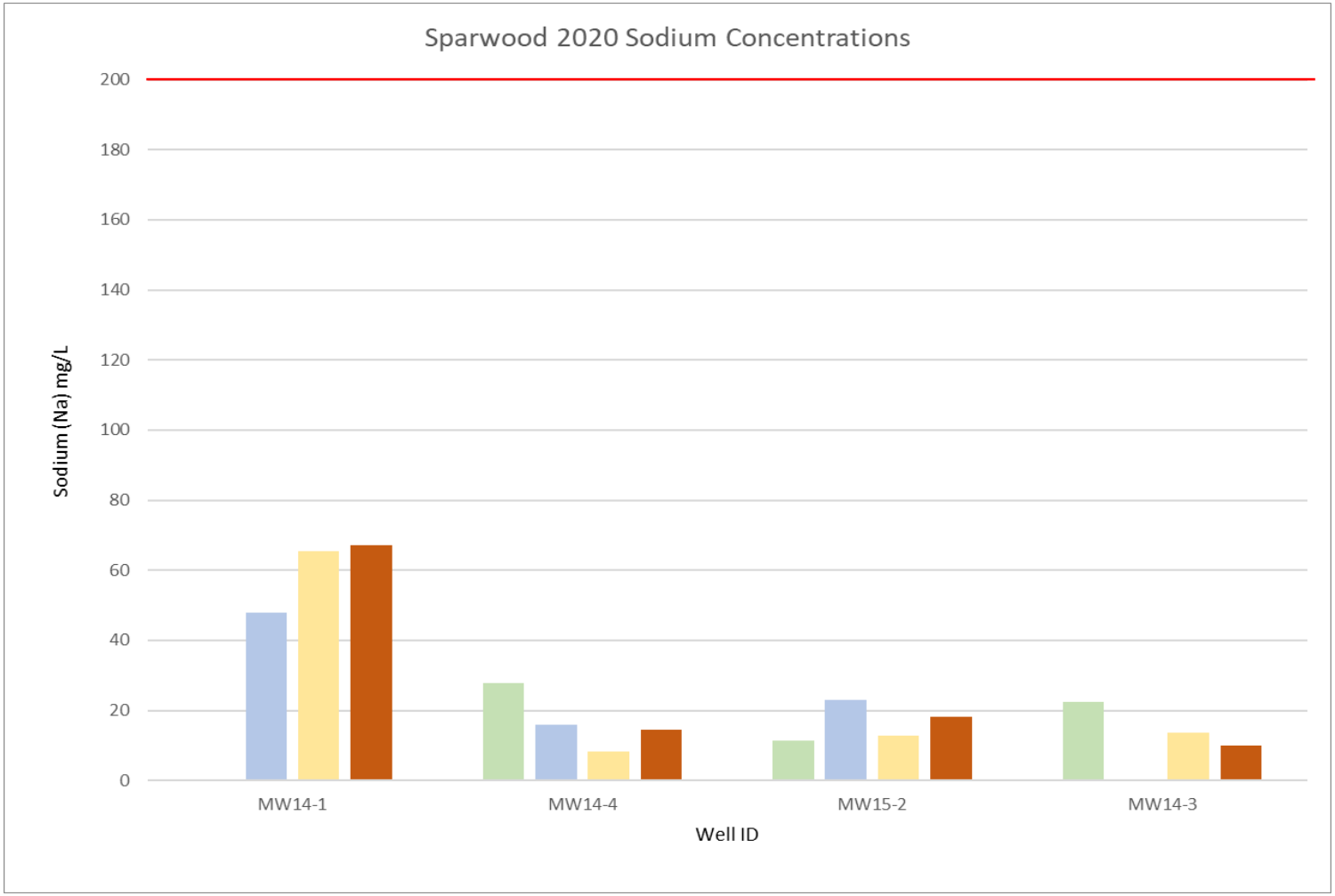
CHECKED	SG	



SPERLING HANSEN ASSOCIATES	Regional District of East Kootenay	PROJECT: SOLID WASTE FACILITY MONITORING PROGRAM 2020-2025	TITLE: 2020 Sodium Concentrations

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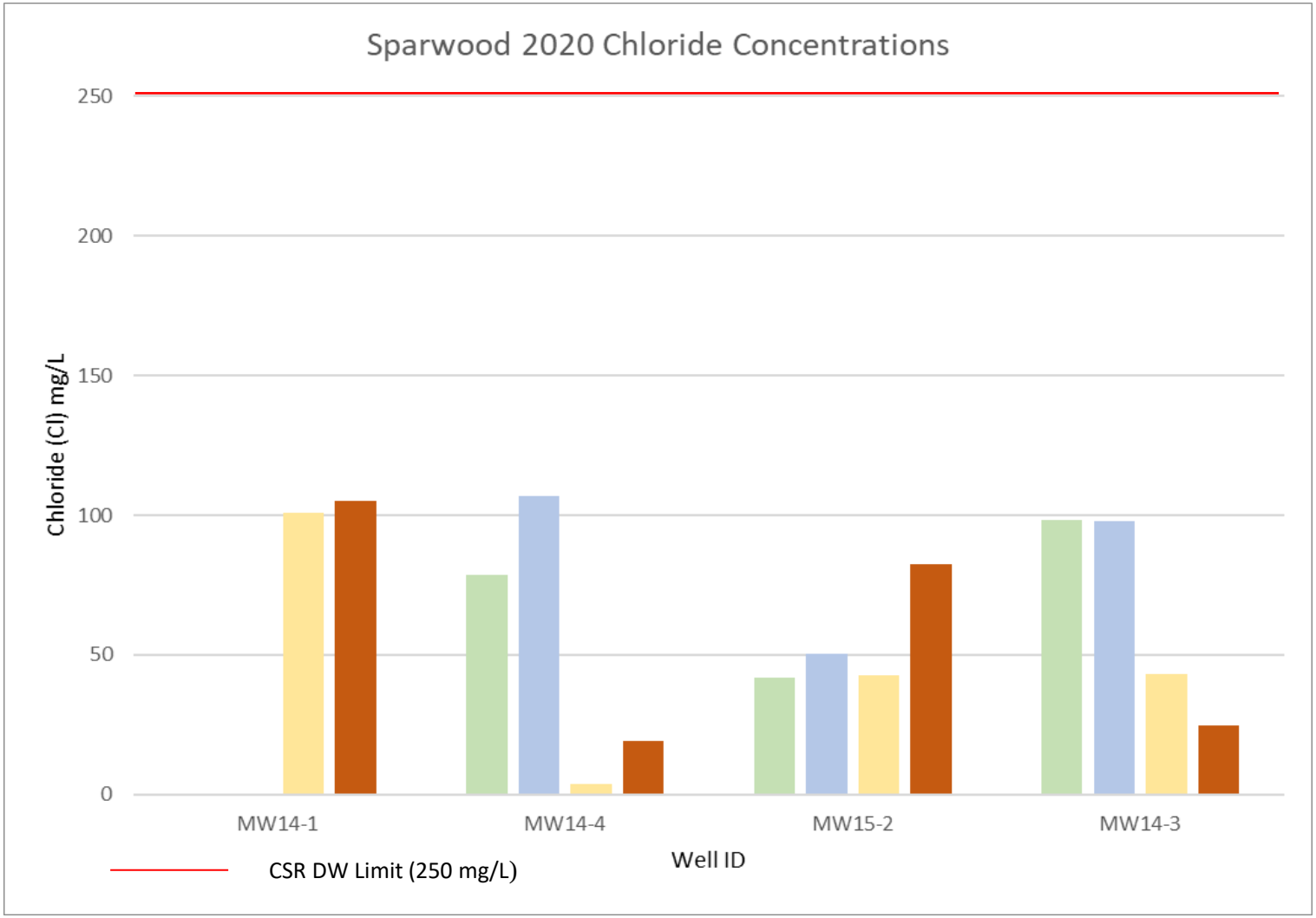
CHECKED	SG	



Sperling Hansen Associates	Regional District of East Kootenay	PROJECT: SOLID WASTE FACILITY MONITORING PROGRAM 2020-2025	TITLE: 2020 Chloride Concentrations

SCALE: N/A	DATE: 28/01/2021 yyyy/mm/dd	PROJECT NO: 20050	
DESIGNED		DRAWING NO: Figure 5	
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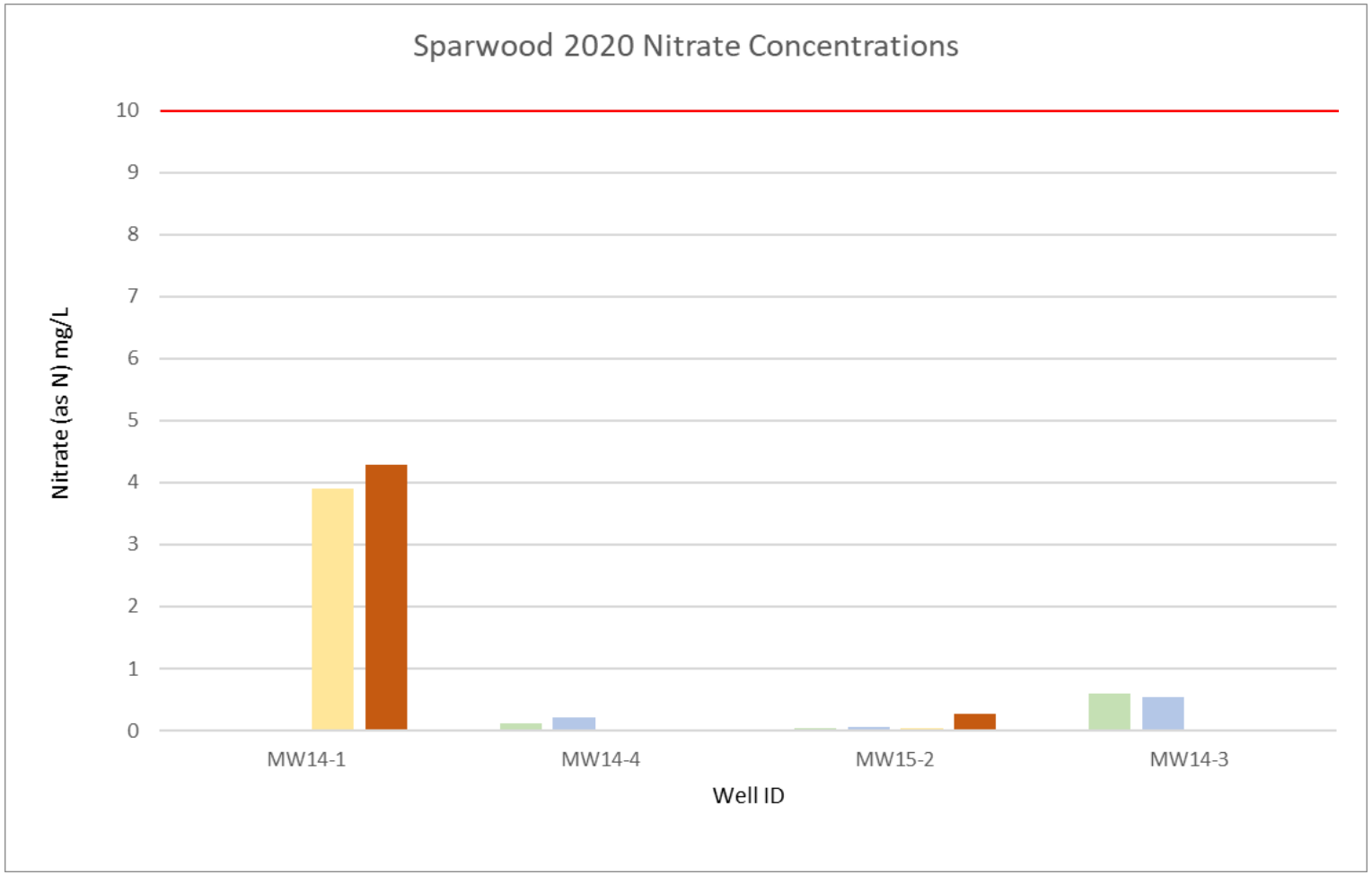
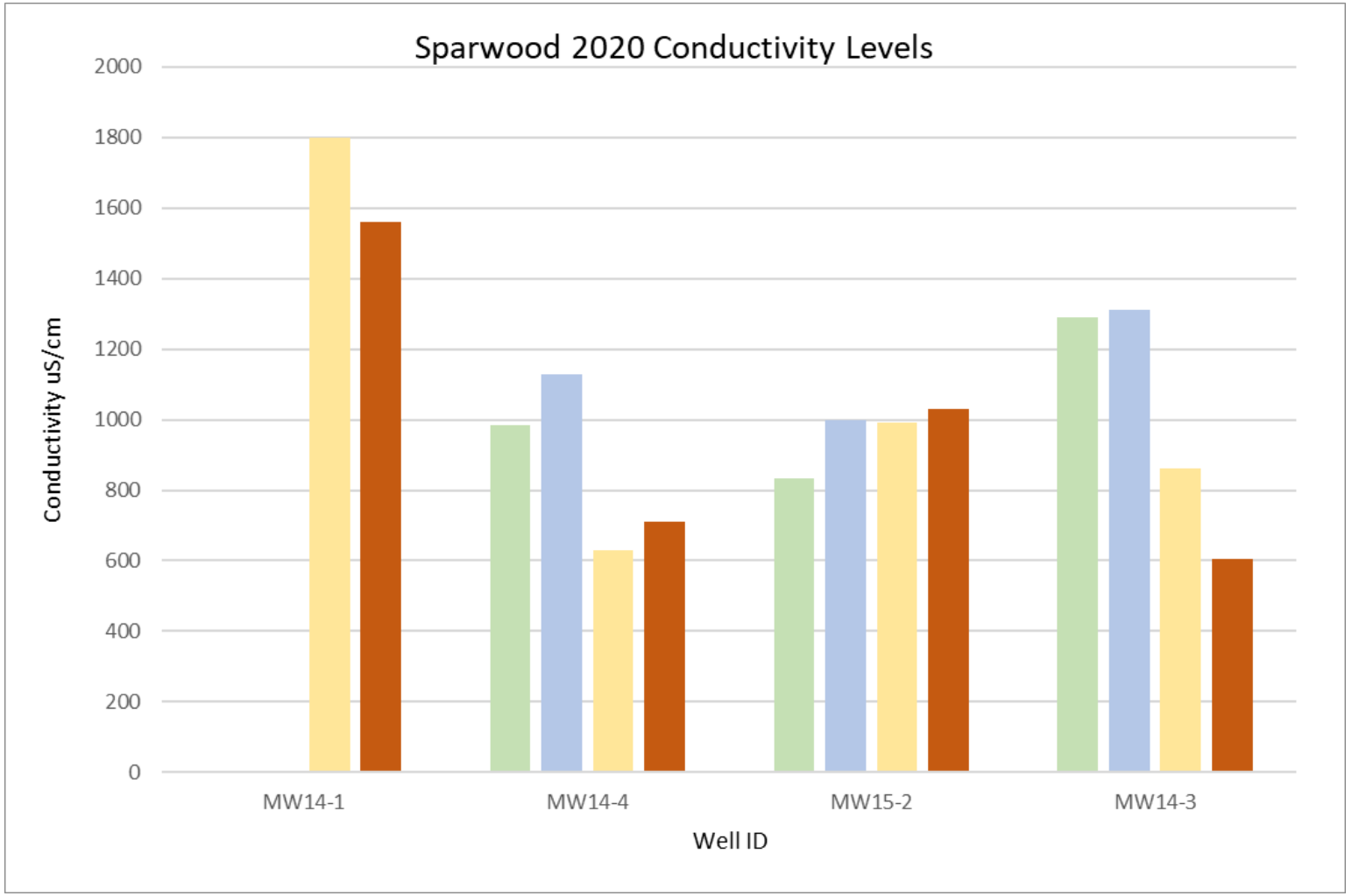
CHECKED	SG		



Sperling Hansen Associates	Regional District of East Kootenay	PROJECT: SOLID WASTE FACILITY MONITORING PROGRAM 2020-2025	TITLE: 2020 Nitrate Concentrations	SCALE: N/A; DATE: 28/01/2021 yyyy/mm/dd; PROJECT NO: 20050; DESIGNED; DRAWN: CH; CHECKED: SG; DRAWING NO: Figure 6



Sperling Hansen Associates	PROJECT: SOLID WASTE FACILITY MONITORING PROGRAM 2020-2025	TITLE: 2020 Conductivity Trend	SCALE: N/A; DATE: 28/01/2021 yyyy/mm/dd; PROJECT NO: 20050
Regional District of East Kootenay			DESIGNED; DRAWN: CH; CHECKED: SG; DRAWING NO: Figure 7

APPENDICES

APPENDIX A
Sparwood Operational Certificate

November 17, 2016

Tracking Number: 337659
Authorization Number: 107745

REGISTERED MAIL

REGIONAL DISTRICT OF EAST KOOTENAY
19 24 AVE S
CRANBROOK, BC
V1C 3H8

Dear Operational Certificate Holder:

Enclosed is Operational Certificate 107745 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the operational certificate. An annual fee will be determined according to the Permit Fees Regulation.

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.

…/2

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,

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

Enclosure

cc: Environment Canada

MINISTRY OF ENVIRONMENT

OPERATIONAL CERTIFICATE

107745

Under the Provisions of the Environmental Management Act

REGIONAL DISTRICT OF EAST KOOTENAY

19 24 AVENUE S
CRANBROOK, BC
V1C 3H8

is authorized to manage municipal solid waste and recyclable material and discharge construction & demolition waste to the ground and contaminants to the air at a landfill located in Sparwood, British Columbia subject to the conditions herein. Contravention of any of these conditions is a violation of the Environmental Management Act and may result in prosecution.

This Operational Certificate supersedes permit 1671 and is issued under Section 28, of the *Environmental Management Act (EMA)*. All ministry guidelines specified in this document refer to the most current versions of these guidelines.

DEFINITIONS

For the purposes of this Operational Certificate –

"Attractant" refers to waste, municipal solid waste, refuse, organic matter, compost, garbage, food or food waste that attracts bears or other wildlife.

"Commercial quality soil" refers to soil which does not contain any substance with a concentration exceeding the lowest applicable numerical soil standard for commercial land as set forth in the Contaminated Sites Regulation.

"Director" refers to the Director or a person delegated to act on behalf of the Director, as defined in the *Environmental Management Act*;

Date issued: November 17, 2016

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

"**Construction and Demolition (C&D) Waste**" refers to waste material that is produced in the process of construction, renovation, or demolition of structures. Structures include buildings of all types (both residential and non-residential) as well as roads and bridges. Components of C&D debris typically include concrete, asphalt, wood, metals, gypsum wallboard, and roofing. Land clearing debris, such as stumps, rocks, and dirt, may also be a part of C&D waste. This waste stream is a part of the Municipal Solid Waste (MSW) stream.

"Duly Authorized Person" refers to an individual or a position having responsibility for the overall operation of the landfill or an individual or position having overall responsibility for environmental or solid waste matters.

"Industrial quality soil" refers to soil which does not contain any substance with a concentration exceeding the lowest applicable numerical soil standard for industrial land as set forth in the Contaminated Sites Regulation.

"Landfill Footprint" refers to the area of the landfill site where MSW is approved to be deposited.

"Landfill Site" refers to the landfill footprint and buffer zone.

"Landfill Site Boundary" refers to the perimeter boundary of the landfill site.

"Open burning" means the combustion of material with or without control of the combustion air and without a stack or chimney to vent the emitted products of combustion to the atmosphere.

"Qualified Professional" refers to an applied scientist or technologist specializing in a particular applied science including, but not necessarily limited to, agrology, biology, chemistry, engineering, geology, or hydrogeology and

- who is registered in British Columbia with their appropriate professional organization, acting under that association's Code of Ethics and subject to disciplinary action by that association, and
- who, through suitable education, experience, accreditation and knowledge, respecting solid waste management and related engineering disciplines for the management of leachate, surface water, storm water, groundwater and landfill gas and other specialist disciplines may be reasonably relied on to provide advice within their area of expertise;

Date issued: November 17, 2016

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

"Regional Director" means Regional Director, Environmental Protection Division, of the Ministry of Environment, or someone designated to carry out permit administration duties on behalf of the Regional Director.

"Vector" refers to an organism or carrier capable of transmitting a pathogen from one organism to another including, but not limited to flies and other insects, rodents, and birds.

"Wood Waste" refers to clean burning land clearing debris.

1. AUTHORIZED DISCHARGES

1.1 This section applies to the discharge of Construction & Demolition (C&D) Waste to a SANITARY LANDFILL at a site known as the SPARWOOD LANDFILL in Sparwood, BC. The site reference number for this discharge is E210063.

1.1.1 The maximum rate of discharge is 4030 tonnes/year.

1.1.2 The authorized discharge is Construction and Demolition (C&D) waste and other waste as may be authorized by the Director in writing.

1.1.3 Contaminated soil that contains contaminants in concentrations less than hazardous waste as defined in the Hazardous Waste Regulation may be disposed at the landfill. Disposal of commercial quality soil and industrial quality soil includes but is not limited to monofilling, co-disposal with other wastes, and use as daily or intermediate cover material. The use of these soils as final cover material is prohibited if contaminants in soil exceed industrial land use standards as specified in the Contaminated Sites Regulation.

1.1.4 The disposal of waste asbestos in compliance with the requirements of Section 40 of the Hazardous Waste Regulation under the *Environmental Management Act* is permitted. In accordance with Section 40 "Management of Waste Asbestos", under part 6 "Management of Specific Hazardous Wastes" of the Hazardous Waste Regulation, the waste asbestos disposed at a landfill other than a secure landfill must be immediately covered with a minimum of 0.5 metre of cover material.

Date issued: November 17, 2016

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

1.1.5 The authorized works are a sanitary landfill and include berms, cover soil or cover material, locking gates, weigh scale, electrified bear fence, surface water diversionary works, environmental monitoring systems and related appurtenances pertaining to the works and discharges specified in this section.

The authorized works are located approximately as shown on the attached Site Plan A.

1.1.6 The location of the point of discharge is that portion of District Lot 4589 that lies west of Highway 3 and lies northwesterly of BCH and PA R/W Plan.

1.2 This section applies to the discharge of contaminants to air and residue of combustion to ground from open burning of wood waste. The site reference number for this discharge is E222779.

1.2.1 The maximum volume of wood waste open burned shall be 50 cubic meters per burn in 2016, 25 cubic meters per burn in 2017, 10 cubic meters per burn in 2018 and zero cubic meters per burn in 2019. Burning must cease by 2019.

1.2.2 The frequency of the burns in 2016, 2017 and 2018 shall not exceed one burn in each calendar month.

2. DESIGN & PERFORMANCE REQUIREMENTS

2.1 Design Operations & Closure Plan (DOCP)

A Design, Operations and Closure Plan (DOCP) prepared by a Qualified Professional must be submitted to the Director within 12 months of the date of issuance of this Operational Certificate. The Plan must address applicable sections of the Landfill Criteria for Municipal Solid Waste and the Guideline for Environmental Monitoring at Municipal Solid Waste Landfills.

The facilities must be developed, operated and closed in accordance with the Plan. On site materials handling and storage of any materials including recycling materials must be in accordance with the DOCP and applicable regulations.

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The DOCP must be reviewed and updated by a Qualified Professional as needed and at least once every five years to encompass the next 10 years of landfill operations and/or closure activities. Any updated hydrogeological reviews and information from annual monitoring must be considered in the review and update of the DOCP.

Requirements of regulations under the *Environmental Management Act*, and applicable bylaws must be incorporated into DOCP reviews as appropriate.

The Director may require additional reviews of the DOCP based on the compliance history and design performance of the site.

2.2 Groundwater & Surface Water Quality Protection

Discharge of municipal solid waste and other waste materials into water is prohibited. The Operational Certificate holder must construct adequate surface water and groundwater diversion works to minimize surface water run-off and groundwater seepage from entering the landfill.

The Operational Certificate holder must take appropriate measures to ensure that groundwater and surface water quality at the landfill site boundary does not decrease beyond that specified by the British Columbia Approved and Working Water Quality Guidelines or background levels or other appropriate criteria as specified by the Director. If exceedances to the specified water quality criteria occur at the landfill property boundary as a result of landfill operations, suitable corrective measures must be undertaken. The Regional Director must be notified of such measures when they are implemented within 30 days.

2.3 Hydrogeology and Hydrology Review

The Operational Certificate holder must characterize the hydrogeology, and hydrology at and near the landfill site. The hydrogeology assessment must address seasonal groundwater quality, seasonal flow direction and assess the adequacy of the groundwater monitoring program at the site.

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The hydrogeology and hydrology assessments must meet the Landfill Criteria for Municipal Solid Waste and the must be incorporated into the DOCP as required in Section 2.1 and form the basis of recommendations to the groundwater and surface water monitoring program. This review must be completed by December 31st 2017.

2.4 Buffer Zones

The Operational Certificate holder must maintain at a minimum, a 50 metre buffer zone between the landfill footprint and the landfill site boundary.

3. LANDFILL OPERATIONS

3.1 Inspections

3.1.1 Waste Inspections

The waste acceptance process at the landfill gate must include procedures to ensure that only construction & demolition waste is discharged at the landfill. Inspection procedures must ensure that no putrescible or organic waste is discharged at the active face.

3.1.2 Inspections of Authorized Works

The Operational Certificate holder must inspect the authorized works and property boundaries in accordance with the DOCP and to ensure compliance with this Operational Certificate and the Landfill Criteria. A record of the inspections (including a photographic record) and action items must be maintained in the operating record at the site office and made available to the Regional Director upon request.

3.2 Site Access & Supervision

Locking gates must be maintained at all access routes to the landfill site. Gates, perimeter fencing and/or barriers must be installed where necessary to prevent unauthorized access to the site by vehicles. Gates must be locked during non-operating hours. Onsite signage must be in accordance with the Landfill Criteria.

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The Operational Certificate holder shall ensure that the site is assigned sufficient staff to ensure proper, orderly, and safe operation of all materials handling equipment and access control. The Operational Certificate holder must ensure that any person(s) authorized to work within the landfill boundary is fully cognizant of this Operational Certificate and the DOCP. A landfill operator that has received BC Qualified Landfill Operator training (BCQLO) and is familiar with the requirements of the Operational Certificate and the DOCP must be present at all times during operating hours.

Training records for staff must be maintained and made available to the Regional Director upon request.

3.3 Scavenging & Salvaging

Uncontrolled scavenging of waste is prohibited. The controlled separation of salvageable waste stream components by persons authorized by the Operational Certificate holder is permitted in areas designated for separation and storage of these materials.

3.4 Public Health, Safety & Nuisance

The landfill must be operated in a manner such that it will not create a public nuisance or become a significant threat to public health or safety with respect to landfill gas, unauthorized access, roads, traffic, airport activity, noise, dust, litter, vectors, or wildlife attraction.

3.5 Waste Deposition, Compaction & Cover

The Operational Certificate holder must ensure that waste deposition and compaction is in accordance with the DOCP. The working face must be confined to the smallest practical area.

3.5.1 Daily Cover

Daily cover consisting of a minimum of 0.15 meters of soil or a functionally Alternate Daily Cover (ADC) must be applied to the working face at the end of each operating day. Adequate measures must be taken to ensure that sufficient cover soil or cover material is available onsite at all times.

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3.5.2 **Intermediate Cover**

An Intermediate cover consisting of 0.3meters of soil or functionally equivalent intermediate cover in accordance with the Landfill Criteria must be applied within thirty (30) days to any area of the landfill which will not receive any further waste for thirty (30) days.

3.5.3 **Final Cover**

Final cover must be installed and maintained in accordance with the requirements of the Landfill Criteria. Completed portions of the landfill are to progressively receive final cover during the active life of the landfill and as specified in the DOCP. The Operational Certificate holder must apply final cover within 365 days to any area of the landfill which will not receive any further waste as per the DOCP.

3.6 **Litter, Wildlife & Vector Control**

The Operational Certificate holder must ensure that litter is controlled by compacting the waste, minimizing the working face, applying cover at the required frequencies, providing litter control fences and instituting a regular litter pickup and general good housekeeping program.

Vector and wildlife attractants as a result of routine waste transfer and landfilling operations at the site must be minimized through:

a. The application of cover material in a timely and consistent manner in compliance with the requirements of the Landfill Criteria.
b. The installation and maintenance of electrified wildlife bear control fencing around the active landfill cell. The fence must be energized during the active bear season and electrified fence warning signs must be posted along the fence**.** Bear warning signs must be posted in the event of bear activity being detected at the site.

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3.7 Operations, Maintenance & Emergency Procedures Manual

The Operational Certificate holder must prepare an Operations, Maintenance and Emergency Procedures Manual. This manual must be reviewed and kept updated to reflect current site conditions. A copy of the manual must be available at the site office and must be made available to the Regional Director upon request.

3.8 Fire Prevention & Control

The Operational Certificate Holder must take all reasonable measures to prevent fires from occurring at the landfill site and must provide and maintain firefighting equipment and materials as required for the site. Adequate fire breaks that are free of combustibles must be maintained around the perimeter of the landfill footprint.

In the event of a landfill fire the following must be notified immediately:

a. The Fire Department
b. Provincial Emergency Program (PEP)
c. The Regional Director

3.9 Maintenance of Works & Emergency Procedures

The Operational Certificate holder must maintain the authorized works in good working order. In the event of an emergency or condition which prevents continuing operation of the authorized works and/or the continued performance of the prescribed methods of operation, the Operational Certificate holder must immediately notify the Regional Director and take appropriate remedial action in consultation with a Qualified Professional as applicable.

Any activity or construction at the disposal site must be carried out in a manner that protects the integrity of the areas under final cover and without compromising landfill stability and without damage to the authorized works.

Any settlement of areas under final cover or differential settlement that prevents the authorized works from functioning as intended in the DOCP must be addressed/ remedied immediately.

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All access roads, within the landfill boundary, used for transporting waste and equipment must be maintained as necessary to assure safe and reliable all-weather access to the active face at all times.

3.10 Qualified Professionals

Information pertaining to the landfill including details of works, plans, assessments, investigations, surveys, programs and reports, must be prepared and certified by a Qualified Professional.

3.11 Additional Facilities, Works, Plans and Studies

The Director may specify additional requirements including requirements for additional, improved and amended facilities, works and information including any plans, drawings, assessments, investigations, studies, surveys, programs, monitoring and reports.

3.12 Landfill Gas

The Operational Certificate holder must ensure that operation of the landfill does not cause combustible gas concentrations to exceed the lower explosive limit in soils at the property boundary or 25% of the lower explosive limit at or in on-site or off-site structures.

The Operational Certificate holder must ensure that the facility is in compliance with the requirements of the *Landfill Gas Management Regulation*. The requirements of the regulation and its guideline documents must be incorporated by into the DOCP revisions as they come into effect and as applicable.

3.13 Operational Requirements for Open Burning

Open burning shall be subject to the following conditions -

a. Each burn must comprise one continuous period necessary to reduce stockpiled waste to ashes and must not exceed one operating day.
b. Burning must take place only when an attendant is on duty.
c. Burning must only take place when conditions promote rapid combustion and dispersion of combustion products. This means that the Venting Index published for the day must be GOOD.
d. No burning may occur during periods of fire hazard nor when burning is prohibited by other government agencies.

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e. On site fire extinguishing equipment and material must be available during an open burn. These include a pressurized water supply, chemical type fire extinguishers, an earth stockpile and earth moving equipment.
f. A fireguard must be cleared and maintained free of combustible equipment.
g. Residue of combustion must be cooled to ambient temperatures and incorporated into the landfill.

4. MONITORING REQUIREMENTS

4.1 Environmental Monitoring Plan

The Operational Certificate holder must ensure that a Qualified Professional develops a monitoring plan to identify potential impacts to the environment and public health from the facility. The plan must meet the requirements set forth in the Landfill Criteria for Municipal Solid Waste and the Guideline for Environmental Monitoring at Municipal Solid Waste Landfills.

The monitoring plan must be reviewed and reported on annually. The review must take into consideration results from previous monitoring programs and any other investigations conducted at the site. The need for subsequent increased or decreased monitoring must be assessed annually on the basis of available monitoring data. The Operational Certificate holder must include an appendix at the end of the Environmental Monitoring Plan that tracks all changes made to program over the years.

Based on the results of monitoring, or any other information relevant to the site, the Director may vary the frequency, location and analyses of environmental monitoring.

The Operational Certificate holder must ensure that groundwater monitoring wells are established and maintained to allow for uninterrupted monitoring as specified by the monitoring plan. If due to any considerations groundwater monitoring wells are to be decommissioned, other monitoring well locations should be identified and wells installed in a timely manner to replace them.

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The location and installation of all monitoring wells must be specified and supervised by a Qualified Professional who is knowledgeable in the fields of Hydrogeology and Landfill Impact Assessment. The Operational Certificate holder must ensure that monitoring wells and other equipment are adequately secured and maintained, including provisions to ensure protection from damage due to weather, vehicles or vandalism. In the event of damage to the wells or monitoring equipment which could affect/compromise the integrity of monitoring data, the Operational Certificate holder must take immediate and necessary measures to ensure that conditions for uninterrupted monitoring are restored.

The Operational Certificate holder must maintain records of all monitoring program data and analyses and make these available to the Director upon request.

4.2 Field Sampling Techniques

Sampling must be carried out in accordance with the procedures described in the most recent edition of the "British Columbia Field Sampling Manual for Continuous Monitoring Plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples", or by suitable alternative procedures as authorized by the Director. A copy of the manual is available on the BC Ministry of Environment Sampling, Methods & Quality Assurance webpage - http://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/sampling-methods-quality-assurance

4.3 Laboratory Analysis

Analyses are to be carried out in accordance with procedures described in the most recent edition of the "British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials", or by suitable alternative procedures as authorized by the Director. A copy of the manual is available on the BC Ministry of Environment Sampling, Methods & Quality Assurance webpage – http://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/sampling-methods-quality-assurance

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5. REPORTING

5.1 Report Submission & Records Retention

All reports and submissions identified in this Operational Certificate must be submitted electronically to the Ministry in accordance with the Ministry's electronic reporting (eReporting) guidelines, or as otherwise specified by the Director.

All reports submitted as per the Routine Reporting section below must be signed by a duly authorized representative of the Operational Certificate holder.

5.2 Non-Compliance Reporting

The Operational Certificate holder must immediately notify the Regional Director of any non-compliance with the requirements of this Operational Certificate. The non-compliance report must be submitted in accordance with the Ministry's non-compliance reporting procedures. The Operational Certificate holder must identify the non-compliance, the cause of non-compliance and any remedial action to address the non-compliance.

5.3 Routine Environmental Reporting

5.3.1 Annual Report

The Operational Certificate holder must submit to the Regional Director an Annual Report for the facility by March 31 of each year. The first report is due in 2017. The report is intended as an operational update and monitoring report and also a self - assessment and review of compliance with the conditions of this Operational Certificate. The content of the report should provide the Ministry sufficient details to confirm that monitoring activities for the site have been completed for the subject year and to make an informed assessment of the environmental performance of the site. The report must be prepared by a Qualified Professional and must include but not be limited to:

a. An executive summary;

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b. The type, volume and tonnage of waste received, recycled, stored on-site and discharged/landfilled for the calendar year reported;
c. An update on the operational status of the authorized works and related appurtenances. The update must include information on operations, construction, inspections, emergencies, maintenance work and repair activities during the subject year. The update must identify any problems/issues and the corrective actions taken to address them;
d. A current topographic map detailing airspace consumption, on-site borrow pit changes and future developments;
e. Volume and density analysis or an in-place material summary, updated estimates for the remaining capacity, site life, revised closure date for the current landfill phase or sequence and revised closure date for the current landfill footprint;
f. Monitoring data for the calendar year including sample data, information on analytical procedures, quality assurance and control, comparison to groundwater and surface water quality standards, data tabulation, graphs, trend analysis, interpretation, any current non-compliances, conclusions and recommendations for any changes to the environmental monitoring plan;
g. Results of any landfill gas monitoring if applicable;
h. A summary of planned operational activities for the next calendar year;
i. An update on the financial assurance for the site including a statement of the current dollar value of the Closure Fund;
j. An assessment of the progress towards made towards achieving the objectives of the Regional District of East Kootenay's current Solid Waste Management plan;
k. A summary of significant occurrences or observations of wildlife (medium and large carnivores) at the landfill;
l. A summary of public complaints received and their resolution;
m. A list of training programs completed for landfill operators during the subject year;
n. A summary of any new information that could affect the authorized works, plans, assessments, surveys, programs and reports;

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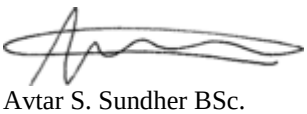

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o. Non-compliances with this operational certificate, and causes, effects, remedial action, and an action plan and schedule, as applicable to achieve compliance; and
p. Any additional information pertaining to the facility if specified by the Director.

5.3.2 **Design, Operations and Closure Plan Review**

The DOCP review and update specified in Section 2 must be submitted to the Ministry 90 days after completion.

5.3.3 **Engineering Drawings**

"As built" drawings certified by a Qualified Professional must be submitted to the Regional Director within 90 days of the completion of engineered construction or closure works at the site.

5.4 **Other Reporting & Recordkeeping**

5.4.1 **Wildlife Reporting**

The Operational Certificate holder must maintain an onsite log of any ongoing bear activity such as digging around the perimeter of the electric fencing or other attempts to penetrate the fencing, and any observations pertaining to wildlife intrusion attempts. Any penetrations of the fencing by bears should be immediately reported to the Conservation Officer Service (COS) via the Report All Poachers & Polluters reporting line at 1 877 952 7277.

5.4.2 **Spill Reporting**

The Operational Certificate holder must ensure that reportable spills as per the Spill Reporting Regulation (SRR) are reported to the Ministry as per prescribed reporting methods.

5.4.3 **Ozone Depleting Substances Recordkeeping**

The Operational Certificate holder must ensure that storage of appliances at the landfill site complies with the labelling and record keeping requirements of the Ozone Depleting Substances and Other Halocarbons Regulation.

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6. CLOSURE & POST CLOSURE REQUIREMENTS

6.1 Closure Plan

A Closure Plan and Final Cover Design that meets or exceeds the requirements of the Landfill Criteria and prepared by a Qualified Professional must be submitted to the Regional Director at least 2 years prior to decommissioning of the landfill.

Completion of closure works in accordance with the Closure Plan and Final Cover Design must be certified by a Qualified Professional within 60 days of the implementation of the Final Cover Design.

6.2 Post Closure Plan

The Closure Plan must also include post closure or aftercare measures including a post closure environmental monitoring plan for the closed landfill. The post closure elements of the Plan must be reviewed every five years throughout the post closure period.

6.3 Closure Fund

The Operational Certificate holder must provide for the funding of progressive closure operations, final closure and operations beyond closure by accruing a closure fund during the operational life of the landfill. The value of the closure fund must meet or exceed the estimated closure and post-closure costs plus a reasonable contingency for any post closure remediation which may be required.

Alternately, a closure and post-closure financial security acceptable to the Director may be built over time.

The Operations Certificate holder must take measures during the operational life of the landfill to ensure that the closure and post-closure funds or financial security will ultimately meet or exceed the estimated closure and post-closure costs and also costs for any remediation that may be required.

An annual financial statement of the fund must be prepared for each year during the operational life of the landfill.

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6.4 Site Decommissioning

In accordance with Section 40 of the *Environmental Management Act* and Part 2 of the Contaminated Sites Regulation, the Operational Certificate holder must submit a site profile to the manager at least 10 days prior to decommissioning the facilities authorized in Section 1.

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Location of Transfer Station & Landfill

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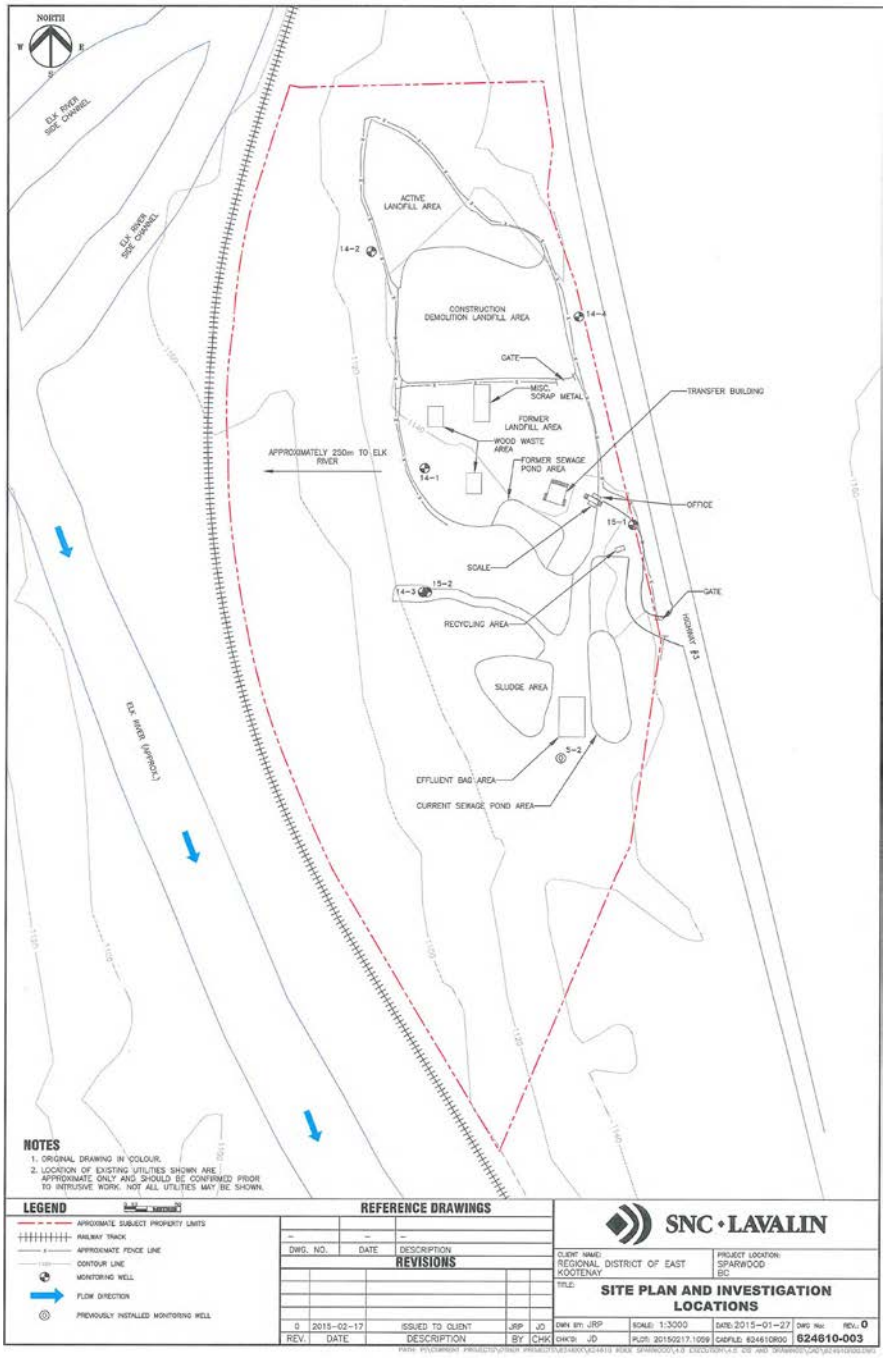

Site Plan

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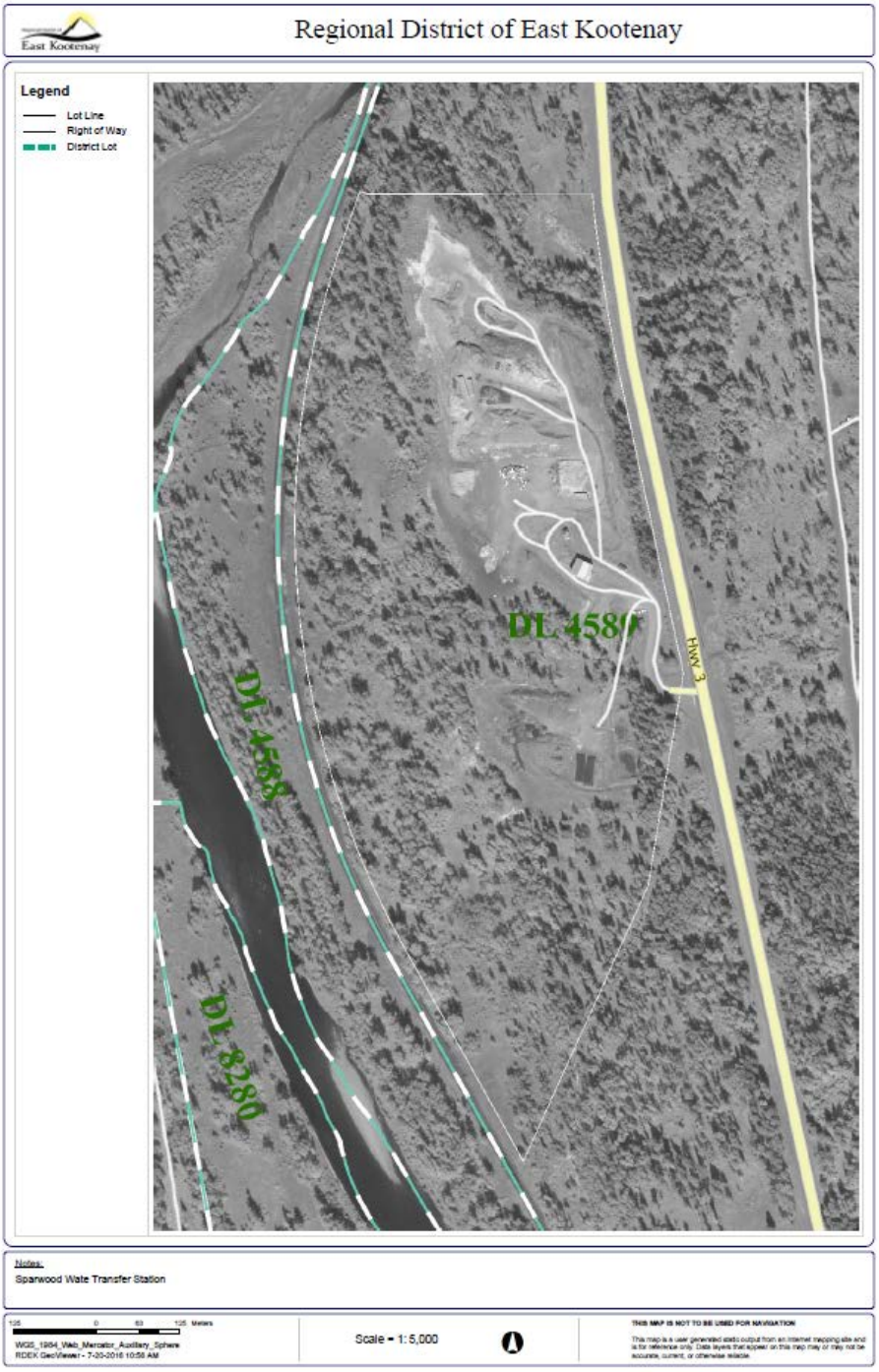

Aerial View of Site

Date issued: November 17, 2016

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APPENDIX B
Water Quality Analysis

Results Summary VA20A0164

Project SPARWOOD

Report To Ron Mickel, Eco/Logic Environmental

Client Sample ID		BCE STANDARDS		MW-4	MW-5	MW-6	Lowest Detection Limit
Date Sampled		DRINKING	AQUATIC	5-Jan-20	5-Jan-20	5-Jan-20	
ALS Sample ID				VA20A0164-001	VA20A0164-002	VA20A0164-003	
Physical Tests (Matrix: Water)							
alkalinity, total (as CaCO3)	mg/L			457	400	594	1.0
conductivity	µS/cm	700	*na*	983	834	1290	2.0
hardness (as CaCO3), dissolved	mg/L	*500*	*na*	462	421	678	0.60
pH	pH units	*6.5-8.5*	*6.5-9*	7.49	7.78	7.27	0.10
solids, total suspended [TSS]	mg/L	*na*	*na*	1960	57.7	135	3.0
Anions and Nutrients (Matrix: Water)							
ammonia, total (as N)	mg/L	*na*	*0.75-27.7*	0.0528	0.0276	<0.0050	0.0050
chloride	mg/L	*250*	*na*	78.5	41.8	98.1	0.50
fluoride	mg/L	*1.5*	*na*	<0.100	0.301	<0.100	0.020
nitrate (as N)	mg/L	*10*	*200*	0.124	0.0438	0.600	0.0050
sulfate (as SO4)	mg/L	*500*	*100*	32.4	34.1	48.2	0.30

Client Sample ID		BCE STANDARDS		MW-4	MW-5	MW-6	LDL
Dissolved Metals (Matrix: Water)		DRINKING	AQUATIC				
aluminum, dissolved	mg/L	*0.2*	*0.1*	0.0017	<0.0010	<0.0010	0.0010
antimony, dissolved	mg/L	*0.006*	*na*	<0.00010	<0.00010	<0.00010	0.00010
arsenic, dissolved	mg/L	*0.025*	*0.005*	<0.00010	0.00029	0.00011	0.00010
barium, dissolved	mg/L	*1*	*na*	0.208	0.132	0.452	0.00010
beryllium, dissolved	mg/L	*na*	*na*	<0.000100	<0.000100	<0.000100	0.000100
bismuth, dissolved	mg/L	*na*	*na*	<0.000050	<0.000050	<0.000050	0.000050
boron, dissolved	mg/L	*5*	*0.12*	0.027	0.033	0.023	0.010
cadmium, dissolved	mg/L	*0.005*	*0.2*	0.0000852	0.0000417	0.0000996	0.0000050
calcium, dissolved	mg/L	*na*	*na*	135	109	199	0.050
cesium, dissolved	mg/L	*na*	*na*	0.000019	<0.000010	<0.000010	0.000010
chromium, dissolved	mg/L	*na*	*1*	0.00018	<0.00010	<0.00010	0.00010
cobalt, dissolved	mg/L	*na*	*na*	<0.00010	<0.00010	0.00018	0.00010
copper, dissolved	mg/L	*5*	*0.09*	0.00082	0.00238	0.00226	0.00020
iron, dissolved	mg/L	*0.03*	*na*	<0.010	0.013	<0.010	0.010
lead, dissolved	mg/L	*0.01*	*3*	<0.000050	<0.000050	<0.000050	0.000050
lithium, dissolved	mg/L	*na*	*na*	0.0183	0.0185	0.0205	0.0010
magnesium, dissolved	mg/L	*na*	*na*	30.5	36.3	43.9	0.0050
manganese, dissolved	mg/L	*0.05*	*na*	0.00172	0.299	0.262	0.00010
mercury, dissolved	mg/L	0.001	0.0006	<0.0000050	<0.0000050	<0.0000050	0.0000050

molybdenum, dissolved	mg/L	*0.25*	*2*	0.000518	0.00118	0.00120	0.000050
nickel, dissolved	mg/L	*0.025*	*na*	0.00182	0.00111	0.00381	0.00050
phosphorus, dissolved	mg/L	*na*	*na*	<0.050	<0.050	<0.050	0.050
potassium, dissolved	mg/L	*na*	*na*	1.67	1.91	2.97	0.050
rubidium, dissolved	mg/L	*na*	*na*	0.00102	0.00054	0.00119	0.00020
selenium, dissolved	mg/L	*0.01*	*na*	0.000129	0.000052	<0.000050	0.000050
silicon, dissolved	mg/L	*na*	*na*	5.95	6.27	8.35	0.050
silver, dissolved	mg/L	*na*	*na*	<0.000010	<0.000010	<0.000010	0.000010
sodium, dissolved	mg/L	*200*	*na*	27.9	11.4	22.5	0.050
strontium, dissolved	mg/L	*na*	*na*	0.427	0.554	0.355	0.00020
sulfur, dissolved	mg/L	*500*	*na*	11.2	11.4	16.6	0.50
tellurium, dissolved	mg/L	*na*	*na*	<0.00020	<0.00020	<0.00020	0.00020
thallium, dissolved	mg/L	*na*	*na*	0.000129	0.000086	0.000035	0.000010
thorium, dissolved	mg/L	*na*	*na*	<0.00010	<0.00010	<0.00010	0.00010
tin, dissolved	mg/L	*na*	*na*	0.00022	0.00014	0.00025	0.00010
titanium, dissolved	mg/L	*na*	*na*	<0.00030	<0.00030	<0.00030	0.00030
tungsten, dissolved	mg/L	*na*	*na*	<0.00010	<0.00010	<0.00010	0.00010
uranium, dissolved	mg/L	0.015	*na*	0.000639	0.00224	0.00130	0.000010
vanadium, dissolved	mg/L	*na*	*na*	<0.00050	<0.00050	<0.00050	0.00050
zinc, dissolved	mg/L	*na*	*0.03*	0.0014	0.0039	0.0053	0.0010
zirconium, dissolved	mg/L	*na*	*na*	<0.00020	<0.00020	<0.00020	0.00020

Qualifier Legend

DLDS

Results Summary VA20A4317

Project SPARWOOD

Date Received 02-Apr-2020 08:25

Client Sample ID			BCE STANDARDS		MW-1 MW-2 MW-3	MW-4	MW-5	MW-6
Date Sampled			DRINKING	AQUATIC		1-Apr-20	1-Apr-20	1-Apr-20
Physical Tests (Matrix: Water)	LDL	UNITS			DRY/BLOCKED			
alkalinity, total (as CaCO3)	1.0	mg/L	*na*	*na*		479	481	582
conductivity	2.0	µS/cm	700	*na*		1130	998	1310
hardness (as CaCO3), dissolved	0.60	mg/L	*500*	*na*		524	535	746
pH	0.10	pH units	*6.5-8.5*	*6.5-9*		7.83	7.69	7.37
solids, total suspended [TSS]	3.0	mg/L	*na*	*na*		147	38.6	22.6
Anions and Nutrients (Matrix: Water)								
ammonia, total (as N)	0.0050	mg/L	*na*	*0.75-27.7*		<0.0050	0.0397	<0.0050
chloride	0.50	mg/L	*250*	*na*		107	50.3	97.8
fluoride	0.020	mg/L	*1.5*	*na*		<0.100	0.263	<0.100
nitrate (as N)	0.0050	mg/L	*10*	*200*		0.217	0.0659	0.531
sulfate (as SO4)	0.30	mg/L	*500*	*100*		33.0	36.9	46.0

Dissolved Metals (Matrix: Water)			BCE STANDARDS		MW-1 MW-2 MW-3			
			DRINKING	AQUATIC		MW-4	MW-5	MW-6
aluminum, dissolved	0.0010	mg/L	*0.2*	*0.1*	<0.0010	<0.0010	<0.0010	
antimony, dissolved	0.00010	mg/L	*0.006*	*na*	<0.00010	<0.00010	<0.00010	
arsenic, dissolved	0.00010	mg/L	*0.025*	*0.005*	<0.00010	0.00035	0.00012	
barium, dissolved	0.00010	mg/L	*1*	*na*	0.267	0.172	0.482	
beryllium, dissolved	0.000100	mg/L	*na*	*na*	<0.000100	<0.000100	<0.000100	
bismuth, dissolved	0.000050	mg/L	*na*	*na*	<0.000050	<0.000050	<0.000050	
boron, dissolved	0.010	mg/L	*5*	*0.12*	0.023	0.034	0.022	
cadmium, dissolved	0.0000050	mg/L	*0.005*	*0.2*	0.000114	0.0000984	0.0000992	
calcium, dissolved	0.050	mg/L	*na*	*na*	150	135	217	
cesium, dissolved	0.000010	mg/L	*na*	*na*	0.000012	<0.000010	<0.000010	
chromium, dissolved	0.00010	mg/L	*na*	*1*	<0.00010	<0.00010	<0.00010	
cobalt, dissolved	0.00010	mg/L	*na*	*na*	<0.00010	0.00025	0.00019	
copper, dissolved	0.00020	mg/L	*5*	*0.09*	0.00105	0.00330	0.00192	
iron, dissolved	0.010	mg/L	*0.03*	*na*	<0.010	<0.010	<0.010	
lead, dissolved	0.000050	mg/L	*0.01*	*3*	<0.000050	<0.000050	<0.000050	
lithium, dissolved	0.0010	mg/L	*na*	*na*	0.0177	0.0209	0.0209	
magnesium, dissolved	0.0050	mg/L	*na*	*na*	36.3	47.9	49.4	
manganese, dissolved	0.00010	mg/L	*0.05*	*na*	0.00257	0.541	0.266	
mercury, dissolved	0.0000050	mg/L	0.001	0.0006	<0.0000050	<0.0000050	<0.0000050	

DRY/BLOCKED

molybdenum, dissolved	0.000050	mg/L	*0.25*	*2*	0.000296	0.00147	0.00116
nickel, dissolved	0.00050	mg/L	*0.025*	*na*	0.00106	0.00139	0.00389
phosphorus, dissolved	0.050	mg/L	*na*	*na*	<0.050	<0.050	<0.050
potassium, dissolved	0.050	mg/L	*na*	*na*	1.87	2.69	3.05
rubidium, dissolved	0.00020	mg/L	*na*	*na*	0.00083	0.00078	0.00123
selenium, dissolved	0.000050	mg/L	*0.01*	*na*	0.000075	0.000065	0.000056
silicon, dissolved	0.050	mg/L	*na*	*na*	6.32	6.83	8.42
silver, dissolved	0.000010	mg/L	*na*	*na*	<0.000010	<0.000010	<0.000010
sodium, dissolved	0.050	mg/L	*200*	*na*	48.0	16.0	23.0
strontium, dissolved	0.00020	mg/L	*na*	*na*	0.472	0.590	0.369
sulfur, dissolved	0.50	mg/L	*500*	*na*	13.7	14.9	18.7
tellurium, dissolved	0.00020	mg/L	*na*	*na*	<0.00020	<0.00020	<0.00020
thallium, dissolved	0.000010	mg/L	*na*	*na*	0.000061	0.000061	0.000034
thorium, dissolved	0.00010	mg/L	*na*	*na*	<0.00010	<0.00010	<0.00010
tin, dissolved	0.00010	mg/L	*na*	*na*	0.00016	<0.00010	<0.00010
titanium, dissolved	0.00030	mg/L	*na*	*na*	<0.00030	<0.00030	<0.00030
tungsten, dissolved	0.00010	mg/L	*na*	*na*	<0.00010	<0.00010	<0.00010
uranium, dissolved	0.000010	mg/L	0.015	*na*	0.000609	0.00274	0.00124
vanadium, dissolved	0.00050	mg/L	*na*	*na*	<0.00050	<0.00050	<0.00050
zinc, dissolved	0.0010	mg/L	*na*	*0.03*	0.0030	0.0092	0.0041
zirconium, dissolved	0.00020	mg/L	*na*	*na*	<0.00020	<0.00020	<0.00020

DELA

Qualifier Legend

DLDS Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.

Results Summary L2480410

Job Reference
Report To David Kvick, Sperling Hansen Associates Inc.
Date Received 28-Jul-2020 8:40
Report Date 6-Aug-2020 12:48
Report Version 1

Client Sample ID			MW14-1	MW14-4	MW15-2	MW14-3
Date Sampled			22-Jul-2020	22-Jul-2020	22-Jul-2020	22-Jul-2020
Time Sampled			0:00	0:00	0:00	0:00
ALS Sample ID			L2480410-10	L2480410-11	L2480410-12	L2480410-13
Parameter	Lowest Detection Limit	Units	Water	Water	Water	Water
Physical Tests (Water)						
Hardness (as CaCO3)	0.50	mg/L	1000	385	608	468
Anions and Nutrients (Water)						
Alkalinity, Total (as CaCO3)	2.0	mg/L	637	327	518	432
Ammonia as N	0.0050	mg/L	0.0365	0.0486	0.0355	0.0685
Bicarbonate (HCO3)	5.0	mg/L	777	399	632	527
Carbonate (CO3)	5.0	mg/L	<5.0	<5.0	<5.0	<5.0
Chloride (Cl)	0.10	mg/L	101	3.67	42.5	43.3
Conductivity (EC)	2.0	uS/cm	1800	630	993	863
Fluoride (F)	0.020	mg/L	<0.10	0.116	<0.10	<0.10
Hydroxide (OH)	5.0	mg/L	<5.0	<5.0	<5.0	<5.0
Nitrate (as N)	0.0050	mg/L	3.91	<0.0050	0.029	0.028
Nitrite (as N)	0.0010	mg/L	<0.0050	<0.0010	<0.0050	<0.0050
pH	0.10	pH	7.00	7.59	7.20	7.44
Orthophosphate-Dissolved (as P)	0.0010	mg/L				
Sulfate (SO4)	0.050	mg/L	336	21.4	37.3	37.7
Organic / Inorganic Carbon (Water)						
Total Organic Carbon	0.50	mg/L				
Total Metals (Water)						
Aluminum (Al)-Total	0.0030	mg/L				
Antimony (Sb)-Total	0.00010	mg/L				
Arsenic (As)-Total	0.00010	mg/L				
Barium (Ba)-Total	0.00010	mg/L				
Beryllium (Be)-Total	0.000020	mg/L				
Bismuth (Bi)-Total	0.000050	mg/L				
Boron (B)-Total	0.010	mg/L				
Cadmium (Cd)-Total	0.0000050	mg/L				
Calcium (Ca)-Total	0.050	mg/L				
Chromium (Cr)-Total	0.00010	mg/L				
Cobalt (Co)-Total	0.00010	mg/L				
Copper (Cu)-Total	0.00050	mg/L				
Iron (Fe)-Total	0.010	mg/L				
Lead (Pb)-Total	0.000050	mg/L				
Lithium (Li)-Total	0.0010	mg/L				
Magnesium (Mg)-Total	0.0050	mg/L				
Manganese (Mn)-Total	0.00010	mg/L				
Molybdenum (Mo)-Total	0.000050	mg/L				
Nickel (Ni)-Total	0.00050	mg/L				
Phosphorus (P)-Total	0.050	mg/L				
Potassium (K)-Total	0.10	mg/L				
Selenium (Se)-Total	0.000050	mg/L				
Silicon (Si)-Total	0.050	mg/L				
Silver (Ag)-Total	0.000010	mg/L				
Sodium (Na)-Total	0.050	mg/L				
Strontium (Sr)-Total	0.00020	mg/L				
Sulfur (S)-Total	0.50	mg/L				
Thallium (Tl)-Total	0.000010	mg/L				
Tin (Sn)-Total	0.00010	mg/L				
Titanium (Ti)-Total	0.00030	mg/L				
Uranium (U)-Total	0.000010	mg/L				
Vanadium (V)-Total	0.00050	mg/L				
Zinc (Zn)-Total	0.0030	mg/L				
Zirconium (Zr)-Total	0.00030	mg/L				
Dissolved Metals (Water)						
Dissolved Metals Filtration Location		-	FIELD	FIELD	FIELD	FIELD
Dissolved Metals Filtration Location		-	FIELD	FIELD	FIELD	FIELD
Aluminum (Al)-Dissolved	0.0010	mg/L	0.0013	0.0014	<0.0010	<0.0010
Antimony (Sb)-Dissolved	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00010	mg/L	0.00017	0.00023	0.00021	0.00026
Barium (Ba)-Dissolved	0.00010	mg/L	0.0431	0.145	0.289	0.138
Beryllium (Be)-Dissolved	0.000020	mg/L	<0.000020	<0.000020	<0.000020	<0.000020
Bismuth (Bi)-Dissolved	0.000050	mg/L	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	0.010	mg/L	0.167	0.026	0.019	0.028
Cadmium (Cd)-Dissolved	0.0000050	mg/L	0.000148	0.0000135	0.0000722	0.0000317
Calcium (Ca)-Dissolved	0.050	mg/L	278	112	165	121
Chromium (Cr)-Dissolved	0.00010	mg/L	0.00017	<0.00010	<0.00010	<0.00010
Cobalt (Co)-Dissolved	0.00010	mg/L	0.00014	0.00013	0.00055	0.00042
Copper (Cu)-Dissolved	0.00020	mg/L	0.00115	0.00061	0.00034	0.00045
Iron (Fe)-Dissolved	0.010	mg/L	<0.010	0.040	0.189	0.417
Lead (Pb)-Dissolved	0.000050	mg/L	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0010	mg/L	0.0200	0.0146	0.0187	0.0169
Magnesium (Mg)-Dissolved	0.0050	mg/L	74.4	25.4	47.8	40.5
Manganese (Mn)-Dissolved	0.00010	mg/L	0.0263	0.0392	0.220	0.465
Molybdenum (Mo)-Dissolved	0.000050	mg/L	0.000530	0.000361	0.00154	0.00133
Nickel (Ni)-Dissolved	0.00050	mg/L	0.00501	0.00107	0.00644	0.00180
Phosphorus (P)-Dissolved	0.050	mg/L	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	0.10	mg/L	5.64	1.24	2.21	2.37
Selenium (Se)-Dissolved	0.000050	mg/L	0.000200	<0.000050	<0.000050	0.000063
Silicon (Si)-Dissolved	0.050	mg/L	8.45	5.08	6.53	6.25
Silver (Ag)-Dissolved	0.000010	mg/L	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	0.050	mg/L	65.5	8.19	12.9	13.7
Strontium (Sr)-Dissolved	0.00020	mg/L	0.369	0.328	0.311	0.492
Sulfur (S)-Dissolved	0.50	mg/L	121	10.6	16.1	14.6
Thallium (Tl)-Dissolved	0.000010	mg/L	0.000054	0.000022	0.000025	0.000036
Tin (Sn)-Dissolved	0.00010	mg/L	0.00013	0.00014	<0.00010	0.00031

Results Summary L2480410

Job Reference
Report To David Kvick, Sperling Hansen Associates Inc.
Date Received 28-Jul-2020 8:40
Report Date 6-Aug-2020 12:48
Report Version 1

Client Sample ID			MW14-1	MW14-4	MW15-2	MW14-3
Date Sampled			22-Jul-2020	22-Jul-2020	22-Jul-2020	22-Jul-2020
Time Sampled			0:00	0:00	0:00	0:00
ALS Sample ID			L2480410-10	L2480410-11	L2480410-12	L2480410-13
Parameter	Lowest Detection Limit	Units	Water	Water	Water	Water
Titanium (Ti)-Dissolved	0.00030	mg/L	<0.00030	<0.00030	<0.00030	<0.00030
Uranium (U)-Dissolved	0.000010	mg/L	0.00137	0.000555	0.00242	0.00251
Vanadium (V)-Dissolved	0.00050	mg/L	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0010	mg/L	0.0063	0.0034	0.0139	0.0046
Zirconium (Zr)-Dissolved	0.00030	mg/L	<0.00030	<0.00030	<0.00030	<0.00030
Aggregate Organics (Water)						
Biochemical Oxygen Demand	2.0	mg/L				
Chemical Oxygen Demand	10	mg/L				

Qualifier Legend

DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavail

Results Summary L2521326

Job Reference 20050 SPARWOOD
Report To Scott Garthwaite, Sperling Hansen Associates Inc.
Date Received 26-Oct-2020 8:30
Report Date 2-Nov-2020 14:56
Report Version 1

Client Sample ID			MW14-1	MW14-4	MW15-2	MW14-3
Date Sampled			22-Oct-2020	22-Oct-2020	22-Oct-2020	22-Oct-2020
Time Sampled			0:00	0:00	0:00	0:00
ALS Sample ID			L2521326-1	L2521326-2	L2521326-3	L2521326-4
Parameter	Lowest Detection Limit	Units	Water	Water	Water	Water
Physical Tests (Water)						
Hardness (as CaCO3)	0.50	mg/L	928	403	688	361
Total Suspended Solids	1.0	mg/L	20100	1380	2680	203
Anions and Nutrients (Water)						
Alkalinity, Total (as CaCO3)	2.0	mg/L	1620	442	697	355
Ammonia as N	0.0050	mg/L	0.0118	0.0086	0.0059	0.0132
Bicarbonate (HCO3)	5.0	mg/L	1980	539	850	433
Carbonate (CO3)	5.0	mg/L	<5.0	<5.0	<5.0	<5.0
Chloride (Cl)	0.10	mg/L	105	19.4	82.4	24.9
Conductivity (EC)	2.0	uS/cm	1560	711	1030	606
Fluoride (F)	0.020	mg/L	<0.10	0.097	<0.10	0.322
Hydroxide (OH)	5.0	mg/L	<5.0	<5.0	<5.0	<5.0
Nitrate and Nitrite (as N)	0.0051	mg/L	4.29	<0.0051	0.275	0.0063
Nitrate (as N)	0.0050	mg/L	4.29	<0.0050	0.261	0.0063
Nitrite (as N)	0.0010	mg/L	<0.0050	<0.0010	0.0141	<0.0010
pH	0.10	pH	7.16	7.42	7.28	7.76
Sulfate (SO4)	0.050	mg/L	353	27.1	50.9	31.9
Dissolved Metals (Water)						
Dissolved Mercury Filtration Location		-	FIELD	FIELD	FIELD	FIELD
Dissolved Metals Filtration Location		-	FIELD	FIELD	FIELD	FIELD
Dissolved Metals Filtration Location		-	FIELD	FIELD	FIELD	FIELD
Aluminum (Al)-Dissolved	0.0010	mg/L	0.0038	0.0024	0.0011	0.0011
Antimony (Sb)-Dissolved	0.00010	mg/L	0.00015	<0.00010	<0.00010	<0.00010
Arsenic (As)-Dissolved	0.00010	mg/L	0.00026	0.00015	0.00015	0.00016
Barium (Ba)-Dissolved	0.00010	mg/L	0.0324	0.162	0.442	0.106
Beryllium (Be)-Dissolved	0.000020	mg/L	<0.000020	<0.000020	<0.000020	<0.000020
Bismuth (Bi)-Dissolved	0.000050	mg/L	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	0.010	mg/L	0.167	0.027	0.026	0.029
Cadmium (Cd)-Dissolved	0.0000050	mg/L	0.000323	0.0000758	0.0000922	0.0000210
Calcium (Ca)-Dissolved	0.050	mg/L	257	114	198	90.1
Chromium (Cr)-Dissolved	0.00010	mg/L	0.00257	0.00158	0.00208	0.00099
Cobalt (Co)-Dissolved	0.00010	mg/L	0.00623	0.00024	0.00049	0.00014
Copper (Cu)-Dissolved	0.00020	mg/L	0.00104	0.00061	0.00043	<0.00020
Iron (Fe)-Dissolved	0.010	mg/L	0.026	0.032	0.029	0.091
Lead (Pb)-Dissolved	0.000050	mg/L	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)-Dissolved	0.0010	mg/L	0.0206	0.0160	0.0218	0.0176
Magnesium (Mg)-Dissolved	0.0050	mg/L	69.5	28.6	47.0	33.1
Manganese (Mn)-Dissolved	0.00010	mg/L	0.321	0.0593	0.272	0.291
Mercury (Hg)-Dissolved	0.0000050	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	0.000050	mg/L	0.0616	0.000950	0.00195	0.00140
Nickel (Ni)-Dissolved	0.00050	mg/L	0.213	0.00232	0.00827	0.00164
Phosphorus (P)-Dissolved	0.050	mg/L	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	0.10	mg/L	5.63	1.33	2.80	1.68
Selenium (Se)-Dissolved	0.000050	mg/L	0.000443	0.000053	0.000065	0.000066
Silicon (Si)-Dissolved	0.050	mg/L	8.61	5.73	7.88	5.71
Silver (Ag)-Dissolved	0.000010	mg/L	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Dissolved	0.050	mg/L	67.0	14.5	18.3	10.0
Strontium (Sr)-Dissolved	0.00020	mg/L	0.356	0.375	0.349	0.466
Sulfur (S)-Dissolved	0.50	mg/L	102	10.3	19.7	12.1
Thallium (Tl)-Dissolved	0.000010	mg/L	0.000082	0.000064	0.000038	0.000049
Tin (Sn)-Dissolved	0.00010	mg/L	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Dissolved	0.00030	mg/L	<0.00030	<0.00030	<0.00030	<0.00030
Uranium (U)-Dissolved	0.000010	mg/L	0.00144	0.000578	0.00136	0.00191
Vanadium (V)-Dissolved	0.00050	mg/L	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved	0.0010	mg/L	0.0108	0.0017	0.0059	0.0016
Zirconium (Zr)-Dissolved	0.00030	mg/L	<0.00030	<0.00030	<0.00030	<0.00030

Qualifier Legend

DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).

APPENDIX B
Certificate of Analysis

Sperling Hansen Associates Inc.
ATTN: David Kvick
#8 - 1225 East Keith Road
North Vancouver BC V7J 1J3

Date Received: 28-JUL-20
Report Date: 06-AUG-20 12:48 (MT)
Version: FINAL

Client Phone: 604-986-7723

Certificate of Analysis

Lab Work Order #: L2480410

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc: Fernie Landfill

Patryk Wojciak, B.Sc., P.Chem.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2480410-1 Water 22-JUL-20 E2572235	L2480410-2 Water 22-JUL-20 E2572237	L2480410-3 Water 22-JUL-20 E2572239	L2480410-4 Water 22-JUL-20 E2572242	L2480410-5 Water 22-JUL-20 E2572244
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	293	511	150	319	229
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	287	496	146	303	205
	Ammonia as N (mg/L)	0.469 DLHC	0.499 DLHC	0.0295	0.101	0.0262
	Bicarbonate (HCO3) (mg/L)	351	605	178	370	250
	Carbonate (CO3) (mg/L)	<5.0	<5.0	<5.0	<5.0	<5.0
	Chloride (Cl) (mg/L)	2.26	7.01	0.18	1.23	5.45
	Conductivity (EC) (uS/cm)	534	910	286	553	418
	Fluoride (F) (mg/L)	0.032	0.042	0.042	0.031	0.064
	Hydroxide (OH) (mg/L)	<5.0	<5.0	<5.0	<5.0	<5.0
	Nitrate (as N) (mg/L)	0.0549	0.418	0.0581	0.0101	0.0126
	Nitrite (as N) (mg/L)	0.0146	0.0109	<0.0010	<0.0010	<0.0010
	pH (pH)	7.67	7.39	7.78	7.62	7.70
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	0.0058	0.0080	<0.0010	0.0089
	Sulfate (SO4) (mg/L)	4.17	16.1	6.47	2.58	14.5
Organic / Inorganic Carbon	Total Organic Carbon (mg/L)	7.9 DLM	5.76	17.7 DLM	4.82	17.2 DLM
Total Metals	Aluminum (Al)-Total (mg/L)					
	Antimony (Sb)-Total (mg/L)					
	Arsenic (As)-Total (mg/L)					
	Barium (Ba)-Total (mg/L)					
	Beryllium (Be)-Total (mg/L)					
	Bismuth (Bi)-Total (mg/L)					
	Boron (B)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Calcium (Ca)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Cobalt (Co)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Lithium (Li)-Total (mg/L)					
	Magnesium (Mg)-Total (mg/L)					
	Manganese (Mn)-Total (mg/L)					
	Molybdenum (Mo)-Total (mg/L)					
	Nickel (Ni)-Total (mg/L)					
	Phosphorus (P)-Total (mg/L)					
	Potassium (K)-Total (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2480410-6 Water 22-JUL-20 E2572245	L2480410-7 Water 22-JUL-20 E2572246	L2480410-8 Water 22-JUL-20 E2572247	L2480410-9 Water 22-JUL-20 E2572250	L2480410-10 Water 22-JUL-20 MW14-1
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	88.5 HTC	92.7 HTC	75.3 HTC	176 HTC	1000
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	92.4	96.5	77.4	187	637
	Ammonia as N (mg/L)	0.0406	0.0216	0.0411	0.0242	0.0365
	Bicarbonate (HCO3) (mg/L)	113	118	94.4	214	777
	Carbonate (CO3) (mg/L)	<5.0	<5.0	<5.0	6.6	<5.0
	Chloride (Cl) (mg/L)	0.11	0.35	0.12	0.54	101 DLHC
	Conductivity (EC) (uS/cm)	182	191	153	338	1800
	Fluoride (F) (mg/L)	0.033	0.043	0.045	0.039	<0.10 DLHC
	Hydroxide (OH) (mg/L)	<5.0	<5.0	<5.0	<5.0	<5.0
	Nitrate (as N) (mg/L)	0.0199	0.0108	0.0054	<0.0050	3.91 DLHC
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050 DLHC
	pH (pH)	8.17	8.05	8.07	8.41	7.00
	Orthophosphate-Dissolved (as P) (mg/L)	0.0149	0.0097	0.0111	0.0176	
	Sulfate (SO4) (mg/L)	3.29	3.61	3.92	2.89	336 DLHC
Organic / Inorganic Carbon	Total Organic Carbon (mg/L)	3.12	2.91	2.79	5.17	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0705	0.0208	0.0197	0.461	
	Antimony (Sb)-Total (mg/L)	0.00015	0.00018	0.00014	0.00017	
	Arsenic (As)-Total (mg/L)	0.00020	0.00021	0.00020	0.00061	
	Barium (Ba)-Total (mg/L)	0.136	0.216	0.201	0.214	
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	0.000039	
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	0.013	
	Cadmium (Cd)-Total (mg/L)	0.0000123	0.0000521	0.0000421	0.0000870	
	Calcium (Ca)-Total (mg/L)	29.8	28.1	22.0	57.4	
	Chromium (Cr)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00053	
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00024	
	Copper (Cu)-Total (mg/L)	<0.00050	0.00062	<0.00050	0.00229	
	Iron (Fe)-Total (mg/L)	0.054	0.032	0.014	0.599	
	Lead (Pb)-Total (mg/L)	0.000057	0.000054	<0.000050	0.000688	
	Lithium (Li)-Total (mg/L)	0.0035	0.0075	0.0092	0.0047	
	Magnesium (Mg)-Total (mg/L)	3.40	5.46	4.97	7.96	
	Manganese (Mn)-Total (mg/L)	0.00164	0.00997	0.00124	0.0230	
	Molybdenum (Mo)-Total (mg/L)	0.000272	0.000526	0.000493	0.00111	
	Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050	<0.00050	0.00184	
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	0.067	
	Potassium (K)-Total (mg/L)	0.59	0.66	0.62	1.21	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2480410-11	L2480410-12	L2480410-13		
	Description	Water	Water	Water		
	Sampled Date	22-JUL-20	22-JUL-20	22-JUL-20		
	Sampled Time					
	Client ID	MW14-4	MW15-2	MW14-3		
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	385	608	468		
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	327	518	432		
	Ammonia as N (mg/L)	0.0486	0.0355	0.0685		
	Bicarbonate (HCO3) (mg/L)	399	632	527		
	Carbonate (CO3) (mg/L)	<5.0	<5.0	<5.0		
	Chloride (Cl) (mg/L)	3.67	42.5 DLHC	43.3 DLHC		
	Conductivity (EC) (uS/cm)	630	993	863		
	Fluoride (F) (mg/L)	0.116	<0.10 DLHC	<0.10 DLHC		
	Hydroxide (OH) (mg/L)	<5.0	<5.0	<5.0		
	Nitrate (as N) (mg/L)	<0.0050	0.029 DLHC	0.028 DLHC		
	Nitrite (as N) (mg/L)	<0.0010	<0.0050	<0.0050		
	pH (pH)	7.59	7.20	7.44		
	Orthophosphate-Dissolved (as P) (mg/L)					
	Sulfate (SO4) (mg/L)	21.4	37.3 DLHC	37.7 DLHC		
Organic / Inorganic Carbon	Total Organic Carbon (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)					
	Antimony (Sb)-Total (mg/L)					
	Arsenic (As)-Total (mg/L)					
	Barium (Ba)-Total (mg/L)					
	Beryllium (Be)-Total (mg/L)					
	Bismuth (Bi)-Total (mg/L)					
	Boron (B)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Calcium (Ca)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Cobalt (Co)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Lithium (Li)-Total (mg/L)					
	Magnesium (Mg)-Total (mg/L)					
	Manganese (Mn)-Total (mg/L)					
	Molybdenum (Mo)-Total (mg/L)					
	Nickel (Ni)-Total (mg/L)					
	Phosphorus (P)-Total (mg/L)					
	Potassium (K)-Total (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2480410-1 Water 22-JUL-20 E2572235	L2480410-2 Water 22-JUL-20 E2572237	L2480410-3 Water 22-JUL-20 E2572239	L2480410-4 Water 22-JUL-20 E2572242	L2480410-5 Water 22-JUL-20 E2572244
WATER						
Total Metals	Selenium (Se)-Total (mg/L)					
	Silicon (Si)-Total (mg/L)					
	Silver (Ag)-Total (mg/L)					
	Sodium (Na)-Total (mg/L)					
	Strontium (Sr)-Total (mg/L)					
	Sulfur (S)-Total (mg/L)					
	Thallium (Tl)-Total (mg/L)					
	Tin (Sn)-Total (mg/L)					
	Titanium (Ti)-Total (mg/L)					
	Uranium (U)-Total (mg/L)					
	Vanadium (V)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
	Zirconium (Zr)-Total (mg/L)					
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0047	0.0016	0.0023	0.0017	0.0016
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00020	0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00516	0.00025	0.00017	0.00071	<0.00010
	Barium (Ba)-Dissolved (mg/L)	0.844	0.294	0.181	0.622	0.139
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.028	0.154	0.018	0.044	0.025
	Cadmium (Cd)-Dissolved (mg/L)	0.0000451	0.000126	0.0000264	0.000322	0.0000797
	Calcium (Ca)-Dissolved (mg/L)	95.9	165	48.3	105	64.8
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00010	<0.00010	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	0.00309	0.00018	<0.00010	0.00511	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00072	0.00140	0.00106	0.00077	0.00051
	Iron (Fe)-Dissolved (mg/L)	2.86	<0.010	<0.010	0.510	<0.010
	Lead (Pb)-Dissolved (mg/L)	0.000056	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0054	0.0052	0.0084	0.0049	0.0117
	Magnesium (Mg)-Dissolved (mg/L)	13.1	24.3	7.10	13.5	16.4
	Manganese (Mn)-Dissolved (mg/L)	1.49 DLHC	0.00432	0.00021	1.14 DLHC	0.00755
	Molybdenum (Mo)-Dissolved (mg/L)	0.00102	0.000097	0.000652	0.000444	0.000306
	Nickel (Ni)-Dissolved (mg/L)	0.00460	0.00148	<0.00050	0.0111	<0.00050
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	1.92	11.2	0.76	1.66	0.80
	Selenium (Se)-Dissolved (mg/L)	<0.000050	0.000110	0.000210	<0.000050	0.000502
	Silicon (Si)-Dissolved (mg/L)	4.98	5.67	3.47	4.32	3.90

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2480410-6 Water 22-JUL-20 E2572245	L2480410-7 Water 22-JUL-20 E2572246	L2480410-8 Water 22-JUL-20 E2572247	L2480410-9 Water 22-JUL-20 E2572250	L2480410-10 Water 22-JUL-20 MW14-1
WATER						
Total Metals	Selenium (Se)-Total (mg/L)	0.000088	0.000240	0.000345	0.000121	
	Silicon (Si)-Total (mg/L)	3.18	2.21	2.06	5.16	
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	0.000018	
	Sodium (Na)-Total (mg/L)	1.50	1.47	1.53	2.27	
	Strontium (Sr)-Total (mg/L)	0.176	0.107	0.0900	0.260	
	Sulfur (S)-Total (mg/L)	2.76	3.21	3.36	3.01	
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	0.000018	
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Total (mg/L)	0.00076	<0.00030	<0.00030	0.00557	
	Uranium (U)-Total (mg/L)	0.000084	0.000229	0.000147	0.000287	
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050	0.00125	
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	0.0114	
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
Dissolved Metals	Dissolved Metals Filtration Location					FIELD
	Aluminum (Al)-Dissolved (mg/L)					0.0013
	Antimony (Sb)-Dissolved (mg/L)					<0.00010
	Arsenic (As)-Dissolved (mg/L)					0.00017
	Barium (Ba)-Dissolved (mg/L)					0.0431
	Beryllium (Be)-Dissolved (mg/L)					<0.000020
	Bismuth (Bi)-Dissolved (mg/L)					<0.000050
	Boron (B)-Dissolved (mg/L)					0.167
	Cadmium (Cd)-Dissolved (mg/L)					0.000148
	Calcium (Ca)-Dissolved (mg/L)					278
	Chromium (Cr)-Dissolved (mg/L)					0.00017
	Cobalt (Co)-Dissolved (mg/L)					0.00014
	Copper (Cu)-Dissolved (mg/L)					0.00115
	Iron (Fe)-Dissolved (mg/L)					<0.010
	Lead (Pb)-Dissolved (mg/L)					<0.000050
	Lithium (Li)-Dissolved (mg/L)					0.0200
	Magnesium (Mg)-Dissolved (mg/L)					74.4
	Manganese (Mn)-Dissolved (mg/L)					0.0263
	Molybdenum (Mo)-Dissolved (mg/L)					0.000530
	Nickel (Ni)-Dissolved (mg/L)					0.00501
	Phosphorus (P)-Dissolved (mg/L)					<0.050
	Potassium (K)-Dissolved (mg/L)					5.64
	Selenium (Se)-Dissolved (mg/L)					0.000200
	Silicon (Si)-Dissolved (mg/L)					8.45

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2480410-11	L2480410-12	L2480410-13		
Description	Water	Water	Water		
Sampled Date	22-JUL-20	22-JUL-20	22-JUL-20		
Sampled Time					
Client ID	MW14-4	MW15-2	MW14-3		
Grouping / **Analyte**					
WATER					
Total Metals					
Selenium (Se)-Total (mg/L)					
Silicon (Si)-Total (mg/L)					
Silver (Ag)-Total (mg/L)					
Sodium (Na)-Total (mg/L)					
Strontium (Sr)-Total (mg/L)					
Sulfur (S)-Total (mg/L)					
Thallium (Tl)-Total (mg/L)					
Tin (Sn)-Total (mg/L)					
Titanium (Ti)-Total (mg/L)					
Uranium (U)-Total (mg/L)					
Vanadium (V)-Total (mg/L)					
Zinc (Zn)-Total (mg/L)					
Zirconium (Zr)-Total (mg/L)					
Dissolved Metals					
Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
Aluminum (Al)-Dissolved (mg/L)	0.0014	<0.0010	<0.0010		
Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
Arsenic (As)-Dissolved (mg/L)	0.00023	0.00021	0.00026		
Barium (Ba)-Dissolved (mg/L)	0.145	0.289	0.138		
Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
Boron (B)-Dissolved (mg/L)	0.026	0.019	0.028		
Cadmium (Cd)-Dissolved (mg/L)	0.0000135	0.0000722	0.0000317		
Calcium (Ca)-Dissolved (mg/L)	112	165	121		
Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
Cobalt (Co)-Dissolved (mg/L)	0.00013	0.00055	0.00042		
Copper (Cu)-Dissolved (mg/L)	0.00061	0.00034	0.00045		
Iron (Fe)-Dissolved (mg/L)	0.040	0.189	0.417		
Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
Lithium (Li)-Dissolved (mg/L)	0.0146	0.0187	0.0169		
Magnesium (Mg)-Dissolved (mg/L)	25.4	47.8	40.5		
Manganese (Mn)-Dissolved (mg/L)	0.0392	0.220	0.465		
Molybdenum (Mo)-Dissolved (mg/L)	0.000361	0.00154	0.00133		
Nickel (Ni)-Dissolved (mg/L)	0.00107	0.00644	0.00180		
Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
Potassium (K)-Dissolved (mg/L)	1.24	2.21	2.37		
Selenium (Se)-Dissolved (mg/L)	<0.000050	<0.000050	0.000063		
Silicon (Si)-Dissolved (mg/L)	5.08	6.53	6.25		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2480410-1 Water 22-JUL-20 E2572235	L2480410-2 Water 22-JUL-20 E2572237	L2480410-3 Water 22-JUL-20 E2572239	L2480410-4 Water 22-JUL-20 E2572242	L2480410-5 Water 22-JUL-20 E2572244
WATER						
Dissolved Metals	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	4.11	9.99	3.57	2.89	3.13
	Strontium (Sr)-Dissolved (mg/L)	0.325	0.595	0.391	0.385	0.398
	Sulfur (S)-Dissolved (mg/L)	3.71	8.67	4.42	3.11	7.42
	Thallium (Tl)-Dissolved (mg/L)	0.000111	0.000029	<0.000010	0.000090	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000567	0.00196	0.000169	0.000835	0.000246
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0047	0.0034	0.0016	0.0073	0.0015
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Aggregate Organics	Biochemical Oxygen Demand (mg/L)	2.2	<2.0	<2.0	<2.0	<2.0
	Chemical Oxygen Demand (mg/L)	31	16	35	17	46

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2480410-6	L2480410-7	L2480410-8	L2480410-9	L2480410-10
Description	Water	Water	Water	Water	Water
Sampled Date	22-JUL-20	22-JUL-20	22-JUL-20	22-JUL-20	22-JUL-20
Sampled Time					
Client ID	E2572245	E2572246	E2572247	E2572250	MW14-1
Grouping / **Analyte**					
WATER					
Dissolved Metals Silver (Ag)-Dissolved (mg/L)					<0.000010
Sodium (Na)-Dissolved (mg/L)					65.5
Strontium (Sr)-Dissolved (mg/L)					0.369
Sulfur (S)-Dissolved (mg/L)					121
Thallium (Tl)-Dissolved (mg/L)					0.000054
Tin (Sn)-Dissolved (mg/L)					0.00013
Titanium (Ti)-Dissolved (mg/L)					<0.00030
Uranium (U)-Dissolved (mg/L)					0.00137
Vanadium (V)-Dissolved (mg/L)					<0.00050
Zinc (Zn)-Dissolved (mg/L)					0.0063
Zirconium (Zr)-Dissolved (mg/L)					<0.00030
Aggregate Organics Biochemical Oxygen Demand (mg/L)	<2.0	<2.0	<2.0	<2.0	
Chemical Oxygen Demand (mg/L)	<10	<10	<10	15	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2480410-11	L2480410-12	L2480410-13		
	Description	Water	Water	Water		
	Sampled Date	22-JUL-20	22-JUL-20	22-JUL-20		
	Sampled Time					
	Client ID	MW14-4	MW15-2	MW14-3		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	8.19	12.9	13.7		
	Strontium (Sr)-Dissolved (mg/L)	0.328	0.311	0.492		
	Sulfur (S)-Dissolved (mg/L)	10.6	16.1	14.6		
	Thallium (Tl)-Dissolved (mg/L)	0.000022	0.000025	0.000036		
	Tin (Sn)-Dissolved (mg/L)	0.00014	<0.00010	0.00031		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.000555	0.00242	0.00251		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0034	0.0139	0.0046		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
Aggregate Organics	Biochemical Oxygen Demand (mg/L)					
	Chemical Oxygen Demand (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
EHR	Exceeded Recommended Holding Time prior to receipt at the lab. - BOD, NO2 AND NO3: HOLD TIME EXCEEDED PRIOR TO RECEIPT

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2480410-1, -10, -11, -12, -13, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2480410-1, -10, -11, -12, -13, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2480410-1, -10, -11, -12, -13, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2480410-1, -10, -11, -12, -13, -2, -3, -4, -5
Matrix Spike	Ammonia as N	MS-B	L2480410-1, -10, -11, -12, -13, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-CL	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

BE-T-L-CCMS-CL	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

BOD-BC-CL	Water	Biochemical Oxygen Demand (BOD)	APHA 5210 B-5 day Incub.-O2 electrode

This analysis is carried out using procedures adapted from APHA Method 5210B - "Biochemical Oxygen Demand (BOD)". All forms of biochemical oxygen demand (BOD) are determined by diluting and incubating a sample for a specified time period, and measuring the oxygen depletion using a dissolved oxygen meter. Dissolved BOD (SOLUBLE) is determined by filtering the sample through a glass fibre filter prior to dilution. Carbonaceous BOD (CBOD) is determined by adding a nitrification inhibitor to the diluted sample prior to incubation.

C-TOT-ORG-LOW-CL	Water	Total Organic Carbon	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

CL-L-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)

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

COD-T-COL-CL	Water	Chemical Oxygen Demand (COD)	APHA 5220 D Colorimetry

Samples are analyzed using the closed reflux colourimetric method

F-L-IC-CL	Water	Fluoride	APHA 4110 B-Ion Chromatography
HARDNESS-CALC-CL	Water	Hardness	APHA 2340 B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

MET-D-CCMS-CL	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Reference Information

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-CL	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-L-F-CL	Water	Ammonia, Total (as N)	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-CL	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

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

NO3-L-IC-N-CL	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

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

PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity	APHA 4500H,2510,2320

All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)
pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode.
Alkalinity measurement is based on the sample's capacity to neutralize acid
Conductivity measurement is based on the sample's capacity to convey an electric current

PO4-DO-L-COL-CL	Water	Orthophosphate-Dissolved (as P)	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

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

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

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

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

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2480410 Report Date: 06-AUG-20

Client: Sperling Hansen Associates Inc.
#8 - 1225 East Keith Road
North Vancouver BC V7J 1J3
Contact: David Kvick

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BE-D-L-CCMS-CL	**Water**							
Batch R5174184								
WG3376114-3 DUP		**L2480410-13**						
Beryllium (Be)-Dissolved		<0.000020	<0.000020	RPD-NA	mg/L	N/A	20	04-AUG-20
WG3376114-2 LCS		**TMRM**						
Beryllium (Be)-Dissolved			102.9		%		80-120	04-AUG-20
WG3376114-1 MB								
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	04-AUG-20
WG3376114-4 MS		**L2480410-13**						
Beryllium (Be)-Dissolved			124.2		%		70-130	04-AUG-20
BE-T-L-CCMS-CL	**Water**							
Batch R5172318								
WG3373753-2 LCS		**TMRM**						
Beryllium (Be)-Total			96.6		%		80-120	30-JUL-20
WG3373753-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	30-JUL-20
BOD-BC-CL	**Water**							
Batch R5173592								
WG3375382-2 LCS								
Biochemical Oxygen Demand			95.1		%		85-115	28-JUL-20
WG3375382-1 MB								
Biochemical Oxygen Demand			<2.0		mg/L		2	28-JUL-20
C-TOT-ORG-LOW-CL	**Water**							
Batch R5174151								
WG3376121-2 LCS								
Total Organic Carbon			95.0		%		80-120	04-AUG-20
WG3376121-1 MB								
Total Organic Carbon			<0.50		mg/L		0.5	04-AUG-20
CL-L-IC-N-CL	**Water**							
Batch R5170778								
WG3372601-10 LCS								
Chloride (Cl)			102.7		%		85-115	28-JUL-20
WG3372601-9 MB								
Chloride (Cl)			<0.10		mg/L		0.1	28-JUL-20
COD-T-COL-CL	**Water**							
Batch R5172139								
WG3373451-3 DUP		**L2480410-6**						
Chemical Oxygen Demand		<10	<10	RPD-NA	mg/L	N/A	20	29-JUL-20
WG3373451-2 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
COD-T-COL-CL	**Water**							
Batch R5172139								
WG3373451-2 LCS								
Chemical Oxygen Demand			100.9		%		85-115	29-JUL-20
WG3373451-1 MB								
Chemical Oxygen Demand			<10		mg/L		10	29-JUL-20
WG3373451-4 MS		**L2480410-6**						
Chemical Oxygen Demand			103.1		%		75-125	29-JUL-20
F-L-IC-CL	**Water**							
Batch R5170778								
WG3372601-10 LCS								
Fluoride (F)			101.3		%		85-115	28-JUL-20
WG3372601-9 MB								
Fluoride (F)			<0.020		mg/L		0.02	28-JUL-20
MET-D-CCMS-CL	**Water**							
Batch R5174184								
WG3376114-3 DUP		**L2480410-13**						
Aluminum (Al)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	04-AUG-20
Antimony (Sb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	04-AUG-20
Arsenic (As)-Dissolved		0.00026	0.00031		mg/L	16	20	04-AUG-20
Barium (Ba)-Dissolved		0.138	0.141		mg/L	2.5	20	04-AUG-20
Bismuth (Bi)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	04-AUG-20
Boron (B)-Dissolved		0.028	0.028		mg/L	0.6	20	04-AUG-20
Cadmium (Cd)-Dissolved		0.0000317	0.0000283		mg/L	11	20	04-AUG-20
Calcium (Ca)-Dissolved		121	121		mg/L	0.1	20	04-AUG-20
Chromium (Cr)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	04-AUG-20
Cobalt (Co)-Dissolved		0.00042	0.00043		mg/L	1.8	20	04-AUG-20
Copper (Cu)-Dissolved		0.00045	0.00046		mg/L	3.5	20	04-AUG-20
Iron (Fe)-Dissolved		0.417	0.439		mg/L	5.2	20	04-AUG-20
Lead (Pb)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	04-AUG-20
Lithium (Li)-Dissolved		0.0169	0.0172		mg/L	1.6	20	04-AUG-20
Magnesium (Mg)-Dissolved		40.5	40.8		mg/L	0.7	20	04-AUG-20
Manganese (Mn)-Dissolved		0.465	0.460		mg/L	1.2	20	04-AUG-20
Molybdenum (Mo)-Dissolved		0.00133	0.00132		mg/L	0.8	20	04-AUG-20
Nickel (Ni)-Dissolved		0.00180	0.00180		mg/L	0.2	20	04-AUG-20
Phosphorus (P)-Dissolved		<0.050	<0.050	RPD-NA	mg/L	N/A	20	04-AUG-20
Potassium (K)-Dissolved		2.37	2.36		mg/L	0.7	20	04-AUG-20
Selenium (Se)-Dissolved		0.000063	0.000059		mg/L	7.2	20	04-AUG-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5174184								
WG3376114-3 DUP		**L2480410-13**						
Silicon (Si)-Dissolved		6.25	6.38		mg/L	2.0	20	04-AUG-20
Silver (Ag)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	04-AUG-20
Sodium (Na)-Dissolved		13.7	13.8		mg/L	0.0	20	04-AUG-20
Strontium (Sr)-Dissolved		0.492	0.493		mg/L	0.1	20	04-AUG-20
Sulfur (S)-Dissolved		14.6	14.9		mg/L	1.9	20	04-AUG-20
Thallium (Tl)-Dissolved		0.000036	0.000041		mg/L	13	20	04-AUG-20
Tin (Sn)-Dissolved		0.00031	0.00030		mg/L	3.7	20	04-AUG-20
Titanium (Ti)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	04-AUG-20
Uranium (U)-Dissolved		0.00251	0.00245		mg/L	2.3	20	04-AUG-20
Vanadium (V)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	04-AUG-20
Zinc (Zn)-Dissolved		0.0046	0.0045		mg/L	2.6	20	04-AUG-20
Zirconium (Zr)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	04-AUG-20
WG3376114-2 LCS		**TMRM**						
Aluminum (Al)-Dissolved			113.5		%		80-120	04-AUG-20
Antimony (Sb)-Dissolved			109.0		%		80-120	04-AUG-20
Arsenic (As)-Dissolved			107.2		%		80-120	04-AUG-20
Barium (Ba)-Dissolved			115.3		%		80-120	04-AUG-20
Bismuth (Bi)-Dissolved			103.5		%		80-120	04-AUG-20
Boron (B)-Dissolved			93.4		%		80-120	04-AUG-20
Cadmium (Cd)-Dissolved			107.3		%		80-120	04-AUG-20
Calcium (Ca)-Dissolved			107.2		%		80-120	04-AUG-20
Chromium (Cr)-Dissolved			109.7		%		80-120	04-AUG-20
Cobalt (Co)-Dissolved			104.2		%		80-120	04-AUG-20
Copper (Cu)-Dissolved			106.9		%		80-120	04-AUG-20
Iron (Fe)-Dissolved			102.4		%		80-120	04-AUG-20
Lead (Pb)-Dissolved			101.5		%		80-120	04-AUG-20
Lithium (Li)-Dissolved			100.2		%		80-120	04-AUG-20
Magnesium (Mg)-Dissolved			114.4		%		80-120	04-AUG-20
Manganese (Mn)-Dissolved			102.6		%		80-120	04-AUG-20
Molybdenum (Mo)-Dissolved			103.4		%		80-120	04-AUG-20
Nickel (Ni)-Dissolved			103.5		%		80-120	04-AUG-20
Phosphorus (P)-Dissolved			111.5		%		70-130	04-AUG-20
Potassium (K)-Dissolved			114.3		%		80-120	04-AUG-20
Selenium (Se)-Dissolved			104.2		%		80-120	04-AUG-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5174184								
WG3376114-2 LCS		**TMRM**						
Silicon (Si)-Dissolved			108.3		%		60-140	04-AUG-20
Silver (Ag)-Dissolved			101.8		%		80-120	04-AUG-20
Sodium (Na)-Dissolved			107.8		%		80-120	04-AUG-20
Strontium (Sr)-Dissolved			107.2		%		80-120	04-AUG-20
Sulfur (S)-Dissolved			105.3		%		80-120	04-AUG-20
Thallium (Tl)-Dissolved			103.2		%		80-120	04-AUG-20
Tin (Sn)-Dissolved			103.8		%		80-120	04-AUG-20
Titanium (Ti)-Dissolved			104.2		%		80-120	04-AUG-20
Uranium (U)-Dissolved			98.8		%		80-120	04-AUG-20
Vanadium (V)-Dissolved			108.5		%		80-120	04-AUG-20
Zinc (Zn)-Dissolved			103.6		%		80-120	04-AUG-20
Zirconium (Zr)-Dissolved			97.8		%		80-120	04-AUG-20
WG3376114-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	04-AUG-20
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	04-AUG-20
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	04-AUG-20
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	04-AUG-20
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	04-AUG-20
Boron (B)-Dissolved			<0.010		mg/L		0.01	04-AUG-20
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	04-AUG-20
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	04-AUG-20
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	04-AUG-20
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	04-AUG-20
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	04-AUG-20
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	04-AUG-20
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	04-AUG-20
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	04-AUG-20
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	04-AUG-20
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	04-AUG-20
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	04-AUG-20
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	04-AUG-20
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	04-AUG-20
Potassium (K)-Dissolved			<0.050		mg/L		0.05	04-AUG-20
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	04-AUG-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5174184								
WG3376114-1 MB								
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	04-AUG-20
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	04-AUG-20
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	04-AUG-20
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	04-AUG-20
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	04-AUG-20
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	04-AUG-20
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	04-AUG-20
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	04-AUG-20
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	04-AUG-20
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	04-AUG-20
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	04-AUG-20
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	04-AUG-20
WG3376114-4 MS		**L2480410-13**						
Aluminum (Al)-Dissolved			118.4		%		70-130	04-AUG-20
Antimony (Sb)-Dissolved			111.7		%		70-130	04-AUG-20
Arsenic (As)-Dissolved			118.2		%		70-130	04-AUG-20
Barium (Ba)-Dissolved			120.9		%		70-130	04-AUG-20
Bismuth (Bi)-Dissolved			109.1		%		70-130	04-AUG-20
Boron (B)-Dissolved			109.3		%		70-130	04-AUG-20
Cadmium (Cd)-Dissolved			117.3		%		70-130	04-AUG-20
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	04-AUG-20
Chromium (Cr)-Dissolved			117.0		%		70-130	04-AUG-20
Cobalt (Co)-Dissolved			114.9		%		70-130	04-AUG-20
Copper (Cu)-Dissolved			115.9		%		70-130	04-AUG-20
Iron (Fe)-Dissolved			114.7		%		70-130	04-AUG-20
Lead (Pb)-Dissolved			111.0		%		70-130	04-AUG-20
Lithium (Li)-Dissolved			116.7		%		70-130	04-AUG-20
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	04-AUG-20
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	04-AUG-20
Molybdenum (Mo)-Dissolved			109.0		%		70-130	04-AUG-20
Nickel (Ni)-Dissolved			115.9		%		70-130	04-AUG-20
Phosphorus (P)-Dissolved			117.8		%		70-130	04-AUG-20
Potassium (K)-Dissolved			115.2		%		70-130	04-AUG-20
Selenium (Se)-Dissolved			120.6		%		70-130	04-AUG-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5174184								
WG3376114-4 MS		**L2480410-13**						
Silicon (Si)-Dissolved			106.5		%		70-130	04-AUG-20
Silver (Ag)-Dissolved			106.5		%		70-130	04-AUG-20
Sodium (Na)-Dissolved			121.5		%		70-130	04-AUG-20
Strontium (Sr)-Dissolved			N/A	MS-B	%		-	04-AUG-20
Thallium (Tl)-Dissolved			110.1		%		70-130	04-AUG-20
Tin (Sn)-Dissolved			109.0		%		70-130	04-AUG-20
Titanium (Ti)-Dissolved			114.4		%		70-130	04-AUG-20
Uranium (U)-Dissolved			108.4		%		70-130	04-AUG-20
Vanadium (V)-Dissolved			116.5		%		70-130	04-AUG-20
Zinc (Zn)-Dissolved			117.0		%		70-130	04-AUG-20
Zirconium (Zr)-Dissolved			106.0		%		70-130	04-AUG-20
MET-T-CCMS-CL	**Water**							
Batch R5172318								
WG3373753-2 LCS		**TMRM**						
Aluminum (Al)-Total			93.1		%		80-120	30-JUL-20
Antimony (Sb)-Total			102.2		%		80-120	30-JUL-20
Arsenic (As)-Total			91.4		%		80-120	30-JUL-20
Barium (Ba)-Total			94.6		%		80-120	30-JUL-20
Bismuth (Bi)-Total			99.5		%		80-120	30-JUL-20
Boron (B)-Total			90.7		%		80-120	30-JUL-20
Cadmium (Cd)-Total			88.5		%		80-120	30-JUL-20
Calcium (Ca)-Total			100.9		%		80-120	30-JUL-20
Chromium (Cr)-Total			92.3		%		80-120	30-JUL-20
Cobalt (Co)-Total			90.8		%		80-120	30-JUL-20
Copper (Cu)-Total			93.2		%		80-120	30-JUL-20
Iron (Fe)-Total			97.6		%		80-120	30-JUL-20
Lead (Pb)-Total			99.7		%		80-120	30-JUL-20
Lithium (Li)-Total			93.8		%		80-120	30-JUL-20
Magnesium (Mg)-Total			90.5		%		80-120	30-JUL-20
Manganese (Mn)-Total			92.1		%		80-120	30-JUL-20
Molybdenum (Mo)-Total			98.1		%		80-120	30-JUL-20
Nickel (Ni)-Total			90.0		%		80-120	30-JUL-20
Phosphorus (P)-Total			93.6		%		70-130	30-JUL-20
Potassium (K)-Total			91.7		%		80-120	30-JUL-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-CL	**Water**							
Batch R5172318								
WG3373753-2 LCS		**TMRM**						
Selenium (Se)-Total			91.8		%		80-120	30-JUL-20
Silicon (Si)-Total			95.4		%		60-140	30-JUL-20
Silver (Ag)-Total			102.2		%		80-120	30-JUL-20
Sodium (Na)-Total			89.9		%		80-120	30-JUL-20
Strontium (Sr)-Total			103.2		%		80-120	30-JUL-20
Sulfur (S)-Total			90.2		%		80-120	30-JUL-20
Thallium (Tl)-Total			97.7		%		80-120	30-JUL-20
Tin (Sn)-Total			88.7		%		80-120	30-JUL-20
Titanium (Ti)-Total			87.2		%		80-120	30-JUL-20
Uranium (U)-Total			100.3		%		80-120	30-JUL-20
Vanadium (V)-Total			91.9		%		80-120	30-JUL-20
Zinc (Zn)-Total			89.5		%		80-120	30-JUL-20
Zirconium (Zr)-Total			101.9		%		80-120	30-JUL-20
WG3373753-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	30-JUL-20
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	30-JUL-20
Arsenic (As)-Total			<0.00010		mg/L		0.0001	30-JUL-20
Barium (Ba)-Total			<0.00010		mg/L		0.0001	30-JUL-20
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	30-JUL-20
Boron (B)-Total			<0.010		mg/L		0.01	30-JUL-20
Cadmium (Cd)-Total			<0.000005(		mg/L		0.000005	30-JUL-20
Calcium (Ca)-Total			<0.050		mg/L		0.05	30-JUL-20
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	30-JUL-20
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	30-JUL-20
Copper (Cu)-Total			<0.00050		mg/L		0.0005	30-JUL-20
Iron (Fe)-Total			<0.010		mg/L		0.01	30-JUL-20
Lead (Pb)-Total			<0.000050		mg/L		0.00005	30-JUL-20
Lithium (Li)-Total			<0.0010		mg/L		0.001	30-JUL-20
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	30-JUL-20
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	30-JUL-20
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	30-JUL-20
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	30-JUL-20
Phosphorus (P)-Total			<0.050		mg/L		0.05	30-JUL-20
Potassium (K)-Total			<0.050		mg/L		0.05	30-JUL-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-CL	**Water**							
Batch R5172318								
WG3373753-1 MB								
Selenium (Se)-Total			<0.000050		mg/L		0.00005	30-JUL-20
Silicon (Si)-Total			<0.050		mg/L		0.05	30-JUL-20
Silver (Ag)-Total			<0.000010		mg/L		0.00001	30-JUL-20
Sodium (Na)-Total			<0.050		mg/L		0.05	30-JUL-20
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	30-JUL-20
Sulfur (S)-Total			<0.50		mg/L		0.5	30-JUL-20
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	30-JUL-20
Tin (Sn)-Total			<0.00010		mg/L		0.0001	30-JUL-20
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	30-JUL-20
Uranium (U)-Total			<0.000010		mg/L		0.00001	30-JUL-20
Vanadium (V)-Total			<0.00050		mg/L		0.0005	30-JUL-20
Zinc (Zn)-Total			<0.0030		mg/L		0.003	30-JUL-20
Zirconium (Zr)-Total			<0.00020		mg/L		0.0002	30-JUL-20
NH3-L-F-CL	**Water**							
Batch R5175008								
WG3376944-15 DUP		**L2480410-2**						
Ammonia as N		0.499	0.511		mg/L	2.4	20	05-AUG-20
WG3376944-14 LCS								
Ammonia as N			103.0		%		85-115	05-AUG-20
WG3376944-13 MB								
Ammonia as N			<0.0050		mg/L		0.005	05-AUG-20
WG3376944-16 MS		**L2480410-2**						
Ammonia as N			N/A	MS-B	%		-	05-AUG-20
NO2-L-IC-N-CL	**Water**							
Batch R5170778								
WG3372601-10 LCS								
Nitrite (as N)			102.1		%		90-110	28-JUL-20
WG3372601-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	28-JUL-20
NO3-L-IC-N-CL	**Water**							
Batch R5170778								
WG3372601-10 LCS								
Nitrate (as N)			103.1		%		90-110	28-JUL-20
WG3372601-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	28-JUL-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH/EC/ALK-CL	**Water**							
Batch R5170378								
WG3372564-14 LCS								
Conductivity (EC)			101.2		%		90-110	28-JUL-20
Alkalinity, Total (as CaCO3)			99.5		%		85-115	28-JUL-20
WG3372564-17 LCS								
Conductivity (EC)			101.0		%		90-110	28-JUL-20
Alkalinity, Total (as CaCO3)			98.7		%		85-115	28-JUL-20
WG3372564-13 MB								
Conductivity (EC)			<2.0		uS/cm		2	28-JUL-20
Bicarbonate (HCO3)			<5.0		mg/L		5	28-JUL-20
Carbonate (CO3)			<5.0		mg/L		5	28-JUL-20
Hydroxide (OH)			<5.0		mg/L		5	28-JUL-20
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	28-JUL-20
WG3372564-16 MB								
Conductivity (EC)			<2.0		uS/cm		2	28-JUL-20
Bicarbonate (HCO3)			<5.0		mg/L		5	28-JUL-20
Carbonate (CO3)			<5.0		mg/L		5	28-JUL-20
Hydroxide (OH)			<5.0		mg/L		5	28-JUL-20
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	28-JUL-20
PO4-DO-L-COL-CL	**Water**							
Batch R5169890								
WG3371921-10 LCS								
Orthophosphate-Dissolved (as P)			101.5		%		80-120	28-JUL-20
WG3371921-6 LCS								
Orthophosphate-Dissolved (as P)			106.0		%		80-120	28-JUL-20
WG3371921-5 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	28-JUL-20
WG3371921-9 MB								
Orthophosphate-Dissolved (as P)			<0.0010		mg/L		0.001	28-JUL-20
SO4-L-IC-N-CL	**Water**							
Batch R5170778								
WG3372601-10 LCS								
Sulfate (SO4)			102.2		%		85-115	28-JUL-20
WG3372601-9 MB								
Sulfate (SO4)			<0.050		mg/L		0.05	28-JUL-20

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	2	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	3	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	4	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	5	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	6	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	7	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	8	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	9	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	10	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	11	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	12	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	13	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
Nitrite in Water by IC (Low Level)							
	1	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	2	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	3	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	4	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	5	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	6	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	7	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	8	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	9	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	10	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	11	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	12	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
	13	22-JUL-20	28-JUL-20 07:33	3	6	days	EHTR
Orthophosphate-Dissolved (as P)							
	1	22-JUL-20	28-JUL-20 14:59	3	6	days	EHTR
	2	22-JUL-20	28-JUL-20 15:02	3	6	days	EHTR
	3	22-JUL-20	28-JUL-20 15:02	3	6	days	EHTR
	4	22-JUL-20	28-JUL-20 15:02	3	6	days	EHTR
	5	22-JUL-20	28-JUL-20 15:04	3	6	days	EHTR
	6	22-JUL-20	28-JUL-20 15:06	3	6	days	EHTR
	7	22-JUL-20	28-JUL-20 15:06	3	6	days	EHTR
	8	22-JUL-20	28-JUL-20 15:06	3	6	days	EHTR
	9	22-JUL-20	28-JUL-20 15:09	3	6	days	EHTR

Legend & Qualifier Definitions:

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

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2480410 were received on 28-JUL-20 08:40.

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

Quality Control Report

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

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

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2480410-COFC

COC Number: 15 -

Report To	Contact and company name below will appear on the final report
Company:	Sperling Hansen Associates Inc.
Contact:	David Kvick
Phone:	604-813-8476
	Company address below will appear on the final report
Street:	8-1225 East Keith Road
City/Province:	North Vancouver B.C.,
Postal Code:	V7J 1J3

Report Format / Distribution

Select Report Format: ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax
Email 2
Email 3

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ | 3 day [P3] ☐ | 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ | Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Invoice To	Same as Report To ☑ ☐ NO
	Copy of Invoice with Report ☑ ☐ NO
Company:	
Contact:	

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax
Email 2

Project Information	
ALS Account # / Quote #:	Q80923
Job #:	
PO / AFE:	
LSD:	
ALS Lab Work Order # (lab use only)	

Oil and Gas Required Fields (client use)

AFE/Cost Center: | PO#
Major/Minor Code: | Routing Code:
Requisitioner:
Location: Fernie Landfill
ALS Contact: | Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	alkalinity	Anions	ammonia	TOC	orthophosphorous	Metals (F/P)	Metals (P)	COD	BOD	Number of Containers
1	E257235	22/07/20		Bailer	x	x	x	x	✓	x		x	✓	4
2	E257237	"		"	x	x	x	x	x	x		✓	x	"
3	E257239	"		"	x	✓	x	x	x	x		x	x	"
4	E257242	"		"	x	✓	x	x	x	x		✓	x	"
5	E257244	"		"	x	✓	x	x	✓	x		✓	x	"
6	E257245	"		"	x	x	x	x	x		x	x	x	"
7	E257246	"		"	x	x	x	✓	x		x	✓	x	"
8	E257247	"		"	x	x	✓	x	x		x	✓	✓	"
9	E257250	"		"	✓	x	✓	✓	✓		x	x	x	"

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ ☑ NO
Are samples for human drinking water use? ☐ ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ | SIF Observations ☑ Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ | Custody seal intact ☑ Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2.1					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: J. Solman	Date: 23/07/20	Time:	Received by:	Date: 24/7/20	Time: 8:40	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

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

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

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2480410-COFC

COC Number: 15 -

Report To	Contact and company name below will appear on the final report
Company:	Sperling Hansen Associates Inc.
Contact:	David Kvick
Phone:	604-813-8476
	Company address below will appear on the final report
Street:	8-1225 East Keith Road
City/Province:	North Vancouver B.C.,
Postal Code:	V7J 1J3
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☑ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution	
Select Report Format:	☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report	☑ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	
Email 2	
Email 3	
Invoice Distribution	
Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	
Email 2	

Project Information	
ALS Account # / Quote #:	Q80923
Job #:	
PO / AFE:	
LSD:	
ALS Lab Work Order # (lab use only)	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	Sparwood Landfill
ALS Contact:	Sampler:

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ | 3 day [P3] ☐ | 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ | Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Conductivity ✓	pH ✓	Anions ✓	NH_3 ✓	Total Alkalinity	Metals (F/P)	Number of Containers
10	MW14-1	24/07/20		bailer	x	x	x	x	x	x	4
11	MW14-4	"		"	x	x	x	x	x	x	"
12	MW15-2	"		"	x	x	x	x	x	x	"
13	MW14-3	"		"	x	x	x	x	x	x	"

SIF

Hold time exceeded prior to receipt

Drinking Water (DW) Samples[1] (client use)	Special Instructio
Are samples taken from a Regulated DW System? ☐ YES ☑ NO	
Are samples for human drinking water use? ☐ YES ☑ NO	

SHIPMENT RELEASE (client use)

Released by:	Date:	T
J. Solman	24/07/20	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ | SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ | Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		

FINAL SHIPMENT RECEPTION (lab use only)

Time:	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please sut

ELLOW - CLIENT COPY as specified on the back page of the white - report copy.

OCTOBER 2015 FRONT

Sperling Hansen Associates Inc.
ATTN: Scott Garthwaite
#8 - 1225 East Keith Road
North Vancouver BC V7J 1J3

Date Received: 26-OCT-20
Report Date: 02-NOV-20 14:56 (MT)
Version: FINAL

Client Phone: 604-986-7723

Certificate of Analysis

Lab Work Order #: L2521326

Project P.O. #: NOT SUBMITTED
Job Reference: 20050 SPARWOOD
C of C Numbers:
Legal Site Desc:

Patryk Wojciak, B.Sc., P.Chem.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2521326-1	L2521326-2	L2521326-3	L2521326-4	
Description	Groundwater	Groundwater	Groundwater	Groundwater	
Sampled Date	22-OCT-20	22-OCT-20	22-OCT-20	22-OCT-20	
Sampled Time					
Client ID	MW14-1	MW14-4	MW15-2	MW14-3	
Grouping / **Analyte**					
WATER					
Physical Tests					
Hardness (as CaCO3) (mg/L)	928	403	688	361	
Total Suspended Solids (mg/L)	20100 DLHC	1380 DLHC	2680 DLHC	203	
Anions and Nutrients					
Alkalinity, Total (as CaCO3) (mg/L)	1620	442	697	355	
Ammonia as N (mg/L)	0.0118	0.0086	0.0059	0.0132	
Bicarbonate (HCO3) (mg/L)	1980	539	850	433	
Carbonate (CO3) (mg/L)	<5.0	<5.0	<5.0	<5.0	
Chloride (Cl) (mg/L)	105 DLHC	19.4	82.4 DLHC	24.9	
Conductivity (EC) (uS/cm)	1560	711	1030	606	
Fluoride (F) (mg/L)	<0.10 DLHC	0.097	<0.10 DLHC	0.322	
Hydroxide (OH) (mg/L)	<5.0	<5.0	<5.0	<5.0	
Nitrate and Nitrite (as N) (mg/L)	4.29	<0.0051	0.275	0.0063	
Nitrate (as N) (mg/L)	4.29 DLHC	<0.0050	0.261 DLHC	0.0063	
Nitrite (as N) (mg/L)	<0.0050 DLHC	<0.0010	0.0141 DLHC	<0.0010	
pH (pH)	7.16	7.42	7.28	7.76	
Sulfate (SO4) (mg/L)	353 DLHC	27.1	50.9 DLHC	31.9	
Dissolved Metals					
Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	
Aluminum (Al)-Dissolved (mg/L)	0.0038	0.0024	0.0011	0.0011	
Antimony (Sb)-Dissolved (mg/L)	0.00015	<0.00010	<0.00010	<0.00010	
Arsenic (As)-Dissolved (mg/L)	0.00026	0.00015	0.00015	0.00016	
Barium (Ba)-Dissolved (mg/L)	0.0324	0.162	0.442	0.106	
Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	
Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
Boron (B)-Dissolved (mg/L)	0.167	0.027	0.026	0.029	
Cadmium (Cd)-Dissolved (mg/L)	0.000323	0.0000758	0.0000922	0.0000210	
Calcium (Ca)-Dissolved (mg/L)	257	114	198	90.1	
Chromium (Cr)-Dissolved (mg/L)	0.00257	0.00158	0.00208	0.00099	
Cobalt (Co)-Dissolved (mg/L)	0.00623	0.00024	0.00049	0.00014	
Copper (Cu)-Dissolved (mg/L)	0.00104	0.00061	0.00043	<0.00020	
Iron (Fe)-Dissolved (mg/L)	0.026	0.032	0.029	0.091	
Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
Lithium (Li)-Dissolved (mg/L)	0.0206	0.0160	0.0218	0.0176	
Magnesium (Mg)-Dissolved (mg/L)	69.5	28.6	47.0	33.1	
Manganese (Mn)-Dissolved (mg/L)	0.321	0.0593	0.272	0.291	
Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
Molybdenum (Mo)-Dissolved (mg/L)	0.0616	0.000950	0.00195	0.00140	
Nickel (Ni)-Dissolved (mg/L)	0.213	0.00232	0.00827	0.00164	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2521326-1	L2521326-2	L2521326-3	L2521326-4	
Description	Groundwater	Groundwater	Groundwater	Groundwater	
Sampled Date	22-OCT-20	22-OCT-20	22-OCT-20	22-OCT-20	
Sampled Time					
Client ID	MW14-1	MW14-4	MW15-2	MW14-3	
Grouping / **Analyte**					
WATER					
Dissolved Metals Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	
Potassium (K)-Dissolved (mg/L)	5.63	1.33	2.80	1.68	
Selenium (Se)-Dissolved (mg/L)	0.000443	0.000053	0.000065	0.000066	
Silicon (Si)-Dissolved (mg/L)	8.61	5.73	7.88	5.71	
Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
Sodium (Na)-Dissolved (mg/L)	67.0	14.5	18.3	10.0	
Strontium (Sr)-Dissolved (mg/L)	0.356	0.375	0.349	0.466	
Sulfur (S)-Dissolved (mg/L)	102	10.3	19.7	12.1	
Thallium (Tl)-Dissolved (mg/L)	0.000082	0.000064	0.000038	0.000049	
Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
Uranium (U)-Dissolved (mg/L)	0.00144	0.000578	0.00136	0.00191	
Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	
Zinc (Zn)-Dissolved (mg/L)	0.0108	0.0017	0.0059	0.0016	
Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
EHR	Exceeded Recommended Holding Time prior to receipt at the lab. - HOLD TIME EXCEEDED UPON ARRIVAL FOR NO2, NO3

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2521326-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2521326-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2521326-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2521326-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2521326-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2521326-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2521326-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2521326-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-CL	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CL-L-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)

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

F-L-IC-CL	Water	Fluoride	APHA 4110 B-Ion Chromatography
HARDNESS-CALC-CL	Water	Hardness	APHA 2340 B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-CL	Water	Dissolved Mercury in Water by CVAAS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS.

MET-D-CCMS-CL	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NH3-L-F-CL	Water	Ammonia, Total (as N)	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-CL	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

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

NO3-L-IC-N-CL	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

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

PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity	APHA 4500H,2510,2320

All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)
pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode.
Alkalinity measurement is based on the sample's capacity to neutralize acid
Conductivity measurement is based on the sample's capacity to convey an electric current

Reference Information

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

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

TSS-L-CL	Water	Total Suspended Solids	APHA 2540 D-Gravimetric

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, and by drying the filter at 104 deg. C.

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

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

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: Sperling Hansen Associates Inc.
#8 - 1225 East Keith Road
North Vancouver BC V7J 1J3
Contact: Scott Garthwaite

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BE-D-L-CCMS-CL	**Water**							
Batch R5272543								
WG3436599-3 DUP		**L2521326-4**						
Beryllium (Be)-Dissolved		<0.000020	<0.000020	RPD-NA	mg/L	N/A	20	01-NOV-20
WG3436599-10 LCS		**TMRM**						
Beryllium (Be)-Dissolved			106.7		%		80-120	01-NOV-20
WG3436599-2 LCS		**TMRM**						
Beryllium (Be)-Dissolved			107.1		%		80-120	01-NOV-20
WG3436599-6 LCS		**TMRM**						
Beryllium (Be)-Dissolved			103.0		%		80-120	01-NOV-20
WG3436599-1 MB								
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	01-NOV-20
WG3436599-5 MB								
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	01-NOV-20
WG3436599-9 MB								
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	01-NOV-20
WG3436599-4 MS		**L2521326-4**						
Beryllium (Be)-Dissolved			95.1		%		70-130	01-NOV-20
CL-L-IC-N-CL	**Water**							
Batch R5269766								
WG3433469-2 LCS								
Chloride (Cl)			103.3		%		85-115	26-OCT-20
WG3433469-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	26-OCT-20
F-L-IC-CL	**Water**							
Batch R5269766								
WG3433469-2 LCS								
Fluoride (F)			96.0		%		85-115	26-OCT-20
WG3433469-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	26-OCT-20
HG-D-CVAA-CL	**Water**							
Batch R5271223								
WG3435128-10 LCS								
Mercury (Hg)-Dissolved			86.8		%		80-120	29-OCT-20
WG3435128-9 MB								
Mercury (Hg)-Dissolved			<0.000005		mg/L		0.000005	29-OCT-20
MET-D-CCMS-CL	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5272543								
WG3436599-3 DUP		**L2521326-4**						
Aluminum (Al)-Dissolved		0.0011	0.0013		mg/L	16	20	01-NOV-20
Antimony (Sb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	01-NOV-20
Arsenic (As)-Dissolved		0.00016	0.00014		mg/L	18	20	01-NOV-20
Barium (Ba)-Dissolved		0.106	0.105		mg/L	0.9	20	01-NOV-20
Bismuth (Bi)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	01-NOV-20
Boron (B)-Dissolved		0.029	0.029		mg/L	0.8	20	01-NOV-20
Cadmium (Cd)-Dissolved		0.0000210	0.0000250		mg/L	18	20	01-NOV-20
Calcium (Ca)-Dissolved		90.1	90.3		mg/L	0.2	20	01-NOV-20
Chromium (Cr)-Dissolved		0.00099	0.00102		mg/L	3.8	20	01-NOV-20
Cobalt (Co)-Dissolved		0.00014	0.00013		mg/L	7.1	20	01-NOV-20
Copper (Cu)-Dissolved		<0.00020	0.00020	RPD-NA	mg/L	N/A	20	01-NOV-20
Iron (Fe)-Dissolved		0.091	0.090		mg/L	1.2	20	01-NOV-20
Lead (Pb)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	01-NOV-20
Lithium (Li)-Dissolved		0.0176	0.0171		mg/L	2.7	20	01-NOV-20
Magnesium (Mg)-Dissolved		33.1	32.9		mg/L	0.7	20	01-NOV-20
Manganese (Mn)-Dissolved		0.291	0.292		mg/L	0.3	20	01-NOV-20
Molybdenum (Mo)-Dissolved		0.00140	0.00138		mg/L	1.7	20	01-NOV-20
Nickel (Ni)-Dissolved		0.00164	0.00167		mg/L	1.5	20	01-NOV-20
Phosphorus (P)-Dissolved		<0.050	<0.050	RPD-NA	mg/L	N/A	20	01-NOV-20
Potassium (K)-Dissolved		1.68	1.68		mg/L	0.5	20	01-NOV-20
Selenium (Se)-Dissolved		0.000066	0.000053	J	mg/L	0.000013	0.0001	01-NOV-20
Silicon (Si)-Dissolved		5.71	5.63		mg/L	1.3	20	01-NOV-20
Silver (Ag)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	01-NOV-20
Sodium (Na)-Dissolved		10.0	10.0		mg/L	0.1	20	01-NOV-20
Strontium (Sr)-Dissolved		0.466	0.463		mg/L	0.6	20	01-NOV-20
Sulfur (S)-Dissolved		12.1	12.1		mg/L	0.4	20	01-NOV-20
Thallium (Tl)-Dissolved		0.000049	0.000050		mg/L	1.8	20	01-NOV-20
Tin (Sn)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	01-NOV-20
Titanium (Ti)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	01-NOV-20
Uranium (U)-Dissolved		0.00191	0.00190		mg/L	0.2	20	01-NOV-20
Vanadium (V)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-NOV-20
Zinc (Zn)-Dissolved		0.0016	0.0015		mg/L	4.3	20	01-NOV-20
Zirconium (Zr)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	01-NOV-20
WG3436599-10 LCS		**TMRM**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5272543								
WG3436599-10 LCS		**TMRM**						
Aluminum (Al)-Dissolved			105.0		%		80-120	01-NOV-20
Antimony (Sb)-Dissolved			101.6		%		80-120	01-NOV-20
Arsenic (As)-Dissolved			101.6		%		80-120	01-NOV-20
Barium (Ba)-Dissolved			102.8		%		80-120	01-NOV-20
Bismuth (Bi)-Dissolved			101.3		%		80-120	01-NOV-20
Boron (B)-Dissolved			97.5		%		80-120	01-NOV-20
Cadmium (Cd)-Dissolved			101.8		%		80-120	01-NOV-20
Calcium (Ca)-Dissolved			102.9		%		80-120	01-NOV-20
Chromium (Cr)-Dissolved			104.6		%		80-120	01-NOV-20
Cobalt (Co)-Dissolved			102.5		%		80-120	01-NOV-20
Copper (Cu)-Dissolved			102.5		%		80-120	01-NOV-20
Iron (Fe)-Dissolved			106.8		%		80-120	01-NOV-20
Lead (Pb)-Dissolved			104.4		%		80-120	01-NOV-20
Lithium (Li)-Dissolved			109.9		%		80-120	01-NOV-20
Magnesium (Mg)-Dissolved			107.0		%		80-120	01-NOV-20
Manganese (Mn)-Dissolved			105.1		%		80-120	01-NOV-20
Molybdenum (Mo)-Dissolved			104.8		%		80-120	01-NOV-20
Nickel (Ni)-Dissolved			101.8		%		80-120	01-NOV-20
Phosphorus (P)-Dissolved			101.7		%		70-130	01-NOV-20
Potassium (K)-Dissolved			104.0		%		80-120	01-NOV-20
Selenium (Se)-Dissolved			99.5		%		80-120	01-NOV-20
Silicon (Si)-Dissolved			110.8		%		60-140	01-NOV-20
Silver (Ag)-Dissolved			105.5		%		80-120	01-NOV-20
Sodium (Na)-Dissolved			103.9		%		80-120	01-NOV-20
Strontium (Sr)-Dissolved			107.8		%		80-120	01-NOV-20
Sulfur (S)-Dissolved			108.9		%		80-120	01-NOV-20
Thallium (Tl)-Dissolved			102.9		%		80-120	01-NOV-20
Tin (Sn)-Dissolved			100.7		%		80-120	01-NOV-20
Titanium (Ti)-Dissolved			94.7		%		80-120	01-NOV-20
Uranium (U)-Dissolved			106.5		%		80-120	01-NOV-20
Vanadium (V)-Dissolved			105.2		%		80-120	01-NOV-20
Zinc (Zn)-Dissolved			97.8		%		80-120	01-NOV-20
Zirconium (Zr)-Dissolved			101.5		%		80-120	01-NOV-20
WG3436599-2 LCS		**TMRM**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5272543								
WG3436599-2 LCS		**TMRM**						
Aluminum (Al)-Dissolved			104.0		%		80-120	01-NOV-20
Antimony (Sb)-Dissolved			99.1		%		80-120	01-NOV-20
Arsenic (As)-Dissolved			102.8		%		80-120	01-NOV-20
Barium (Ba)-Dissolved			103.2		%		80-120	01-NOV-20
Bismuth (Bi)-Dissolved			102.0		%		80-120	01-NOV-20
Boron (B)-Dissolved			103.5		%		80-120	01-NOV-20
Cadmium (Cd)-Dissolved			103.8		%		80-120	01-NOV-20
Calcium (Ca)-Dissolved			105.4		%		80-120	01-NOV-20
Chromium (Cr)-Dissolved			106.8		%		80-120	01-NOV-20
Cobalt (Co)-Dissolved			103.6		%		80-120	01-NOV-20
Copper (Cu)-Dissolved			101.8		%		80-120	01-NOV-20
Iron (Fe)-Dissolved			109.4		%		80-120	01-NOV-20
Lead (Pb)-Dissolved			105.0		%		80-120	01-NOV-20
Lithium (Li)-Dissolved			105.0		%		80-120	01-NOV-20
Magnesium (Mg)-Dissolved			109.3		%		80-120	01-NOV-20
Manganese (Mn)-Dissolved			105.6		%		80-120	01-NOV-20
Molybdenum (Mo)-Dissolved			102.3		%		80-120	01-NOV-20
Nickel (Ni)-Dissolved			103.6		%		80-120	01-NOV-20
Phosphorus (P)-Dissolved			104.0		%		70-130	01-NOV-20
Potassium (K)-Dissolved			103.1		%		80-120	01-NOV-20
Selenium (Se)-Dissolved			101.0		%		80-120	01-NOV-20
Silicon (Si)-Dissolved			111.2		%		60-140	01-NOV-20
Silver (Ag)-Dissolved			103.9		%		80-120	01-NOV-20
Sodium (Na)-Dissolved			102.5		%		80-120	01-NOV-20
Strontium (Sr)-Dissolved			106.2		%		80-120	01-NOV-20
Sulfur (S)-Dissolved			114.3		%		80-120	01-NOV-20
Thallium (Tl)-Dissolved			104.3		%		80-120	01-NOV-20
Tin (Sn)-Dissolved			99.4		%		80-120	01-NOV-20
Titanium (Ti)-Dissolved			89.3		%		80-120	01-NOV-20
Uranium (U)-Dissolved			106.4		%		80-120	01-NOV-20
Vanadium (V)-Dissolved			105.3		%		80-120	01-NOV-20
Zinc (Zn)-Dissolved			94.4		%		80-120	01-NOV-20
Zirconium (Zr)-Dissolved			100.1		%		80-120	01-NOV-20
WG3436599-6 LCS		**TMRM**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5272543								
WG3436599-6 LCS		**TMRM**						
Aluminum (Al)-Dissolved			102.5		%		80-120	01-NOV-20
Antimony (Sb)-Dissolved			99.2		%		80-120	01-NOV-20
Arsenic (As)-Dissolved			102.7		%		80-120	01-NOV-20
Barium (Ba)-Dissolved			103.0		%		80-120	01-NOV-20
Bismuth (Bi)-Dissolved			98.1		%		80-120	01-NOV-20
Boron (B)-Dissolved			98.5		%		80-120	01-NOV-20
Cadmium (Cd)-Dissolved			104.4		%		80-120	01-NOV-20
Calcium (Ca)-Dissolved			102.7		%		80-120	01-NOV-20
Chromium (Cr)-Dissolved			104.6		%		80-120	01-NOV-20
Cobalt (Co)-Dissolved			103.0		%		80-120	01-NOV-20
Copper (Cu)-Dissolved			102.6		%		80-120	01-NOV-20
Iron (Fe)-Dissolved			106.1		%		80-120	01-NOV-20
Lead (Pb)-Dissolved			102.1		%		80-120	01-NOV-20
Lithium (Li)-Dissolved			104.7		%		80-120	01-NOV-20
Magnesium (Mg)-Dissolved			105.8		%		80-120	01-NOV-20
Manganese (Mn)-Dissolved			102.8		%		80-120	01-NOV-20
Molybdenum (Mo)-Dissolved			102.4		%		80-120	01-NOV-20
Nickel (Ni)-Dissolved			103.2		%		80-120	01-NOV-20
Phosphorus (P)-Dissolved			97.7		%		70-130	01-NOV-20
Potassium (K)-Dissolved			104.8		%		80-120	01-NOV-20
Selenium (Se)-Dissolved			100.1		%		80-120	01-NOV-20
Silicon (Si)-Dissolved			109.2		%		60-140	01-NOV-20
Silver (Ag)-Dissolved			102.5		%		80-120	01-NOV-20
Sodium (Na)-Dissolved			106.9		%		80-120	01-NOV-20
Strontium (Sr)-Dissolved			104.7		%		80-120	01-NOV-20
Sulfur (S)-Dissolved			105.9		%		80-120	01-NOV-20
Thallium (Tl)-Dissolved			100.5		%		80-120	01-NOV-20
Tin (Sn)-Dissolved			101.2		%		80-120	01-NOV-20
Titanium (Ti)-Dissolved			88.5		%		80-120	01-NOV-20
Uranium (U)-Dissolved			106.2		%		80-120	01-NOV-20
Vanadium (V)-Dissolved			105.7		%		80-120	01-NOV-20
Zinc (Zn)-Dissolved			100.9		%		80-120	01-NOV-20
Zirconium (Zr)-Dissolved			99.9		%		80-120	01-NOV-20
WG3436599-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5272543								
WG3436599-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	01-NOV-20
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Boron (B)-Dissolved			<0.010		mg/L		0.01	01-NOV-20
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	01-NOV-20
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-20
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	01-NOV-20
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	01-NOV-20
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	01-NOV-20
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	01-NOV-20
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Potassium (K)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-20
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-20
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	01-NOV-20
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-20
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	01-NOV-20
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-20
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	01-NOV-20
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	01-NOV-20
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-20
WG3436599-5 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5272543								
WG3436599-5 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	01-NOV-20
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Boron (B)-Dissolved			<0.010		mg/L		0.01	01-NOV-20
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	01-NOV-20
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-20
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	01-NOV-20
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	01-NOV-20
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	01-NOV-20
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	01-NOV-20
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Potassium (K)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-20
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-20
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	01-NOV-20
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-20
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	01-NOV-20
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-20
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	01-NOV-20
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	01-NOV-20
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-20
WG3436599-9 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5272543								
WG3436599-9 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	01-NOV-20
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Boron (B)-Dissolved			<0.010		mg/L		0.01	01-NOV-20
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	01-NOV-20
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-20
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	01-NOV-20
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	01-NOV-20
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	01-NOV-20
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	01-NOV-20
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Potassium (K)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	01-NOV-20
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-20
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	01-NOV-20
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-20
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	01-NOV-20
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-20
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	01-NOV-20
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	01-NOV-20
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	01-NOV-20
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	01-NOV-20
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	01-NOV-20
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	01-NOV-20
WG3436599-4 MS		**L2521326-4**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R5272543								
WG3436599-4 MS		**L2521326-4**						
Aluminum (Al)-Dissolved			95.6		%		70-130	01-NOV-20
Antimony (Sb)-Dissolved			91.5		%		70-130	01-NOV-20
Arsenic (As)-Dissolved			94.5		%		70-130	01-NOV-20
Barium (Ba)-Dissolved			92.2		%		70-130	01-NOV-20
Bismuth (Bi)-Dissolved			93.0		%		70-130	01-NOV-20
Boron (B)-Dissolved			93.6		%		70-130	01-NOV-20
Cadmium (Cd)-Dissolved			95.8		%		70-130	01-NOV-20
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	01-NOV-20
Chromium (Cr)-Dissolved			97.4		%		70-130	01-NOV-20
Cobalt (Co)-Dissolved			95.6		%		70-130	01-NOV-20
Copper (Cu)-Dissolved			95.0		%		70-130	01-NOV-20
Iron (Fe)-Dissolved			96.4		%		70-130	01-NOV-20
Lead (Pb)-Dissolved			95.7		%		70-130	01-NOV-20
Lithium (Li)-Dissolved			91.6		%		70-130	01-NOV-20
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	01-NOV-20
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	01-NOV-20
Molybdenum (Mo)-Dissolved			91.0		%		70-130	01-NOV-20
Nickel (Ni)-Dissolved			96.9		%		70-130	01-NOV-20
Phosphorus (P)-Dissolved			90.0		%		70-130	01-NOV-20
Potassium (K)-Dissolved			93.8		%		70-130	01-NOV-20
Selenium (Se)-Dissolved			97.1		%		70-130	01-NOV-20
Silicon (Si)-Dissolved			89.7		%		70-130	01-NOV-20
Silver (Ag)-Dissolved			93.4		%		70-130	01-NOV-20
Sodium (Na)-Dissolved			96.3		%		70-130	01-NOV-20
Strontium (Sr)-Dissolved			N/A	MS-B	%		-	01-NOV-20
Thallium (Tl)-Dissolved			95.0		%		70-130	01-NOV-20
Tin (Sn)-Dissolved			89.4		%		70-130	01-NOV-20
Titanium (Ti)-Dissolved			91.4		%		70-130	01-NOV-20
Uranium (U)-Dissolved			97.8		%		70-130	01-NOV-20
Vanadium (V)-Dissolved			95.8		%		70-130	01-NOV-20
Zinc (Zn)-Dissolved			90.1		%		70-130	01-NOV-20
Zirconium (Zr)-Dissolved			87.7		%		70-130	01-NOV-20
NH3-L-F-CL	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-L-F-CL	**Water**							
Batch R5271409								
WG3435133-22 LCS								
Ammonia as N			105.8		%		85-115	29-OCT-20
WG3435133-21 MB								
Ammonia as N			<0.0050		mg/L		0.005	29-OCT-20
NO2-L-IC-N-CL	**Water**							
Batch R5269766								
WG3433469-2 LCS								
Nitrite (as N)			108.3		%		90-110	26-OCT-20
WG3433469-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	26-OCT-20
NO3-L-IC-N-CL	**Water**							
Batch R5269766								
WG3433469-2 LCS								
Nitrate (as N)			103.7		%		90-110	26-OCT-20
WG3433469-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	26-OCT-20
PH/EC/ALK-CL	**Water**							
Batch R5269935								
WG3433714-20 LCS								
Conductivity (EC)			92.3		%		90-110	27-OCT-20
Alkalinity, Total (as CaCO3)			100.6		%		85-115	27-OCT-20
WG3433714-19 MB								
Conductivity (EC)			<2.0		uS/cm		2	27-OCT-20
Bicarbonate (HCO3)			<5.0		mg/L		5	27-OCT-20
Carbonate (CO3)			<5.0		mg/L		5	27-OCT-20
Hydroxide (OH)			<5.0		mg/L		5	27-OCT-20
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	27-OCT-20
SO4-L-IC-N-CL	**Water**							
Batch R5269766								
WG3433469-2 LCS								
Sulfate (SO4)			104.4		%		85-115	26-OCT-20
WG3433469-1 MB								
Sulfate (SO4)			<0.050		mg/L		0.05	26-OCT-20
TSS-L-CL	**Water**							

Quality Control Report

Workorder: L2521326 Report Date: 02-NOV-20

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TSS-L-CL	**Water**							
Batch R5270296								
WG3432274-8 LCS								
Total Suspended Solids			106.3		%		85-115	27-OCT-20
WG3432274-7 MB								
Total Suspended Solids			<1.0		mg/L		1	27-OCT-20

Legend:

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

Sample Parameter Qualifier Definitions:

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

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	22-OCT-20	26-OCT-20 09:00	3	4	days	EHTR
	2	22-OCT-20	26-OCT-20 09:00	3	4	days	EHTR
	3	22-OCT-20	26-OCT-20 09:00	3	4	days	EHTR
	4	22-OCT-20	26-OCT-20 09:00	3	4	days	EHTR
Nitrite in Water by IC (Low Level)							
	1	22-OCT-20	26-OCT-20 09:00	3	4	days	EHTR
	2	22-OCT-20	26-OCT-20 09:00	3	4	days	EHTR
	3	22-OCT-20	26-OCT-20 09:00	3	4	days	EHTR
	4	22-OCT-20	26-OCT-20 09:00	3	4	days	EHTR

Legend & Qualifier Definitions:

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

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2521326 were received on 26-OCT-20 08:30.

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

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

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

Two coolers sent

Chain of Custody (COC) / Ana

L2521326-COFC

mber: 20 -

Canada Toll Free: 1 80

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Report To	Contact and company name below will appear on the final report
Company:	Sperling Hansen Associates Inc.
Contact:	Scott Garthwaite
Phone:	778-471-7088
	Company address below will appear on the final report
Street:	1225 East Keith Road
City/Province:	North Vancouver, B.C.
Postal Code:	V7J 1J3
Invoice To	Same as Report To ☑ ☑ NO
	Copy of Invoice with Report ☑ ☐ NO
Company:	
Contact:	

Reports / Recipients

Select Report Format: ☐ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Merge QC/QCI Reports with COA ☐ YES ☐ NO ☐ N/A

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax sgarthwaite@sperlinghansen.com

Email 2 chetherington@sperlinghansen.com

Email 3

Invoice Recipients

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax rhajjafari@sperlinghansen.com

Email 2

Turnaround Time (TAT) Requested

☑ Routine [R] if received by 3pm M-F - no surcharges apply

☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum

☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum

☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum

☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum

☐ Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-

AFFIX ALS BARCODE LABEL HERE (ALS use only)

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm am/pm

For all tests with rush TATs requested, please contact your AM to confirm availability.

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:	20050 Sparwood	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	

ALS Lab Work Order # (ALS use only): ALS Contact: Dean Watt Sampler: Tyler McBride

Analysis Request

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	Anions	Total Alkalinity	TSS	Dissolved Metals (F/P)	Total Metals (P)	Ammonia	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	MW14-1	22-10-20		Groundwater	4	X	X	X	X	X	X			
	MW14-4	22-10-20		Groundwater	4	X	X	X	X	X	X			
	MW15-2	22-10-20		Groundwater	4	X	X	X	X		X			
	MW14-3	22-10-20		Groundwater	4	X	X	X	X		X			

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

Drinking Water (DW) Samples[1] (client use)	Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)
Are samples taken from a Regulated DW System? ☐ ☑ NO	British Columbia Contaminated Sites Regulation Stage 10 Amendment (NOV, 2017)
Are samples for human consumption/ use? ☐ ☑ NO	British Columbia Approved and Working Water Quality Guidelines (MAY, 2015)

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☐ ICE ☐ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO

Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				12°			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (ALS use only)			FINAL SHIPMENT RECEPTION (ALS use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
Tyler McBride	October 23, 2020						25/10	8:30

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

AUG 2020 FRONT

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

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

END OF REPORT