

2018 HYDROGEOLOGICAL CHARACTERIZATION REPORT GOLDEN REFUSE AND DISPOSAL FACILITY (MR – 17006), GOLDEN, B.C.

Prepared for:

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*April 2019
Project: 14-024-21*

April 29, 2019

Project # 14-024-16

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Dear Mr. Van Nostrand:

Re: DRAFT 2018 Hydrogeological Characterization – Golden Disposal Facility, Golden, B.C.

Western Water Associates Ltd. (WWAL) is pleased to provide this report for the Hydrogeological Characterization at the Golden Refuse Disposal Facility (RDF) in 2018. This analysis helps us better understand the current hydrogeological setting, groundwater usage and degree of impact on the receiving environment. This report satisfies the requirements of BC Landfill Criteria for Municipal Solid Waste, 2nd Edition (2016) and is suitable for submission to the B.C. Ministry of Environment and Climate Change Strategy.

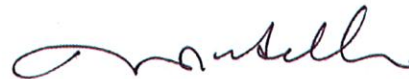
We trust that the professional opinions and advice presented in this document are sufficient for your current requirements. Should you have any questions or if we can be of further assistance in this matter, please contact the undersigned.

WESTERN WATER ASSOCIATES LTD.

Reviewed by:



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I. INTRODUCTION

Western Water Associates Limited (WWAL) was retained by the Columbia Shuswap Regional District (CSRD) to prepare the five-year update of the 2018 Hydrogeological Characterization for the Golden Refuse Disposal Facility (RDF) (hereinafter called the “site”). The last Hydrogeological Characterization report was completed by WWAL in 2013 (WWAL 2013).

The Golden RDF has operated as a natural attenuation site since the late 1970s when the permit was transferred to Columbia Shuswap Regional District (CSRD). The site operates under the now referenced Operational Certificate (OC) I7006, issued May 5, 2003 and most recently amended August 29, 2012, by the British Columbia Ministry of Environment and Climate Change Strategy (MoE). The Golden waste shed includes the municipality of Golden and CSRD Electoral Area A, which includes the unincorporated communities of Parson and Nicholson and services approximately 7,000 residents (Summit 2013).

2. PROJECT OBJECTIVE AND REGULATORY SETTING

We understand the CSRD has been asked by the MoE to provide a hydrogeological assessment of the Golden Landfill site, located in Golden, B.C. to occur every five-years. The purpose of the 2018 Characterization Report is to characterize the geology, hydrogeology, and surface hydrology at and near the landfill site.

From the Landfill Criteria for Municipal Soil Waste (MoE 2016), the minimum requirements of a hydrogeological characterization report are summarized in the Table I, with the corresponding sections and page number for each required component as it is addressed in this report.

Table 1: Required Components of a Hydrogeological Report and Corresponding Section Number

Requirements of a Hydrogeological Characterization Report	Location in Report
Map and Cross Section - A geologic map and geologic cross-section of the landfill site showing lithology and structural features.	Section 4 and Figure 2a and 2b
Geologic Structure - A description of the natural geologic structure of materials underlying and adjacent to the landfill site.	Section 4
Hydraulic Conductivity - The in-place hydraulic conductivity of soils immediately underlying the landfill footprint including: ○ Hydraulic conductivity data, in tabular form, for selected locations within the landfill footprint. ○ A map of the landfill site showing test locations where these hydraulic conductivity data were obtained. ○ An evaluation of the test procedures and rationale used to obtain these hydraulic conductivity data.	Section 6.2, Appendix I
Groundwater Flow Direction – the perennial direction(s) of ground water movement beneath and adjacent to the landfill site.	Section 6.3 and Figure 1b
Groundwater Flux – the groundwater flux within the aquifer(s) beneath the landfill site.	Section 6.4
Springs/ Groundwater Discharge – A map showing the location of all springs and groundwater discharge locations within 1 km of the landfill footprint.	Section 5, Section 8.3 and Figure 1a
Surface Hydrology – A study of water and contaminant transport over the earth's surface, and through near-surface soils within 1 km of the landfill footprint.	Section 8.4
Water Quality – An evaluation, supported by water quality analysis, of the baseline water quality within 1 km of the landfill footprint.	Section 9
Background – A tabulation of background water quality for all applicable monitoring parameters and indicator parameters identified in the environmental monitoring program.	Appendix F

Requirements of a Hydrogeological Characterization Report	Location in Report
Land and Water Use ○ <u>Well Map</u> – a map showing the locations of all wells including water supply monitoring, oil and gas wells, geothermal, etc. within 1 km of the landfill footprint. ○ <u>Well Information</u> – well information, where available, for each water well indicated on the well map. ○ <u>Land Use</u> – Current and allowed land uses within 1 km of the landfill footprint.	Section 8. Receptor Survey Figure 1 shows 500 m and 1 km radius from the site and show registered water wells. Appendix C provides the well logs for the registered wells located within 1 km of the Golden landfill. Appendix D contains well logs for the wells in the current monitoring program.
Groundwater and Surface Water Uses – Current and planned future uses of groundwater and surface water within 1 km of the landfill footprint including types of water use (drinking, aquatic life, irrigation and livestock watering, etc.)	Section 8. Receptor Survey

3. METHODS

Since the 2013 Hydrogeological Characterization report was written, further work has been done to investigate soil and groundwater at and around the site. In 2018 soils at the site and on the property to the south of the site were assessed for signs of impact from the landfill. Water wells within one kilometer of the site were inventoried and a select few were sampled to evaluate the bedrock geochemistry around the site. Further, two boreholes were drilled in 2018 at the site to further explore the hydrogeologic setting at the site. The following sections outline the methods used for the current hydrogeological characterization.

3.1 DOCUMENT REVIEW

The following documents and data were reviewed for the current hydrogeological assessment:

- Ministry of Environment Operational Certificate 17006, Issued May 5, 2003 and amended August 29, 2012;
- Kala Groundwater Consulting Ltd. (Kala). Hydrogeological Assessment, Columbia Shuswap Regional District Sanitary Landfill — Golden, B.C., Report Prepared for Reid Crowther & Partners Ltd. Kelowna BC, Reference No. KG095.-05 7 (1995);
- Golder Associates Ltd. Conceptual Model, Preliminary Numerical Model and Contaminant Inventory. Town of Golden, B.C. Aquifer Protection Plan (2006);
- Sperling Hansen Associates. Golden Landfill Water Quality Report 2007. Prepared for CSRD. Reference No. SHA PRJ8007 (2008);

- Western Water Associates Ltd (WWAL). Annual Environmental Monitoring Reports Golden Disposal Facility (MR-17006) Golden, BC. Reports prepared for the CSRD (for the calendar years 2014 to 2017);
- Summit Environmental Consultants Ltd. (Summit). Annual Environmental Monitoring Report: Golden Refuse Disposal Site, Golden, BC. Reports prepared for the CSRD (for the calendar years 2008 to 2012);
- Summit Environmental Consultants Inc. (Summit). Statistical assessment in support of reducing the number of annual groundwater samples required at the Columbia Shuswap Regional District Refuse and Disposal Sites. Prepared for Columbia Shuswap Regional District (2010);
- Background historic water quality data from the Town of Golden for Town Wells 2, 3 and 5; and
- Online geological and aquifer maps (B.C. Water Resources Atlas, MoE 2018).

3.2 RECEPTOR ASSESSMENT

Historically, only one well had been sampled at the Golden RDF; MW09-06S/D. Several other wells are monitored in the current program; however, all other wells are located off the landfill site. Previous drilling attempts at the southwest corner of the landfill site were unsuccessful both in the 90s and again in 2010. In 2018 two new monitoring wells were drilled at the Golden RDF, MW18-10 and MW18-11. Further, a well receptor study was conducted in 2018 to assess geochemistry of groundwater wells within 1 km of the site. In order to comment on the potential impact of landfill operation on the near surface water bodies, both Hospital Creek and Kicking Horse River were also sampled. Due to concern over off-site leachate migration via surface runoff, soils assessment was completed at the neighbouring property to the south of the site. The following section describes the methods to complete the groundwater surface water and soils assessment in 2018.

3.2.1 Drilling of New Monitoring Wells On-site (MW18-10 and MW18-11)

Two boreholes, located on the southern property boundary and southwest corner of the site were drilled in 2018, MW18-10 and MW18-11, respectively (Figure 1a). At MW18-10 bedrock was encountered at about 22.83 m (75 ft) bgs and the well was completed at 35.65 m (117 ft) bgs. At MW18-11, bedrock was encountered at 116 m (380 ft) bgs and the well was completed to a depth of 146.3 m (480 ft) bgs when a fracture was found that could produce enough water to be sampled. A dedicated submersible pump was installed by Kicking Horse Water Services, so that the well will be able to be sampled in future monitoring events. The well logs can be found in Appendix D.

3.2.2 Well Receptor Survey and Sampling

A water well receptor survey was completed in 2018 to inventory water wells within a 1 km perimeter of the landfill. Well locations and well logs were obtained from the B.C. Water Resource Atlas and conversation with local residents. From this list of wells, we attempted to contact well owners to confirm water use and well completion detail. Based on property owners that were receptive, and the well depth; five domestic wells (see Figure 1 - DMW-5, DMW-606, DMW-571, DMW-568 and Well ID 22653) were sampled for water quality to help assess background groundwater geochemistry.

3.2.3 Surface Water Sampling

In 2018 both the Kicking Horse River and Hospital Creek were sampled. Hospital Creek was sampled for the full list of parameters, whereas Kicking Horse River was only sampled for field parameters, along with

chloride and nitrate, which are the landfill parameters of concern; and also are general parameters used to identify anthropogenic effects from other land uses (e.g. septic systems, road salting, and so on).

3.2.4 Soil Sampling

Soil sampling was performed at the site and at the neighbouring property to the south, where there was concern that potentially affected surface runoff waters had affected soils off-site. Procedures were used to ensure that no contamination of the recovered samples occurred, and representative soil samples were obtained from the Weissenborne Property (220 Golden Donald Upper Road - property south of the landfill boundary) as well as the samples collected onsite. Two sampling events occurred; in June 2018 and a confirmatory sampling event was completed in September 2018, see Figure 3 for soil sample locations. Sampling protocol followed provincial guidelines in the British Columbia Field Sampling Manual (MoE 2013) and Contaminated Sites Regulation (CSR) guidance documents.

Prior to soil sample collection, the shovel was submerged in a 29% hydrogen peroxide solution and rinsed with deionized water. Two holes were dug, one with a minimum depth of 25 cm (1 ft), and a secondary hole to a depth of 90 cm (3 ft) located right beside. A composite sample was taken by mixing soil from both the 1 ft and 3 ft depth holes in a large container before samples were collected into clean laboratory supplied jars.

3.2.4.1 Regulatory Setting for Soil Sampling

The Contaminated Sites Regulation (CSR) under the Environmental Management Act (EMA) is the principal regulatory document defining requirements for contaminated sites management in British Columbia. The CSR was instituted on April 1, 1997 and has been subject to several amendments, most recently in November 2017. The EMA and CSR have provisions for both numerical standards and risk-based standards approaches to managing site contamination. They outline the procedures for site assessment, remediation and application for environmental closure for a property. Numerical standards are a key component of the requirements in the CSR, as they define whether a site is considered contaminated.

Generic Numerical Soil Standards for a variety of inorganic and organic substances are presented in Schedules 3.1 of the CSR. Standards are under eight classes of land use in 3.1: Wildlands Natural (WLN); Wildlands Reverted (WLR); Agricultural (AL); Urban Park (PL); Residential Low Density (RLLD); Residential High Density (RLHD); Commercial (CL); and, Industrial (IL). The 220 Golden Donald Upper Road is used for residential purposes. As such, Residential Low Density (RLLD); numerical standards were applied to onsite soils.

4. GEOLOGIC SETTING

Surficial geology in the Golden area is mainly comprised of a thick continuous glacial till blanket, which may include fluted landforms, morainal deposits, and drumlins (GSC 2014). Deposits at the Golden RDF site consist of dense gravely sand and silty ablation till along the eastern slopes, with well-sorted bedded sand and gravels and alluvial deposits in the south central and western sections, as well as within the trench at the southwest corner of the site (Kala 1995; SHA 2008). Silt with sand and gravel deposits were observed in test hole 4 (MW95-4) at the western edge of the landfill (Kala 1995). Based on well logs for test hole 7 (MW09-7) and MW18-11 the unconsolidated deposits are thicker in the southwest area of

the site (surficial deposits to 115 m (380 ft) bgs at MW18-11) thinner towards the north, with bedrock outcropping at the eastern edge of the site. Deposits in exposures along the west side of Golden-Donald Road (across from the RDF site) consist of dense, well-sorted sands and gravels with traces of silt and clay and occasional bedding planes.

The bedrock underlying the landfill site is mapped as Cambrian to Ordovician (439 to 570 million years ago) rocks of the McKay Group (GSC 1980). This group is made up of limestone, limestone conglomerate, shale and associated meta-sedimentary rocks. Bedrock outcrops have been noted at the northeastern part of the site and when MW09-6D (Figure 1) was installed in 2009, limestone bedrock was encountered at approximately 34 m (112 ft) below the ground surface. During drilling of MW18-10 bedrock was encountered at (24 m) 80 ft bgs and the offsite well MW10-08 encountered bedrock at 15 m (50 ft) bgs. However, at MW18-11, drilled at the southwest corner of the site, bedrock was encountered at 116 m (380 ft) bgs. We see that the bedrock is steeply dipping to the southwest at the site. Figure 2a and 2b show the cross sections AA' (from northeast to southwest) and BB' (northwest to southeast), with the locations of AA' and BB' indicated on Figure 1a.

5. HYDROLOGIC SETTING

Surface drainage at the RDF site is dependent on the local topography. A narrow ravine located midway along the east side of the site collects the surface water from the east side of the site and diverts flow away from the landfill during extreme rain events or periods of high run-off from snowmelt. There are no other surface water drainage courses leading away from the landfill. The permeability of the surficial deposits at the site ranges from low to moderate. Silty surficial deposits along the eastern side of the landfill limit groundwater recharge, while the silty sand and gravel located in the south-central section of the landfill is moderately permeable (SHA 2008).

The Kicking Horse River is approximately 1 km southeast of the RDF site and nearly 130 m lower in elevation (800 masl). The river flows northwest through the western range of the Rocky Mountains and lower Kicking Horse Canyon, where it drains into the Columbia River at the Town of Golden. The Columbia River flows northwest and is approximately 3 km west of the site. Hospital Creek, located in a deeply incised valley about 800 m northwest of the landfill site, flows southwest into the Columbia River. As noted above, WWAL collected water quality samples from both Kicking Horse River and Hospital Creek in 2018, and results are discussed in Sections 8.3 and 9.2.

Figure 1a shows a surface water course cutting through the middle of the site; this water course does not exist as a permanent stream. However, during seasonal wet periods run-off can form at the southeast end of the site and this drainage requires management. Typically, the run-off has been managed by digging a drainage ditch on the south property boundary, at the toe of the active landfill face, and allowing the surface run-off to seep into the ground in the southwest corner of the site where soils are more permeable.

6. HYDROGEOLOGIC SETTING

Golden RDF lies on the west flank of the Rocky Mountains, and the area around the landfill is characterized by a variable thickness of glacially derived sediments overlying sedimentary bedrock. The unconsolidated materials typically do not form aquifers. Saturated groundwater flow is chiefly via bedrock fracture systems as described further below.

6.1 Site Hydrogeology

The B.C. Water Resources Atlas shows MoE sand and gravel Aquifer 456 IIB approximately 60 m southwest of the Golden RDF boundary. This aquifer, which is classified as having a moderate demand, high productivity, and moderate vulnerability, covers an area of 10.2 km². Demand describes local reliance on the groundwater water source, productivity indicates relative well yields, and vulnerability describes the potential for contaminants to move from the surface into the aquifer.

There are no MoE reported aquifers beneath the site. Based on site topography and the piezometric surface elevations from the four monitoring wells (MW09-6D, MW10-8, MW18-10 and MW18-11) which are completed in the local bedrock aquifer, groundwater flow direction at the site is calculated to be from northeast to southwest, moving from the uplands towards the Kicking Horse River (Figure 1b). Rain and snowmelt percolating through the landfill will likely migrate vertically down until reaching the bedrock surface; there is no surficial aquifer underlying or in the vicinity of the site.

Cross sections were completed by WWAL using the well logs from the wells present at the landfill as well as logs accessed from the Water Resource Atlas for the surrounding wells near the landfill. Figure 1a shows the locations of cross-sections A A' and B B', and Figures 2a and 2b show the cross sections for the Golden RDF and area. Based on information provided from drilling the two new monitoring wells at the site, we see that although bedrock is at surface at the northeast part of the landfill site, at the southwest corner of the site, bedrock is encountered at over 115 m below ground surface. This steeply dipping bedrock surface presents challenges for interpretation of contaminant migration.

One data gap that still exists, is how and where leachate-affected groundwater migrating through the bedrock aquifer is discharging into aquifer 456. We know that chloride and nitrate are found above drinking water guidelines and standards at both the western and southern property boundary of the site within the bedrock aquifer. However after assessment of water quality at the southwest corner of the landfill site sampled from the bedrock aquifer indicated chloride and nitrate are both at ambient concentrations, unaffected by operation of landfill activity. Further, groundwater flow direction within the bedrock aquifer appears to be directly towards the southwest.

Groundwater flow within bedrock aquifers can be complex and unpredictable, due to several factors including fracture orientation and fracture density, and small-scale hydraulic gradients and flow processes that are difficult to assess with widely spaced monitoring wells. That we see elevated chloride and nitrate at the west and south property boundaries, but not southwest corner of the site suggest that natural attenuation is providing satisfactory renovation of landfill leachate affected groundwater. Groundwater sampled at the western property boundary from MW09-06S/D, shows quite elevated concentrations of chloride and nitrate (well above the drinking water guidelines and standards). However, this area may be a zone of relatively stagnant groundwater, receiving contaminated groundwater from up gradient; yet chloride and nitrate have progressively decreased since the wells installation in 2009 (Figures 7 and 8).

Now that we have a monitoring well at the southern property boundary, we see the chloride and nitrate slightly exceed drinking water standards and guidelines. Results thus far suggest there could be contaminant migration beneath the property to the south of the site. However, prior to recommending drilling off site, further water quality data should be gathered to better understand the temporal trend for chloride and nitrate at the southern property boundary, see Section II: Recommendations for further details for an action plan moving forward.

6.2 Hydraulic Conductivity

Hydraulic testing was performed on newly drilled monitoring well MW18-10, located on the southern perimeter of the Golden Landfill in order to estimate the hydraulic conductivity of the bedrock aquifer in the area surrounding the well. From our assessment, the hydraulic conductivity of the bedrock aquifer is estimate at **2 X 10⁻⁶ m/sec** in the vicinity of the Golden RDF and the method and results for the hydraulic testing can be found in Appendix I.

6.3 Groundwater Flow

Within MoE mapped surficial aquifer 456, groundwater flow is a subdued replica of the Kicking Horse River and flows from east to west and then from southeast to northwest, eventually becoming part of the more regional system associated with the Columbia River, flowing from southeast to northwest (Figure 1a). Sand and gravel Aquifer 456 is the receptor for contaminants moving through the upper bedrock aquifer and discharging into the lower sand and gravel aquifer.

Within the unmapped bedrock aquifer underlying the site, we have calculated groundwater flow direction to be towards the southwest (Figure 1b). Flow direction was interpolated from the piezometric surface elevation and ground surface levels surveyed within ± 1 mm using a differential GPS.

6.4 Discharge and Mass Flux Estimates

As an estimate of contaminate migration was made, in-terms of mass flux of chloride and nitrate leaving the site within the bedrock aquifer compared to the proportion of chloride and nitrate migrating through Aquifer 456. Table 2 summarizes the calculations based on Darcy's flux and the concentrations of chloride and nitrate measured within the bedrock aquifer beneath the site and within the valley bottom aquifer.

$$Q = -kia$$

Where:

- Q = discharge (length³/time)
- k = hydraulic conductivity (length/time)
- i = hydraulic gradient (unitless)
- a = cross sectional area (length²)

Table 2: Discharge and Max Flux Estimates from the Golden Landfill

Surficial (Sand and Gravel) MoE Mapped Aquifer 456			Bedrock Aquifer (not mapped by the province)		
Q=-kia			Q=-kia		
k	3.0E-03 m/sec		k (conservative estimate)	3.0E-05 m/sec	
i (from southeast to northeast)	0.003 [m/m]		i (from east to west)	0.06 [m/m]	
a (15 m X 2,500 m)	37,500 m ²		a (30 m X 130 m)	3,900 m ²	
Q Aquifer 456	0.3 m ³ /sec		Q BR LF to Aq456	7.6E-03 m ³ /sec	
Q Aquifer 456	29,000 m ³ /day		Q BR LF to Aq456	656 m ³ /day	
Mass loading of chloride and nitrate from the landfill site into Aquifer 456					
[Cl] max concentration	600 mg/l		0.6 mg/m ³		
[No3] max concentration	60 mg/l		0.06 mg/m ³		
Mass flux chloride (Q[Cl])	394 mg/day		3.9E-04 kg/day	0.14 kg/year	
Mass flux nitrate (Q[NO3])	39 mg/day		3.9E-05 kg/day	0.014 kg/year	
Mass loading of chloride and nitrate moving through the sand and gravel aquifer (AQ 456).					
[Cl] min concentration	23 mg/l		0.02 mg/m ³		
[No3] min concentration	0.7 mg/l		7.0E-04 mg/m ³		
Q[Cl]	561,885 mg/day		0.6 kg/day	205 kg/year	
Q[NO3]	17,101 mg/day		0.02 kg/day	6.2 kg/year	
			Percent of annual chloride in aquifer 456 from landfill	0.1%	
			Percent of annual nitrate in aquifer 456 from landfill	0.2%	

From our estimates of mass flux, we see that relative to the quantity of chloride and nitrate migrating through the valley bottom aquifer, what is estimated to be moving through the bedrock aquifer beneath site is less than 1 %. The implicate of this mass flux assessment is that there appears to be another source for chloride and nitrate from a land use situated within the valley bottom.

Further support for the theory that chloride and nitrate within the valley bottom aquifer are derived from some other source than the landfill comes from water quality sampling of Well ID 22653 (Figure 1a) which is a newer domestic well located but 250 m upgradient to the sentry well MW15-01. Chloride concentrations at both MW15-01 and Town Well #4 are elevated above ambient, whereas Well ID 22653 shows chloride to be at ambient concentrations (Table 3). Well ID 22653 is located hydraulically between Town Well #4 and the landfill site.

Based on our estimates of chloride and nitrate mass flux and measured concentrations of chloride and nitrate within newly sampled wells at the southwest property boundary (MW18-11) and within the valley bottom aquifer up gradient to Town Well #4 and MW15-01 (domestic Well ID 22653) we believe the landfill is not contributing to measurable water quality degradation within MoE mapped aquifer 456.

Table 3: GW – Summary Statistics for Chloride and Nitrate (2002 to 2018)

Analyte	Sampling Location	Aquifer Type	Avg	Min	Max	95% Percentile	Std Dev	Count	Number of Results with Exceedances
Chloride (mg/L) BD CSR DW Standard 250 mg/L	MW10-08	Bedrock	738	509	988	898	132	19	19
	MW09-06D	Bedrock	600	358	715	710	145	5	5
	MW09-65	Bedrock	587	416	732	711	86	29	29
	MW18-10	Bedrock	323	313	343	340	17	3	3
	MW15-01	Sand and Gravel	114.2	94.5	125	125	9.9	10	0
	Town Well #4	Sand and Gravel	77.4	57.6	105	99.9	12.7	32	0
	DMW-568	Bedrock	51.1	51.1	51.1	51.1	NA	1	0
	DMW-1b	Bedrock	40.9	12.4	92.2	52.8	14.7	23	0
	DMW-606	Bedrock	32.7	32.7	32.7	32.7	NA	1	0
	Town Well #6	Sand and Gravel	29.6	22.9	39.7	37.4	5.1	14	0
	Well ID 22653	Sand and Gravel	29.4	29.4	29.4	29.4	NA	1	0
	MW18-11 375 ft	Sand and Gravel	26.6	26.6	26.6	26.6	NA	1	0
	MW18-11 475 ft	Bedrock	23.2	23.2	23.2	23.2	NA	1	0
	DMW-571	Bedrock	20	20	20	20	NA	1	0
Nitrate (as N) (mg/L) BD CSR DW Standard 10 mg/L	DMW-4	Bedrock	17	10.9	46.5	26	8	18	0
	MW09-06D	Bedrock	55.1	27.2	67.7	66.7	16.1	5	5
	MW09-65	Bedrock	48.4	31.3	66.9	65	11.4	28	28
	MW18-10	Bedrock	16.8	12.9	21.7	21.1	4.5	3	3
	Town Well #4	Sand and Gravel	1.314	0.755	1.76	1.67	0.233	32	0
	MW18-11 375 ft	Sand and Gravel	1.03	1.03	1.03	1.03	NA	1	0
	MW15-01	Sand and Gravel	1.007	0.803	1.19	1.19	0.163	10	0
	Town Well #6	Sand and Gravel	1.006	0.781	1.3	1.255	0.142	14	0
	DMW-568	Bedrock	0.673	0.673	0.673	0.673	NA	1	0
	MW10-08	Bedrock	0.466	<0.010	1.11	0.957	0.344	19	0
	DMW-4	Bedrock	0.361	<0.010	0.725	0.659	0.227	18	0
	MW18-11 475 ft	Bedrock	0.043	0.043	0.043	0.043	NA	1	0
	DMW-1b	Bedrock	0.04	<0.010	0.397	0.197	0.094	23	0
	Well ID 22653	Sand and Gravel	<0.010	<0.010	<0.010	<0.010	NA	1	0
	DMW-606	Bedrock	<0.010	<0.010	<0.010	<0.010	NA	1	0
	DMW-571	Bedrock	<0.010	<0.010	<0.010	<0.010	NA	1	0

Note: average concentrations are listed from highest to lowest.

7. EXISTING GROUNDWATER MONITORING PROGRAM

A brief summary of the current groundwater monitoring program is provided here; for a full description and results of the program refer to the 2018 annual monitoring report (Western Water Associates 2019). Water quality sampling and water levels measurements occurred tri-annually in 2018 in June, September and December. Seven wells were monitored, including the two newly drilled wells in June 2018. Newly drilled MW18-10 was sampled three times in 2018 during all three sampling events. MW18-11 was unable to be sampled during the June or September sampling event due to the depth of the well. However, a slurry of water and drill cuttings from a depth of 360 ft (110 m) bgs was sampled during the drilling of the well in June 2018, and development water from 145 m (374 ft) was sampled in December 2018. Well details are provided in Table 4 below and the locations of the wells are provided in Figure 1, attached and well logs are provided in Appendix D. The water quality parameters sampled include the following:

- Total Alkalinity (total as CaCO₃);
- Total suspended solids (TSS)
- Turbidity;
- pH and Conductivity;

- Hardness (dissolved, as CaCO₃);
- Anions (chloride, fluoride, bromide, and sulphate);
- Nutrients: (nitrate (as N), nitrite (as N), and ammonia (as N)); and
- Dissolved metals.

Table 4: Summary of Monitoring Well Information

Well ID	Location relative to landfill	Ground Surface Elevation (masl)	Well depth (m) below top of casing	Screen length (m)	Aquifer monitored	Status
MW09-6S	Northwest, down gradient	917.675	34.5	3	Fractured Bedrock	Active
MW10-08	Northwest, up gradient	920.168	26.8	6.1	Fractured Bedrock	Active
Town Well #4	Northwest, down gradient	790	unknown	unknown	Surficial – Columbia Valley bottom	Active
Town Well # 6	Northwest, down gradient	795	unknown	unknown	Surficial – Columbia Valley bottom	Active
MW15-01	Northwest, down gradient	797	29.08	3.05	Surficial – Columbia Valley bottom	Active
DMW-1b	East, upgradient	975	unknown	unknown	Bedrock	Active
DMW-4	East, upgradient	967	unknown	unknown	Bedrock	Active
MW18-10	South, cross gradient	915.303	36.4	N/A	Bedrock	Active
MW18-11	Southwest, cross gradient	908.834	146.3	N/A	Bedrock	Active

8. RESULTS

8.1 Groundwater and Surface Water Uses

The Town of Golden bylaw zoning map is attached in Appendix E as Figure 12. The current and planned future land uses within 1 km of the landfill footprint include residential, commercial, park, community and industrial. Although there are sensitive land uses within 500 m of the site due to historic land use planning, the Town of Golden and the CSRD should not allow any further sensitive land use, which includes residential and park development, within 500 m perimeter of the site.

8.2 Aquifer Assessment

With the data gaps that existed prior to 2018, it was not possible to characterize groundwater flow within the bedrock aquifer underlying the site with any degree of certainty. Without an understanding of groundwater flow within the bedrock aquifer, knowing where to investigate to determine where off-site migration is likely occurring was not possible. In the 2018 program, two new monitoring wells were installed at the site and additional domestic groundwater wells were sampled to assess water quality within the bedrock aquifer surrounding the site. With the addition of water level measurements from the newly

installed monitoring wells, the piezometric surface of the bedrock aquifer underlying the site was able to be assessed. Results of assessment for groundwater flow direction are provided in Section 6.3 above.

8.2.1 Well Receptor Survey

A door-to-door domestic well receptor survey was completed within a 1 km perimeter of the landfill on June 27, 2018. Well logs were accessed from the Water Resource Atlas. Communication was made with homeowners present during the survey and business cards and a well survey form were left with homeowners that were not home. Five domestic wells were sampled during the receptor survey which provide spatially extensive assessment of groundwater quality in the area. Available well details are provided in Table 5 below and locations are depicted on Figure 1a. Water quality at the five domestic wells will be addressed in Section 9, below. A full list of provincially registered wells located within 1 km of the site, along with available well logs are provided in Appendix C. Appendix F houses the full water quality database, including the five additional domestic wells, along with historic results from the current groundwater monitoring program for the site.

Well ID #22653, located at BNW Contracting in Golden BC was sampled during the December 2018 sampling event. Well ID #22653 is located in the valley bottom aquifer upgradient of Town Well #4, and is completed to 28.2 m (95.3 ft) btoc, with a static water level of 5.82 m (19 ft) btoc.

Table 5: Summary of Wells Sampled in 2018 Receptor Survey

Address	Location relative to landfill	Approx ground surface elevation (masl)	Well depth m (ft)
620 Crowmac Ridge	Northwest of landfill	976	65.5 m (215 ft)
606 Lafontaine Rd	Northeast of landfill	1006	Approx. 182 m (600 ft)
571 Lapp Rd	East of landfill	1011	Unknown
568 Lapp Rd	East of landfill	996	Unknown
Well ID #22653	West of landfill, in Town of Golden	796	28.2 m (95.3 ft)

8.3 2018 Surface Water Assessment

Kicking Horse River and Hospital Creek, both sampling in 2018, showed no indication of impact from operation of the landfill site. In the spring of 2017 substantial runoff was observed migrating from the northeast off the southern property boundary. In the spring of 2018, there were no surface waters present on-site. To address concerns regarding off-site runoff of surface water, soil sampling was conducted, with the results provided in the next section.

8.4 Soils Assessment

Based on concern over off-site surface water runoff soil sampling occurred off site on the property neighbouring the southern boundary of the landfill owned by the Weissenborne family. The soil sampling event was completed in June of 2018 as a result of runoff noticed by the property owner in the spring of 2017. Eight soil sample locations were sampled on the offsite property and two sample locations were sampled onsite on the landfill property in June of 2018. One soil sample location LOC-6 was in exceedance

of BC CSR RL – LD standard for manganese in June 2018. A confirmatory soil sampling event was completed in September of 2018, adding an additional eighteen sampling locations concentrated around LOC-6 on the offsite neighbouring property. All soil sample locations for both sampling events are depicted in Figure 3.

9. WATER QUALITY

9.1 Groundwater Quality Exceedances

Assessing impact on the receiving environment from operation of the Golden RDS is the objective of the current monitoring program at Golden. Due to the proximity of domestic water wells and surface water bodies (Kicking Horse River and Columbia River) in the vicinity of the site, the 2018 groundwater quality results were compared to the following applicable guidelines and standards:

- Guidelines for Canadian Drinking Water Quality Maximum Acceptable Concentration (health-based guideline) (GCDWQ MAC) and Aesthetic Objective (based on aesthetic considerations) (GCDWQ AO) (Health Canada 2017);
- B.C. Contaminated Sites Regulation 375/96, Schedule 6, Generic Numerical Water Standards for drinking water (CSR DW) (MoE 2017).

Table 6 (located after the main text) provides a list of exceedances in water quality guidelines and standards for drinking water. Similar to previous years, a number of parameters were detected at concentrations above guidelines/standards in 2018 (Table 6). Consistent with historical data, arsenic concentrations were in exceedance of GCDWQ MAC guidelines and BC CSR DW standards at DMW-1b. DMW-5, sampled during the receptor survey and newly drilled MW18-11 were also in exceedance of arsenic (Table 6). Total and dissolved iron were in exceedance of GCDWQ AO guidelines at DMW-1b, DMW-568, DMW-571, and DMW-606. The arsenic, lithium, strontium, fluoride, iron, manganese and cobalt exceedances are believed to be naturally occurring and not related to landfill activity, as these metals can be found at a high concentration throughout the Golden area and throughout interior BC (Figures 5 and 6 provide a visual comparison of landfill associated parameters (i.e. chloride, nitrate, sodium and sulphate) versus naturally occurring parameters (i.e. arsenic, cobalt, lithium, iron and manganese). It should be noted that residences of domestic wells sampled were notified by WWAL field staff of exceedances of the drinking water guidelines and standards. Toluene exceeded the drinking water quality guideline and standard at MW10-08; as toluene does not exceed within the groundwater at the western property boundary (MW09-6S/D), we believe the toluene exceedance at MW10-08 is not related to landfill activity.

Chloride was detected at concentrations above the GCDWQ AO (250 mg/l) and BC CSR DW standards at MW09-6S and at MW10-08, which was sampled in 2018 for the first time since 2015. Newly drilled well MW18-10, located on the southern perimeter of the landfill was in exceedance of the BC CSR DW standard and GCDWQ AO guideline for chloride for all three sampling events in 2018. Nitrate concentrations at MW09-6S and MW18-10 are in exceedance of GCDWQ MAC and sulphate (MW09-6S) of GCDWQ AO. The full list of exceedances is provided in Table 6 below.

Exceedances of chloride and nitrate at the landfill site monitoring wells (MW09-06S/D and MW18-10) are understood to be derived from the site. MW10-08 is located hydraulically upgradient of the site, as has

been shown from the calculated groundwater flow direction (Figure 1b). Therefore, we do not believe the exceedance of chloride at MW10-08 is related to landfill activity. From the geochemical Piper Plot, the solution chemistry for MW10-08, although comparable in terms of chloride concentration to MW09-06S, does not appear to have the landfill contaminant signature (Figure 4). The source for chloride at MW10-08 is unknown at this time, although at this time we do not believe it to be the landfill-derived. Based on the potential for complex fracture flow within the bedrock aquifer, we will retain the slight possibility that the source of chloride could be from the landfill.

The highest manganese concentrations measured in 2018 were at MW18-11 at 114 m (375 ft), with a measured concentration of 0.294 mg/l in December 2018, exceeding the GCDWQ AO guideline. Development water was also sampled at a depth of 145 m (475 ft) at MW18-11 and dissolved manganese concentrations were measured to be much lower at 0.0149 mg/l in December 2018. The second highest manganese concentration measured at the site are at MW10-08 with an average concentration of 0.12 mg/l. MW09-6S exceeded the GCDWQ AO guideline during the June 2018 sampling event with a measured concentration of 0.147 mg/l, concentrations decreased slightly in September 2018 to 0.0262 mg/l. DMW-1b and DMW-4 had dissolved manganese concentrations below 0.007 mg/l in 2018.

Dissolved Arsenic was elevated at DMW-1b in 2018 as is typical, with measured concentrations of 0.0434 mg/l (June) and 0.0411 mg/l (September), exceeding the GCDWQ AO guidelines. The development water sampled at 145 m (475 ft) at MW18-11 was also in exceedance of the GCDWQ AO guidelines with a concentration of 0.0352 mg/l, measured in December 2018. Dissolved arsenic concentrations were below detection limits (<0.0050 mg/l) for all sampling events in 2018 at both Town Well # 4 and Town Well # 6. Arsenic concentrations were below 0.002 for all other sampled locations in 2018.

DMW-1b and DMW-4 display elevated concentrations of dissolved lithium with average values of 0.0251 mg/l and 0.0354 mg/l, respectively. The development water sampled at 145 m (475 ft) from MW18-11 had a measured dissolved lithium concentration of 0.0871 mg/l, the highest concentration sampled, exceeding the BC CSR DW standard. MW09-6S also displayed elevated dissolved lithium concentrations in 2018, exceeding the BC CSR DW standard for both the September and June 2018 sampling events with concentrations around 0.04 mg/l. MW10-08 and MW18-10 both displayed elevated lithium concentrations for all of the sampling events in 2018 with measured values around 0.02 mg/l.

Town Well # 4 and Town Well # 6 completed in the surficial valley bottom aquifer have low dissolved lithium concentrations with measured values of 0.00212 mg/l (September 2018) and 0.00132 mg/l (June 2018), respectively. All of these sampling locations that display the elevated dissolved lithium concentrations are completed in the bedrock aquifer, we conclude that lithium is naturally occurring as a result of the bedrock geochemistry (Figure 11).

9.2 Surface Water Quality Exceedances

For the water quality samples taken at both the Kicking Horse River and Hospital Creek, compared to the BC Approved Water Quality Guidelines for freshwater aquatic life, there were no exceedances.

9.3 Review of Site Geochemistry and Time Series Plots

A geochemical Piper Plot is provided in Figure 4; the Piper Plot shows the relative concentrations of major ions for the sampled sites. From the water quality database which houses the CSRD landfill water quality data, time series plots for select landfill indicators (chloride, sodium, nitrate, sulphate, dissolved calcium and dissolved boron) were created and provided in Figures 7 through 11. Below is a summary of the geochemistry and water quality trend analysis for the Golden Refuse Disposal Site, the full discussion can be found in the 2018 Environmental Monitoring Report, located in Section 4.3.

Chloride concentrations are elevated at monitoring wells MW09-6S, MW09-6D, MW10-08 and MW18-10 compared to all other sampling locations (Figure 7). MW10-08 has the highest average chloride concentration amongst all the sample locations with an average value of 738 mg/l, MW09-06S has the second highest average concentration at 587 mg/l. MW18-10, drilled in June 2018, exceeded the GCDWQ AO guidelines of 250 mg/l for all three sampling events in 2018, with measured concentrations around 300 mg/l. Chloride concentrations at MW09-6S, MW09-6D have been declining since the well was installed in 2009 (Figure 7).

Chloride concentrations measured at Town Well #4 ranged between 103 mg/l (June) and 87.4 mg/l (July) in 2018. Chloride concentrations at Town Well #4 are elevated above Town Well #6, which has measured concentrations of chloride around 40 mg/l in 2018. Town Well #2 and Town Well #5 located on the southern bank of the Kicking Horse River (Figure 1), display much lower chloride concentrations of 10 mg/l (Town Well #2) and 14 mg/l (Town Well # 5) measured in 2016.

Nitrate concentrations are also elevated at MW09-6S, with an average value of 48.4 mg/l; concentrations measured in 2018 are slightly lower than average, at about 30 mg/l. MW18-10 had the second highest nitrate concentrations at the site ranging between 21.7 mg/l (September 2018) and 12.9 mg/l (June 2018), exceeding the GCDWQ MAC (10 mg/l) guidelines for all three sampling events in 2018. The development water sampled at a depth of 145 m (475 ft) from MW18-11 had a nitrate concentration of 0.043 mg/l (December 2018). Nitrate concentrations were below 2 mg/l for all other locations sampled. Like chloride, concentrations of nitrate at MW09-6S, MW09-6D have also been on the decline since 2009.

DMW-1b displayed elevated dissolved iron during the June 2018 sampling event exceeding the GCDWQ AO guidelines at 0.381 mg/l (Figure 9). MW10-18 had dissolved iron concentrations below detection limits (<0.010 mg/l). MW09-6S displayed low dissolved iron concentrations with values around 0.04 mg/l measured in 2018.

9.4 Review of Receptor Survey Wells Geochemistry

Four additional domestic wells (DMW-5, DMW-568, DMW-571, DMW-606) located within 1,000 m radius of the Golden Landfill were sampled in June 2018. One additional well located in the valley bottom aquifer in the Town of Golden (Well ID 22653) was sampled in December 2018, locations of all wells sampled in the receptor survey are depicted in Figure 1a.

DMW-568 displayed the highest concentrations of chloride with a measured value of 51.1 mg/l, followed by DMW-606 with a concentration of 32.7 mg/l. DMW-571 had a measured concentration of 20 mg/l and DMW-5 had the lowest concentration amongst all of the wells sampled in the receptor survey with a

concentration of 1.75 mg/l. Well ID 22653, located in the Town of Golden, had a measured chloride concentration of 29.4 mg/l, comparable to Town Well # 6 with an average concentration of 29.6 mg/l.

Nitrate concentrations were below GCDWQ MAC guidelines at all wells sampled in the receptor survey (Figure 8). DMW-586 displayed the highest concentrations at 0.673 mg/l, followed by DMW-5 with a concentration of 0.109 mg/l. DMW-571, DMW-606 and Well ID 22653 had nitrate concentrations below detection limits (<0.0010 mg/l).

DMW-571 was in exceedance of GCDWQ AO guidelines for total iron and manganese with concentrations of 0.552 mg/l and 0.36 mg/l, respectively. DMW-606 and DMW-568 were also in exceedance of GCDWQ AO guidelines for total iron with concentrations of 3.6 mg/l (DMW-606) and 0.446 mg/l (DMW-568) (Figure 9). DMW-5 displayed low concentrations of total iron with a measured value of 0.059 mg/l. Well ID 22653 displayed elevated iron and manganese concentrations of 1.93 mg/l and 0.0986 mg/l, respectively. These elevated concentrations could be attributed to the casing of the well, and not representative of the groundwater. Total manganese at all wells sampled in the receptor survey, except for DMW-571 and Well ID 22653 were below 0.002 mg/l.

Total Arsenic concentrations were elevated at DMW-5 with a concentration of 0.0674 mg/l, exceeding the GCDWQ MAC guideline and BC CSR DW standard. DMW-606 had the second highest total arsenic amongst the wells sampled in the receptor survey with a concentration of 0.00239 mg/l. DMW-568, DMW-571 and Well ID 22653 had arsenic concentrations below detection limits (<0.0050 mg/l).

All domestic wells sampled in the well receptor survey were in exceedance of BC CSR DW standard for total lithium (0.008 mg/l). DMW-606 displayed the highest total lithium concentrations with a measured value of 0.137 mg/l, followed by DMW-5, DMW-568 and DMW-571 with concentrations of 0.0592 mg/l, 0.0518 mg/l and 0.00868 mg/l, respectively. Well ID 22653 located in the valley bottom aquifer, was sampled for dissolved lithium in December 2018, and had a measured concentration of 0.00204 mg/l, much lower than the concentrations measured at the domestic wells. DMW-1b and DMW-4 also display elevated lithium concentrations, this could be related to the parent rock material present at the bedrock wells.

10. DISCUSSION

From the analysis performed in 2018, the following discussion of the results is provided.

10.1 Naturally Occurring Water Quality Exceedances

From the long-term environmental monitoring for the site, we see domestic wells DMW-1b and DMW-4 have and continue to show concentrations of arsenic and iron above the GCDWQ MAC and AO, along with the BC CSR DW. Arsenic, lithium, strontium, fluoride, iron, manganese and cobalt exceedances observed at the historically monitored wells, along with the two new monitoring wells and five additional domestic wells sampling in 2018, are believed to be naturally occurring within the bedrock aquifer. These exceedances are not believed to be related to landfill activity, as these chemical species can be found at a high concentration throughout the Golden area and throughout interior B.C.

In the MoE Warning Letter, dated July 27, 2018 to the CSRD, there was mention of contamination from landfill operation on the domestic wells sampled. From historic evaluation, along with the current assessment we do not believe operation of the landfill has had an impact on the currently monitored domestic wells DMW-1b – 1B or DMW-4. DMW-4 has the lowest concentrations of chloride of all monitored locations at an average of 17 mg/L; chloride is our prime parameter of concern at the property boundaries downgradient of the landfill site. The low concentrations of chloride observed at both DMW-1b and DMW-4 indicate no impact from the landfill. As mentioned above, exceedances observed at the currently monitored and additionally monitored locations in 2018 were likely naturally occurring.

10.2 Landfill Operation Associated Exceedances

We note that although MW10-08 is located hydraulically up gradient to the site, chloride concentrations at this well are comparable to affected wells on-site. However, nitrate and other landfill associated geochemical species do not look similar at MW10-08, compared to the on-site monitoring wells. With the potentially complex groundwater flow within the bedrock aquifer, the possibility for influence at MW10-08 by operational and for site must always be considered. At this point in time we do not believe the elevated chloride concentration at MW10-08 is due to operation of the landfill site.

As has been discussed above, landfill associated parameters chloride, nitrate, and sulphate exceed drinking water quality guidelines and standards at one or more of the site's property boundaries. These exceedances are believed to be due to operation of the landfill site. With new information acquired in 2018, we understand the groundwater flow direction within the bedrock aquifer is calculated to be southwest. The newly drilled monitoring well MW18-11 has been sampled once during the drilling process. Sample results show ambient levels of all landfill leachate associated water quality parameters.

10.3 Concern Regarding Off-site Migration of Landfill Leachates Affected Groundwater

Based on the hydrogeologic setting at the site along with the low concentrations of landfill associated parameters at the southwest boundary of the site we believe migration of the landfill leachate affected groundwater is minimal. At MW18-10, located at the south property boundary (Figure 1a), both chloride and nitrate exceed applicable drinking water quality guidelines and standards. Based on the southwest groundwater flow direction within the bedrock aquifer there could be a portion of the neighbouring property where nitrate and chloride exceed drinking water quality guidelines or standards. We believe a drilling program to investigate groundwater quality downgradient (southwest) and potentially on the neighbouring property to the south of the site, should be completed after 2-years of data acquisition from the newly installed monitoring wells.

11. RECOMMENDED ACTION PLAN

In the MoE issued Warning Letter sent to the CSRD July 27, 2018, they requested that an Action Plan detailing what steps will be taken to ensure that the landfill is being operated in a manner that prevents surface water and groundwater exceedances of parameters distinctive of leachate at the landfill boundary.

We provided the following recommendations moving forward:

R1 Surface Drainage Plan - Surface Water Run-on and Runoff at the South Property Boundary

In 2018 soils were sampled at the neighbouring property to the south of the site. From this soil assessment, no impact on soils from off-site surface water runoff was detected. The Surface Drainage Plan should continue to be implemented at the site to continue to eliminate off-site overland flow of run-on and run-off water. Surfacing of on-site landfill leachate affected waters must be managed, as the site is frequented by wildlife and affected surface waters could be consumed by wildlife.

Further, to eliminate surfacing of leachate from the south toe of the landfill surface, an engineered material should be used to bury the daylighted leachate. Hybridized polar trees should be planted at the south property line, to help attenuate affected on-site water and soil.

To characterize the surface waters (assess if surface waters are affected or not-affected) and influence an engineered Surface Drainage Plan, continue water quality sampling of on-site surface waters, if present at the site during the tri-annual sampling events.

R2 Restrict Land Groundwater Use in the Vicinity of the Site

We understand there are no water wells completed in the bedrock aquifer and in the use directly downgradient of the site. The CSRD should communicate the Town of Golden and both authorities should place a moratorium on use of groundwater within the bedrock aquifer downgradient of the site (southwest).

Further, should be consideration to change the zoning for the Town of Golden, so as not to include sensitive land use within 500 m of the site.

R3 Continued Sampling of New Monitoring Wells

Continue to monitor newly added monitoring wells MW18-10 and MW18-1, located at the south property boundary and southwest corner of the site, respectively. MW18-10 was only sampled three times in 2018 and additional sampling at this location should occur prior to making further decisions about drilling. At MW18-11 only development water collected during drilling of the monitoring well in 2018. If the land owner agrees, add Well ID 22653 to the annual monitoring program.

Prior to determining an off-site location to explore for drilling, 2-years more years of water level and aquifer geochemical data should be gathered. Variation in groundwater flow direction within the bedrock aquifer should be determined and the trend of chloride and nitrate concentrations overtime should be assessed. Therefore, the site would continue to be operated a monitored natural attenuation site for at least the next two-years.

R4 Potential Off-Site Migration of Landfill Leachate within the Bedrock Aquifer

Exploring contaminant migration within bedrock aquifers where the bedrock surface potentially lies deep below sand and gravel deposits, like what sits above the Town of Golden, can require over 400 feet of

casing to even reach the bedrock surface. This sort of exploration for contamination within a bedrock aquifer can be costly and there is always potential of intercepting unaffected fracture zones. Hence the recommendation to assess water quality over the next two-years prior to initiating another extensive drilling program. Now that groundwater flow direction within the bedrock aquifer has been established, we have a better sense of where contaminant migration within the bedrock fracture zones could potentially be occurring. As was noted above, fracture flow within bedrock can be unpredictable.

After 2-years of further data collection from the monitoring network, if further exploration of the bedrock aquifer contamination downgradient of the site is deemed appropriate, the CSRD should secure a location hydraulically downgradient of the site. At this point in time we recommend drilling at Pine Road and Golden Donald Upper Road, about 250 m southwest of MW18-10 (at 51°18'22.24" N / 116°57'14.61" W). Permissions to drill can take some time, if drilling is planned to occur on Ministry of Transportation right of way.

Further exploration within the valley bottom aquifer should only be pursued if a contaminant plume is identified within bedrock aquifer at the above recommended drilling location. Based on concentrations of chloride and nitrate at Well ID 22653 we do not believe there is perceivable impact of landfill leachate associated parameters (i.e. chloride and nitrate) within the valley bottom aquifer.

R5 If Off-site Leachate Migration is Confirmed - Close Site or Implement Leachate Collection and On-Site Management

As has been discussed, groundwater flow within the bedrock aquifer is from northeast to southwest and bedrock groundwater quality at the southwest corner landfill site does not show concentrations of chloride or nitrate that would exceed contaminated site regulation drinking water guidelines or standards. Further, the concentration of chloride and nitrate at the southwest property boundary, as was measured in 2018, appear comparable to background concentrations.

Further, although at the west property boundary chloride and nitrate concentrations exceed drinking water quality guidelines and standards in the bedrock aquifer, levels of leachate associated parameters have consistently declined at the property boundary from 2009 to 2018.

Although we have not established that off-site leachate migration is occurring; concern over potential impact to the bedrock aquifer persists. After two more years operating as a natural monitored attenuation site there should be enough data from MW18-10 to help with the most optimal placement of an off-site well for future drilling. If after installation and assessment of the off-site well, off-site leachate migration is established, the Golden RDF should either be closed or engineered for leachate collection and on-site management of landfill leachate.

R6 In 5 years complete another well survey of the area.

For the 2023 program, for the 5-year hydrogeological assessment, complete another well receptor survey.

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TABLES FOLLOWING TEXT

Table 6: 2018 Groundwater Quality Exceedances

Tables

5-Year 2018 Hydrogeological Assessment
CSRD
Golden RDF
WWAL Ref: 14-024-21



Sampling Location	Guideline	2018 Exceedances
DMW-1b	GCDWQ MAC	Arsenic (dissolved)
	GCDWQ AO	Iron (dissolved)
	BC CSR DW	Arsenic (dissolved), Lithium (dissolved)
DMW-4	BC CSR DW	Cobalt (dissolved), Lithium (dissolved), Lithium (total), Strontium (dissolved), Strontium (total)
DMW-5	GCDWQ MAC	Arsenic (total), Fluoride
	GCDWQ AO	Sodium (total), Total dissolved solids (computed)
	BC CSR DW	Arsenic (total), Fluoride, Sodium (total)
DMW-568	GCDWQ MAC	Total coliforms (counts)
	GCDWQ AO	Iron (total), Total dissolved solids (computed)
DMW-571	GCDWQ MAC	Total coliforms (counts)
	GCDWQ AO	Iron (total), Manganese (total), Total dissolved solids (computed)
	BC CSR DW	Cobalt (total)
DMW-606	GCDWQ MAC	Fluoride, Total coliforms (counts)
	GCDWQ AO	Iron (total), Sodium (total), Total dissolved solids (computed)
	BC CSR DW	Cobalt (total), Fluoride, Sodium (total)
MW09-06D	GCDWQ MAC	Nitrate (as N), Nitrate + Nitrite (as N) (calculated)
	GCDWQ AO	Chloride, pH [F], Sodium (dissolved), Sulphate
	BC CSR DW	Chloride, Cobalt (dissolved), Lithium (dissolved), Nitrate (as N), Nitrate + Nitrite (as N) (calculated), Sodium (dissolved), Sulphate
MW09-6S	GCDWQ MAC	Nitrate (as N), Nitrate + Nitrite (as N) (calculated)
	GCDWQ AO	Chloride, Iron (dissolved), Manganese (dissolved), Sodium (dissolved), Sulphate
	BC CSR DW	Chloride, Cobalt (dissolved), Lithium (dissolved), Nitrate (as N), Nitrate + Nitrite (as N) (calculated), Sodium (dissolved), Sulphate
MW10-08	GCDWQ MAC	Toluene
	GCDWQ AO	Chloride, Sodium (dissolved), Toluene
	BC CSR DW	Chloride, Lithium (dissolved), Sodium (dissolved), Toluene, Tungsten (dissolved)
MW18-10	GCDWQ MAC	Nitrate (as N), Nitrate + Nitrite (as N) (calculated)
	GCDWQ AO	Chloride, Manganese (dissolved), pH [F]
	BC CSR DW	Chloride, Cobalt (dissolved), Lithium (dissolved), Nitrate (as N), Nitrate + Nitrite (as N) (calculated)
MW18-11 375 ft	GCDWQ AO	Manganese (dissolved)
	BC CSR DW	Lithium (dissolved)
MW18-11 475 ft	GCDWQ MAC	Arsenic (dissolved)
	GCDWQ AO	Sodium (dissolved)
	BC CSR DW	Arsenic (dissolved), Cobalt (dissolved), Lithium (dissolved), Sodium (dissolved)
Well ID 22653	GCDWQ AO	Iron (dissolved), Manganese (dissolved)

[F] = Field Results

Notes:

BC CSR DW BC CSR, Schedule 6 and 10, Generic Numerical Water Standards for Drinking Water

GCDWQ AO Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives

GCDWQ MAC Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations

Appendix A:

Figures

5-Year 2018 Hydrogeological Assessment
CSRD
Golden RDF
WWAL Ref: 14-024-21



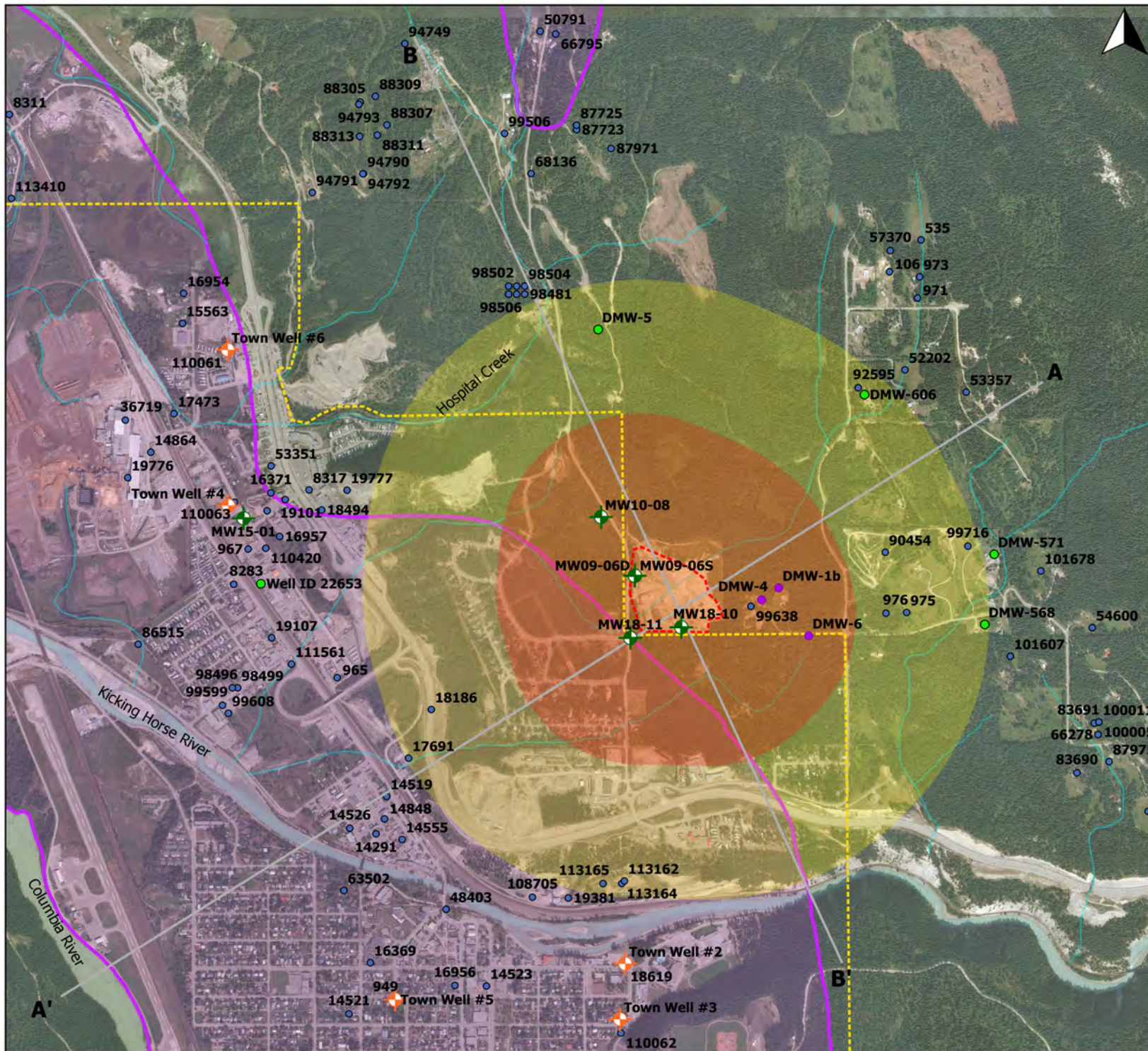


Figure 1a:

**Golden RDF
Monitoring**

Legend

- Well from GWELLS
- Domestic Monitoring Well
- Monitoring Well
- Well sampled in 2018
- Receptor survey
- Production Well

— Creeks

--- City Boundary

□ Aquifer 456

□ Landfill Boundary

Distance from landfill:

500 m

1000 m

0 200 400 600 m

western water
ASSOCIATES LTD

Client: CSRD
Project Number: 14-024-16
Date: April 26, 2019
Drawn by: Tim Sivak
Checked by: Bryer Manwell

Map Projection: NAD83 UTM Zone 11

Data from DataBC (2018), ENV GWELLS
(2018) and Bing Satellite (2018)

Key Map



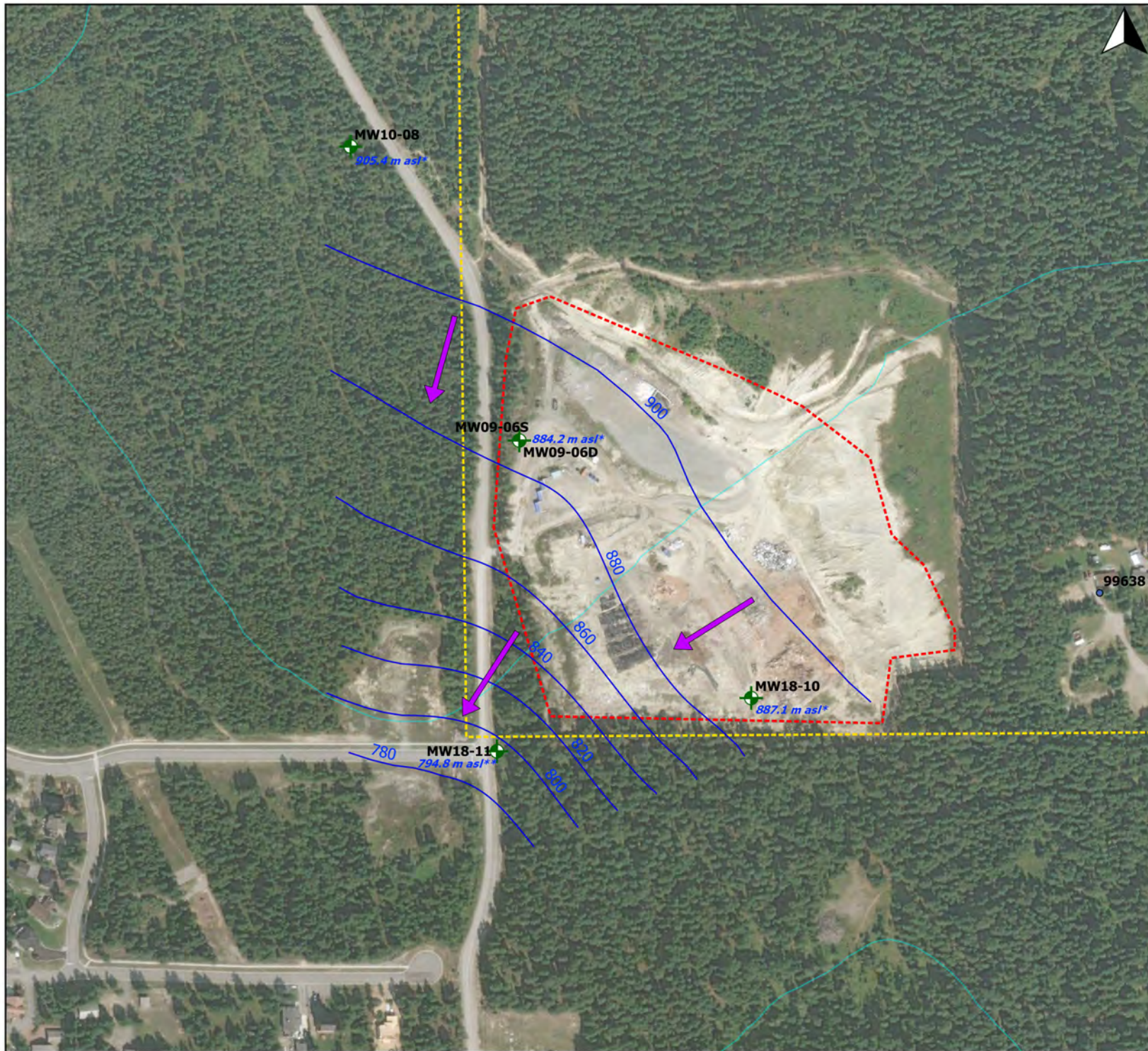


Figure 1b:

Golden RDF Monitoring

Legend

- Well from GWELLS
- Domestic Monitoring Well
- ⊕ Monitoring Well
- Creeks
- City Boundary
- Landfill Boundary
- Piezometric surface (m asl)
- ➔ Calculated groundwater flow direction

* December 3, 2018
** December 4, 2018

0 50 100 m

 **western water**
ASSOCIATES LTD

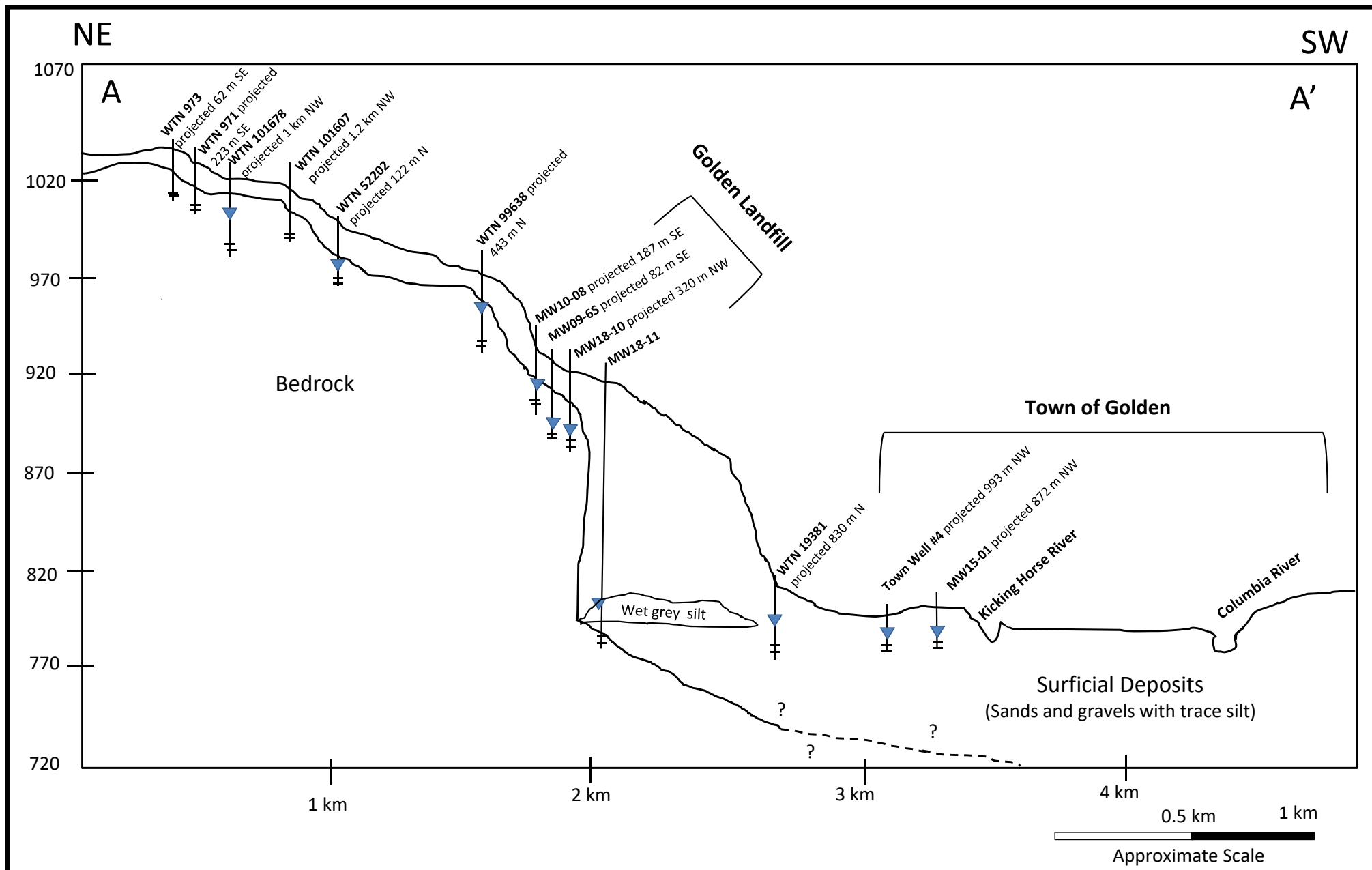
Client: CSRD
Project Number: 14-024-16
Date: April 26, 2019
Drawn by: Tim Sivak
Checked by: Bryer Manwell

Map Projection: NAD83 UTM Zone 11

Data from DataBC (2018), ENV GWELLS (2018) and Bing Satellite (2018)

Key Map





**CSRD Golden RDF
Hydrogeological Assessment**



TITLE

Figure 2a: Cross Section from A to A'

DRAWN

DATE

June 2018

PROJECT NO.

18-063-01

CHECKED

SCALE

See figure

DWG. NO.

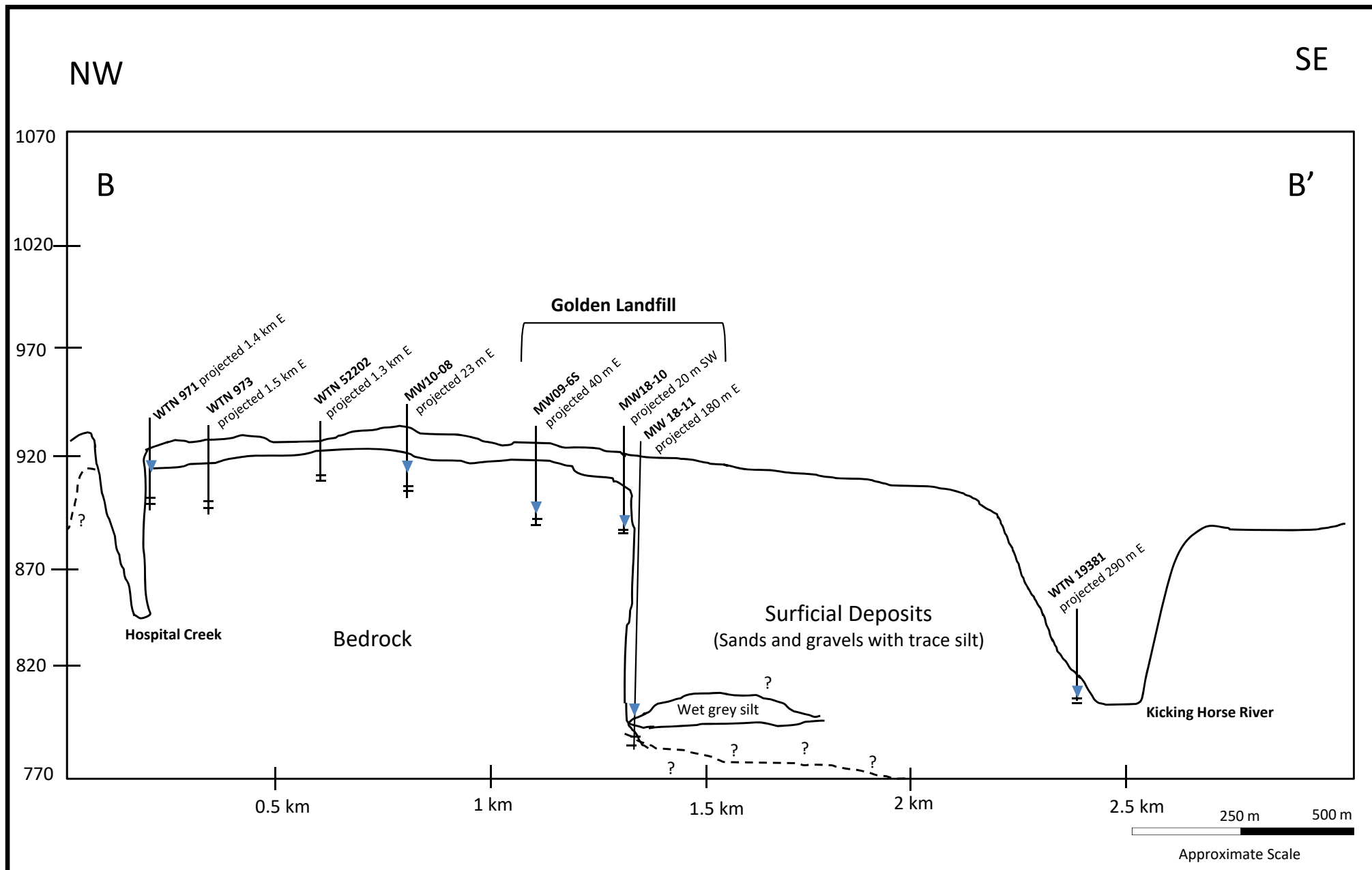
na

REVIEWED

FILE NO.

FIGURE VERSION NO.

1



**CSRD Golden RDF
Hydrogeological Cross Section**



TITLE

Figure 2b: Cross Section from B to B'

DRAWN

DATE

June 2018

PROJECT NO.

18-063-01

CHECKED

SCALE

See figure

DWG. NO.

na

REVIEWED

FILE NO.

FIGURE VERSION NO.

1

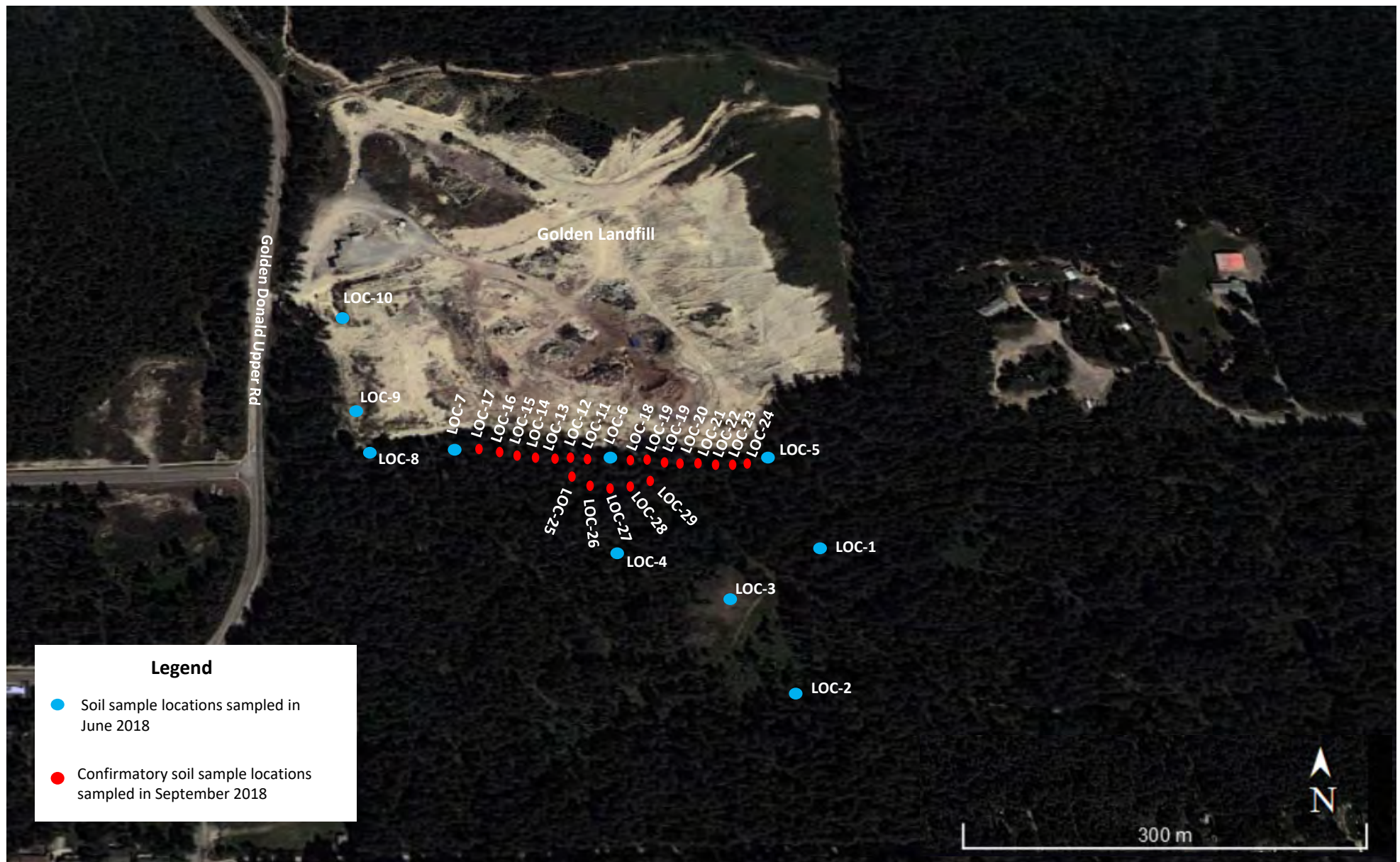


Image Source: Google Earth Pro, 2018

CSRD Golden RDF Hydrogeological Assessment



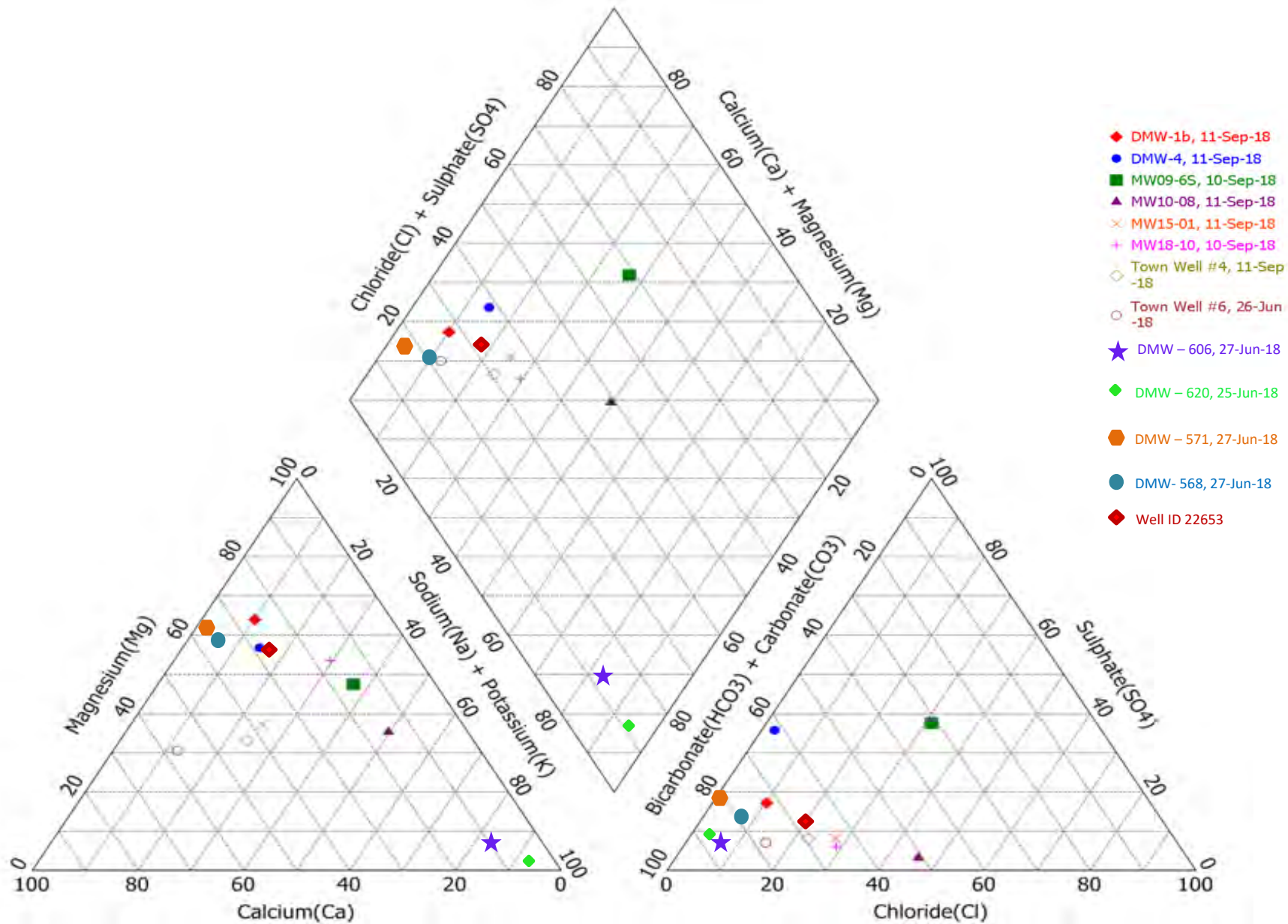
TITLE

Figure 3: Soil Sample Locations on Weissenborne Property

DRAWN RA
CHECKED BRM
REVIEWED DG

DATE September 2018
SCALE See figure
FILE NO.

PROJECT NO. 14-024-21
DWG. NO. na
FIGURE VERSION NO. 1

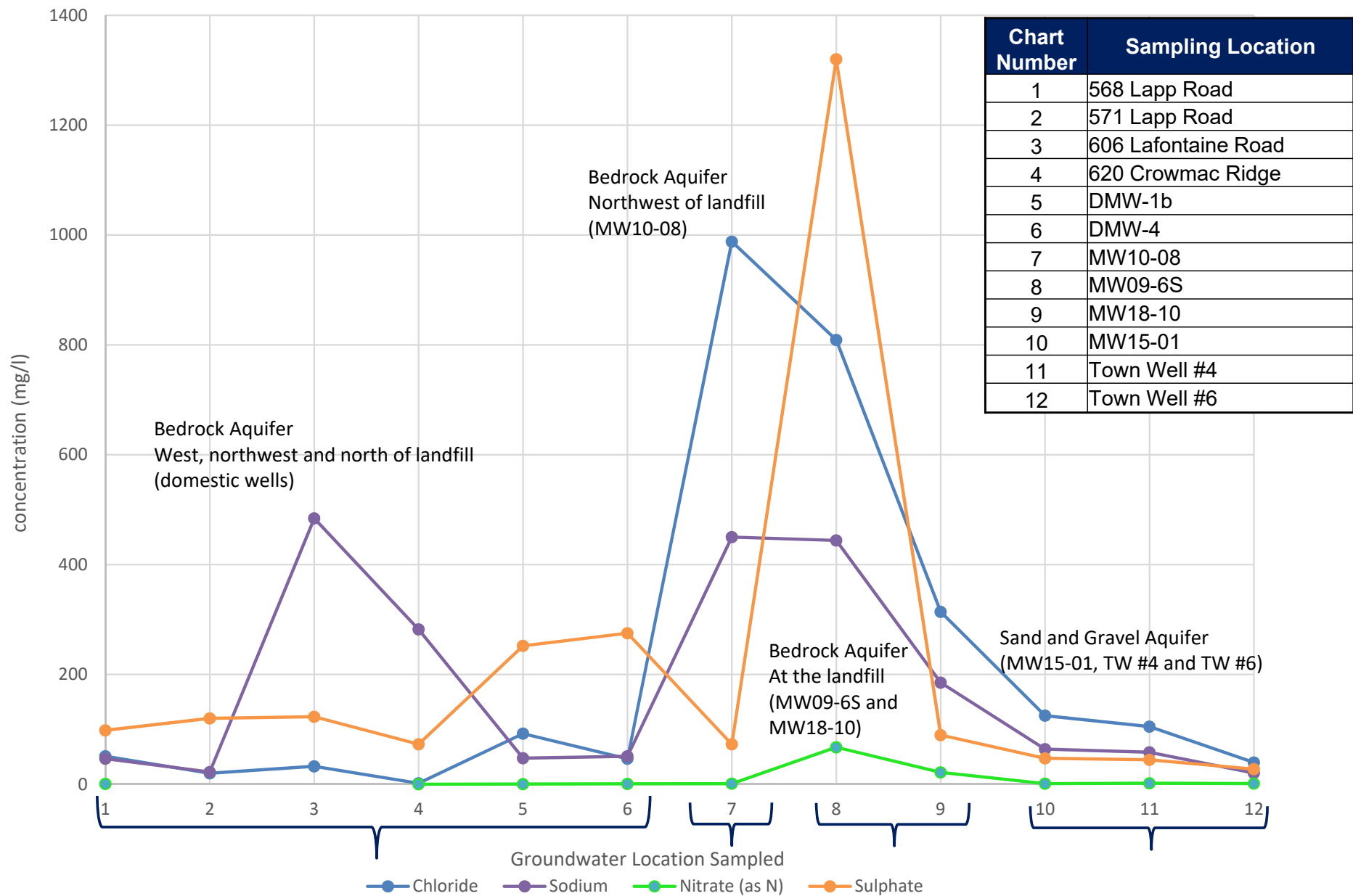


**CSRD Golden RDF
Hydrogeological Assessment**

TITLE Figure 4: Piper Plot for routinely monitored wells and the off site wells sampled in well survey.



DRAWN	RA	DATE	April 2019	PROJECT NO.	14-024-21
CHECKED	BRM	SCALE	See figure	DWG. NO.	na
REVIEWED	DG	FILE NO.		FIGURE VERSION NO.	1

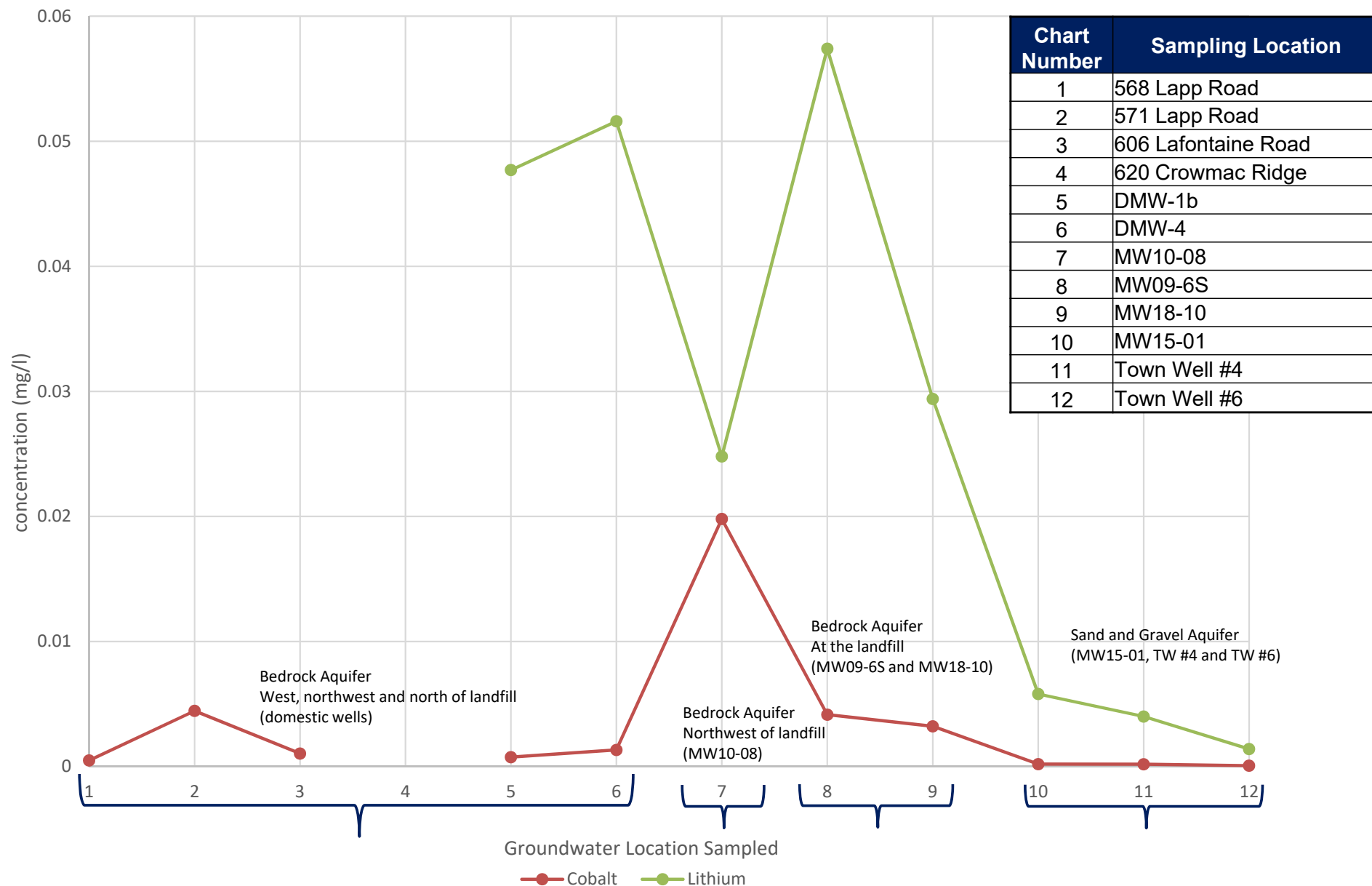


**CSRD Golden RDF
Hydrogeological Assessment**



TITLE Figure 5: Comparison of Maximum Concentrations for Parameters that Exceed On the Golden RDF Site (Cl, Na, NO₃, and SO₄).

DRAWN	RA	DATE	October 2018	PROJECT NO.	14-024-21
CHECKED	BRM	SCALE	See figure	DWG. NO.	na
REVIEWED	DG	FILE NO.		FIGURE VERSION NO.	1

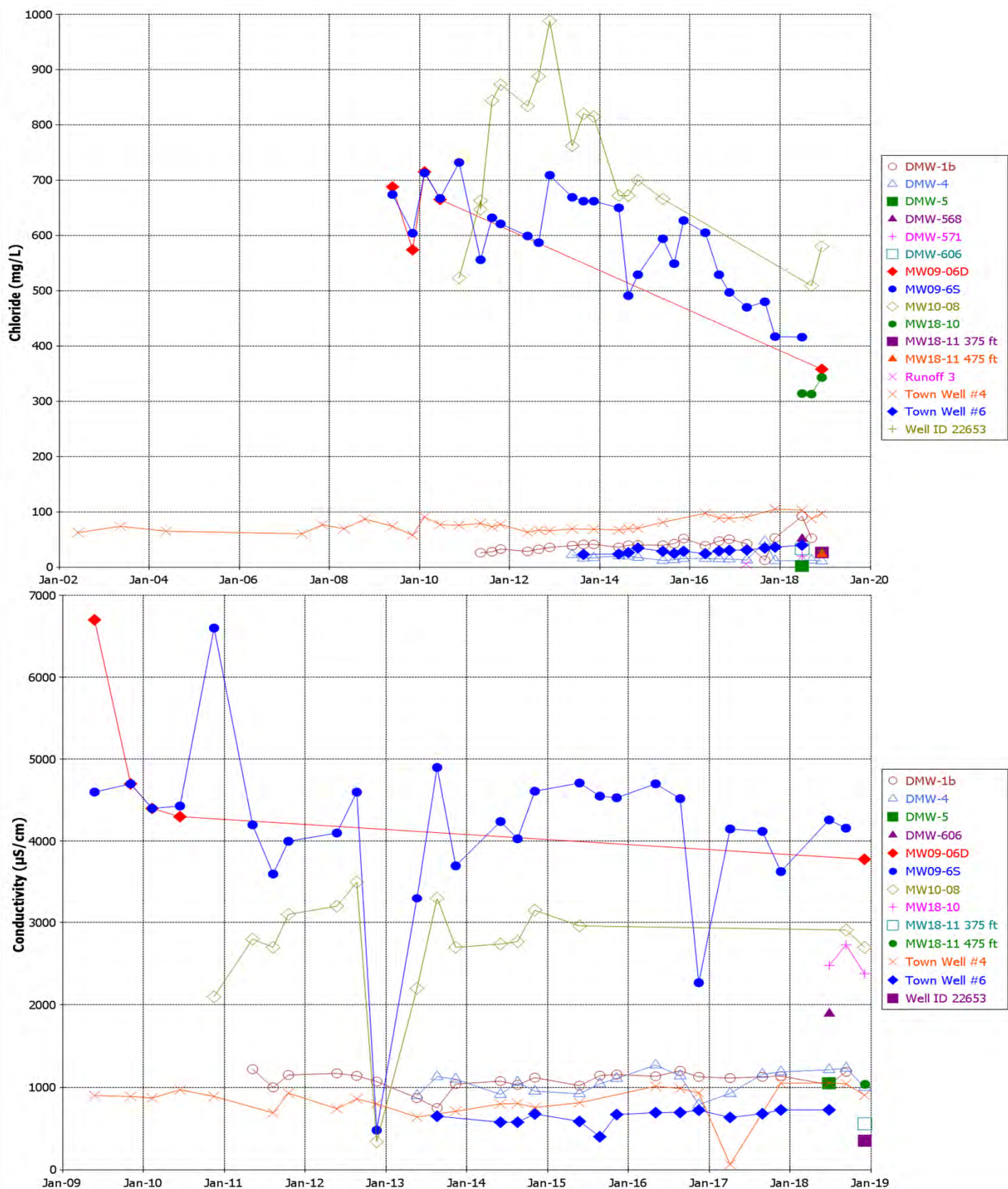


**CSRD Golden RDF
Hydrogeological Assessment**



TITLE Figure 6: Comparison of Maximum Concentrations for Parameters that Exceed On the Golden RDF Site (Co and Li).

DRAWN	RA	DATE	October 2018	PROJECT NO.	14-024-21
CHECKED	BRM	SCALE	See figure	DWG. NO.	na
REVIEWED	DG	FILE NO.		FIGURE VERSION NO.	1



Columbia Shuswap Regional District



TITLE

Figure 7: Chloride (Top) and Conductivity (Bottom) Time Series Plots, Golden RDF

DRAWN RA

DATE March 2019

PROJECT NO. 14-024-16

CHECKED BRM

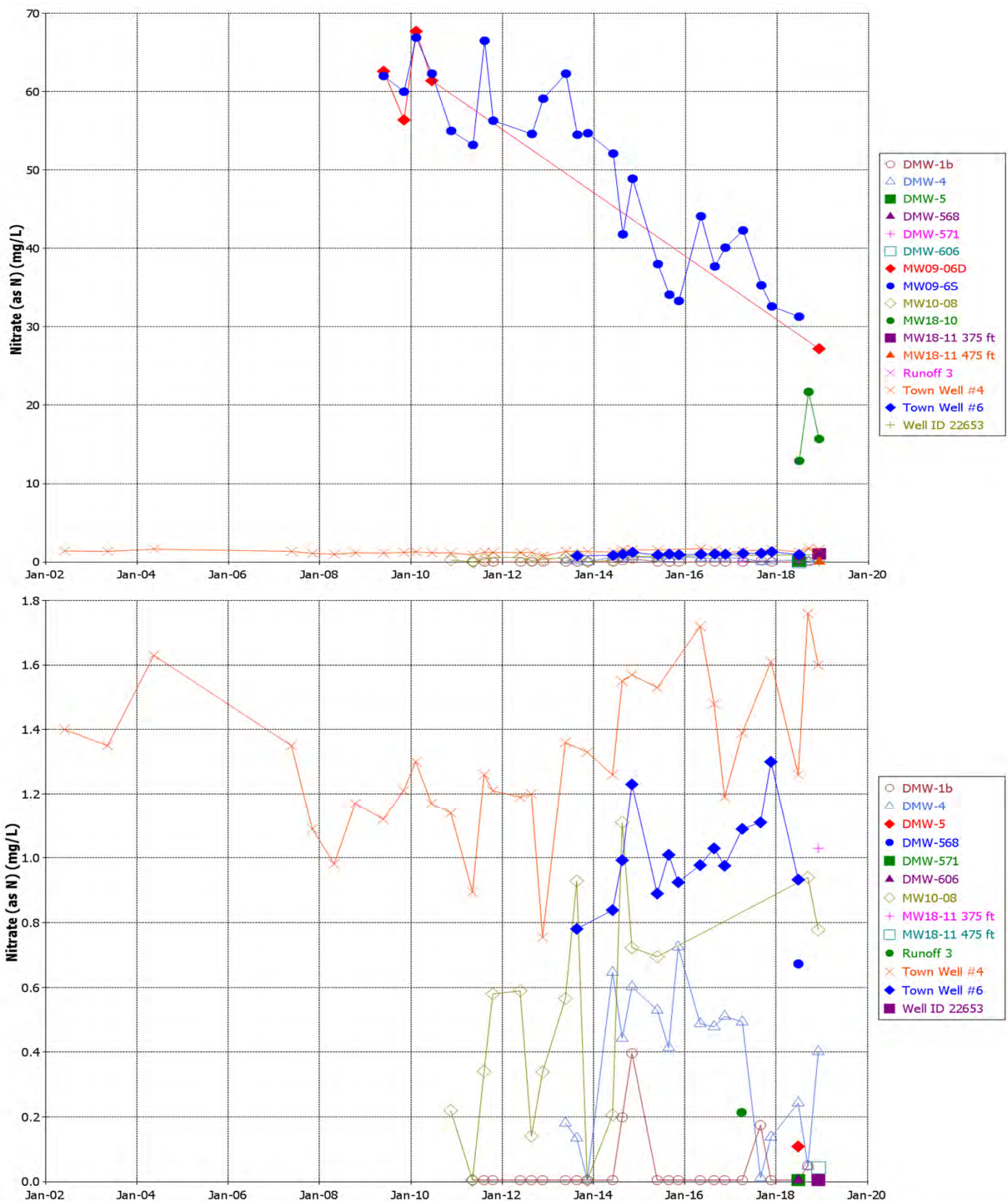
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DWG. NO. n/a

REVIEWED DG

FILE NO.

FIGURE REV. NO.



Columbia Shuswap
Regional District



TITLE

Figure 8: Nitrate (Top) and Modified Nitrate (Bottom), Time Series Plots, Golden RDF

DRAWN RA

DATE March 2019

PROJECT NO. 14-024-16

CHECKED BRM

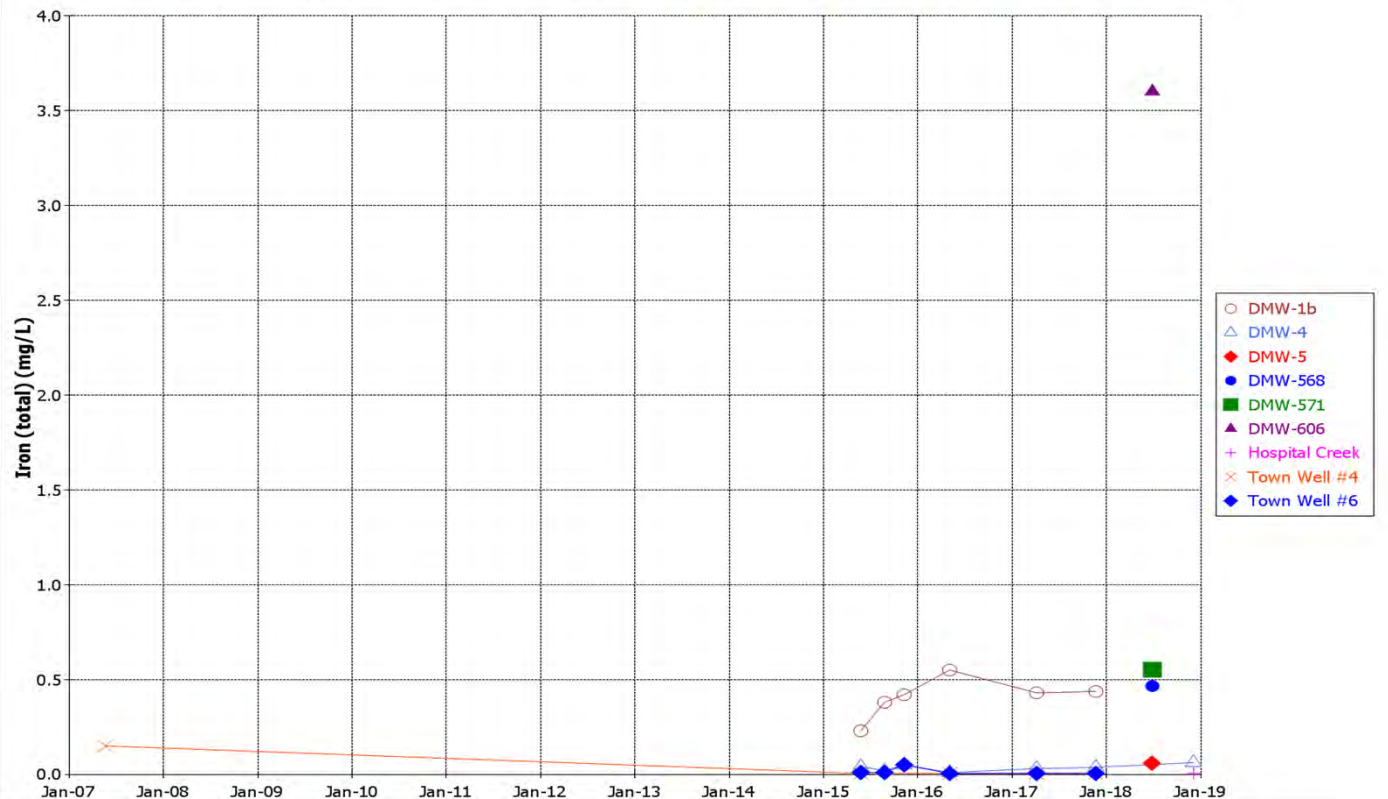
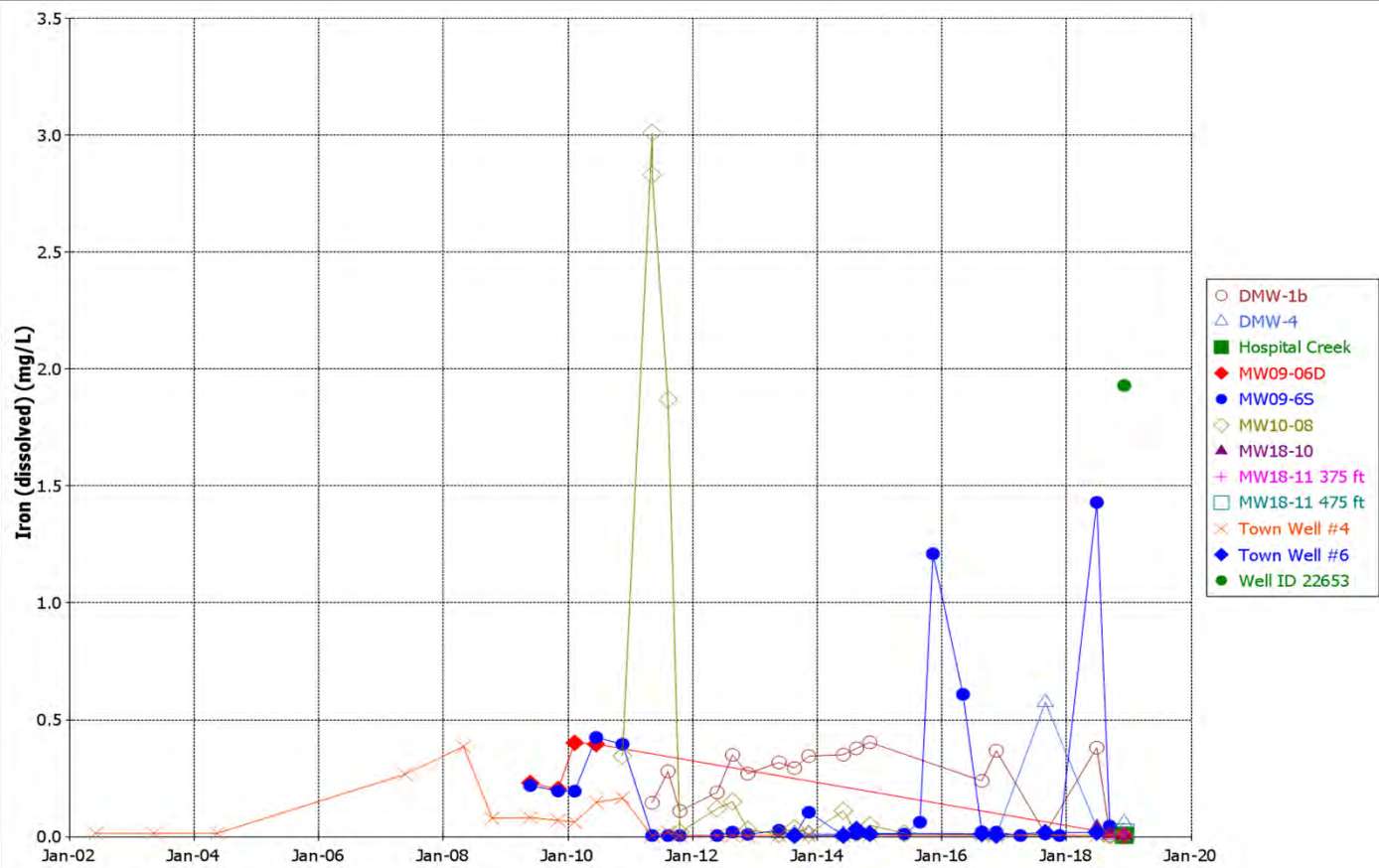
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DWG. NO. n/a

REVIEWED DG

FILE NO.

FIGURE REV. NO.



Columbia Shuswap Regional District



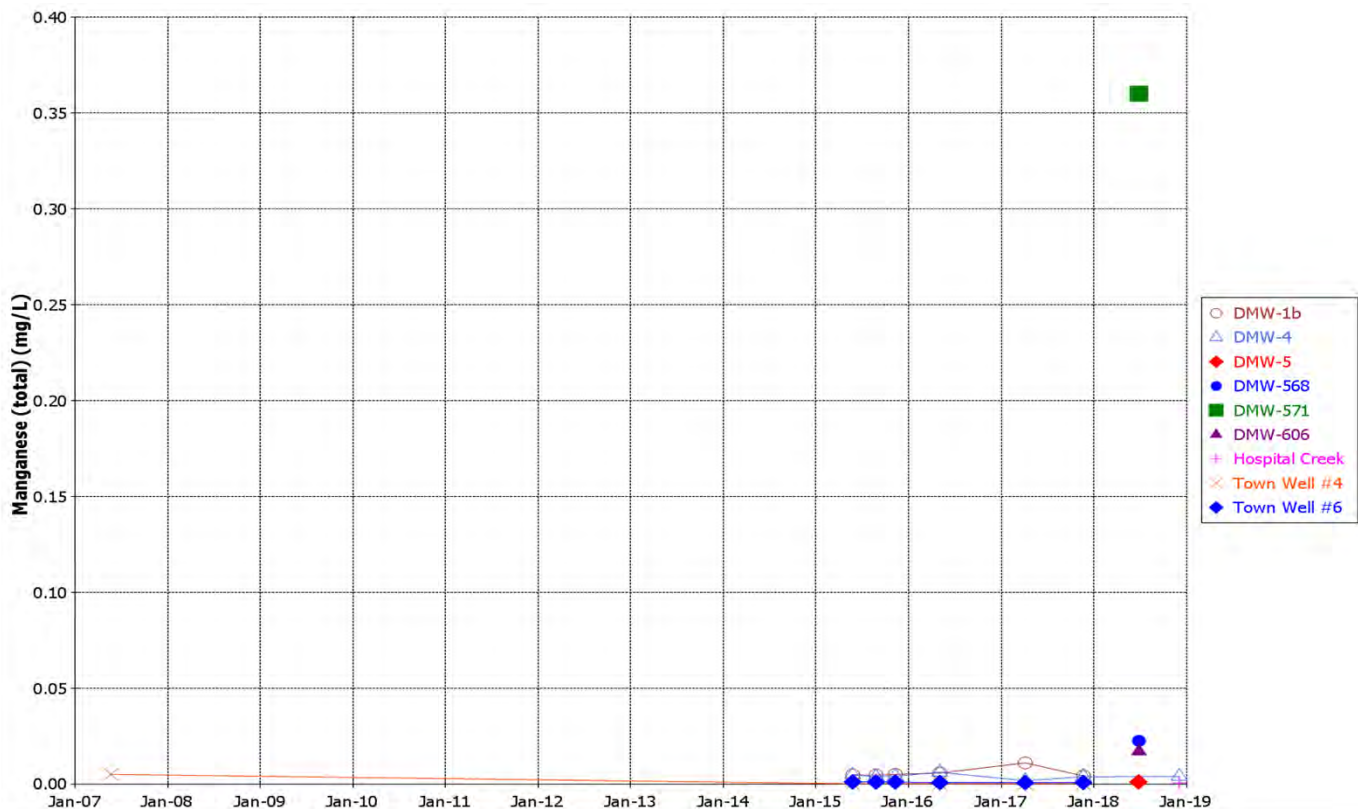
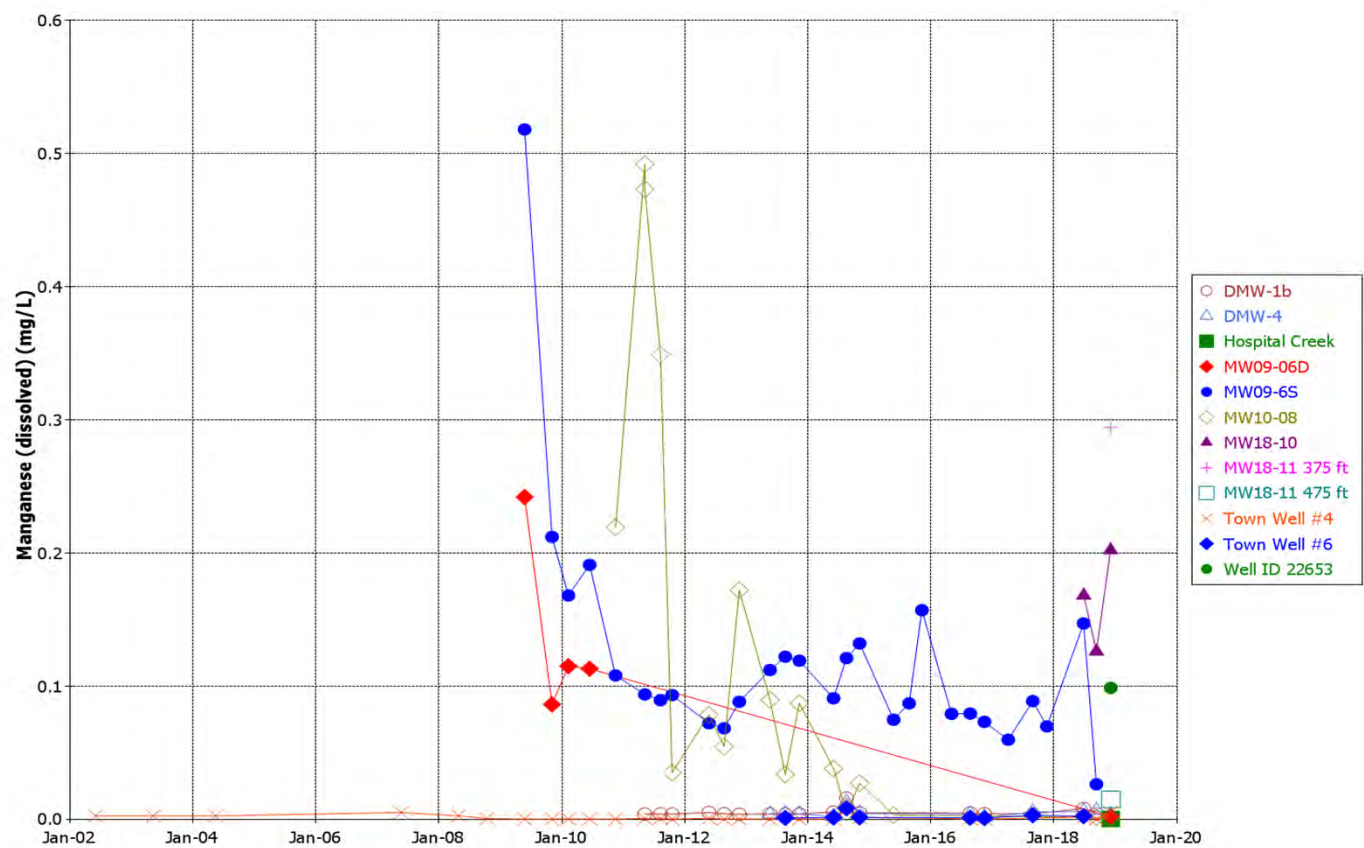
TITLE

Figure 9: Dissolved Iron (Top) and Total Iron (Bottom) Time Series Plots, Golden RDF

DRAWN
RA
CHECKED
BRM
REVIEWED
DG

DATE
March 2019
SCALE
n/a
FILE NO.

PROJECT NO.
14-024-16
DWG. NO.
n/a
FIGURE REV. NO.



Columbia Shuswap Regional District



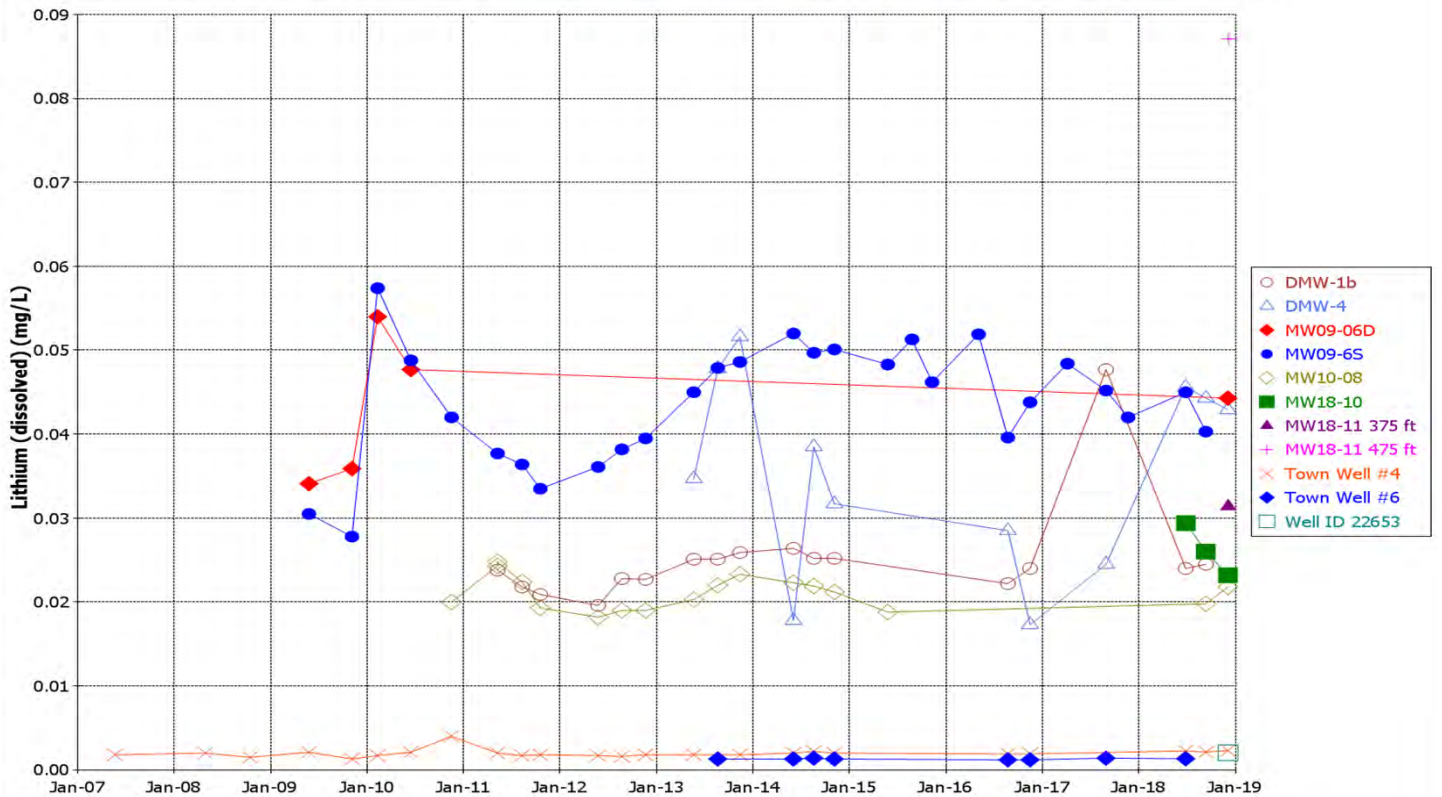
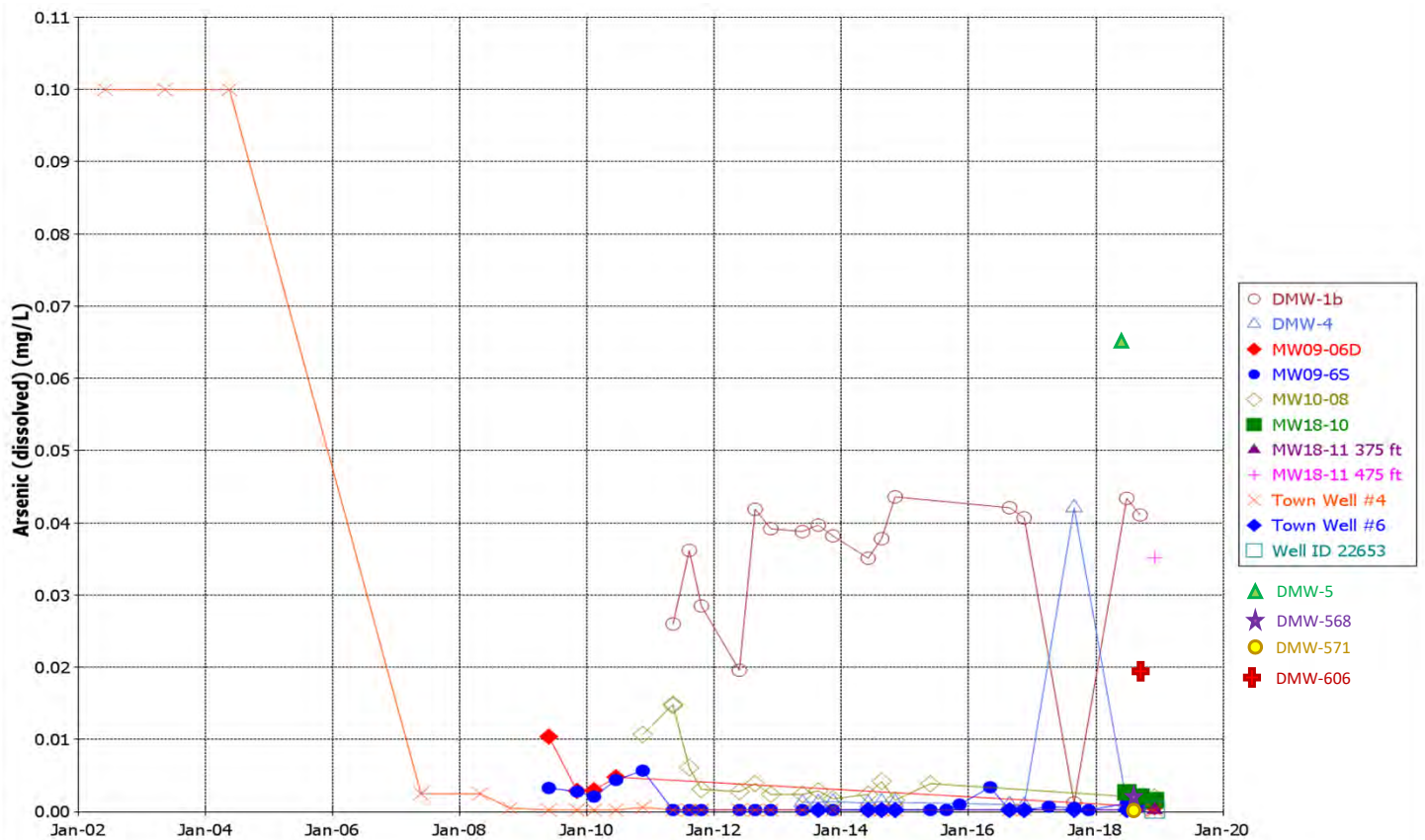
TITLE

Figure 10: Dissolved Manganese (Top) and Total Manganese (Bottom) Time Series Plots, Golden RDF

DRAWN
RA
CHECKED
BRM
REVIEWED
DG

DATE
March 2019
SCALE
n/a
FILE NO.

PROJECT NO.
14-024-16
DWG. NO.
n/a
FIGURE REV. NO.



Columbia Shuswap Regional District



TITLE

Figure 11: Dissolved / Total Arsenic (Top) and Dissolved / Total Lithium (Bottom) Time Series Plots, Golden RDF

DRAWN RA

DATE March 2019

PROJECT NO. 14-024-16

CHECKED BRM

SCALE n/a

DWG. NO. n/a

REVIEWED DG

FILE NO.

FIGURE REV. NO.

Appendix B:

Operational Certificate for I7006

5-Year 2018 Hydrogeological Assessment
CSRD
Golden RDF
WWAL Ref: 14-024-21





August 29, 2012

Tracking Number: 243578
Authorization Number: 17006

REGISTERED MAIL

**Columbia Shuswap Regional District
Box 978
781 Marine Park Drive NE
Salmon Arm, BC V1E 4P1**

Dear Operational Certificate Holder:

Enclosed is Amended Operational Certificate 17006 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 operational certificate will be carried out by staff from the Southern Interior Region - Kootenay. Plans, data and reports pertinent to the operational certificate are to be submitted to the Regional Manager, Environmental Protection, at Ministry of Environment, Regional Operations, Southern Interior Region - Kootenay, 401 - 333 Victoria St., Nelson, BC V1L 4K3.

Yours truly,

A handwritten signature in dark ink, appearing to read 'Chris Stroich', with a stylized, flowing script.

Chris Stroich, M.Sc., P.Ag.
for Director, *Environmental Management Act*
Southern Interior Region - Kootenay

Enclosure

cc: Environment Canada



**MINISTRY OF
ENVIRONMENT**

OPERATIONAL CERTIFICATE

17006

Under the Provisions of the Environmental Management Act

Columbia Shuswap Regional District

**Box 978
781 Marine Park Drive NE
Salmon Arm, BC V1E 4P1**

is authorized to manage waste and recyclable material from the Columbia Shuswap Regional District and environs at the Columbia Shuswap Regional District in Golden landfill located near Golden, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the *Environmental Management Act* and may result in prosecution.

This Operational Certificate supersedes all previous versions of the Operational Certificate MR-17006 issued under the authority of the *Environmental Management Act*.

1. AUTHORIZED DISCHARGE

This section applies to the discharge of refuse from municipal, commercial and light industrial sources to a sanitary landfill known as the GOLDEN LANDFILL. The site reference number for this discharge is E246600.

- 1.1 The authorized works are a sanitary landfill and related appurtenances approximately located as shown on the attached location map.

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)

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for Director, *Environmental Management Act*
Southern Interior Region - Kootenay

- 1.2 The maximum quantity of waste discharges must not exceed the design capacity of the landfill as specified in the approved Design and Operations Plan. The final footprint and profile of the discharged waste must be within that specified in the Design and Operations Plan, and approximately as shown on the attached location map.
- 1.3 The authorized discharge is municipal solid waste as defined in the *Environmental Management Act* and other waste as may be authorized by the Director.
- 1.4 The legal description of the location of the authorized landfill facility is Subdivision 12 of Section 18, Township 27, Range 21, West of the 5th Meridian, Kootenay District.
- 1.5 The site is located approximately 2 kilometres travelling northeast on Highway 1 as shown on the location map.

2. **DESIGN AND PERFORMANCE REQUIREMENTS**

2.1 **Design and Operating Plan**

The Operational Certificate holder must prepare and maintain a current Design and Operations Plan prepared by a qualified professional. The Plan must be reviewed and updated as needed at least once every five years. The next update must be undertaken and completed in 2013. The Plan must address, but not be limited to, each of the subsections in the Landfill Criteria for Municipal Solid Waste including performance, siting, design, operational, closure and post-closure criteria. The facilities must be developed, operated and closed in accordance with the Plan. Should there be any inconsistency between this Operational Certificate and the Plan, this Operational Certificate must take precedence.

Written authorization from the Director must be obtained prior to implementing any changes to the approved plans. Based on any information obtained in connection with this facility, the Director may require revision of, or addition to, the design, operating and closure plans.

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)



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2.2 **Qualified Professionals**

All facilities and information, including works, plans, assessments, monitoring, investigations, surveys, programs and reports, must be certified by Qualified Professionals.

2.3 **Maintenance of Works and Emergency Procedures**

The authorized works must be inspected regularly and maintained in good working order. In the event of an emergency or condition beyond the control of the Columbia Shuswap Regional District including, but not limited to, unauthorized fires arising from spontaneous combustion or other causes, or detection of surfacing leachate on the property, the Columbia Shuswap Regional District must take appropriate remedial action and notify the Regional Office. The Director may reduce or suspend operations to protect the environment until the authorized works has been restored, and/or corrective steps taken to prevent unauthorized discharges.

2.4 **Additional Facilities or Works**

The Director may require investigations, surveys, and the construction of additional facilities or works. The Director may also amend any information requirements of this Operational Certificate including plans, programs, monitoring, assessments and reports.

2.5 **Public Health, Safety and 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.

2.6 **Ground and Surface Water Quality Impairment**

The landfill must be operated in a manner such that ground or surface water quality does not decrease beyond that specified by the British Columbia Water Quality Guidelines, or other appropriate criteria as may be specified by the Director, at or beyond the landfill property boundary.

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)



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Southern Interior Region - Kootenay

The certificate holder must take all reasonable measures to ensure that BCWQG are met at or beyond the property boundary. These measures include but are not limited to:

- a) Prohibiting the discharge of municipal solid waste into water.
- b) Ensuring that no new waste is landfilled within 1.2 m of the highest groundwater level.
- c) Ensuring that adequate surface water and groundwater diversion works are constructed and maintained to minimize surface water run-off and groundwater seepage from entering the landfill.
- d) Ensuring that the management systems for surface water that has not come in contact with waste are hydraulically separate from those for managing impacted surface water.
- e) Ensuring that the landfill is operated in a manner that prevents the exceedance in surface water and groundwater of anticipated leachate indicators or parameters distinctive of leachate or those specified by the Director at the landfill boundary.
- f) Ensuring that the indicators in e) above, at specified groundwater monitoring wells within the property boundary are in accordance with those predicted by design and that suitable measures are taken to address the cause of any exceedances above the trigger levels identified in the most current Design and Operations Plan.
- g) Ensuring that the landfill is operated in accordance with a Design & Operations Plan which specifies measures to prevent decreases in groundwater and surface water quality at and beyond the property boundary.

If exceedances to the specified water quality criteria occur as a result of landfill operations, the Director may require that leachate management control measures or works be undertaken. Terms of reference for any leachate management study and/or design work must be submitted to the Director for review prior to conducting the work.

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)



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Southern Interior Region - Kootenay

2.7 **Landfill Gas Management**

The Landfill must 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 under the *Greenhouse Gas Reduction (Emissions Standards) Statutes Amendment Act*, 2008 on or before applicable dates specified in the regulation. The requirements of the regulation and its guideline documents must be incorporated by the Operational Certificate holder into the Design and Operation Plan revisions as they come into effect and as applicable.

2.8 **Buffer Zone**

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

3. **OPERATIONAL REQUIREMENTS**

3.1 **Waste Compaction and Coverage**

The Operational Certificate holder must ensure that waste deposition and compaction meets or exceeds the requirements of the BC Landfill Criteria or its most current version for daily, intermediate and final cover. Control must be exercised to ensure keeping freshly deposited refuse in a well defined and small / manageable working face.

3.2 **Prohibited Wastes**

The disposal of the following types of wastes is strictly prohibited:

- (a) Hazardous Wastes other than those specifically approved for disposal to authorized landfills in the Hazardous Waste Regulation under the *Environmental Management Act*.
- (b) Biomedical wastes as defined in the Guidelines for the Management of Biomedical Wastes in Canada (Canadian Council of Ministers of the Environment, February 1992),

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- (c) Bulk liquids and semi-solid wastes, which contain free liquids, as determined by US EPA Method 90954 Paint Filter Liquids Test, Test Methods for Evaluating Solid Wastes-Physical/Chemical Methods (EPA Publication No. Sw-846),
- (d) Release of ozone depleting substances from the storage, handling and disposal of used appliances, equipment, or any material containing ozone depleting substances is prohibited in accordance with the requirements of the Ozone Depleting Substances Regulation. Onsite removal or evacuation of Ozone Depleting Substances (ODS) from appliances and the subsequent storage of appliances on site is permitted subject to both activities being in compliance with the Ozone Depleting Substances Regulation.

3.3 **Waste Asbestos**

Waste asbestos is authorized for disposal subject to compliance with the requirements of section 40 of the Hazardous Waste Regulation and the following conditions:

- (a) The asbestos waste may not be mixed with any other hazardous waste.
- (b) The Regional District must approve the disposal before disposal takes place.
- (c) All other applicable requirements of the Hazardous Waste Regulation, including but not limited to manifesting and waste record keeping, must also be complied with.

3.4 **Contaminated Soil**

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

3.5 **Wildlife and Vector Control**

Vectors (carriers capable of transmitting a pathogen from one organism to another including, but not limited to flies and other insects, rodents, and birds) must be controlled by the application of cover material at the required frequency or by such additional methods as specified by the Director. Wildlife control fencing must be maintained around the perimeter of the landfill site and must be

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)



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for Director, *Environmental Management Act*
Southern Interior Region - Kootenay

electrified for at least the active bear season of each year.

This landfill must be operated so as to minimize the attraction of wildlife such as bears and birds by applying cover at required frequencies and instituting a good housekeeping program.

3.6 **Site Access and Supervision**

A landfill operator that has received BC Qualified Landfill Operator training, is familiar with the requirements of the Operational Certificate and the specifications of the Design and Operations Plan, must be present at all times during operating hours.

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.

3.7 **Dust Control**

Dust created within the landfill property must be controlled, using methods and materials acceptable to the Director, such that it does not cause a public nuisance.

3.8 **Litter Control**

The best practical means must be used to prevent the scatter of litter. Any litter scattered into the neighbouring property, along access roads, in drainage ditches, along litter-control fences, into surrounding trees or elsewhere on the landfill site must be cleaned up. The frequency of clean up and other additional requirements for refuse scatter control must be determined by the Director.

3.9 **Waste Reduction and Alternate Disposal**

The Provincial Government has developed policies to promote the reduction, reuse and recycling of wastes. The Operational Certificate holder is encouraged to segregate for recycling and reuse, where possible, materials destined for disposal at this site.

Public scavenging must not be permitted at the landfill. The controlled salvaging of waste by the landfill operator or persons authorized by the

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)



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Southern Interior Region - Kootenay

Operational Certificate holder is encouraged if areas or facilities for separation and storage of recyclable or reusable materials are provided.

In certain landfill environments, some construction and demolition debris or other wastes may create specific air and water quality concerns. If problems arise at this site that are attributable to specific wastes, the Director may require that alternate disposal/storage procedures be implemented.

3.10 **Operations and Maintenance Manual**

The Operational Certificate holder must prepare an Operations and Maintenance Manual to be reviewed and updated as necessary on at least an annual basis.

4. **MONITORING AND REPORTING REQUIREMENTS**

4.1 **Landfill Monitoring**

A monitoring program must be developed by a Qualified Professional and identify potential environmental impacts of the authorized facility and must address but not be limited to the Landfill Criteria for Municipal Solid Waste and Guidelines for Environmental Monitoring. The monitoring program must be updated every five years and submitted to the satisfaction of the Director. The next monitoring plan update is required to be undertaken and completed in 2013. Monitoring must be conducted in accordance with the monitoring program.

The program must be designed to assess and identify:

- The design performance of the landfill as per the Design & Operations Plan including but not limited to compliance with water quality performance standards at the landfill boundary.
- Landfill leachate as a contaminant source.
- Residential well water quality.
- Surface water quality.

The monitoring program must address, but not be limited to relevant sections of the Landfill Criteria for Municipal Solid Waste and the Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills. The Environmental Monitoring Program must take into consideration results from previous monitoring programs and any other investigations conducted at the site to ensure that early detection of potential impacts is possible.

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)



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4.2 **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 above manual may be purchased from the Queen's Printer Publications Centre, P.O. Box 9452, Stn. Prov. Gov't., Victoria, British Columbia, V8W 9V7 (1-800-663-6105 or (250) 387-6409).

4.3 **Analysis**

Analyses must 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 above manual may be purchased from the Queen's Printer Publication Centre.

4.4 **Quality Assurance**

The Operational Certificate holder must produce, within 60 days on the request of the Regional Manager Environmental Protection, 'Field and Laboratory Quality Protocols and Quality Assurance Criteria' acceptable to the Director. The 'Laboratory Quality Protocols' must include the procedures used to assess precision, accuracy and blank quality, including frequency of application of those procedures, the procedures for sampling, handling (e.g. preservation, hold times) and corrective measures to be initiated when deficiencies are indicated. The 'Quality Assurance Criteria' must include the acceptance criteria for accuracy (based on recoveries for reference samples/spikes), for precision (based on deviation in field and lab duplicates) and method blanks (designed to indicate false positives).

5. **LANDFILL REPORTING**

5.1 **Annual Report**

The Operation Certificate Holder must submit an Annual Report to the Director on or before April 30th each year for the previous calendar year. The report must contain at least the following information:

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)



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for Director, *Environmental Management Act*
Southern Interior Region - Kootenay

- (a) an executive summary;
- (b) the type and tonnage of waste received, recycled, stored on-site and discharged / landfilled for the year;
- (c) Any proposed changes to the Design and Operations Plan and the environmental monitoring program (EMP), with rationale for the changes; a description of unanticipated occurrences and any changes to the closure or post-closure plans and funds;
- (d) A review of the preceding year of operation or an operations update which summarizes landfill development work completed in the subject reporting year and work planned for the subsequent year. A summary of any new information or changes to the facilities and plans, assessments, surveys, programs and reports;
- (e) Occurrences or observations of wildlife (medium and large carnivores) at the facility;
- (f) A statement regarding the facility's progress in reducing the regional solid waste stream being landfilled and the objectives of the Regional Solid Waste Management Plan;
- (g) An outline of the current Environmental Monitoring Program and a compendium of all environmental monitoring data in accordance with requirements specified in the most recent version of Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills and Landfill Criteria for Municipal Solid Waste. The annual report must document any effect of the discharge on the quality of the receiving environment using appropriate statistical and graphical analysis. Trend analyses, as well as an evaluation of the impacts of the discharges on the receiving environment must be included;
- (h) A list of training programs completed for landfill operators during the previous year; and
- (i) Any additional information requested by the Director.

All reports must be submitted, suitably formatted and tabulated in both print and electronic format (portable document format).

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)



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5.2 **Five Year Report**

The Operation Certificate Holder must submit a Five Year Report to the Director on or before April 30th on the five year anniversary of the last submission. The next report is due by the end of 2013. The report must contain at least the following information:

- (a) An executive summary;
- (b) An updated Design and Operations Plan;
- (c) A detailed hydrogeological assessment;
- (d) The type and tonnage of waste received, recycled, stored on-site and discharged / landfilled for the year;
- (e) A current topographic map detailing airspace consumption, on-site borrow pit changes and future developments;
- (f) Volume and density analysis or an in-place material summary, updated estimates for the remaining capacity, site life, revised closure date for the current phase or sequence and revised closure date for the current landfill footprint;
- (g) An outline of the current Environmental Monitoring Program and a compendium of all environmental monitoring data in accordance with requirements specified in the most recent version of Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills and Landfill Criteria for Municipal Solid Waste. The annual report must document any effect of the discharge on the quality of the receiving environment using appropriate statistical and graphical analysis. Trend analyses, as well as an evaluation of the impacts of the discharges on the receiving environment must be included;
- (h) An update on the financial assurance mechanism including a statement of the current dollar value of the Closure Fund and the amount earmarked for the Landfill site; and
- (i) Any additional information requested by the Director.

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)



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6. **LANDFILL CLOSURE PLAN**

6.1 **Closure Plan and Post Closure**

The Operational Certificate holder must perform closure and post-closure care in accordance with all applicable requirements of the BC Landfill Criteria for Municipal Solid Waste. This Operational Certificate is issued on the condition that a Closure Plan and Final Cover Design that meets or exceeds the requirements of the criteria will be submitted to the Director during the operating life of the landfill. The Closure Plan must be reviewed every five years throughout the operating life of the landfill.

A certification by a Qualified Professional attesting that all closure works have been completed in accordance with the Closure Plan and Final Cover Design is to be submitted to the Director no later than 60 days after the implementation of the Final Cover Design.

The Operational Certificate Holder must submit a Post Closure or Aftercare Plan to the Ministry at least two years prior to the anticipated closure date of the landfill.

6.2 **Closure Fund**

The Operational Certificate holder must provide for the funding of progressive closure operations, final closure and operations beyond closure by maintaining a closure fund. The value of the closure fund must meet or exceed the estimated closure and post-closure costs as established in the approved Design and Operations Plan and updated in the annual report, plus a reasonable contingency for any remediation which may be required. Reported costs must be adjusted for inflation annually. Alternately, a closure and post-closure financial security acceptable to the Director may be built over time.

The Operational Certificate holder must determine and ensure that the closure fund is adequate by preparing annually a financial statement of the fund which must be made available to the Director upon request. The financial statement must report the accrued capital, interest and additions to the fund for the previous year and review the sufficiency of the fund and the rate of accrual in consideration of the projected costs of closure and post-closure obligations.

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)



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6.3 **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 ten days prior to decommissioning the facilities authorized in Section 1.

6.4 **Declaration of Landfill**

Landfills sited on titled land must register a covenant that the property was used for the purpose of waste disposal as a charge against the title to the property as provided for under Section 215.1 of the *Land Title Act*. Landfills located on crown land are to have a “notation on file” registered that the property was used for the purpose of waste disposal.

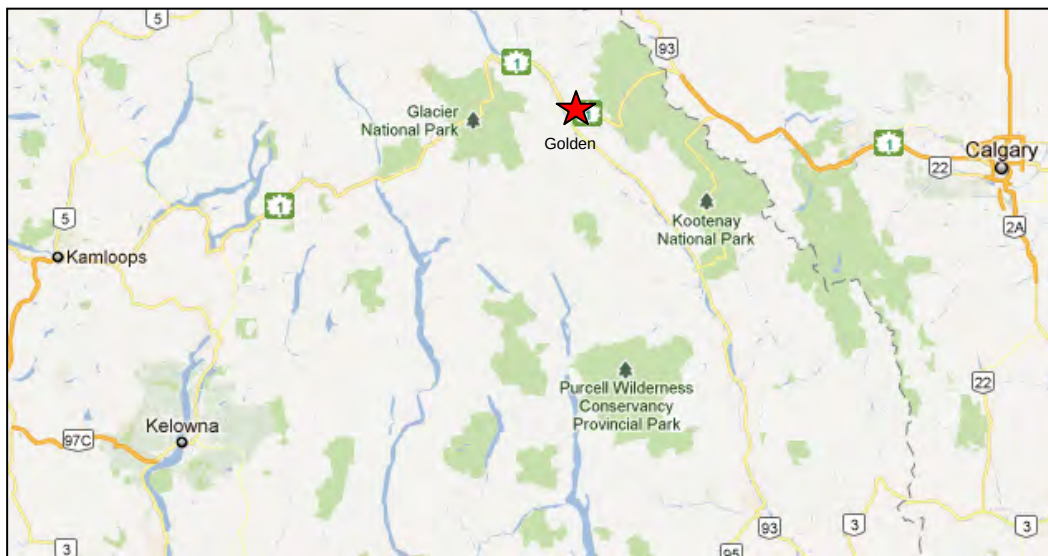
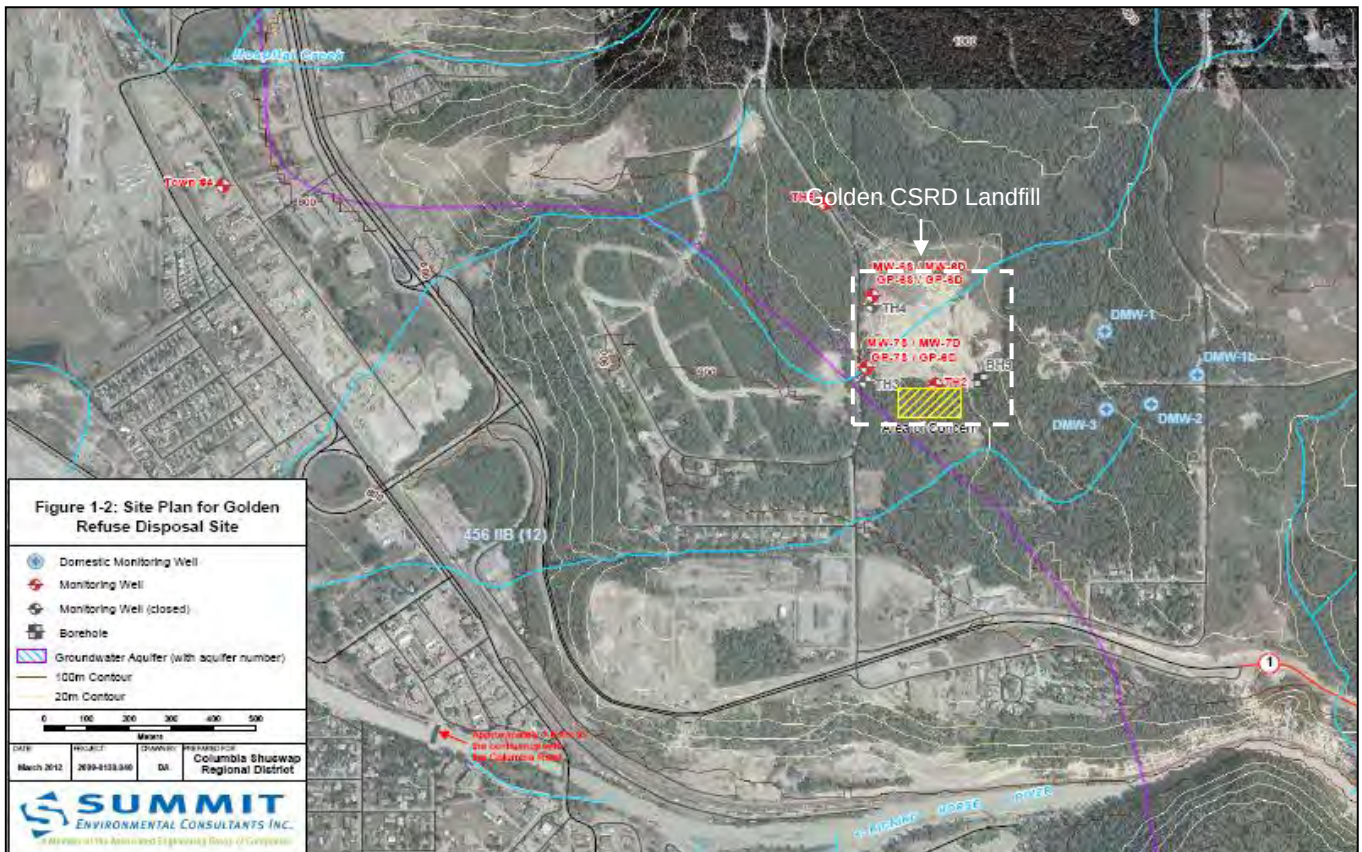
The Operational Certificate holder must, upon closure of the landfill, register a charge against the property title, or provide other legal notification acceptable to the Director that the property described in Section 1 was used for the purpose of waste disposal. The Director must be notified of the charge or legal notification.

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)



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Location Map



Date issued:
Date amended:
(most recent)

May 5, 2003
August 29, 2012

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Southern Interior Region - Kootenay

Appendix C:

Well Logs for Wells Registered Within 1 km of the Landfill Site

5-Year 2018 Hydrogeological Assessment

CSRD

Golden RDF

WWAL Ref: 14-024-21





Report 1 - Detailed Well Record

Well Tag Number: 535	Construction Date:
Owner: GARTH THOMPSON	Driller: Alkan Drilling
Address:	Well Identification Plate Number:
Area: GOLDEN	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: 8 (Driller's Estimate) Gallons per Hour (U.S./Imperial)
District Lot: Plan: 13414 Lot: 3	Development Method:
Township: 27 Section: 19 Range: 21	Pump Test Info Flag:
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082N036123 Well: 3	WATER QUALITY:
Class of Well:	Character:
Subclass of Well:	Colour:
Orientation of Well:	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method: Drilled	Water Utility:
Diameter: 0.0 inches	Water Supply System Name:
Casing drive shoe:	Water Supply System Well Name:
Well Depth: 205 feet	
Elevation: 0 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: inches	Flag:
Well Cap Type:	Material:
Bedrock Depth: 48 feet	Method:
Lithology Info Flag:	Depth (ft):

File Info Flag:	Thickness (in):
Sieve Info Flag:	
Screen Info Flag:	WELL CLOSURE INFORMATION:
	Reason For Closure:
Site Info Details:	Method of Closure:
Other Info Flag:	Closure Sealant Material:
Other Info Details:	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:
YIELD: 8 GPH DOMESTIC

LITHOLOGY INFORMATION:

From 0 to 1 Ft. TOPSOIL
From 1 to 3 Ft. BOULDER
From 3 to 15 Ft. HARDPAN
From 15 to 20 Ft. BOULDERS & CLAY
From 20 to 48 Ft. CLAY & GRAVEL
From 48 to 205 Ft. BEDROCK (SILICA)

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Report 1 - Detailed Well Record

Well Tag Number: 971	Construction Date:
Owner: GARTH THOMPSON	Driller: Unknown
Address:	Well Identification Plate Number:
Area: GOLDEN	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: 25 (Driller's Estimate) Gallons per Minute (U.S./Imperial)
District Lot: Plan: 13414 Lot: 3	Development Method:
Township: 27 Section: 19 Range: 21	Pump Test Info Flag:
Indian Reserve: Meridian: W5 Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082N036123 Well: 5	WATER QUALITY:
Class of Well:	Character:
Subclass of Well:	Colour:
Orientation of Well:	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method: Unknown Constr	Water Utility:
Diameter: 0.0 inches	Water Supply System Name:
Casing drive shoe:	Water Supply System Well Name:
Well Depth: 133 feet	
Elevation: 0 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: inches	Flag:
Well Cap Type:	Material:
Bedrock Depth: feet	Method:
Lithology Info Flag:	Depth (ft):

File Info Flag:	Thickness (in):			
Sieve Info Flag:				
Screen Info Flag:	WELL CLOSURE INFORMATION:			
	Reason For Closure:			
Site Info Details:	Method of Closure:			
Other Info Flag:	Closure Sealant Material:			
Other Info Details:	Closure Backfill Material:			
	Details of Closure:			
Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
GENERAL REMARKS: YIELD: 25 GPM (WATER VERY HARD,SULPHUR & SALT,VERY STRONG TASTE) DOMESTIC				
LITHOLOGY INFORMATION: From 0 to 133 Ft. NO LOG				

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Report 1 - Detailed Well Record

Well Tag Number: 973	Construction Date:
Owner: GARTH THOMPSON	Driller: Alkan Drilling
Address:	Well Identification Plate Number:
Area: GOLDEN	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: .3 (Driller's Estimate) Gallons per Minute (U.S./Imperial)
District Lot: Plan: 13414 Lot: 3	Development Method:
Township: 27 Section: 19 Range: 21	Pump Test Info Flag:
Indian Reserve: Meridian: W5 Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082N036123 Well: 4	WATER QUALITY:
Class of Well:	Character:
Subclass of Well:	Colour:
Orientation of Well:	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method: Drilled	Water Utility:
Diameter: 6.0 inches	Water Supply System Name:
Casing drive shoe:	Water Supply System Well Name:
Well Depth: 70 feet	
Elevation: 0 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: inches	Flag:
Well Cap Type:	Material:
Bedrock Depth: 30 feet	Method:
Lithology Info Flag:	Depth (ft):

File Info Flag:	Thickness (in):			
Sieve Info Flag:				
Screen Info Flag:	WELL CLOSURE INFORMATION:			
	Reason For Closure:			
Site Info Details:	Method of Closure:			
Other Info Flag:	Closure Sealant Material:			
Other Info Details:	Closure Backfill Material:			
	Details of Closure:			
Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
GENERAL REMARKS: YIELD: 0.25 GPM (QUALITY:SULPHUR,SALTY) DOMESTIC LITHOLOGY INFORMATION: From 0 to 16 Ft. SAND & GRAVEL From 16 to 30 Ft. PEA GRAVEL From 30 to 70 Ft. BEDROCK (SHALE & SILICA)HARD				

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Report 1 - Detailed Well Record

Well Tag Number: 975	Construction Date:
Owner: CALVIN LUMLEY	Driller: Owen's Drilling Ltd.
Address: LAPP RD	Well Identification Plate Number:
Area: GOLDEN	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: .5 (Driller's Estimate) Gallons per Minute (U.S./Imperial)
District Lot: Plan: Lot: 10	Development Method:
Township: 27 Section: 18 Range: 21	Pump Test Info Flag:
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082N036121 Well: 1	WATER QUALITY:
Class of Well:	Character:
Subclass of Well:	Colour:
Orientation of Well:	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method: Drilled	Water Utility:
Diameter: 6.0 inches	Water Supply System Name:
Casing drive shoe:	Water Supply System Well Name:
Well Depth: 190 feet	
Elevation: 0 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: inches	Flag:
Well Cap Type:	Material:
Bedrock Depth: 47 feet	Method:
Lithology Info Flag:	Depth (ft):

File Info Flag:	Thickness (in):
Sieve Info Flag:	
Screen Info Flag:	WELL CLOSURE INFORMATION:
	Reason For Closure:
Site Info Details:	Method of Closure:
Other Info Flag:	Closure Sealant Material:
Other Info Details:	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:
YIELD: 0.5-0.75 GPM DOMESTIC

LITHOLOGY INFORMATION:

From 0 to 0 Ft. # 2 HOLE
From 0 to 25 Ft. SANDY GRAVEL & CLAY
From 25 to 36 Ft. SANDY GRAVEL & CLAY
From 36 to 47 Ft. CLAY,LITTLE GRAVEL
From 47 to 190 Ft. BEDROCK

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Report 1 - Detailed Well Record

Well Tag Number: 976	Construction Date:
Owner: CALVIN LUMLEY	Driller: Owen's Drilling Ltd.
Address: LAPP RD	Well Identification Plate Number:
Area: GOLDEN	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: (Driller's Estimate) DRY HOLE
District Lot: Plan: Lot: 10	Development Method:
Township: 27 Section: 18 Range: 21	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082N036121 Well: 2	WATER QUALITY:
Class of Well:	Character:
Subclass of Well:	Colour:
Orientation of Well:	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method: Drilled	Water Utility:
Diameter: 6.0 inches	Water Supply System Name:
Casing drive shoe:	Water Supply System Well Name:
Well Depth: 40 feet	
Elevation: 0 feet (ASL)	SURFACE SEAL:

Final Casing Stick Up: inches	Flag: N
Well Cap Type:	Material:
Bedrock Depth: feet	Method:
Lithology Info Flag: N	Depth (ft):
File Info Flag: N	Thickness (in):
Sieve Info Flag: N	
Screen Info Flag: N	WELL CLOSURE INFORMATION:
	Reason For Closure:
Site Info Details:	Method of Closure:
Other Info Flag:	Closure Sealant Material:
Other Info Details:	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size
Casing from	to feet	Diameter	Material
			Drive Shoe

GENERAL REMARKS:
YIELD: DRY HOLE DOMESTIC

LITHOLOGY INFORMATION:

From 0 to 16 Ft. SANDY GRAVEL & CLAY
 From 16 to 19 Ft. CLAY(WET STICKY)BROWN
 From 19 to 31 Ft. SANDY GRAVEL & CLAY
 From 31 to 40 Ft. CLAY,WET,BLUIISH GRAY

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Report 1 - Detailed Well Record

Well Tag Number: 17691	Construction Date: 1963-01-01 00:00:00
Owner: GOLDEN ARMS HOTEL	Driller: Interprovincial Drilling
Address:	Well Identification Plate Number:
Area: GOLDEN	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: 0 (Driller's Estimate)
District Lot: Plan: Lot:	Development Method:
Township: 27 Section: 13 Range: 22	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082N036112 Well: 7	WATER QUALITY:
Class of Well:	Character:
Subclass of Well:	Colour:
Orientation of Well:	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method: Drilled	Water Utility:
Diameter: 0.0 inches	Water Supply System Name:
Casing drive shoe:	Water Supply System Well Name:
Well Depth: 40 feet	
Elevation: 0 feet (ASL)	SURFACE SEAL:

Final Casing Stick Up: inches	Flag: N
Well Cap Type:	Material:
Bedrock Depth: feet	Method:
Lithology Info Flag: N	Depth (ft):
File Info Flag: N	Thickness (in):
Sieve Info Flag: N	
Screen Info Flag: N	WELL CLOSURE INFORMATION:
	Reason For Closure:
Site Info Details:	Method of Closure:
Other Info Flag:	Closure Sealant Material:
Other Info Details:	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size
Casing from	to feet	Diameter	Material
			Drive Shoe

GENERAL REMARKS:
YIELD: GOOD SUPPLY (WATER VERY HARD) HOTEL. NO LOG. NO LITHOLOGIC INFORMATION AVAILABLE.

LITHOLOGY INFORMATION:

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Report 1 - Detailed Well Record

Well Tag Number: 18186	Construction Date: 1963-08-01 00:00:00
Owner: GOLDEN WEIGH SCALE	Driller: Golden Drilling
Address:	Well Identification Plate Number:
Area: GOLDEN	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: 0 (Driller's Estimate)
District Lot: Plan: Lot:	Development Method:
Township: 27 Section: 13 Range: 22	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082N036112 Well: 6	WATER QUALITY:
Class of Well:	Character:
Subclass of Well:	Colour:
Orientation of Well:	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Other	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method: Drilled	Water Utility:
Diameter: 6.0 inches	Water Supply System Name:
Casing drive shoe:	Water Supply System Well Name:
Well Depth: 70 feet	
Elevation: 0 feet (ASL)	SURFACE SEAL:

Final Casing Stick Up: inches	Flag: N
Well Cap Type:	Material:
Bedrock Depth: feet	Method:
Lithology Info Flag: N	Depth (ft):
File Info Flag: N	Thickness (in):
Sieve Info Flag: N	
Screen Info Flag: N	WELL CLOSURE INFORMATION:
	Reason For Closure:
Site Info Details:	Method of Closure:
Other Info Flag:	Closure Sealant Material:
Other Info Details:	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size
Casing from	to feet	Diameter	Material Drive Shoe

GENERAL REMARKS:
YIELD: NO DATA WEIGH SCALE. NO LOG. NO LITHOLOGIC INFORMATION AVAILABLE.

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Report 1 - Detailed Well Record

Well Tag Number: 55357	Construction Date: 1985-10-01 00:00:00
Owner: PETER KORN	Driller: Owen's Drilling Ltd.
Address: COLUMBIA GARDENS ROAD	Well Identification Plate Number:
Area:	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: 5 (Driller's Estimate) Gallons per Minute (U.S./Imperial)
District Lot: 8383 Plan: 10244 Lot: 10	Development Method:
Township: Section: Range:	Pump Test Info Flag:
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level: 45 feet
BCGS Number (NAD 83): 082F003332 Well: 2	WATER QUALITY:
Class of Well:	Character:
Subclass of Well:	Colour:
Orientation of Well:	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method: Drilled	Water Utility:
Diameter: 0.0 inches	Water Supply System Name:
Casing drive shoe:	Water Supply System Well Name:
Well Depth: 400 feet	
Elevation: 0 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: inches	Flag:
Well Cap Type:	Material:
Bedrock Depth: 12 feet	Method:
Lithology Info Flag:	Depth (ft):

File Info Flag:	Thickness (in):
Sieve Info Flag:	
Screen Info Flag:	WELL CLOSURE INFORMATION:
	Reason For Closure:
Site Info Details:	Method of Closure:
Other Info Flag:	Closure Sealant Material:
Other Info Details:	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:

MAR. 86, WELL LOCATED. GOOD DRINKING WATER AND SUFFICIENT QUANTITY.

LITHOLOGY INFORMATION:

From 0 to 12 Ft. sandy gravel and boulders

From 12 to 120 Ft. broken bedrock

From 0 to 0 Ft. Well deepened - original drilled in May

From 0 to 0 Ft. '82

From 120 to 400 Ft. bedrock

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Report 1 - Detailed Well Record

Well Tag Number: 57370	Construction Date: 1987-08-16 00:00:00
Owner: VICTOR MORIN	Driller: Dan Gare Drilling
Address: MORIN RD.	Well Identification Plate Number:
Area: GOLDEN	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: 2 (Driller's Estimate) Gallons per Minute (U.S./Imperial)
District Lot: Plan: 13414 Lot: 2	Development Method:
Township: 27 Section: 19 Range: 21	Pump Test Info Flag: Y
Indian Reserve: Meridian: W5 Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level: 150 feet
BCGS Number (NAD 83): 082N036123 Well: 7	WATER QUALITY:
Class of Well:	Character:
Subclass of Well:	Colour:
Orientation of Well:	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method: Drilled	Water Utility:
Diameter: 6.0 inches	Water Supply System Name:
Casing drive shoe:	Water Supply System Well Name:
Well Depth: 340 feet	
Elevation: 0 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: inches	Flag:
Well Cap Type:	Material:
Bedrock Depth: 55 feet	Method:
Lithology Info Flag:	Depth (ft):

File Info Flag:	Thickness (in):
Sieve Info Flag:	
Screen Info Flag:	WELL CLOSURE INFORMATION:
	Reason For Closure:
Site Info Details:	Method of Closure:
Other Info Flag:	Closure Sealant Material:
Other Info Details:	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe

GENERAL REMARKS:
YIELD: 2 GPM DOMESTIC

LITHOLOGY INFORMATION:

From 0 to 15 Ft. CLAY
From 15 to 20 Ft. BLUE CLAY
From 20 to 48 Ft. CLAY
From 48 to 55 Ft. BROKEN ROCK
From 55 to 340 Ft. BASALT & DOLEMITE W/QUARTZ

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Report 1 - Detailed Well Record

Well Tag Number: 90454	Construction Date: 1999-09-01 00:00:00
Owner: JMAIFF	Driller: J. R. Drilling
Address:	Well Identification Plate Number:
Area:	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: .125 (Driller's Estimate) U.S. Gallons per Minute
District Lot: Plan: 17480 Lot: 3	Development Method: Air lifting
Township: 27 Section: 18 Range: 21	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level: 75 feet
BCGS Number (NAD 83): 082N036121 Well:	WATER QUALITY:
Class of Well: Water supply	Character:
Subclass of Well: Domestic	Colour:
Orientation of Well: Vertical	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag: N
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	Water Utility:
Diameter: inches	Water Supply System Name:
Casing drive shoe: Y N	Water Supply System Well Name:
Well Depth: 98 feet	
Elevation: feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: inches	Flag: N
Well Cap Type:	Material:
Bedrock Depth: 12 feet	Method:

Lithology Info Flag: Y	Depth (ft):
File Info Flag: N	Thickness (in):
Sieve Info Flag: N	Liner from To: feet
Screen Info Flag: N	
Site Info Details:	WELL CLOSURE INFORMATION:
Other Info Flag:	Reason For Closure:
Other Info Details:	Method of Closure:
	Closure Sealant Material:
	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size
Casing from	to feet	Diameter	Material
0	20	6	Steel
20	98	6	Open hole
			Drive Shoe
			Y
			N

GENERAL REMARKS:
MEASUREMENTS FROM TOP OF CASING. PITLESS UNIT WELDED. WATER QUALITY & QUANTITY NOT GUARANTEED BY CONTRACTOR.

LITHOLOGY INFORMATION:

From 0 to 12 Ft. till
From 12 to 98 Ft. bedrock

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Report 1 - Detailed Well Record

Well Tag Number: 92595	Construction Date: 1999-11-29 00:00:00
Owner: BOHRMANN	Driller: J. R. Drilling
Address:	Well Identification Plate Number:
Area:	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
Land District	Well Yield: 1 (Driller's Estimate) U.S. Gallons per Minute
District Lot: Plan: 15055 Lot: 1	Development Method: Air lifting
Township: 27 Section: 19 Range: 21	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082N036123 Well:	WATER QUALITY:
	Character:
Class of Well: Water supply	Colour:
Subclass of Well: Domestic	Odour:
Orientation of Well: Vertical	Well Disinfected: N
Status of Well: New	EMS ID:
Licence General Status: UNLICENSED	Water Chemistry Info Flag: N
Well Use: Private Domestic	Field Chemistry Info Flag:
Observation Well Number:	Site Info (SEAM):
Observation Well Status:	
Construction Method:	Water Utility:
Diameter: 6 inches	Water Supply System Name:
Casing drive shoe: Y	Water Supply System Well Name:
Well Depth: 600 feet	
Elevation: feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: inches	Flag: N
Well Cap Type:	Material:
Bedrock Depth: 10 feet	Method:
Lithology Info Flag: Y	Depth (ft):
File Info Flag: N	Thickness (in):
Sieve Info Flag: N	Liner from To: feet
Screen Info Flag: N	
	WELL CLOSURE INFORMATION:

Site Info Details:	Reason For Closure:
Other Info Flag:	Method of Closure:
Other Info Details:	Closure Sealant Material:
	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
0	35	6	Steel	Y

GENERAL REMARKS:

MEASUREMENTS FROM TOP OF CASING. PITLESS UNIT: WELDED. SHOE: BARBER. WATER QUALITY & QUANTITY NOT GUARANTEED BY CONTRACTOR.

LITHOLOGY INFORMATION:

From 0 to 10 Ft. till

From 10 to 600 Ft. bedrock

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Information Disclaimer

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Report 1 - Detailed Well Record

Well Tag Number: 99638	Construction Date: 2000-10-25 00:00:00
Owner: KATS CONTRACTING	Driller: Owen's Drilling Ltd.
Address: 532 HIETALA ROAD	Well Identification Plate Number:
Area: GOLDEN	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: 6 (Driller's Estimate) U.S. Gallons per Minute
District Lot: Plan: Lot:	Development Method: Air lifting
Township: 27 Section: 18 Range: 21	Pump Test Info Flag: N
Indian Reserve: Meridian: W5M Block: A	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level: 50 feet
BCGS Number (NAD 83): 082N036121 Well:	WATER QUALITY:
Class of Well: Water supply	Character:
Subclass of Well: Domestic	Colour:
Orientation of Well: Vertical	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag: N
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	Water Utility:
Diameter: inches	Water Supply System Name:
Casing drive shoe: Y N	Water Supply System Well Name:
Well Depth: 276 feet	
Elevation: feet (ASL)	SURFACE SEAL:

Final Casing Stick Up: 6 inches

Well Cap Type: PLASTIC CAP

Bedrock Depth: 18 feet

Lithology Info Flag: N

File Info Flag: N

Sieve Info Flag: N

Screen Info Flag: N

Site Info Details:

Other Info Flag:

Other Info Details:

Flag: N

Material:

Method:

Depth (ft):

Thickness (in):

Liner from To: feet

WELL CLOSURE INFORMATION:

Reason For Closure:

Method of Closure:

Closure Sealant Material:

Closure Backfill Material:

Details of Closure:

Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
0	36	6	Steel	Y
36	276	5.88	Open hole	N

GENERAL REMARKS:

260' OF PVC LINER. BOTTOM 40' PERFORATED. SHOE: 1X6" CARBIDE BOTTON. RECOMMENDED PUMP TYPE: SUB

LITHOLOGY INFORMATION:

From 0 to 18 Ft. CLAY, GRAVEL, COBBLES

From 18 to 36 Ft. BEDROCK, BROKEN

From 36 to 150 Ft. 2 Gallons per Minute (U.S./Imperial) bedrock

From 150 to 257 Ft. 2 Gallons per Minute (U.S./Imperial) bedrock

From 256 to 276 Ft. 1 Gallons per Minute (U.S./Imperial) bedrock

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Information Disclaimer

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Report 1 - Detailed Well Record

Well Tag Number: 99716	Construction Date: 2005-04-28 00:00:00
Owner: ERICKSON	Driller: Owen's Drilling Ltd.
Address: 561 LAPP ROAD	Well Identification Plate Number:
Area: GOLDEN	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: 1.5 (Driller's Estimate) U.S. Gallons per Minute
District Lot: Plan: Lot: LS 9	Development Method: Air lifting
Township: 27 Section: 18 Range: 21	Pump Test Info Flag: N
Indian Reserve: Meridian: W5M Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082N036121 Well:	WATER QUALITY:
Class of Well: Water supply	Character:
Subclass of Well: Domestic	Colour:
Orientation of Well: Vertical	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Private Domestic	Water Chemistry Info Flag: N
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	Water Utility:
Diameter: inches	Water Supply System Name:
Casing drive shoe: Y N	Water Supply System Well Name:
Well Depth: 155 feet	
Elevation: feet (ASL)	SURFACE SEAL:

Final Casing Stick Up: 6 inches

Well Cap Type:

Bedrock Depth: 30 feet

Lithology Info Flag: Y

File Info Flag: N

Sieve Info Flag: N

Screen Info Flag: N

Site Info Details:

Other Info Flag:

Other Info Details:

Flag: N

Material:

Method:

Depth (ft):

Thickness (in):

Liner from To: feet

WELL CLOSURE INFORMATION:

Reason For Closure:

Method of Closure:

Closure Sealant Material:

Closure Backfill Material:

Details of Closure:

Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
0	35	6	Steel	Y
35	155	5.88	Open hole	N

GENERAL REMARKS:

SHOE 6" CARBIDE BUTTON RECOMMENDED PUMP TYPE SUB PUMPING RATE 1 USGPM

LITHOLOGY INFORMATION:

From 0 to 30 Ft. CLAY GRAVEL

From 30 to 35 Ft. CASED BEDROCK

From 35 to 155 Ft. bedrock

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Report 1 - Detailed Well Record

Well Tag Number: 113162	Construction Date: 2017-04-17 00:00:00
Owner: emcon road services	Driller: J. R. Drilling
Address: Station Avenue	Well Identification Plate Number: 40028
Area: Golden	Plate Attached By: rick france
	Where Plate Attached: side of casing
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: 50 (Driller's Estimate) U.S. Gallons per Minute
District Lot: Plan: Lot:	Development Method: Air lifting
Township: Section: Range:	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level: 31 feet
BCGS Number (NAD 83): 082N026334 Well:	WATER QUALITY:
Class of Well: Water supply	Character:
Subclass of Well: Non-domestic	Colour:
Orientation of Well: Vertical	Odour:
Status of Well: New	Well Disinfected: Y
Licence General Status: UNLICENSED	EMS ID:
Well Use: Commercial and Industrial	Water Chemistry Info Flag: N
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	Water Utility:
Diameter: 6 inches	Water Supply System Name:
Casing drive shoe: Y	Water Supply System Well Name:
Well Depth: 103 feet	
Elevation: feet (ASL)	SURFACE SEAL:

Final Casing Stick Up: 24 inches

Well Cap Type: vermin proof

Bedrock Depth: feet

Lithology Info Flag: N

File Info Flag: N

Sieve Info Flag: N

Screen Info Flag: N

Site Info Details:

Other Info Flag:

Other Info Details:

Flag: N

Material: Bentonite clay

Method: Poured

Depth (ft): 16 feet

Thickness (in): 2 inches

Liner from To: feet

WELL CLOSURE INFORMATION:

Reason For Closure:

Method of Closure:

Closure Sealant Material:

Closure Backfill Material:

Details of Closure:

Screen from	to feet	Type	Slot Size
99	103		40
97	104		null

Casing from	to feet	Diameter	Material	Drive Shoe
0	100	6	Steel	Y

GENERAL REMARKS:

LITHOLOGY INFORMATION:

From 0 to 11 Ft. Loose sand with gravel till tan
 From 11 to 105 Ft. Dense sand with gravel till tan
 From 105 to 106 Ft. Dense clay tan

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Report 1 - Detailed Well Record

Well Tag Number: 113164	Construction Date: 2017-04-20 00:00:00
Owner: emcon road services	Driller: J. R. Drilling
Address: Station Road	Well Identification Plate Number: 35718
Area: Golden	Plate Attached By: rick france
	Where Plate Attached: side of casing
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: (Driller's Estimate)
District Lot: Plan: Lot:	Development Method:
Township: Section: Range:	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082N026334 Well:	WATER QUALITY:
Class of Well: Monitoring	Character:
Subclass of Well: Temporary	Colour:
Orientation of Well: Vertical	Odour:
Status of Well: New	Well Disinfected: Y
Licence General Status: UNLICENSED	EMS ID:
Well Use: Observation Well	Water Chemistry Info Flag: N
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method: Drilled	Water Utility:
Diameter: 2 inches	Water Supply System Name:
Casing drive shoe: Y	Water Supply System Well Name:
Well Depth: 14 feet	
Elevation: feet (ASL)	SURFACE SEAL:

Final Casing Stick Up: 6 inches	Flag: N
Well Cap Type: locking cap	Material: Bentonite clay
Bedrock Depth: feet	Method: Poured
Lithology Info Flag: N	Depth (ft): 5 feet
File Info Flag: N	Thickness (in): 2 inches
Sieve Info Flag: N	Liner from To: feet
Screen Info Flag: N	
Site Info Details:	WELL CLOSURE INFORMATION:
Other Info Flag:	Reason For Closure:
Other Info Details:	Method of Closure:
	Closure Sealant Material:
	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size
Casing from	to feet	Diameter	Material
0	15	6	null
			Drive Shoe
			Y

GENERAL REMARKS:

LITHOLOGY INFORMATION:

From 0 to 15 Ft. Dense clay sand with gravel grey

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Report 1 - Detailed Well Record

Well Tag Number: 113165	Construction Date: 2017-04-19 00:00:00
Owner: emcon road services	Driller: J. R. Drilling
Address: Station Ave	Well Identification Plate Number: 35717
Area: Revelstoke	Plate Attached By: rick france
	Where Plate Attached: side of casing
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
KOOTENAY Land District	Well Yield: (Driller's Estimate)
District Lot: Plan: Lot:	Development Method: Air lifting
Township: Section: Range:	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082N026334 Well:	WATER QUALITY:
Class of Well: Monitoring	Character:
Subclass of Well: Temporary	Colour:
Orientation of Well: Vertical	Odour:
Status of Well: New	Well Disinfected: Y
Licence General Status: UNLICENSED	EMS ID:
Well Use: Observation Well	Water Chemistry Info Flag: N
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method:	Water Utility:
Diameter: 2 inches	Water Supply System Name:
Casing drive shoe: Y	Water Supply System Well Name:
Well Depth: 11 feet	
Elevation: feet (ASL)	SURFACE SEAL:

Final Casing Stick Up: 6 inches	Flag: N
Well Cap Type: locking cap	Material: Bentonite clay
Bedrock Depth: feet	Method: Poured
Lithology Info Flag: N	Depth (ft): 5 feet
File Info Flag: N	Thickness (in): 2 inches
Sieve Info Flag: N	Liner from To: feet
Screen Info Flag: N	
Site Info Details:	WELL CLOSURE INFORMATION:
Other Info Flag:	Reason For Closure:
Other Info Details:	Method of Closure:
	Closure Sealant Material:
	Closure Backfill Material:
	Details of Closure:

Screen from	to feet	Type	Slot Size
Casing from	to feet	Diameter	Material
0	15	6	null
			Drive Shoe
			Y

GENERAL REMARKS:

LITHOLOGY INFORMATION:

From 0 to 15 Ft. Dense clay sand with gravel tan

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Red lettering indicates a minimum mandatory information.

See reverse for notes & definitions of abbreviations.

Owner name: Subsac Land Co. Ltd.
Mailing address: Rm 25
Well Location Address: Street no. 5 Street name Hole #5 Town Coquitlam Prov. BC Postal Code V3B 1K0
(or) Legal description: Lot 5 Plan SE 1/4 DL 219 Block 219 Subdiv. 219 Land District Coquitlam
(or) MD 506-506-778 and Description of well location (attach sketch, if nec.)

NAD 83 Zone: (see note 2) UTM Easting and UTM Northing m 0 Latitude (see note 3) 0 Longitude 0

Method of drilling: ☒ Rotary ☐ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ excavating ☐ other (specify)
Orientation of well: ☒ vertical ☐ horizontal Ground elevation: ft (m) Method (see note 4)

Class of well (see note 3): Sub-class of well:

Water supply well: Indicate intended water use ☒ private domestic ☐ water supply system ☐ irrigation ☐ commercial or industrial ☐ other (specify)

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Material Description (Use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g. fractured, weathered, well sorted, silty, washed, closure details)
0	30	MD	BROWN	SILT/GRANUL		
30	216	SEPT	GRAY	BEDROCK		

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material / Open Hole	Wall Thickness in	Drive Shoe
0	36	6	STEEL	219	BARREL

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size
------------------	----------------	-----------	--------------------	-----------

Surface seal: Type: Butterfly Depth: 15 ft
Method of installation: ☒ Poured ☐ Pumped Thickness: 1 in
Backfill: Type: Depth: ft
Liner: ☒ PVC ☐ Other (specify):
Diameter: 4 in Thickness: 250 in
From: 16 ft (bgl) To: 216 ft (bgl) Perforated: From: 16 ft (bgl) To: 216 ft (bgl)

Intake: ☐ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☐ Telescope ☐ Pipe size
Screen material: ☐ Stainless steel ☐ Plastic ☐ Other (specify):
Screen opening: ☐ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☐ Bar ☐ Plug ☐ Plate ☐ Other (specify):
Filter pack: From: ft To: ft Thickness: in
Type and size of material:

Developed by:

☒ Air lifting ☐ Surging ☐ Jetting ☐ Pumping ☐ Bailing
☐ Other (specify): Total duration: hrs

Notes:

Well yield estimated by:

☐ Pumping ☒ Air lifting ☐ Bailing ☐ Other (specify):
Rate: 5 1/2 USgpm Duration: 1 hrs
SWL before test: ft (bgl) Pumping water level: ft (bgl)

Obvious water quality characteristics:

☒ Fresh ☐ Salty ☐ Clear ☒ Cloudy ☐ Sediment ☐ Gas

Colour/odour:

Water sample collected: ☐

Well driller (print clearly):

Name (first, last) (see note 19): W. L. R. 219 / Mike Butcher

Registration no. (see note 20):

Consultant (if applicable, name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the Water Act and the Groundwater Protection Regulation.

Signature of Driller Responsible: [Signature]

PLEASE NOTE: The information recorded in this well report constitutes the basis for the well's construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed by the number of factors, including natural variability, human activities and the state of the works, which may change over time.

Final well completion data:

Total depth drilled: 216 ft Finished well depth: 216 ft (bgl)
Final stick up: 12 in Depth to bedrock: 30 ft (bgl)
SWL: ft (bgl) Estimated well yield: 5 1/2 USgpm
Artesian flow: USgpm, or Artesian pressure: ft

Type of well cap: 5 ft Well disinfected: ☐ Yes ☒ No
Where well ID plate is attached: Sink

Well closure information:

Reason for closure:
Method of closure: ☐ Poured ☐ Pumped
Sealant material: Backfill material:
Details of closure (see note 17):

Date of work (YYYYMMDD):

Started: 2003/05/23 Completed: 2003/05/26
Comments: Water Quality & Quantity not Guaranteed by Contractor

Appendix D:

Well Logs for

Current Monitoring Program

5-Year 2018 Hydrogeological Assessment
CSRD
Golden RDF
WWAL Ref: 14-024-21



Symbol Legend

Common Symbols

	Sand		Silty Sand		Sandy Silt		Clayey Sand
	Sand and Gravel		Gravel		Silt		Clayey Silt
	Clay		Silty Clay		Sandy Silty Clay		Silty Sand and Gravel
	Silty Gravel		Silty Clay and Gravel		Topsoil		Peat
	Limestone		Shale				

Well Symbols

Pipe and Screen

	None		Pipe		Double Walled Pipe		Sealed Pipe
	Fine Screen		Coarse Screen		Slotted Screen		Slotted Screen

Top Fittings

	None		Cap		Flush-mounted Cap		Above-ground Cap
	Connector		Reducer		Pipe Break		Packer

Bottom Fittings

	None		Cap		Cone		Screw-on Cap
	Connector		Enlarger		Pipe Break		Packer

Packing and Backfill

	None		Bentonite		Clay		Silt
	Cement		Sand		Sand and Gravel		Gravel

Project No: 7130-010.01

Client: CSRD

Location: Golden, BC

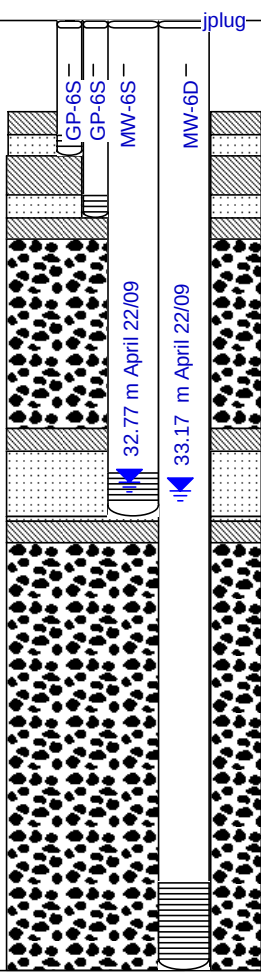
Logged by/ Checked by: BRM/ MG

Test Hole / Borehole I.D.: TH-6 (6")

Well I.D.: MW-6S, MW-6D, GP-6S, GP-6D

Location on site: near weight scale (replaces TH4)

Northing/ Easting/ Elevation: 0

SUBSURFACE PROFILE			SAMPLE			Well Details	Well Completion Details / Remarks
Depth	Symbol	Description	Type	I.D.	Flag for analysis		
0		Ground Surface					
10		Light brown, GRAVEL, w. sand, loose, dry				Configuration: - Two groundwater monitoring wells (each 2" diameter) - Two gas monitoring probes (each 1" diameter) - Schedule 40 PVC - Gas piezos. are threaded 20/40 sand pack around each monitoring well Screen Assembly: - No. 10 slot PVC MW6D -Screened in bedrock - Screened btw 59.76 m (196 ft) and 65.85 (216 ft) bgs MW6S -Screened in surficial deposits (overburden) -Screened btw 31.40 m (103 ft) and 34.45 m (113 ft) bgs GP6D -Screened btw 12.20 m (40 ft) and 16.77 m (55 ft) bgs GP6S -Screened btw 7.93 m (26 ft) and 9.45 m (31 ft) bgs Casing height =	
30		Light brown, SILT w/ sand, trace gravel, loose, dry					
50		Grey, GRAVEL w/ sand and silt, loose, dry					
60		Grey, GRAVEL w/ sand and silt, loose, dry					
70		Note: larger gravel than above					
80		Light brown, (f.) SAND w/ silt and trace gravel, dense, moist					
90		Grey, (m.) SAND, w/ silt and gravel, dense, moist					
100		Grey, cemented GRAVEL, dense, dry					
110		Yellow, SILT w/ some angular gravel and m.-c. sand, dense, moist					
130		Black, Limestone bedrock					
220		End of Borehole					



Contractor: JR Drilling Central Ltd.

Operator(s): Jerry Oppen

Drill Method: Dual Air Rotary

Ground conditions: bare

Date: April 20, 2009

Time:

Temperature: 10 degC

Sheet: 1 of 1

Project No: 7130-010.01

Client: CSRD

Location: Golden, BC

Logged by/ Checked by: BRM/ MG

Test Hole / Borehole I.D.: TH-7 (6")

Well I.D.: MW-7, GP-7S, GP-7D (replaces TH3)

Location on site: Golden-Donald Upper Rd.

Northing/ Easting/ Elevation: 0

SUBSURFACE PROFILE			SAMPLE			Well Details	Well Completion Details / Remarks
Depth	Symbol	Description	Type	I.D.	Flag for analysis		
0		Ground Surface					
0		Yellow/ brown, SILT, loose, damp				Configuration: - One groundwater monitoring well (2" diameter) - Two gas monitoring probes (each 1" diameter) - Schedule 40 PVC - Gas probes are threaded 20/40 sand pack around each monitoring well Screen Assembly: - No. 10 slot PVC MW-7 - Screened in the surficial deposits (overburden) - Screened btw 25.6 m (84 ft) and 31.7 m (104 ft) bgs GP-7D - Screened btw 13.72 m (45 ft) and 15.24 m (50 ft) bgs GP-7S - Screened btw 4.5 m (15 ft) and 6.10 m (20 ft) bgs Casing Height: 1.2 m (3.9 ft)	
10		Grey, SILT and clay, dense, moist					
20		Grey, SILT, dense, moist					
30							
40							
50		Light brown, SILT w/ (f.) sand and gravel, loose, moist, fining upwards					
60		Grey, cemented GRAVEL w/ sand and silt, dense, damp					
70		Grey, SILT trace sand, dense, moist					
80		Grey, GRAVEL w/ (m.) sand and silt, dense, moist					
90		Grey, (f.-m.) SAND w/ silt, dense, moist, coarsening upward					
100							
110		Grey, cemented GRAVEL, dense, dry					
120		Grey, (f.) angular GRAVEL w/ sand and silt, dense, dry,					
130							
140		End of Borehole					



Contractor: JR Drilling Central Ltd.

Operator(s): Jerry Opper

Drill Method: Dual Air Rotary

Ground conditions: bare

Date: April 23, 2009

Time:

Temperature: 7 deg C

Sheet: 1 of 1

Project No: 7130-010.01

Test Hole / Borehole I.D.: TH3

Client: CSRD

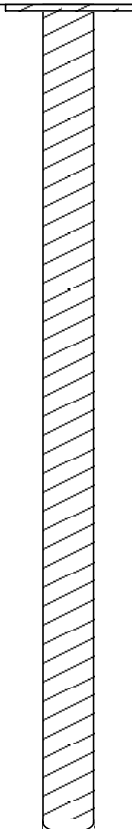
Well I.D.: TH-3 (well closure)

Location: Golden, BC

Location on site: on Golden-Donald Upper Rd

Logged by/ Checked by: BRM/ MG

Northing/ Easting/ Elevation: 0

SUBSURFACE PROFILE			SAMPLE			Well Details	Well Completion Details / Remarks
Depth	Symbol	Description	Type	I.D.	Flag for analysis		
0		Ground Surface					
10						TH-3 was replaced by MW-7. TH-3 was decommissioned according to the Groundwater Protection Regulation. The surface casing was removed, the 2" piezometer was cut approximately 4" below ground surface and bentonite chips were poured into the casing. Bentonite was poured around the outer annulus of the piezometer to bring the hole to ground surface.	
20							
30							
40							
50							
60		End of Borehole					
70							



Contractor: JR Drilling

Date: April 20, 2009

Operator(s): Jerry

Time:

Drill Method:

Temperature: 10 degC

Ground conditions: bare

Sheet: 1 of 1

CLIENT: RCP	PROJECT: Hydrogeological	TESTHOLE: BH95-03
LOCATION: Golden Landfill	Assessment - Golden BC	PROJECT NO: KE95-057
DRILL RIG: Becker Hammer	SURF ELV: 908.5m ASL.	CO-ORDINATES:

DEPTH (m) ELV. (m)	INDEX: METHANE %	Plot	SOIL DESCRIPTION	Lab Test	SAMPLES	COMPLETION DETAILS
0	5	10	15	20		
Gravel					Depth (m)	N
2.0 906.5	0-8.54		Silt-some fine sand, some gravel, fine to coarse, iso. cobbles, non-plastic, red/brown, dense, damp	AR1 1.5	50	Stickup 1.2m 50mm dia. Solid pipe
4.0 904.5				AR2 3.0 D1 3.5/3.95		Bentonite Grout
6.0 902.5				AR3 4.5		Top 6.0m
8.0 900.2				AR4 6.0 D2 6.5/6.95	50	
10.0 898.2	8.54-11.3		Silt-and fine sand, trace gravel, fine to coarse, non-plastic, iso. cobbles, grey, hard, moist.	AR5 7.5		Sand
12.0 896.2	11.3-15.5		Silt-some fine sand, trace gravel, fine to coarse, non-plastic, grey/brown, hard, moist	AR6 10.0		
14.0 894.2				AR7 11.5		
16.0 892.2	15.5-18.3		Sand-fine and silt, some gravel fine to coarse, occ. cobbles, dense, light brown, damp.	AR8 13.0 D3 13.5/13.9 AR9 14.0	50	0.010" slotted pipe
18.0 890.2				AR10 15.0 D4 16/16.45	75	
20.0 888.2				AR11 16.5		
22.0				AR12 18.0		18.3m
			End of TH95-01 at 18.3m - No groundwater seepage Monitoring Well installed			
Prepared by: Paul Blackett			Reviewed by:		Figure: 3	
Groundwater Depth: no groundwater			Borehole Depth: 18.3m below surface		Date: 10/9/95	

Project No: 7130-010.01

Test Hole / Borehole I.D.: TH4

Client: CSRD

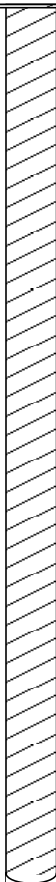
Well I.D.: TH-4 (well closure)

Location: Golden, BC

Location on site: near weight scale

Logged by/ Checked by: BRM/ MG

Northing/ Easting/ Elevation: 0

SUBSURFACE PROFILE			SAMPLE			Well Details	Well Completion Details / Remarks
Depth	Symbol	Description	Type	I.D.	Flag for analysis		
0		Ground Surface					
10						TH-4 was replaced by MW-6S. TH-4 was decommissioned according to the Groundwater Protection Regulation. The surface casing was removed, the 2" piezometer was cut approximately 4" below ground surface and bentonite chips were poured into the casing. Bentonite was poured around the outer annulus of the piezometer to bring the hole to ground surface.	
20							
30							
40							
50							
60							
70							
80							
90							
100							
110		End of Borehole					



Contractor: JR Drilling

Date: April 20, 2009

Operator(s): Jerry

Time:

Drill Method:

Temperature: 10 degC

Ground conditions: bare

Sheet: 1 of 1

CLIENT: RCP	PROJECT: Hydrogeological	TESTHOLE: BH95-04
LOCATION: Golden Landfill	Assessment - Golden BC	PROJECT NO: KE95-057
DRILL RIG: Becker Hammer	SURF ELV: 916.9m ASL	CO-ORDINATES:

DEPTH (m) ELV. (m)	INDEX: METHANE %	Plot	SOIL DESCRIPTION	Lab Test	SAMPLES	COMPLETION DETAILS
	0 5 10 15 20					
Grass					Depth (m) N	Stickup 1.2m
2.0 914.9	0-3.35		Silt-and fine sand, trace gravel fine to coarse, occ. cobbles, non-plastic, dense, yellow/brown, damp.	AR1 1.5	50mm dia. Solid pipe	
4.0 912.9	3.35-5.49		Gravel-fine to coarse, and silt, trace sand fine to coarse, occ. cobbles, light brown, moist.	AR2 3.0 D1 3.5/3.95	Bentonite Grout & backfill	
6.0 910.9	5.49-11.0		Silt-and fine sand, trace coarse sand, trace gravel, fine to coarse, iso. cobbles, non-plastic, grey/brown, hard, moist.	AR3 4.5		
8.0 908.9				AR4 6.0 D2 6.5/6.95		
10.0 906.9				AR5 7.5		
12.0 904.9	11.0-12.8		Sand-fine to medium, and gravel, fine to coarse, iso. cobbles, trace silt, dense, red/brown, moist.	AR6 10.0 D3 10/10.45		
14.0 902.9	12.8-17.7		Sand- fine to medium, and silt, little gravel fine to coarse, iso. cobbles, brown, hard, moist.	AR7 11.5		
16.0 900.2				AR8 13.0 D2 13.5/13.9	0.010" slotted pipe	
18.0 898.2	17.7-30.48		Sand - fine and silt, trace gravel, fine to coarse, brown, hard, moist.	AR9 14.0		
20.0 896.2				AR10 15.0 D4 15/15.45		
30.0 894.2			End of TH95-01 at 30.48m - No groundwater seepage Monitoring Well installed	AR11 16.5 AR12 18.0 AR13 22.0 AR14 25.0 AR15 27.5 AR16 30.0	Top 20.0m Bot 30.5m	
Prepared by: Paul Blackett			Reviewed by:		Figure:	
Groundwater Depth: no groundwater			Borehole Depth: 30.5m below surface		Date: 10/9/95	

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	COLOR CODE	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 200 SIEVE)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW		RED	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			GP		RED	POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM		YELLOW	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC		YELLOW	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
	SANDS MORE THAN HALF FINE GRAINS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW		RED	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			SP		RED	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM		YELLOW	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE P.I. LESS THAN 4
			SC		YELLOW	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES 200 SIEVE)	SILTS BELOW "A" LINE NEGLECTIBLE ORGANIC CONTENT	$W_L < 50\%$	ML		GREEN	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below)	
		$W_L > 50\%$	MH		BLUE	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS		
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART NEGLECTIBLE ORGANIC CONTENT	$W_L < 30\%$	CL		GREEN	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS		
		$30\% < W_L < 50\%$	CI		GREEN-BLUE	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50\%$	CH		BLUE	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE ON CHART	$W_L < 50\%$	OL		GREEN	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	WHENEVER THE NATURE OF THE FINE CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F", E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		$W_L > 50\%$	OH		BLUE	ORGANIC CLAYS OF HIGH PLASTICITY		
	HIGHLY ORGANIC SOILS			Pt		ORANGE	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE

SPECIAL SYMBOLS



BEDROCK
(Undifferentiated)



VOLCANIC ASH

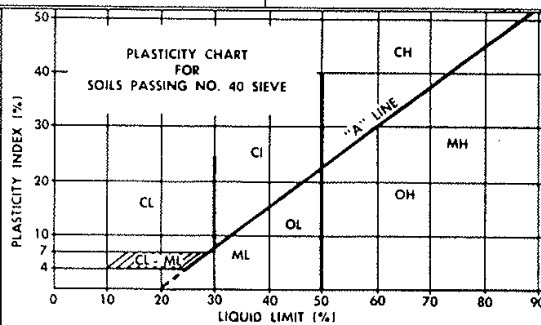
SOIL COMPONENTS

FRACTION	U.S. STANDARD SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
	PASSING	RETAINED	PERCENT	DESCRIPTOR
GRAVEL	coarse	76 mm	50 - 35	and
	fine	19 mm No 4	35 - 20	some
SAND	coarse	4.75 mm	20 - 10	little
	medium	2.00 mm 425 μm	10 - 1	trace
	fine	425 μm 75 μm		
SILT (non plastic) or CLAY (plastic)		75 μm		

OVERSIZE MATERIAL

Rounded or subrounded
COBBLES 76 mm to 203 mm
BOULDERS > 203 mm

Not rounded
ROCK FRAGMENTS > 76 mm
ROCKS > 0.76 cubic metre in volume



- ALL SIEVE SIZES MENTIONED ON THIS CHART ARE U.S. STANDARD, A.S.T.M. E.11.
- BOUNDARY CLASSIFICATIONS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN COMBINED GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%.

Kala Groundwater Consulting Ltd.
Vernon Kamloops

Testhole Log - TH95-01	
Depth (m)	Soil Description
0-5.8	Silt-and fine sand, little gravel fine to coarse, iso. cobbles, non-plastic, dense, yellow/brown, moist.
5.8-6.71	Silt-and sand fine to medium, some gravel fine to coarse, non-plastic, hard, grey, moist.
6.71-8.54	Silt-and fine sand, trace coarse sand, trace gravel, fine to coarse, iso. cobbles, non-plastic, grey/brown, hard, moist.
8.54-11.3	Silt-and fine sand, trace gravel, fine to coarse, non-plastic, iso. cobbles, grey, hard, moist.
11.3-14.9	Silt-some fine sand, trace gravel, fine to coarse, occ. cobbles, non-plastic, red/brown, hard, damp.
14.9-18.9	Clay-and silt, trace fine sand, trace fine gravel, iso. cobbles, low to none plastic, grey, hard, moist.
End of TH95-01 at 18.9m - No groundwater seepage - Monitoring Well installed	

Testhole Log - TH95-02	
Depth (m)	Soil Description
0-9.76	Sand-fine and silt, some gravel fine to coarse, occ. cobbles, dense, light brown, damp. Upper 0.3m fill
9.76-12.8	Sand-fine and silt, some gravel fine to coarse, iso. cobbles, dense, red/brown, moist.
12.8-15.5	Sand-fine, some silt, some gravel fine to coarse, occ. cobbles, dense, red/brown, moist.
15.5-16.5	Silt-some fine sand, trace gravel, fine to coarse, non-plastic, iso. grey/brown, cobbles, stiff, moist.
16.5-20.1	Silt-little fine sand, trace clay, trace gravel, fine to coarse, occ. cobbles, non-plastic, red/brown, hard, damp.
20.1-22.9	Silt - some sand, fine to coarse, trace gravel fine to coarse, iso. cobbles, grey, very hard, non-plastic,
End of TH95-02 at 22.9m - No groundwater seepage - Monitoring Well installed	

Testhole Log - TH95-03	
Depth (m)	Soil Description
0-8.54	Silt-some fine sand, some gravel, fine to coarse, iso. cobbles, non-plastic, red/brown, dense, damp
8.54-11.3	Silt-and fine sand, trace gravel, fine to coarse, non-plastic, iso. cobbles, grey, hard, moist
11.3-15.5	Silt-some fine sand, trace gravel, fine to coarse, non-plastic, grey/brown, hard, moist
15.5-18.3	Sand-fine and silt, some gravel fine to coarse, occ. cobbles, dense, light brown, damp.
End of TH95-03 at 18.3m - No groundwater seepage - Monitoring Well installed	

Testhole Log - TH95-04	
Depth (m)	Soil Description
0-3.35	Silt-and fine sand, trace gravel fine to coarse, occ. cobbles, non-plastic, dense, yellow/brown, damp.
3.35-5.49	Gravel-fine to coarse, and silt, trace sand fine to coarse, occ. cobbles, light brown, moist.
5.49-11.0	Silt-and fine sand, trace coarse sand, trace gravel, fine to coarse, iso. cobbles, non-plastic, grey/brown, hard, moist.
11.0-12.8	Sand-fine to medium, and gravel, fine to coarse, iso. cobbles, trace silt, dense, red/brown, moist.
12.8-17.7	Sand- fine to medium, and silt, little gravel fine to coarse, iso. cobbles, brown, hard, moist.
17.7-30.48	Sand - fine and silt, trace gravel, fine to coarse, brown, hard, moist.
End of TH95-04 at 26.2m - No groundwater seepage - Monitoring Well installed	

Testhole Log - TH95-05	
Depth (m)	Soil Description
0-1.3	Silt-and fine sand, little gravel fine to coarse, iso. cobbles, non-plastic, dense, yellow/brown, moist.
1.3-3.1	Waste-municipal debris, paper, tin plastics, mixed with soil, damp.
3.1-3.4	Sand-fine to medium, some silt, little gravel, fine to coarse, compact, brown, moist.
3.4-5.1	Waste-municipal debris, paper, tin plastics, mixed with soil, damp.
5.1-5.4	Sand-fine to medium, some silt, little gravel, fine to coarse, compact, brown, moist.
5.4-6.2	Waste-municipal debris, paper, tin plastics, mixed with soil, damp.
6.2-7.1	Sand-fine to medium, some silt, little gravel, fine to coarse, compact, brown, moist.
End of TH5 at 7.1m no groundwater-temporary installation	

CLIENT: RCP	PROJECT: Hydrogeological	TESTHOLE: BH95-02
LOCATION: Golden Landfill	Assessment - Golden BC	PROJECT NO: KE95-057
DRILL RIG: Becker Hammer	SURF ELV: 914.0m ASL	CO-ORDINATES:

DEPTH (m) ELV. (m)	INDEX:	Plot	SOIL DESCRIPTION	Lab Test	SAMPLES	COMPLETION DETAILS
-----------------------	--------	------	------------------	----------	---------	-----------------------

0 20 40 60 80 100 120 140

Grass					Depth (m)	N	Stickup 1.2m
0-9.76			Sand-fine and silt, some gravel fine to coarse, occ. cobbles, dense, light brown, damp. <i>Upper 0.3m fill</i>		AR1 1.5		50mm dia. Solid pipe
2.0 912					AR2 3.0		Bentonite Grout
4.0 910					AR3 4.5		Top 6.0m
6.0 908					AR4 6.0		
8.0 906					D1 6.5/6.95	50	
10.0 904	9.76-12.8		Sand-fine and silt, some gravel fine to coarse, iso. cobbles, dense, grey, moist.		AR5 7.5		Sand
12.0 902					AR6 10.0		
14.0 900	12.8-15.5		Sand-fine, some silt, some gravel fine to coarse, occ. cobbles, dense, red/brown, moist.		AR7 11.5		
16.0 898	15.5-16.5		Silt-some fine sand, trace gravel, fine to coarse, non-plastic, iso. grey/brown, cobbles, stiff, moist.		AR8 13.0	50	0.010" slotted pipe
18.0 896	16.5-20.1		Silt-little fine sand, trace clay, trace gravel, fine to coarse, occ. cobbles, non-plastic, red/brown, hard, damp		AR9 14.0		
20.0 894					AR10 15.0		
22.0 892	20.1-22.9		Silt - some sand, fine to coarse, trace gravel fine to coarse, iso. cobbles, grey, very hard, non-plastic, moist.		AR11 16.5		
			<i>End of TH95-01 at 18.9m - No groundwater seepage Well installed</i>		AR12 18.0		
					D3 20/20.45	80	Well base 22.9m

Prepared by: Paul Blackett

Reviewed by:

Figure:

Groundwater Depth: no groundwater

Borehole Depth: 22.9m below surface

Date: 10/9/95

Logged by: Bryer Manwell

Subsurface Geology			Well Details and Notes	Well Construction
Depth	Symbol	Description		
0		Ground Surface	No well installed.	

Project No: 2010-8835.010.006

Well I.D.: TH-8

Client: CSRD

First Water: n/a

Ground Elevation: Approx. 915 m asl

Location: Golden Landfill

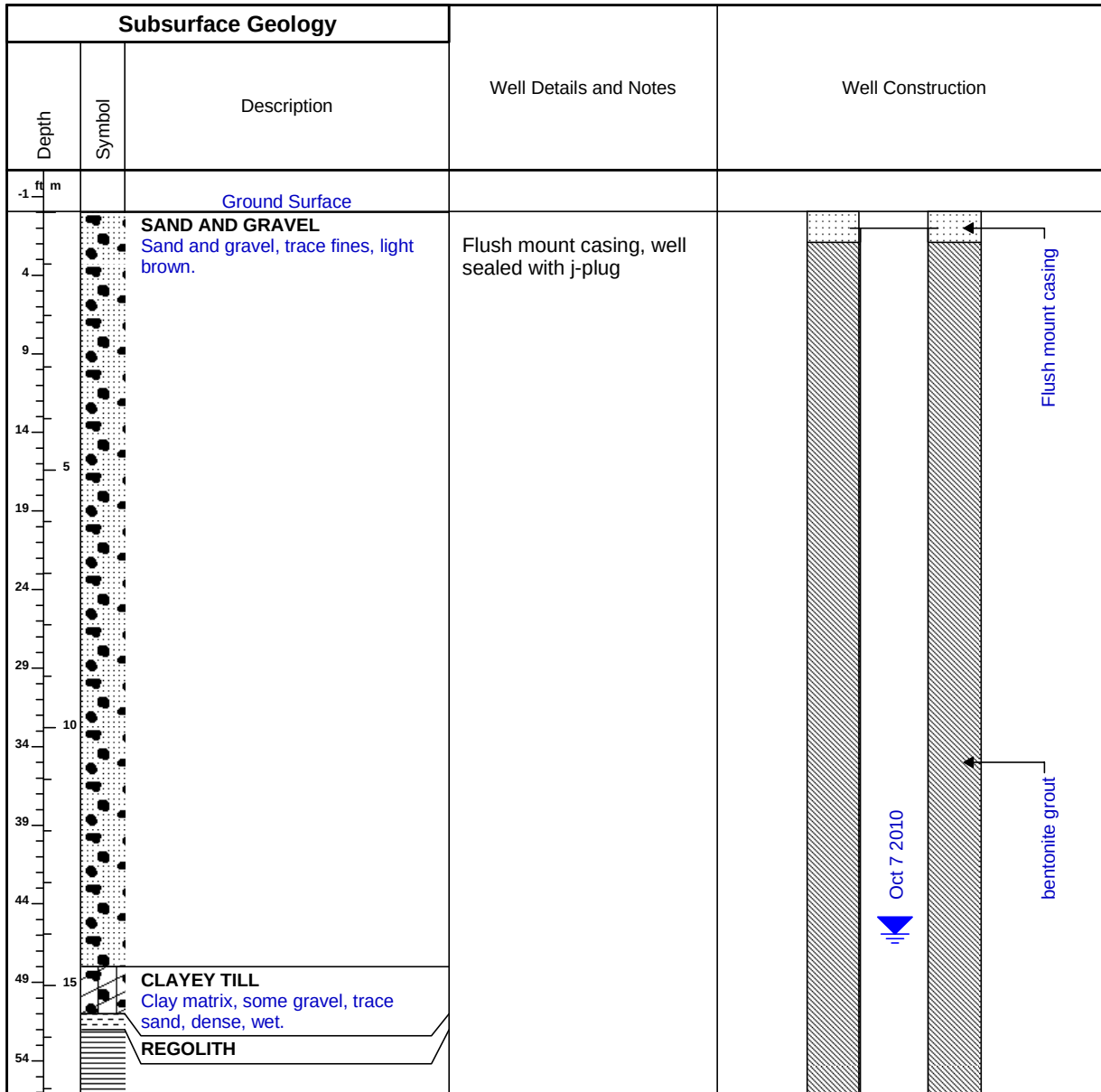
Stabilized Water Level: 14 m btoc

Top of Casing Elevation: flush mount

Location on site: 150 m NW of landfill on Golden Donald Upper Road

Reviewed by: Tilman Roschinski

Logged by: Bryer Manwell



Project No: 2010-8835.010.006

Well I.D.: TH-8

Client: CSRD

First Water: n/a

Ground Elevation: Approx. 915 m asl

Location: Golden Landfill

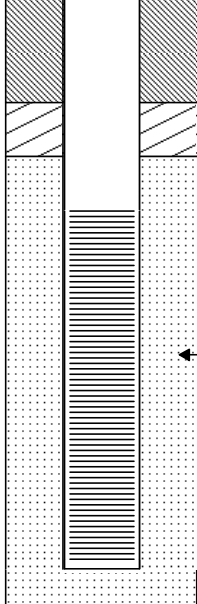
Stabilized Water Level: 14 m btoc

Top of Casing Elevation: flush mount

Location on site: 150 m NW of landfill on Golden Donald Upper Road

Reviewed by: Tilman Roschinski

Logged by: Bryer Manwell

Subsurface Geology			Well Details and Notes	Well Construction
Depth	Symbol	Description		
60		SLATE BEDROCK Slaty bedrock, in places phyllitic, grey, fractured, some fractures filled with clay.	1 m bentonite seal	 Bentonite seal 10/20 sand
65		QUARTZ BEDROCK Quartz, likely a large vein. Fluid mixing with sedimentary deposits on either end.		
70		SLATE BEDROCK Slaty bedrock, as above.	Screen depth: 67-87 ft (20.4 - 26.5 m)	
75		QUARTZ BEDROCK Quartz, as above.	Screen details: -10 slot PVC, 2 inch diameter -10/20 sand pack	
80		SLATE BEDROCK Slaty bedrock, as above		
90		End of Borehole		

Contractor: Target Drilling Inc.

Operator(s):

Drill Method: Coring

Date: Oct 5-7 2010

Boring Diameter/ Depth: 6 in / 27.3 m

Sheet: 2 of 2



Report 1 - Detailed Well Record

Well Tag Number: 99638	Construction Date: 2000-10-25 00:00:00.0		
Owner: KATS CONTRACTING	Driller: Owen's Drilling Ltd.		
Address: 532 HIETALA ROAD	Well Identification Plate Number:		
Area: GOLDEN	Plate Attached By:		
WELL LOCATION:	Where Plate Attached:		
KOOTENAY Land District	PRODUCTION DATA AT TIME OF DRILLING:		
District Lot: Plan: Lot:	Well Yield: 6 (Driller's Estimate) U.S. Gallons per Minute		
Township: 27 Section: 18 Range: 21	Development Method: Air lifting		
Indian Reserve: Meridian: W5M Block: A	Pump Test Info Flag: N		
Quarter:	Artesian Flow:		
Island:	Artesian Pressure (ft):		
BCGS Number (NAD 27): 082N036121 Well:	Static Level: 50 feet		
Class of Well: Water supply	WATER QUALITY:		
Subclass of Well: Domestic	Character:		
Orientation of Well: Vertical	Colour:		
Status of Well: New	Odour:		
Well Use: Private Domestic	Well Disinfected: N		
Observation Well Number:	EMS ID:		
Observation Well Status:	Water Chemistry Info Flag: N		
Construction Method:	Field Chemistry Info Flag:		
Diameter: inches	Site Info (SEAM):		
Casing drive shoe: Y N	Water Utility:		
Well Depth: 276 feet	Water Supply System Name:		
Elevation: feet (ASL)	Water Supply System Well Name:		
Final Casing Stick Up: 6 inches	SURFACE SEAL:		
Well Cap Type: PLASTIC CAP	Flag: N		
Bedrock Depth: 18 feet	Material:		
Lithology Info Flag: N	Method:		
File Info Flag: N	Depth (ft):		
Sieve Info Flag: N	Thickness (in):		
Screen Info Flag: N	Liner from To: feet		
Site Info Details:	WELL CLOSURE INFORMATION:		
Other Info Flag:	Reason For Closure:		
Other Info Details:	Method of Closure:		
	Closure Sealant Material:		
	Closure Backfill Material:		
	Details of Closure:		
Screen from to feet	Type	Slot Size	
Casing from to feet	Diameter	Material	Drive Shoe
0 36	6	Steel	Y
36 276	5.88	Open hole	N
GENERAL REMARKS:			
260' OF PVC LINER. BOTTOM 40' PERFORATED. SHOE: 1X6" CARBIDE BOTTON. RECOMMENDED PUMP TYPE: SUB			
LITHOLOGY INFORMATION:			
From 0 to 18 Ft.	CLAY, GRAVEL, COBBLES		
From 18 to 36 Ft.	BEDROCK, BROKEN		
From 36 to 150 Ft.	2 Gallons per Minute (U.S./Imperial)	bedrock	
From 150 to 257 Ft.	2 Gallons per Minute (U.S./Imperial)	bedrock	
From 256 to 276 Ft.	1 Gallons per Minute (U.S./Imperial)	bedrock	

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Information Disclaimer

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Monitoring Well ID: MW18-10**Project Number:** 14-024-21**Client:** CSRD**Project:** Golden RDF Additional Drilling **Location:** Golden, BC

Depth Below Ground Surface	Symbol	Lithology	Well Construction	Well Completion Details
ft m 0 0		Ground Surface		Lockable steel wellcap with a 0.81 m (32") stick up
		Topsoil		8" Steel casing from 0.81m (3 ft) above ground surface (ags) to 35.65 m (117 ft) below ground surface (bgs).
15		Sand and gravel , medium grained sand, sub angular gravel, moderately to poorly sorted, brown, dry.		Bentonite fill from 0 m (0 ft) to 6.1 m (20 ft) bgs, 10.7 m (35 ft) to 11.3 m (37 ft) bgs, 15.2 m (50 ft) to 15.8 m (52 ft) bgs 19.8 m (65 ft) to 20.4 m (67 ft) bgs and from 24.7 m (81 ft) to 25.3 m (83 ft) bgs.
45		Sand and gravel , medium to coarse grained sand, sub angular gravel, grey, dry.		Natural fill from 6.1 m (20 ft) to 10.7 m (35 ft) bgs, 11.3 m (37 ft) to 15.2 m (50 ft) bgs, 15.8 m (52 ft) to 19.8 m (65 ft) bgs and from 20.4 m (67 ft) to 24.7 m (81 ft) bgs.
60		Sand and gravel , medium grained sand, sub angular gravel, moderately sorted, brown, moist at 58 ft.		
75		Sand and gravel , with silt, fine to medium grained sand, sub angular gravel, moderately sorted, grey, moist.		
90		Bedrock , grey, mapped as argillite, shale and limestone, dry.		Sand pack with 10 filter sand from 25.3 m (83 ft) to 35 m (115 ft) bgs.
105				Water Level 28.53 m (94 ft) bgs June 25, 2018.
				3 m (10 ft) length of threaded 10 slot screen from 32 m (105 ft) bgs to 35.1 m (115 ft) bgs.
				0.3 m (1 ft) length sandpack from 35.4 m (116 ft) bgs to 35.7 m (117 ft) bgs.

Coordinates: 503411.92 m E 5684049.84 m N 11 U**Static Water Level:** 28.53 m June 26, 2018**Ground Elevation:** 919 m above sea level (asl)**Total Borehole Depth:** 35.65 m (117 ft) bgs**Drawn By:** RA**Checked By:** BRM**Drilling Contractor:** JR Drilling**Drilling Method:** Dual Air Rotary**Date of Completion:** June 25, 2018**Logged By:** RA**Sheet:** 1 of 1

Monitoring Well ID: MW18-11**Project Number:** 14-024-21**Client:** CSRD**Project:** Golden RDF**Location:** Golden, BC

Depth Below Ground Surface	Symbol	Lithology	Well Construction	Well Completion Details
ft m				
0 0		Ground Surface		Lockable steel wellcap with 1.1 m (35") stick up
15		Silt, with trace gravel, loose, brown, dry.		
30		Silt, loose, grey, dry.		4.6 m (15 ft) length bentonite surface seal from 0 m (0 ft) bgs to 4.6 m (15 ft) below ground surface (bgs)
45 15		Silt with gravel, coarsening downwards, loose, brown, dry.		
60		Gravel, with trace sand and silt, fine grained sand, sub angular to sub rounded gravel, angular silt, loose, brown, moist at 44.2 m (145 ft) bgs.		6" Steel casing from 1.1 m (3.5 ft) above ground surface (ags) to 115.8 m (380 ft) bgs
75				
90				
105 30				
120				5" Steel casing from 0 m (0 ft) bgs to 125 m (410 ft) bgs
135				
150 45				
165				
180				
195 60				
210				
225		Silt, loose, brown, dry.		
240		Gravel, with trace silt, sub angular to rounded silt, loose, brown, dry.		
75		Gravel, with trace sand, fine grained sand, loose, brown, dry.		

Coordinates: 503205.13 m E 5684006.34 m N 11 U**Static Water Level:** 114 m (374 ft) December 6, 2018**Ground Elevation:** 915 m above sea level (masl)**Total Borehole Depth:** 115.8 m (380 ft)**Drawn By:** RA**Checked By:** BRM**Drilling Contractor:** JR Drilling Kamloops**Drilling Method:** Dual Air Rotary**Date of Completion:** December 3 - 6, 2018**Logged By:** RA/BRM**Sheet:** 1 of 2

Monitoring Well ID: MW18-11**Project Number:** 14-024-21**Client:** CSRD**Project:** Golden RDF**Location:** Golden, BC

Depth Below Ground Surface m	Symbol	Lithology	Well Construction	Well Completion Details
255		Silt and gravel, layered, loose, brown, dry		Static Water Level 114 m (374 ft) bgs - December 6, 2018
270		Silt, fine grained, loose to compact, brown dry.		
285		Silt, with clay stringers, fine grained, loose to compact, dark grey, moist at 108.2 m (355 ft) bgs to 115.8 m (380 ft) bgs.		
300		Weathered Bedrock, grey, mapped as argillite, shale and limestone, loose, dry.		
315		Bedrock, grey, mapped as argillite, shale and limestone, moist.		
330				
345				
360				
375				
390				
405				
420				
435				
450				
465				
480				
495				

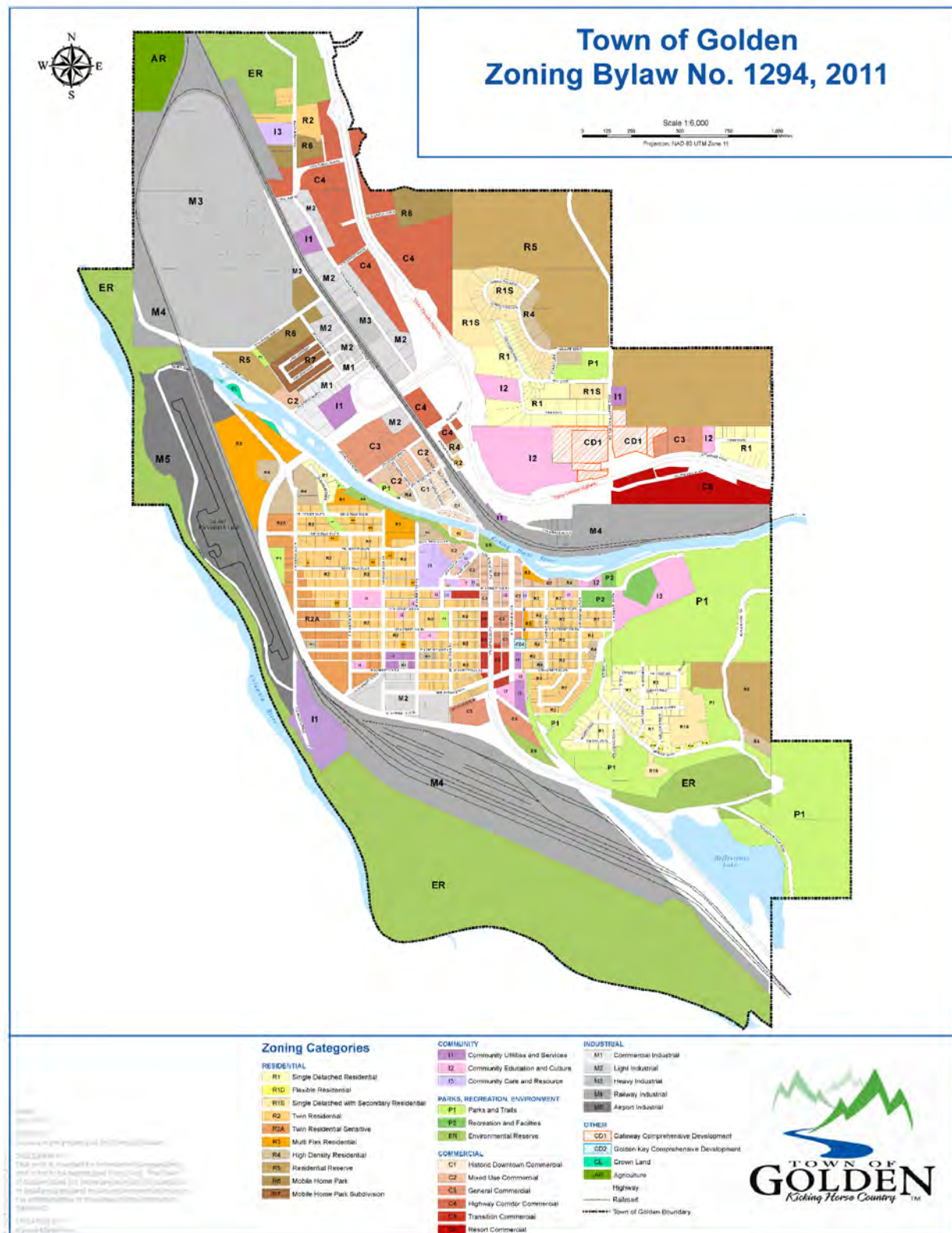
Coordinates: 503205.13 m E 5684006.34 m N 11 U**Static Water Level:** 114 m (374 ft) December 6, 2018**Ground Elevation:** 915 m above sea level (masl)**Total Borehole Depth:** 115.8 m (380 ft)**Drawn By:** RA**Checked By:** BRM**Drilling Contractor:** JR Drilling Kamloops**Drilling Method:** Dual Air Rotary**Date of Completion:** December 3 - 6, 2018**Logged By:** RA/BRM**Sheet:** 2 of 2

Appendix E:

Zoning Map for Town of Golden

5-Year 2018 Hydrogeological Assessment
CSRD
Golden RDF
WWAL Ref: 14-024-21





Source: Town of Golden

Columbia Shuswap
Regional District

TITLE

Figure 12: Town of Golden Zoning Bylaw Map



DRAWN

CHECKED

BRM

REVIEWED

DG

DATE

April 2019

SCALE

n/a

FILE NO.

PROJECT NO.

14-024-16

DWG. NO.

n/a

FIGURE REV. NO.

Appendix F: Water Quality Report (from 2002 to 2018)

5-Year 2018 Hydrogeological Assessment

CSRD

Golden RDF

WWAL Ref: 14-024-21



Golden Refuse Disposal Site

Water Quality Results

Legend for Reports for CSRD Refuse Disposal Sites Water Quality Results

<	Less than reported detection limit
>	Greater than reported upper detection limit
>=	Greater than or equal to
A	Absent
BC CSR DW	BC CSR, Schedule 3.2, Generic Numerical Water Standards for Drinking Water (2017 and updates)
Calc	Calculated guideline or standard. The guideline or standard is dependent on the value of one or more other analytes, and is calculated from a formula or table.
GCDWQ AO	Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives
GCDWQ MAC	Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations
L	Laboratory reading type (Lab result)
m asl	metres above sea level
N	Narrative type of guideline or standard, or Result Note.
ND	Non-detect. Result is less than lower detection limit.
NG	No Guideline
NR	No Result
NS	No Standard
NT	Not Tested
OG	Overgrown
P	Present
PR	Presumptive
TK	Test kit reading type (Field result)
TNTC	Too numerous to count

	Highlighted value has a lower detection limit that is greater than the guideline/standard maximum and/or the guideline/standard minimum, or has an upper detection limit that is less than the guideline/standard maximum and/or the guideline/standard minimum.
BC CSR DW	Highlighted value exceeds BC CSR DW
GCDWQ AO	Highlighted value exceeds GCDWQ AO
GCDWQ MAC	Highlighted value exceeds GCDWQ MAC
SL Criteria Override	Highlighted value exceeds sampling location criteria override

Golden Refuse Disposal Site

[illegible]

Water Quality Results

[illegible]

Golden Refuse Disposal Site

[illegible]

Golden Refuse Disposal Site

[illegible]

Golden Refuse Disposal Site

[illegible]

Golden Refuse Disposal Site

[illegible]

		Town Well #4	Town Well #4	Town Well #4	Town Well #4	Town Well #4	Town Well #4	Town Well #4	Town Well #6	Town Well #6	Town Well #6	Town Well #6	Town Well #6	Town Well #6	Town Well #6	Town Well #6	Town Well #6	Town Well #6	Town Well #6	Town Well #6	Town Well #6	Town Well #6	Well ID 22653
		22-Aug-16 6081698-04 Normal	14-Nov-16 6111141-02 Normal	05-Apr-17 7040434-04 Normal	20-Nov-17 7111886-03 Normal	26-Jun-18 8062674-04 Normal	11-Sep-18 8090975-06 Normal	03-Dec-18 8120636-05 Normal	20-Aug-13 3081378-02 Normal	02-Jun-14 4060249-01 Normal	18-Aug-14 4081094-02 Normal	04-Nov-14 4110161-02 Normal	25-May-15 5051773-01 Normal	25-Aug-15 5081710-01 Normal	09-Nov-15 5110693-04 Normal	03-May-16 6050336-04 Normal	22-Aug-16 6081698-05 Normal	14-Nov-16 6111141-01 Normal	05-Apr-17 7040434-05 Normal	29-Aug-17 7090074-02 Normal	20-Nov-17 7111886-02 Normal	26-Jun-18 8062674-05 Normal	04-Dec-18 8120636-07 Normal
Analyte	Unit																						
Field Results																							
Conductivity	µS/cm	986	932	63	1050	1055	1043	904	650	577	577	677	587	401	670	693	695	723	635	680	726	727	352
Depth to Water	m																						5.82
Dissolved oxygen	mg/L	4.67					5.59	5.67		8.14	7.68	7.38	6.40	7.04	6.51	5.61	6.13	5.71		9.27	9.21		2.87
Dissolved oxygen (percent)	%	39.8					47.6	48.3		68.1	65.3	64.0	57	63.6			52.5	49.8		83.1	78.7		25.2
Field measured depth to bottom	m																						
Flow rate - container	L/s																						
Ground Elevation	m	790	790	790	790	790	790	790															
Oxidation reduction potential	mV	240	293	261		218	123	102	246	183	172	66	211	46	74	122	234	163	265	31		204	
pH		7.3	7.5	7.5	7.2	7.46	7.52	7.26	7.15	7.3	7.9	7.4	7.4	6.6	7.3	7.2	7.2	7.3	7.3		7.5	7.45	8.65
Temperature	°C	8.6	8.3	8	8.2	8.3	8.4	8.3	7.9	7.7	8.1	8.1	7.8	10.2	8.2	8.2	8.4	8.0	7.9	9.5	7.9	8.1	7.8
Lab Results																							
Chlorinated Hydrocarbons																							
1,2-Dichlorobenzene	mg/L			<0.0005			<0.0005												<0.0005				
1,3-Dichlorobenzene	mg/L			<0.0010			<0.0010												<0.0010				
1,4-Dichlorobenzene	mg/L			<0.0010			<0.0010												<0.0010				
1,1-Dichloroethane	mg/L			<0.0010			<0.0010												<0.0010				
1,2-Dichloroethane	mg/L			<0.0010			<0.0010												<0.0010				
1,1-Dichloroethylene	mg/L			<0.0010			<0.0010												<0.0010				
cis-1,2-Dichloroethylene	mg/L			<0.0010			<0.0010												<0.0010				
trans-1,2-Dichloroethylene	mg/L			<0.0010			<0.0010												<0.0010				
Monochlorobenzene	mg/L			<0.0010			<0.0010												<0.0010				
1,1,2,2-Tetrachloroethane	mg/L			<0.0005			<0.0005												<0.0005				
Tetrachloroethylene	mg/L			<0.0010			<0.0010												<0.0010				
1,1,1-Trichloroethane	mg/L			<0.0010			<0.0010												<0.0010				
1,1,2-Trichloroethane	mg/L			<0.0010			<0.0010												<0.0010				
Trichloroethylene	mg/L			<0.0010			<0.0010												<0.0010				
General																							
Alkalinity (bicarbonate, as CaCO3)	mg/L	338	336	343	361	336	378	355								292	296	308	314	288	304	288	142
Alkalinity (carbonate, as CaCO3)	mg/L	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0								<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity (hydroxide, as CaCO3)	mg/L	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0								<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0								<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity (total, as CaCO3)	mg/L	338	336	343	361	336	378	355	268	276	277	291	303	288	295	292	296	308	314	288	304	288	142
Bicarbonate Alkalinity (as HCO3)	mg/L	412	410	418	441	410	461	433								356	361	375	383	352	371	351	173
Carbonate Alkalinity (as CO3)	mg/L	<0.6	<0.6	<0.600	<0.600	<0.600	<0.600	<0.600								<1	<0.6	<0.6	<0.600	<0.600	<0.600	<0.600	<0.600
Hydroxide Alkalinity (as OH)	mg/L	<0.3	<0.3	<0.340	<0.340	<0.340	<0.340	<0.340								<1	<0.3	<0.3	<0.340	<0.340	<0.340	<0.340	<0.340
Bromide	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10					<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chemical Oxygen Demand	mg/L																						
Chloride	mg/L	88.5	88.6	90.4	105	103	87.4	97.0	22.9	23.7	26.2	34.5	28.7	24.8	28.6	24.4	29.2	30.5	31.0	34.4	36.2	39.7	29.4
Colour	CU																						
Conductivity	µS/cm	948	966	959	1050	1010	1020	1000	620	621	634	679	672	618	661	658	666	712	692	655	704	702	387
Total cyanide	mg/L																						
Fluoride	mg/L	<0.10	<0.10	<0.10	<0.10	0.15	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.11	0.18	<0.10	0.13
Hardness, Total (dissolved as CaCO3)	mg/L	453	386	398		408	399	397	319	324	325	322				398	380	333	334	327		328	159
Hardness, Total (total as CaCO3)	mg/L				389								346	332	328						308		
Langelier Index																							
pH		7.77	7.97	7.85	7.91	7.88	7.83	7.92	7.94	7.87	7.70	7.86	7.81	7.79	7.72	7.74	7.76	7.89	7.89	8.03	8.00	7.93	8.00
Sulphate	mg/L	41.5	40.2	42.8	43.8	38.8	42.3	42.9	20.4	23.5	24.1	24.3	24.3	23.8	24.8	25.2	27.1	24.9	27.6	24.4	23.0	25.2	23.5
Temperature of observed pH	°C																						
Total dissolved solids (computed)	mg/L																						
Total organic carbon	mg/L																						
Total suspended solids	mg/L	<2	<2	<2	<2.0	<2.0	<2.0	<2.0	<1	<1	<1	<1	<2	<2	<3	<2	<2	<2	<2	<2.0	8.6	<2.0	71.0
Turbidity	NTU	<0.10	<0.10	<0.10	0.26	<0.10		<0.10	0.6	<0.1	<0.1	0.1	<0.1	0.2	0.1	<0.1	0.11	0.13	0.16	0.12	0.10	<0.10	142
Halogenated Methanes																							
Bromodichloromethane	mg/L			<0.0010			<0.0010												<0.0010				
Bromoform	mg/L			<0.0010			<0.0010												<0.0010				
Carbon tetrachloride	mg/L			<0.0005			<0.0005												<0.0005				
Chloroform	mg/L			<0.0010			<0.0010												<0.0010				
Dibromochloromethane	mg/L			<0.0010			<0.0010												<0.0010				
Dibromomethane	mg/L			<0.0010			<0.0010												<0.0010				
Dichloromethane	mg/L			<0.0030			<0.0030												<0.0030				
Total Trihalomethanes (calculated)	mg/L			<0.0020			<0.0020												<0.0020				
Trichlorofluoromethane	mg/L			<0.0010			<0.0010												<0.0010				
Metals																							
Aluminum (dissolved)	mg/L	<0.005	<0.005			0.0057	<0.0050	<0.0050	<0.005	<0.005	0.011	<0.005					<0.005	<0.005		<0.0050		0.0069	0.0068
Aluminum (total)	mg/L			<0.005	<0.0050								<0.005	<0.005	<0.05	<0.005		<0.005		<0.0050	<0.0050		
Antimony (dissolved)	mg/L	<0.0001	<0.0001			<0.00020	<0.00020	<0.00020	0.0005	0.0005	0.0003	0.0002					<0.0001	<0.0001		<0.00020		<0.00020	<0.00020
Antimony (total)	mg/L			<0.0001	<0.00020																		

		Town Well #4 22-Aug-16 6081698-04 Normal	Town Well #4 14-Nov-16 6111141-02 Normal	Town Well #4 05-Apr-17 7040434-04 Normal	Town Well #4 7111886-03 Normal	Town Well #4 26-Jun-18 8062674-04 Normal	Town Well #4 11-Sep-18 8090975-06 Normal	Town Well #4 8120636-05 Normal	Town Well #6 20-Aug-13 3081378-02 Normal	Town Well #6 02-Jun-14 4060249-01 Normal	Town Well #6 18-Aug-14 4081094-02 Normal	Town Well #6 04-Nov-14 4110161-02 Normal	Town Well #6 25-May-15 5051773-01 Normal	Town Well #6 25-Aug-15 5081710-01 Normal	Town Well #6 09-Nov-15 5110693-04 Normal	Town Well #6 03-May-16 6050336-04 Normal	Town Well #6 22-Aug-16 6081698-05 Normal	Town Well #6 14-Nov-16 6111141-01 Normal	Town Well #6 05-Apr-17 7040434-05 Normal	Town Well #6 29-Aug-17 7090074-02 Normal	Town Well #6 20-Nov-17 7111886-02 Normal	Town Well #6 26-Jun-18 8062674-05 Normal	Town Well #6 04-Dec-18 8120636-07 Normal	Well ID 22053	
Analyte	Unit																								
Lithium (dissolved)	mg/L	0.0019	0.0019			0.00226	0.00212	0.00231	0.0013	0.0013	0.0014	0.0013		0.0014	0.0012	0.001	0.0017	0.0012	0.0012	0.00140		0.00132	0.00204		
Lithium (total)	mg/L			0.0020	0.00199													0.0013			0.00115				
Magnesium (dissolved)	mg/L	49.3	41.5			42.6	42.3	44.1	28.1	28.5	28.7	27.1		29.2	27.1	26.8	33.0	33.6	28.8		28.2		27.7	26.2	
Magnesium (total)	mg/L			39.6	39.2															26.8		24.0			
Manganese (dissolved)	mg/L	0.0003	<0.0002			0.00162	<0.00020	0.00517	0.0009	0.0013	0.0082	0.0014						0.0011	0.0008		0.00294	0.00229	0.0986		
Manganese (total)	mg/L			<0.0002	<0.00020								0.0011	0.0010	<0.002	0.0007				0.00077					
Mercury (dissolved)	mg/L	<0.00002	<0.00002			<0.000010	<0.000040	<0.000010	<0.00002	<0.00002	<0.00002	<0.00002						<0.00002	<0.00002		<0.000010	<0.000040	<0.000010		
Mercury (total)	mg/L		<0.00002	<0.000010	<0.000010								<0.00002		<0.00002	<0.00002				<0.00002	<0.000010				
Molybdenum (dissolved)	mg/L	0.0002	0.0002			0.00018	0.00021	0.00023	0.0003	0.0004	0.0004	0.0004						0.0003	0.0002		0.00030	0.00044	0.00025		
Molybdenum (total)	mg/L			0.0002	0.00019								0.0005	0.0003	<0.001	0.0003				0.0003	0.00026				
Nickel (dissolved)	mg/L	<0.0002	<0.0002			<0.00040	<0.00040	<0.00040	0.0003	<0.0002	0.0012	0.0004						0.0002	0.0003		<0.00040	<0.00040	<0.00040		
Nickel (total)	mg/L			<0.0002	<0.00040								<0.0002	0.0006	<0.002	0.0002				0.0002	<0.00040				
Selenium (dissolved)	mg/L	<0.0005	<0.0005			<0.00050	<0.00050	<0.00050	<0.0005	<0.0005	<0.0005	<0.0005						<0.0005	<0.0005		<0.00050	<0.00050	<0.00050		
Selenium (total)	mg/L			<0.0005	<0.00050								<0.0005	<0.0005	<0.005	<0.0005				<0.0005	<0.00050				
Silicon (dissolved, as Si)	mg/L	4.5	4.9			4.9	4.6	4.9	4.1	4.0	4.4	4.5						4.2	4.5		4.0	4.3	<1.0		
Silicon (total, as Si)	mg/L			4.7	4.4								4.7	4.3	<5	5.2				4.3	3.7				
Silver (dissolved)	mg/L	<0.00005	<0.00005			<0.000050	<0.000050	<0.000050	<0.00005	<0.00005	<0.00005	<0.00005						<0.00005	<0.00005		<0.000050	<0.000050	<0.000050		
Silver (total)	mg/L			<0.00005	<0.000050								<0.00005	0.00154	<0.0005	<0.00005				<0.00005	<0.000050				
Sodium (dissolved)	mg/L	58.2	50.0			57.8	56.9	58.5	15.2	13.9	15.4	17.9						17.9	16.7		17.0	20.3	14.7		
Sodium (total)	mg/L			52.7	52.1								18.9	15.1	15.9	17.9				17.1	15.7				
Strontium (dissolved)	mg/L	0.527	0.462			0.492	0.460	0.471	0.282	0.269	0.301	0.290						0.344	0.312		0.258	0.281	0.115		
Strontium (total)	mg/L			0.446	0.486								0.296	0.298	0.27	0.325				0.294	0.285				
Sulphur (dissolved)	mg/L	18	15			16.1	14.3	15.0	8	10	8	7						13	9		7.8	9.8	7.1		
Sulphur (total)	mg/L			12	14.0								9	8	<10	11				6	7.9				
Tellurium (dissolved)	mg/L	<0.0002	<0.0002			<0.00050	<0.00050	<0.00050	<0.0002	<0.0002	<0.0002	<0.0002						<0.0002	<0.0002		<0.00050	<0.00050	<0.00050		
Tellurium (total)	mg/L			<0.0002	<0.00050								<0.0002	<0.0002	<0.002	<0.0002				<0.0002	<0.00050				
Thallium (dissolved)	mg/L	<0.00002	<0.00002			<0.000020	<0.000020	<0.000020	<0.00002	<0.00002	<0.00002	<0.00002						<0.00002	<0.00002		<0.000020	<0.000020	<0.000020		
Thallium (total)	mg/L			<0.00002	<0.000020								<0.00002	<0.00002	<0.0002	<0.00002				<0.00002	<0.000020				
Thorium (dissolved)	mg/L	<0.0001	<0.0001			<0.00010	<0.00010	<0.00010	<0.0001	<0.0001	<0.0001	<0.0001						<0.0001	<0.0001		<0.00010	<0.00010	<0.00010		
Thorium (total)	mg/L			<0.0001	<0.00010								<0.0001	<0.0001	<0.001	<0.0001				<0.0001	<0.00010				
Tin (dissolved)	mg/L	<0.0002	<0.0002			<0.00020	<0.00020	0.00022	<0.0002	<0.0002	<0.0002	<0.0002						<0.0002	<0.0002		<0.00020	<0.00020	0.00077		
Tin (total)	mg/L			<0.0002	<0.00020								<0.0002	<0.0002	<0.002	<0.0002				<0.0002	<0.00020				
Titanium (dissolved)	mg/L	<0.005	<0.005			<0.0050	<0.0050	<0.0050	<0.005	<0.005	<0.005	<0.005						<0.005	<0.005		<0.0050	<0.0050	<0.0050		
Titanium (total)	mg/L			<0.005	<0.0050								<0.005	<0.005	<0.05	<0.005				<0.005	<0.0050				
Tungsten (dissolved)	mg/L					<0.0010	<0.0010	<0.0010														<0.0010	<0.0010	<0.0010	
Tungsten (total)	mg/L				<0.0010																	<0.0010			
Uranium (dissolved)	mg/L	0.00130	0.00115			0.00117	0.00132	0.00133	0.00105	0.00103	0.00114	0.00114						0.00117	0.00106		0.00109	0.00100	<0.000020		
Uranium (total)	mg/L			0.00124	0.00127								0.00112	0.00111	0.0011	0.00133				0.00109	0.00107				
Vanadium (dissolved)	mg/L	<0.001	<0.001			<0.0010	<0.0010	<0.0010	<0.001	<0.001	<0.001	<0.001						<0.001	<0.001		<0.0010	<0.0010	<0.0010		
Vanadium (total)	mg/L			<0.001	<0.0010								<0.001	<0.001	<0.01	<0.001				<0.001	<0.0010				
Zinc (dissolved)	mg/L	<0.004	<0.004			0.0062	<0.0040	0.0063	<0.004	<0.004	0.010	0.005						<0.004	<0.004		0.0100	0.0052	0.0043		
Zinc (total)	mg/L			<0.004	<0.0040								<0.004	0.016	<0.04	<0.004				0.004	<0.0040				
Zirconium (dissolved)	mg/L	<0.0001	<0.0001			<0.00010	<0.00010	<0.00010	<0.0001	<0.0001	<0.0001	<0.0001						<0.0001	<0.0001		<0.00010	<0.00010	<0.00010		
Zirconium (total)	mg/L			<0.0001	<0.00010								<0.0001	<0.0001	<0.001	<0.0001				<0.0001	<0.00010				
Microbiological																									
Background Bacteria	CFU/100 mL																								
E. coli (counts)	MPN/100 mL																								
E. coli (MPN)	CFU/100 mL																								
Fecal coliforms (counts)	MPN/100 mL																								
Fecal coliforms (MPN)	CFU/100 mL																								
Total coliforms (counts)	MPN/100 mL																								
Total coliforms (MPN)	CFU/100 mL																								
Miscellaneous Organic Substances																									
Chloroethane	mg/L			<0.0020			<0.0020													<0.0020					
1,2-Dibromoethane	mg/L			<0.0002			<0.0003													<0.0002					
1,2-Dichloropropane	mg/L			<0.0010			<0.0010													<0.0010					
1,3-Dichloropropene	mg/L			<0.0010			<0.0010													<0.0010					
Methyl tert-butyl ether (MTBE)	mg/L			<0.0010			<0.0010													<0.0010					
VHw6-10	mg/L																								
Vinyl chloride	mg/L			<0.0010			<0.0010													<0.0010					
VPHw	mg/L																								
Monocyclic Aromatic Hydrocarbons (MAHs)																									
Benzene	mg/L			<0.0005			<0.0005													<0.0005					
Ethylbenzene	mg/L			<0.0010			<0.0010													<0.0010					
Styrene	mg/L			<0.0010			<0.0010													<0.0010					
Toluene	mg/L			<0.0010</																					

Guideline Notes for Reports for CSRD Refuse Disposal Sites Water Quality Results

1. Notes for Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations (GCDWQ MAC)

Note 1.1 for Total cyanide:

The MAC for free cyanide is 0.2 mg/L. A maximum of 0.2 mg/L was used, in this report, to identify exceedances for total cyanide as a means for determining the potential for exceeding the free cyanide guideline.

Note 1.2 for Turbidity:

Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters should meet the requirements described in GCDWQ.

For systems that use groundwater that is not under the direct influence of surface water, which are considered less vulnerable to faecal contamination, turbidity should generally be below 1.0 NTU.

For effective operation of the distribution system, it is good practice to ensure that water entering the distribution system has turbidity levels below 1.0 NTU.

Note 1.3 for Bromodichloromethane:

The maximum acceptable concentration (MAC) for trihalomethanes (THMs) in drinking water is 0.100 mg/L (100 µg/L) based on a locational running annual average of a minimum of quarterly samples taken at the point in the distribution system with the highest potential THM levels. Trihalomethanes refers to the total of chloroform, bromodichloromethane, dibromochloromethane and bromoform compounds.

Note 1.4 for Bromoform:

The maximum acceptable concentration (MAC) for trihalomethanes (THMs) in drinking water is 0.100 mg/L (100 µg/L) based on a locational running annual average of a minimum of quarterly samples taken at the point in the distribution system with the highest potential THM levels. Trihalomethanes refers to the total of chloroform, bromodichloromethane, dibromochloromethane and bromoform compounds.

Note 1.5 for Chloroform:

The maximum acceptable concentration (MAC) for trihalomethanes (THMs) in drinking water is 0.100 mg/L (100 µg/L) based on a locational running annual average of a minimum of quarterly samples taken at the point in the distribution system with the highest potential THM levels. Trihalomethanes refers to the total of chloroform, bromodichloromethane, dibromochloromethane and bromoform compounds.

Note 1.6 for Dibromochloromethane:

The maximum acceptable concentration (MAC) for trihalomethanes (THMs) in drinking water is 0.100 mg/L (100 µg/L) based on a locational running annual average of a minimum of quarterly samples taken at the point in the distribution system with the highest potential THM levels. Trihalomethanes refers to the total of chloroform, bromodichloromethane, dibromochloromethane and bromoform compounds.

Note 1.7 for Total Trihalomethanes (calculated):

Trihalomethanes refers to the total of chloroform, bromodichloromethane, dibromochloromethane and bromoform compounds. The maximum acceptable concentration (MAC) for trihalomethanes (THMs) in drinking water is 0.100 mg/L (100 µg/L) based on a locational running annual average of a minimum of quarterly samples taken at the point in the distribution system with the highest potential THM levels. Utilities should make every effort to maintain concentrations as low as reasonably achievable without compromising the effectiveness of disinfection.

Note 1.8 for Arsenic (dissolved):

Every effort should be made to maintain arsenic levels in drinking water as low as reasonably achievable.

Note 1.9 for Arsenic (total):

Every effort should be made to maintain arsenic levels in drinking water as low as reasonably achievable.

Note 1.10 for Lead (dissolved):

The maximum acceptable concentration (MAC) for total lead in drinking water is 0.005 mg/L (5 µg/L), based on a sample of water taken at the tap and using the appropriate protocol for the type of building being sampled. Every effort should be made to maintain lead levels in drinking water as low as reasonably achievable (or ALARA). (GCDWQ: Guideline Technical Document: March, 2019)

Note 1.11 for Lead (total):

The maximum acceptable concentration (MAC) for total lead in drinking water is 0.005 mg/L (5 µg/L), based on a sample of water taken at the tap and using the appropriate protocol for the type of building being sampled. Every effort should be made to maintain lead levels in drinking water as low as reasonably achievable (or ALARA). (GCDWQ: Guideline Technical Document: March, 2019)

Note 1.12 for E. coli (counts):

MAC is none detectable per 100 mL

Note 1.13 for E. coli (MPN):

MAC is none detectable per 100 mL

Note 1.14 for Fecal coliforms (counts):

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Water Quality Results

The GCDWQ does not have a guideline for fecal coliforms. The GCDWQ were revised in 2006 when the guideline for fecal coliforms was deleted, and a guideline for E. coli was added. However the GCDWQ has a guideline for total coliforms that includes the following statement: "The MAC of total coliforms in water leaving a treatment plant in a public system and throughout semi-public and private supply systems is none detectable per 100 mL." Therefore a guideline of none detectable per 100 mL was used for fecal coliforms for this report.

Note that the Drinking Water Protection Regulation (2003), under the BC Drinking Water Protection Act, has a water quality standard for notable water for fecal coliforms of "No detectable fecal coliform bacteria per 100 ml"

Note 1.15 for Fecal coliforms (MPN):

The GCDWQ does not have a guideline for fecal coliforms. The GCDWQ were revised in 2006 when the guideline for fecal coliforms was deleted, and a guideline for E. coli was added. However the GCDWQ has a guideline for total coliforms that includes the following statement: "The MAC of total coliforms in water leaving a treatment plant in a public system and throughout semi-public and private supply systems is none detectable per 100 mL." Therefore a guideline of none detectable per 100 mL was used for fecal coliforms for this report.

Note that the Drinking Water Protection Regulation (2003), under the BC Drinking Water Protection Act, has a water quality standard for notable water for fecal coliforms of "No detectable fecal coliform bacteria per 100 ml"

Note 1.16 for Total coliforms (counts):

The maximum acceptable concentration (MAC) of total coliforms in water leaving a treatment plant and in non-disinfected groundwater leaving the well is none detectable per 100 mL.

Total coliforms should be monitored in the distribution system because they are used to indicate changes in water quality.

Detection of total coliforms from consecutive samples from the same site or from more than 10% of the samples collected in a given sampling period should be investigated.

Note 1.17 for Total coliforms (MPN):

The maximum acceptable concentration (MAC) of total coliforms in water leaving a treatment plant and in non-disinfected groundwater leaving the well is none detectable per 100 mL.

Total coliforms should be monitored in the distribution system because they are used to indicate changes in water quality.

Detection of total coliforms from consecutive samples from the same site or from more than 10% of the samples collected in a given sampling period should be investigated.

Note 1.18 for Vinyl chloride:

Every effort should be made to maintain vinyl chloride levels in drinking water as low as reasonably achievable.

Note 1.19 for Nitrate + Nitrite (as N):

The MAC for Nitrate (as N) is 10 mg/L

Note 1.20 for Nitrate + Nitrite (as N) (calculated):

The MAC for Nitrate (as N) is 10 mg/L

2. Notes for Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives (GCDWQ AO)

Note 2.1 for pH:

The operational guideline for pH is a range of 7.0 to 10.5 in finished drinking water.

Note 2.2 for pH:

The operational guideline for pH is a range of 7.0 to 10.5 in finished drinking water.

Note 2.3 for Sulphate:

There may be a laxative effect in some individuals when sulphate levels exceed 500 mg/L. Health authorities should be notified of drinking water sources containing above 500 mg/L.

Note 2.4 for Aluminum (dissolved):

This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants. The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.

Note 2.5 for Aluminum (total):

This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants. The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.

3. Notes for BC CSR, Schedule 3.2, Generic Numerical Water Standards for Drinking Water (2017 and updates) (BC CSR DW)

General Notes:

Drinking water standards are for unfiltered samples obtained at the point of consumption. Heavy metals, metalloids and inorganic ions are expressed as total substance concentrations unless otherwise indicated.

Note 3.1 for 1,2-Dichlorobenzene:

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.2 for 1,4-Dichlorobenzene:

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.3 for Monochlorobenzene:

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.4 for Chloride:

Standard to protect against taste and odour concerns.

Note 3.5 for Total cyanide:

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Water Quality Results

To demonstrate compliance with the drinking water (DW) standard, samples for cyanide in water must be analyzed using the appropriate "Cyanide Strong Acid Dissociable (SAD)" analytical method for water specified in the 2015 British Columbia Environmental Laboratory Manual, as updated from time to time.

Note 3.6 for Sulphate:

Standard to protect against taste and odour concerns.

Note 3.7 for Bromodichloromethane:

Standard is specific for total trihalomethanes. Sum of the concentrations of bromodichloromethane (BDCM), dibromochloromethane (DBCM), bromoform (tribromomethane) and chloroform (trichloromethane) must not exceed the standard specified.

Note 3.8 for Bromoform:

Standard is specific for total trihalomethanes. Sum of the concentrations of bromodichloromethane (BDCM), dibromochloromethane (DBCM), bromoform (tribromomethane) and chloroform (trichloromethane) must not exceed the standard specified.

Note 3.9 for Chloroform:

Standard is specific for total trihalomethanes. Sum of the concentrations of bromodichloromethane (BDCM), dibromochloromethane (DBCM), bromoform (tribromomethane) and chloroform (trichloromethane) must not exceed the standard specified.

Note 3.10 for Dibromochloromethane:

Standard is specific for total trihalomethanes. Sum of the concentrations of bromodichloromethane (BDCM), dibromochloromethane (DBCM), bromoform (tribromomethane) and chloroform (trichloromethane) must not exceed the standard specified.

Note 3.11 for Total Trihalomethanes (calculated):

Standard is specific for total trihalomethanes. Sum of the concentrations of bromodichloromethane (BDCM), dibromochloromethane (DBCM), tribromomethane (bromoform) and trichloromethane (chloroform) must not exceed the standard specified.

Note 3.12 for Aluminum (dissolved):

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.13 for Aluminum (total):

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.14 for Chromium (dissolved):

Analytical results for chromium (all species) in water may be used to demonstrate compliance with the standards. Where the standards cannot be met based on analytical results for chromium (all species), chromium speciation may be necessary.

Standard is 50 µg/L for chromium, hexavalent. Standard is 6000 µg/L for chromium, trivalent. The standard of 50 µg/L was used to identify exceedances for dissolved chromium in order to demonstrate compliance with the standards.

Note 3.15 for Chromium (total):

Analytical results for chromium (all species) in water may be used to demonstrate compliance with the standards. Where the standards cannot be met based on analytical results for chromium (all species), chromium speciation may be necessary.

Standard is 50 µg/L for chromium, hexavalent. Standard is 6000 µg/L for chromium, trivalent. The standard of 50 µg/L was used to identify exceedances for total chromium in order to demonstrate compliance with the standards.

Note 3.16 for Copper (dissolved):

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.17 for Copper (total):

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.18 for Iron (dissolved):

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Water Quality Results

Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as

- (a) item A6, A7, A8 or A11
- (b) item C1, C2, C3, C4 or C6,
- (c) item D2, D3, D5, or D6
- (d) item E4, or
- (e) item H14.

Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as item H11 or H20, but only if the site was used for the purpose or activity in conjunction with or as a result of the site also being used for at least one of the purposes or activities set out above.

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups. Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.19 for Iron (total):

Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as

- (a) item A6, A7, A8 or A11
- (b) item C1, C2, C3, C4 or C6,
- (c) item D2, D3, D5, or D6
- (d) item E4, or
- (e) item H14.

Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as item H11 or H20, but only if the site was used for the purpose or activity in conjunction with or as a result of the site also being used for at least one of the purposes or activities set out above.

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.20 for Manganese (dissolved):

Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as

- (a) item B1
- (b) item C1, C3 or C4
- (c) item D2, D3, D5, or D6
- (d) item E4, or
- (e) item H3 or H14.

Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as item H11 or H20, but only if the site was used for the purpose or activity in conjunction with or as a result of the site also being used for at least one of the purposes or activities set out above.

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.21 for Manganese (total):

Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as

- (a) item B1
- (b) item C1, C3 or C4
- (c) item D2, D3, D5, or D6
- (d) item E4, or
- (e) item H3 or H14.

Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as item H11 or H20, but only if the site was used for the purpose or activity in conjunction with or as a result of the site also being used for at least one of the purposes or activities set out above.

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.22 for Sodium (dissolved):

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Note 3.23 for Sodium (total):

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Note 3.24 for Zinc (dissolved):

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Note 3.25 for Zinc (total):

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Note 3.26 for Methyl tert-butyl ether (MTBE):

Golden Refuse Disposal Site

Water Quality Results

Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.27 for VHw6-10:

VHw6-10 - Volatile Hydrocarbons (nC6-nC10) in water as defined in the 2015 British Columbia Environmental Laboratory Manual, as updated from time to time. Standard is applicable at all sites, irrespective of water use.

Note 3.28 for Ethylbenzene:

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.29 for Toluene:

Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

Note 3.30 for Nitrate (as N):

Where nitrate and nitrite are present, total nitrate plus nitrite-nitrogen should not exceed this value.

Note 3.31 for Nitrate + Nitrite (as N):

Where nitrate and nitrite are present, total nitrate plus nitrite-nitrogen should not exceed this value.

Note 3.32 for Nitrate + Nitrite (as N) (calculated):

Where nitrate and nitrite are present, total nitrate plus nitrite-nitrogen should not exceed this value.

Golden Refuse Disposal Site

Water Quality Results

Legend for Reports for CSRD Refuse Disposal Sites Water Quality Results

<	Less than reported detection limit
>	Greater than reported upper detection limit
>=	Greater than or equal to
A	Absent
BCAWQG AL	BC Approved Water Quality Guidelines for freshwater aquatic life
BCAWQG ALA	BC Approved Water Quality Guidelines for freshwater aquatic life (30-day average)
Calc	Calculated guideline or standard. The guideline or standard is dependent on the value of one or more other analytes, and is calculated from a formula or table.
L	Laboratory reading type (Lab result)
m asl	metres above sea level
N	Narrative type of guideline or standard, or Result Note.
ND	Non-detect. Result is less than lower detection limit.
NG	No Guideline
NR	No Result
NS	No Standard
NT	Not Tested
OG	Overgrown
P	Present
PR	Presumptive
TK	Test kit reading type (Field result)
TNTC	Too numerous to count

	Highlighted value has a lower detection limit that is greater than the guideline/standard maximum and/or the guideline/standard minimum, or has an upper detection limit that is less than the guideline/standard maximum and/or the guideline/standard minimum.
BCAWQG AL	Highlighted value exceeds BCAWQG AL
BCAWQG ALA	Highlighted value exceeds BCAWQG ALA
SL Criteria Override	Highlighted value exceeds sampling location criteria override

		Sampling Location		Hospital Creek	Kicking Horse
		Date Sampled		04-Dec-18	27-Jun-18
		Lab Sample ID		8120636-06	8062805-03
		Sample Type		Normal	Normal
Analyte	Unit	Guideline			
		BCAWQG AL	BCAWQG ALA		
Field Results					
Conductivity	µS/cm	NG	NG	360	220
Dissolved oxygen	mg/L	min 5 ^{1.1}	min 8 ^{2.1}	13.48	
Dissolved oxygen (percent)	%	NG	NG	92	
Oxidation reduction potential	mV	NG	NG		138
pH		N ^{1.2}	N ^{2.2}	7.49	8.48
Temperature	°C	19 ^{1.3}	19 ^{2.3}	0.1	10.1
Lab Results					
General					
Alkalinity (bicarbonate, as CaCO3)	mg/L	NG	NG	189	
Alkalinity (carbonate, as CaCO3)	mg/L	NG	NG	<1.0	
Alkalinity (hydroxide, as CaCO3)	mg/L	NG	NG	<1.0	
Alkalinity (phenolphthalein, as CaCO3)	mg/L	NG	NG	<1.0	
Alkalinity (total, as CaCO3)	mg/L	NG	NG	189	
Bicarbonate Alkalinity (as HCO3)	mg/L	NG	NG	230	
Carbonate Alkalinity (as CO3)	mg/L	NG	NG	<0.600	
Hydroxide Alkalinity (as OH)	mg/L	NG	NG	<0.340	
Bromide	mg/L	NG	NG	<0.10	
Chloride	mg/L	600 ^{1.4}	150 ^{2.4}	0.97	4.04
Conductivity	µS/cm	NG	NG	382	
Fluoride	mg/L	Calc ^{1.5}	Calc ^{2.5}	<0.10	
Hardness, Total (dissolved as CaCO3)	mg/L	NG	NG	205	
pH		N ^{1.6}	N ^{2.6}	8.21	
Sulphate	mg/L	Calc ^{1.7}	Calc ^{2.7}	28.9	
Total suspended solids	mg/L	N ^{1.8}	N ^{2.8}	<5.0	
Turbidity	NTU	N ^{1.9}	N ^{2.9}	0.83	
Metals					
Aluminum (dissolved)	mg/L	Calc ^{1.10}	Calc ^{2.10}	<0.0050	
Aluminum (total)	mg/L	NG	NG	0.0089	
Antimony (dissolved)	mg/L	NG	NG	<0.00020	
Antimony (total)	mg/L	NG	NG	<0.00020	
Arsenic (dissolved)	mg/L	0.005 ^{1.11}	0.005 ^{2.11}	<0.00050	
Arsenic (total)	mg/L	0.005	0.005	<0.00050	
Barium (dissolved)	mg/L	NG	NG	0.0555	
Barium (total)	mg/L	NG	NG	0.0589	
Beryllium (dissolved)	mg/L	NG	NG	<0.00010	
Beryllium (total)	mg/L	NG	NG	<0.00010	
Bismuth (dissolved)	mg/L	NG	NG	<0.00010	
Bismuth (total)	mg/L	NG	NG	<0.00010	
Boron (dissolved)	mg/L	1.2 ^{1.12}	1.2 ^{2.12}	0.0091	
Boron (total)	mg/L	1.2	1.2	0.0093	
Cadmium (dissolved)	mg/L	Calc ^{1.13}	Calc ^{2.13}	<0.000010	
Cadmium (total)	mg/L	NG	NG	<0.000010	
Calcium (dissolved)	mg/L	NG	NG	53.2	
Calcium (total)	mg/L	NG	NG	52.4	
Chromium (dissolved)	mg/L	NG	NG	<0.00050	
Chromium (total)	mg/L	NG	NG	<0.00050	
Cobalt (dissolved)	mg/L	0.110 ^{1.14}	0.004 ^{2.14}	<0.00010	
Cobalt (total)	mg/L	0.110 ^{1.15}	0.004 ^{2.15}	<0.00010	
Copper (dissolved)	mg/L	Calc ^{1.16}	Calc ^{2.16}	<0.00040	
Copper (total)	mg/L	Calc ^{1.17}	Calc ^{2.17}	0.00323	
Iron (dissolved)	mg/L	0.35	0.35	<0.010	
Iron (total)	mg/L	1.0	1.0	<0.010	
Lead (dissolved)	mg/L	Calc ^{1.18}	Calc ^{2.18}	<0.00020	
Lead (total)	mg/L	Calc ^{1.19}	Calc ^{2.19}	0.00096	
Lithium (dissolved)	mg/L	NG	NG	0.00102	
Lithium (total)	mg/L	NG	NG	0.00107	
Magnesium (dissolved)	mg/L	NG	NG	17.5	
Magnesium (total)	mg/L	NG	NG	18.1	
Manganese (dissolved)	mg/L	Calc ^{1.20}	Calc ^{2.20}	<0.00020	
Manganese (total)	mg/L	Calc ^{1.21}	Calc ^{2.21}	0.00048	
Mercury (dissolved)	mg/L	0.000020 ^{1.22}	0.000020 ^{2.22}	<0.000040	
Mercury (total)	mg/L	0.000020 ^{1.23}	0.000020 ^{2.23}	<0.000010	
Molybdenum (dissolved)	mg/L	2 ^{1.24}	1 ^{2.24}	0.00036	
Molybdenum (total)	mg/L	2 ^{1.25}	1 ^{2.25}	0.0004	
Nickel (dissolved)	mg/L	NG	NG	<0.00040	
Nickel (total)	mg/L	NG	NG	<0.00040	
Selenium (dissolved)	mg/L	0.002 ^{1.26}	0.002 ^{2.26}	<0.00050	
Selenium (total)	mg/L	0.002 ^{1.27}	0.002 ^{2.27}	<0.00050	
Silicon (dissolved, as Si)	mg/L	NG	NG	3.3	
Silicon (total, as Si)	mg/L	NG	NG	3.3	
Silver (dissolved)	mg/L	Calc ^{1.28}	Calc ^{2.28}	<0.000050	
Silver (total)	mg/L	Calc ^{1.29}	Calc ^{2.29}	<0.000050	
Sodium (dissolved)	mg/L	NG	NG	1.89	
Sodium (total)	mg/L	NG	NG	1.86	
Strontium (dissolved)	mg/L	NG	NG	0.174	
Strontium (total)	mg/L	NG	NG	0.173	
Sulphur (dissolved)	mg/L	NG	NG	10.8	
Sulphur (total)	mg/L	NG	NG	10.1	
Tellurium (dissolved)	mg/L	NG	NG	<0.00050	
Tellurium (total)	mg/L	NG	NG	<0.00050	
Thallium (dissolved)	mg/L	NG	NG	<0.000020	
Thallium (total)	mg/L	NG	NG	<0.000020	
Thorium (dissolved)	mg/L	NG	NG	<0.00010	
Thorium (total)	mg/L	NG	NG	<0.00010	
Tin (dissolved)	mg/L	NG	NG	<0.00020	
Tin (total)	mg/L	NG	NG	<0.00020	
Titanium (dissolved)	mg/L	NG	NG	<0.0050	
Titanium (total)	mg/L	NG	NG	<0.0050	
Tungsten (dissolved)	mg/L	NG	NG	<0.0010	
Tungsten (total)	mg/L	NG	NG	<0.0010	
Uranium (dissolved)	mg/L	NG	NG	0.000797	
Uranium (total)	mg/L	NG	NG	0.000856	
Vanadium (dissolved)	mg/L	NG	NG	<0.0010	
Vanadium (total)	mg/L	NG	NG	<0.0010	
Zinc (dissolved)	mg/L	Calc ^{1.30}	Calc ^{2.30}	<0.0040	
Zinc (total)	mg/L	Calc ^{1.31}	Calc ^{2.31}	0.0085	
Zirconium (dissolved)	mg/L	NG	NG	<0.00010	
Zirconium (total)	mg/L	NG	NG	<0.00010	
Nutrients					
Ammonia (total, as N)	mg/L	Calc ^{1.32}	Calc ^{2.32}	<0.020	
Nitrate (as N)	mg/L	32.8 ^{1.33}	3.0 ^{2.33}	0.052	0.096
Nitrate + Nitrite (as N) (calculated)	mg/L	32.8 ^{1.34}	3.0 ^{2.34}	0.052	
Nitrite (as N)	mg/L	Calc ^{1.35}	Calc ^{2.35}	<0.010	
Orthophosphate (dissolved, as P)	mg/L	NG	NG	<0.0050	
Phosphorus (dissolved, by ICPLMS/ICPOES)	mg/L	N ^{1.36}	N ^{2.36}	<0.050	
Phosphorus (total, by ICPLMS/ICPOES)	mg/L	N ^{1.37}	N ^{2.37}	<0.050	
Phosphorus (dissolved, APHA 4500-P)	mg/L	N ^{1.38}	N ^{2.38}	<0.0020	
Potassium (dissolved)	mg/L	NG	NG	0.47	
Potassium (total)	mg/L	NG	NG	0.45	

Guideline Notes for Reports for CSRD Refuse Disposal Sites Water Quality Results

1. Notes for BC Approved Water Quality Guidelines for freshwater aquatic life (BCAWQG AL)

General Notes:

The Water Quality Guidelines (Criteria) Reports by BC Ministry of Environment were used as references for the guidelines. (Internet address: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html). Overview Reports (BC MOE) were used as the references for the guidelines unless the note for specific analyte indicates that the Technical Appendix (BC MOE) was used. / For some parameters, guidelines are specified as two values: the maximum value or the acute criterion, and the 30-day average value or the chronic criterion. The maximum value was used in this report for parameters that have both guideline values.

Note 1.1 for Dissolved oxygen:

The instantaneous minimum guideline for dissolved oxygen is 5 mg/L for all life stages other than buried embryo/alevin. The instantaneous minimum guideline for dissolved oxygen in the water column is 9 mg/L for buried embryo/alevin. The instantaneous minimum guideline for dissolved oxygen in interstitial water is 6 mg/L for buried embryo/alevin.

The 30-day mean guideline (minimum) for dissolved oxygen is 8 mg/L for all life stages other than buried embryo/alevin.

The 30-day mean guideline (minimum) for dissolved oxygen in the water column is 11 mg/L for buried embryo/alevin. The

30-day mean guideline (minimum) for dissolved oxygen in interstitial water is 8 mg/L for buried embryo/alevin.

Note 1.2 for pH:

pH less than 6.5: No statistically significant decrease in pH from background.

pH from 6.5 to 9.0: Unrestricted change permitted within this range.

pH over 9.0: No statistically significant increase in pH from background.

See BC MOE Overview Report for additional details.

Note 1.3 for Temperature:

The maximum daily temperature of 19 degrees Celsius is for streams with unknown fish distribution. See BC MOE Overview Report for additional details for streams with unknown fish distribution, and specific guidelines for streams with known fish distribution, and guideline for lakes and impoundments.

Note 1.4 for Chloride:

To protect freshwater aquatic life from acute and lethal effects, the maximum concentration of chloride (mg/L as NaCl) at any time should not exceed 600 mg/L.

To protect freshwater aquatic life from chronic effects, the average (arithmetic mean computed from five weekly samples collected over a 30-day period) concentration of chloride (mg/L as NaCl) should not exceed 150 mg/L.

Note 1.5 for Fluoride:

Correction by BC MOE Sept. 2011: The criteria for Fluoride (total) in mg/L is 0.4 as a maximum where the water hardness (as CaCO₃) is less than or equal to 10 mg/L. Otherwise use the equation:

LC50 fluoride = $-51.73 + 92.57 \log_{10}(\text{Hardness})$ and multiply by 0.01.

Hardness is as CaCO₃ in units mg/L.

Note 1.6 for pH:

pH less than 6.5: No statistically significant decrease in pH from background.

pH from 6.5 to 9.0: Unrestricted change permitted within this range.

pH over 9.0: No statistically significant increase in pH from background.

See BC MOE Overview Report for additional details.

Note 1.7 for Sulphate:

The approved 30-day average (minimum of 5 evenly-spaced samples collected in 30 days) water quality guidelines to protect aquatic life in BC for sulphate are:

128 mg/L at hardness of 0 to 30 mg/L as CaCO₃

218 mg/L at hardness of 31 to 75 mg/L as CaCO₃

309 mg/L at hardness of 76 to 180 mg/L as CaCO₃

429 mg/L at hardness 181 to 250 mg/L as CaCO₃

Need to determine guideline based on site water for hardness greater than 250 mg/L as CaCO₃.

For screening purposes in this report, exceedance were flagged for sulphate greater than 429 mg/L at hardness greater than 250 mg/L as CaCO₃.

Note 1.8 for Total suspended solids:

Maximum Induced Suspended Sediments - mg/L or % of background:

- 25 mg/L in 24 hours when background is less than or equal to 25;

- Mean of 5 mg/L in 30 days when background is less than or equal to 25;

- 25 mg/L when background is between 25 and 250;

- 10% when background is greater than or equal to 250. / There are two refuse disposal sites (Revelstoke and Skimikin) where up gradient and down gradient samples have been collected in one water body; therefore, this guideline applies to

Revelstoke and Skimikin only

Note 1.9 for Turbidity:

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When background is less than or equal to 8 NTU:

- Maximum Induced Turbidity of 8 NTU in 24 hours.

- For sediment inputs that last between 24 hours and 30 days (daily sampling preferred) the mean turbidity should not exceed background by more than 2 NTU.

Maximum Induced Turbidity of 5 NTU when background is between 8 and 50 NTU.

Maximum Induced Turbidity of 10% when background is greater than 50 NTU. / There are two refuse disposal sites (Revelstoke and Skimikin) where up gradient and down gradient samples have been collected in one water body; therefore, this guideline applies to Revelstoke and Skimikin only

Note 1.10 for Aluminum (dissolved):

The maximum concentration of dissolved aluminum at any time should not exceed:

1. 0.10 mg/L when the pH is greater than or equal to 6.5

2. The value (in mg/L) determined by the following relationship if pH less than 6.5

Dissolved Aluminum = $e^{(1.209 - 2.426(\text{pH}) + 0.286(\text{pH})^2)}$

The 30-day average concentration of dissolved aluminum (based on a minimum of 5 approximately weekly samples) should not exceed:

1. 0.05 mg/L when the median pH over 30 days is greater than or equal to 6.5

2. the value determined by the following relationship at median pH less than 6.5

Dissolved Aluminum = $e^{(1.6 - 3.327(\text{median pH}) + 0.402(\text{median pH})^2)}$

Note 1.11 for Arsenic (dissolved):

The recommended guideline is for total arsenic.

Note 1.12 for Boron (dissolved):

The recommended guideline is for total boron.

Note 1.13 for Cadmium (dissolved):

The guideline for cadmium is determined on a site-specific basis according to the local water hardness. The guideline for cadmium (dissolved) in µg/L is determined by the following equations for short term exposure:

1. If hardness (as CaCO₃) is less than 7 mg/L then maximum is 0.0380 µg/L

2. If hardness (as CaCO₃) is from 7 to 45 mg/L then maximum is based on equation:

$e^{\{1.03[\ln(\text{hardness})] - 5.274\}}$

3. If hardness (as CaCO₃) is greater than 45 mg/L then maximum is 2.8 µg/L.

When water hardness is greater than the upper bound (i.e., highest water hardness tested), a site-specific assessment may be required

Note 1.14 for Cobalt (dissolved):

The interim maximum concentration for total cobalt is 110 µg/L to protect aquatic life in the freshwater environment from acute effects of cobalt.

The interim 30-day average concentration for total cobalt (based on five weekly samples) is 4 µg/L to protect aquatic life from chronic effects of cobalt.

Note 1.15 for Cobalt (total):

The interim maximum concentration for total cobalt is 110 µg/L to protect aquatic life in the freshwater environment from acute effects of cobalt.

The interim 30-day average concentration for total cobalt (based on five weekly samples) is 4 µg/L to protect aquatic life from chronic effects of cobalt.

Note 1.16 for Copper (dissolved):

The maximum concentration of total copper should not exceed at any time the numerical value (in µg/L) given by the formula " $0.094(\text{hardness})+2$ ", where water hardness is reported as mg/L CaCO₃.

The 30-day average concentration of total copper (based on a minimum of 5 approximately weekly samples) should not exceed 2 µg/L when average water hardness over the same period (expressed as mg/L CaCO₃) is less than 50 mg/L.

When average water hardness is greater than 50 mg/L the 30-day average concentration should not exceed the numerical value (in µg/L) given by the formula " $0.04(\text{average hardness})$ ", where water hardness is reported as mg/L CaCO₃

Note 1.17 for Copper (total):

The maximum concentration of total copper should not exceed at any time the numerical value (in µg/L) given by the formula " $0.094(\text{hardness})+2$ ", where water hardness is reported as mg/L CaCO₃.

The 30-day average concentration of total copper (based on a minimum of 5 approximately weekly samples) should not exceed 2 µg/L when average water hardness over the same period (expressed as mg/L CaCO₃) is less than 50 mg/L.

When average water hardness is greater than 50 mg/L the 30-day average concentration should not exceed the numerical value (in µg/L) given by the formula " $0.04(\text{average hardness})$ ", where water hardness is reported as mg/L CaCO₃.

Note 1.18 for Lead (dissolved):

The maximum guideline for total lead in water, at a water hardness less than or equal to 8 mg/L as CaCO₃ is set at 3.0 µg/L. When water hardness exceeds 8.0 mg/L CaCO₃ the maximum guideline for lead at any time is given by the following equation:

Maximum Criteria (µg/L) = $\exp(1.273 \ln(\text{hardness}) - 1.460)$.

The 30-day average guideline for total lead in water, when water hardness exceeds 8 mg/L as CaCO₃, is as follows:

30-Day Average (µg/L) is less than or equal to $3.31 + \exp(1.273 \ln(\text{mean hardness}) - 4.704)$.

For hardness less than or equal to 8.0 mg/L there is no 30-day average guideline; hence the maximum concentration of 3.0 µg/L is used

Note 1.19 for Lead (total):

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The maximum guideline for total lead in water, at a water hardness less than or equal to 8 mg/L as CaCO₃ is set at 3.0 µg/L. When water hardness exceeds 8.0 mg/L CaCO₃ the maximum guideline for lead at any time is given by the following equation:

Maximum Criteria (µg/L) = $\exp(1.273 \ln(\text{hardness}) - 1.460)$.

The 30-day average guideline for total lead in water, when water hardness exceeds 8 mg/L as CaCO₃, is as follows:

30-Day Average (µg/L) is less than or equal to $3.31 + \exp(1.273 \ln(\text{mean hardness}) - 4.704)$.

For hardness less than or equal to 8.0 mg/L there is no 30-day average guideline; hence the maximum concentration of 3.0 µg/L is used.

Note 1.20 for Manganese (dissolved):

The maximum concentration of total manganese in mg/L at any time should not exceed the value as determined by the following relationship:

$0.01102 \text{ hardness} + 0.54$

where water hardness is reported as mg/L of CaCO₃.

The 30-day mean concentration of total manganese in mg/L should be less than or equal to the value as determined by the following relationship:

$0.0044 \text{ hardness} + 0.605$

where water hardness is reported as mg/L of CaCO₃.

Note 1.21 for Manganese (total):

The maximum concentration of total manganese in mg/L at any time should not exceed the value as determined by the following relationship:

$0.01102 \text{ hardness} + 0.54$

where water hardness is reported as mg/L of CaCO₃.

The 30-day mean concentration of total manganese in mg/L should be less than or equal to the value as determined by the following relationship:

$0.0044 \text{ hardness} + 0.605$

where water hardness is reported as mg/L of CaCO₃.

Note 1.22 for Mercury (dissolved):

The average concentration of total mercury in water as measured over a 30-day period (based on five weekly samples) should not exceed 0.02 µg/L when the methyl mercury (MeHg) constitutes less than or equal to 0.5% of the total mercury concentration. When the proportion of MeHg is greater than 0.5%, the guideline should be adjusted as indicated in the Table 1 and Table 4 of the BC MOE Overview Report - First Update, February 2001.

There is no guideline maximum for total mercury in water, for freshwater aquatic life.

Note 1.23 for Mercury (total):

The average concentration of total mercury in water as measured over a 30-day period (based on five weekly samples) should not exceed 0.02 µg/L when the methyl mercury (MeHg) constitutes less than or equal to 0.5% of the total mercury concentration. When the proportion of MeHg is greater than 0.5%, the guideline should be adjusted as indicated in the Table 1 and Table 4 of the BC MOE Overview Report - First Update, February 2001.

There is no guideline maximum for total mercury in water, for freshwater aquatic life.

Note 1.24 for Molybdenum (dissolved):

The maximum concentration for total molybdenum is 2 mg/L.

The 30-day average concentration for total molybdenum (based on at least five weekly samples in a period of 30 days) is less than or equal to 1 mg/L.

Note 1.25 for Molybdenum (total):

The maximum concentration for total molybdenum is 2 mg/L.

The 30-day average concentration for total molybdenum (based on at least five weekly samples in a period of 30 days) is less than or equal to 1 mg/L.

Note 1.26 for Selenium (dissolved):

The 30-day average water quality guideline for protection of aquatic life is 2 µg/L determined as the mean concentration of 5 evenly spaced samples collected over 30 days, and measured as total selenium.

The 30-day average alert concentration for the protection of aquatic life in sensitive ecosystems is 1 µg/L determined as the mean concentration of 5 evenly spaced samples collected over 30 days, and measured as total selenium.

Note 1.27 for Selenium (total):

The 30-day average water quality guideline for protection of aquatic life is 2 µg/L determined as the mean concentration of 5 evenly spaced samples collected over 30 days, and measured as total selenium.

The 30-day average alert concentration for the protection of aquatic life in sensitive ecosystems is 1 µg/L determined as the mean concentration of 5 evenly spaced samples collected over 30 days, and measured as total selenium.

Note 1.28 for Silver (dissolved):

The guideline maximum for total silver is:

0.1 µg/L maximum if hardness less than or equal to 100 mg/L

3.0 µg/L maximum if hardness greater than 100 mg/L.

The guideline 30-day average for total silver is:

0.05 µg/L as 30-day mean if hardness less than or equal to 100 mg/L

1.5 µg/L as 30-day mean if hardness greater than 100 mg/L.

Note 1.29 for Silver (total):

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Water Quality Results

The guideline maximum for total silver is:

0.1 µg/L maximum if hardness less than or equal to 100 mg/L

3.0 µg/L maximum if hardness greater than 100 mg/L.

The guideline 30-day average for total silver is:

0.05 µg/L as 30-day mean if hardness less than or equal to 100 mg/L

1.5 µg/L as 30-day mean if hardness greater than 100 mg/L

Note 1.30 for Zinc (dissolved):

The Short-term Maximum concentration of total zinc (µg/L) at any time should not exceed 33 µg/L when water hardness is less than or equal to 90 mg/L as CaCO₃.

When water hardness exceeds 90 mg/L CaCO₃, the Short-term Maximum guideline in µg/L for total zinc is the value determined by the following relationship:

$$33 + 0.75 * (\text{hardness} - 90)$$

where water hardness is reported as mg/L of CaCO₃.

Short-term maximum WQG formula applies to water hardness between 90 – 500 mg/L CaCO₃.

The Long-term Average concentration of total zinc (µg/L) at any time should not exceed 7.5 µg/L when water hardness is less than or equal to 90 mg/L as CaCO₃.

When water hardness exceeds 90 mg/L CaCO₃, the Long-term Average guideline in µg/L for total zinc is the value determined by the following relationship:

$$7.5 + 0.75 * (\text{hardness} - 90)$$

where water hardness is reported as mg/L of CaCO₃.

Long-term average WQG formula applies to water hardness between 90 – 500 mg/L CaCO₃.

Note 1.31 for Zinc (total):

The maximum concentration of total zinc (µg/L) at any time should not exceed 33 µg/L when water hardness is less than or equal to 90 mg/L as CaCO₃.

When water hardness exceeds 90 mg/L CaCO₃, the guideline maximum in µg/L for total zinc is the value determined by the following relationship:

$$33 + 0.75 * (\text{hardness} - 90)$$

where water hardness is reported as mg/L of CaCO₃.

The 30-day average concentration of total zinc (µg/L) at any time should not exceed 7.5 µg/L when water hardness is less than or equal to 90 mg/L as CaCO₃.

When water hardness exceeds 90 mg/L CaCO₃, the guideline maximum in µg/L for total zinc is the value determined by the following relationship:

$$7.5 + 0.75 * (\text{hardness} - 90)$$

where water hardness is reported as mg/L of CaCO₃.

Note 1.32 for Ammonia (total, as N):

The maximum guideline for ammonia varies as a function of pH and temperature. See Table 3 in Overview Report Update September 2009.

The 30-day average guideline for ammonia varies as a function of pH and temperature. See Table 4 in Overview Report Update September 2009. / The lab pH and field temperature results were used for determining the maximum ammonia for this report. If a lab pH result was not available then the field pH result was used.

Note 1.33 for Nitrate (as N):

The guideline maximum for nitrate (as N) is 32.8 mg/L.

The 30-day average guideline for nitrate (as N) is 3.0 mg /L. The 30-day average (chronic) concentration is based on 5 weekly samples collected within a 30-day period.

Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed these values.

Note 1.34 for Nitrate + Nitrite (as N) (calculated):

The guideline maximum for nitrate (as N) is 32.8 mg/L.

The 30-day average guideline for nitrate (as N) is 3.0 mg /L. The 30-day average (chronic) concentration is based on 5 weekly samples collected within a 30-day period.

Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed these values.

Note 1.35 for Nitrite (as N):

The guideline maximum for nitrite as N is:

0.06 mg/L if chloride less than 2 mg/L

0.12 mg/L if chloride is 2 to 4 mg/L

0.18 mg/L if chloride is 4 to 6 mg/L

0.24 mg/L if chloride is 6 to 8 mg/L

0.30 mg/L if chloride is 8 to 10 mg/L

0.60 mg/L if chloride is greater than 10 mg/L.

The guideline 30-day average for nitrite as N is:

0.02 mg/L if chloride less than 2 mg/L

0.04 mg/L if chloride is 2 to 4 mg/L

0.06 mg/L if chloride is 4 to 6 mg/L

0.08 mg/L if chloride is 6 to 8 mg/L

0.10 mg/L if chloride is 8 to 10 mg/L

0.20 mg/L if chloride is greater than 10 mg/L

Note 1.36 for Phosphorus (dissolved, by ICPMS/ICPOES):

Golden Refuse Disposal Site

Water Quality Results

Streams: None proposed for streams.

Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

Note 1.37 for Phosphorus (total, by ICPMS/ICPOES):

Streams: None proposed for streams.

Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

Note 1.38 for Phosphorus (dissolved, APHA 4500-P):

Streams: None proposed for streams.

Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

2. Notes for BC Approved Water Quality Guidelines for freshwater aquatic life (30-day average) (BCAWQG ALA)

General Notes:

The Water Quality Guidelines (Criteria) Reports by BC Ministry of Environment were used as references for the guidelines. (Internet address: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html). Overview Reports (BC MOE) were used as the references for the guidelines unless the note for specific analyte indicates that the Technical Appendix (BC MOE) was used. / For some parameters, guidelines are specified as two values: the maximum value or the acute criterion, and the 30-day average value or the chronic criterion. The 30-day average value was used in this report for parameters that have both guideline values.

Note 2.1 for Dissolved oxygen:

The instantaneous minimum guideline for dissolved oxygen is 5 mg/L for all life stages other than buried embryo/alevin. The instantaneous minimum guideline for dissolved oxygen in the water column is 9 mg/L for buried embryo/alevin. The instantaneous minimum guideline for dissolved oxygen in interstitial water is 6 mg/L for buried embryo/alevin.

The 30-day mean guideline (minimum) for dissolved oxygen is 8 mg/L for all life stages other than buried embryo/alevin.

The 30-day mean guideline (minimum) for dissolved oxygen in the water column is 11 mg/L for buried embryo/alevin. The

30-day mean guideline (minimum) for dissolved oxygen in interstitial water is 8 mg/L for buried embryo/alevin

Note 2.2 for pH:

pH less than 6.5: No statistically significant decrease in pH from background.

pH from 6.5 to 9.0: Unrestricted change permitted within this range.

pH over 9.0: No statistically significant increase in pH from background.

See BC MOE Overview Report for additional details.

Note 2.3 for Temperature:

The maximum daily temperature of 19 degrees Celsius is for streams with unknown fish distribution. See BC MOE Overview Report for additional details for streams with unknown fish distribution, and specific guidelines for streams with known fish distribution, and guideline for lakes and impoundments.

Note 2.4 for Chloride:

To protect freshwater aquatic life from acute and lethal effects, the maximum concentration of chloride (mg/L as NaCl) at any time should not exceed 600 mg/L.

To protect freshwater aquatic life from chronic effects, the average (arithmetic mean computed from five weekly samples collected over a 30-day period) concentration of chloride (mg/L as NaCl) should not exceed 150 mg/L.

Note 2.5 for Fluoride:

Correction by BC MOE Sept. 2011: The criteria for Fluoride (total) in mg/L is 0.4 as a maximum where the water hardness (as CaCO₃) is less than or equal to 10 mg/L. Otherwise use the equation:

LC50 fluoride = $-51.73 + 92.57 \log_{10}(\text{Hardness})$ and multiply by 0.01.

Hardness is as CaCO₃ in units mg/L.

Note 2.6 for pH:

pH less than 6.5: No statistically significant decrease in pH from background.

pH from 6.5 to 9.0: Unrestricted change permitted within this range.

pH over 9.0: No statistically significant increase in pH from background.

See BC MOE Overview Report for additional details.

Note 2.7 for Sulphate:

The approved 30-day average (minimum of 5 evenly-spaced samples collected in 30 days) water quality guidelines to protect aquatic life in BC for sulphate are:

128 mg/L at hardness of 0 to 30 mg/L as CaCO₃

218 mg/L at hardness of 31 to 75 mg/L as CaCO₃

309 mg/L at hardness of 76 to 180 mg/L as CaCO₃

429 mg/L at hardness 181 to 250 mg/L as CaCO₃

Need to determine guideline based on site water for hardness greater than 250 mg/L as CaCO₃.

For screening purposes in this report, exceedance were flagged for sulphate greater than 429 mg/L at hardness greater than 250 mg/L as CaCO₃.

Note 2.8 for Total suspended solids:

Golden Refuse Disposal Site

Water Quality Results

Maximum Induced Suspended Sediments - mg/L or % of background:

- 25 mg/L in 24 hours when background is less than or equal to 25;
- Mean of 5 mg/L in 30 days when background is less than or equal to 25;
- 25 mg/L when background is between 25 and 250;
- 10% when background is greater than or equal to 250.

Note 2.9 for Turbidity:

When background is less than or equal to 8 NTU:

- Maximum Induced Turbidity of 8 NTU in 24 hours.
- For sediment inputs that last between 24 hours and 30 days (daily sampling preferred) the mean turbidity should not exceed background by more than 2 NTU.

Maximum Induced Turbidity of 5 NTU when background is between 8 and 50 NTU.

Maximum Induced Turbidity of 10% when background is greater than 50 NTU.

Note 2.10 for Aluminum (dissolved):

The maximum concentration of dissolved aluminum at any time should not exceed:

1. 0.10 mg/L when the pH is greater than or equal to 6.5
2. The value (in mg/L) determined by the following relationship if pH less than 6.5

Dissolved Aluminum = $e^{(1.209 - 2.426(\text{pH}) + 0.286(\text{pH})^2)}$

The 30-day average concentration of dissolved aluminum (based on a minimum of 5 approximately weekly samples) should not exceed:

1. 0.05 mg/L when the median pH over 30 days is greater than or equal to 6.5
2. the value determined by the following relationship at median pH less than 6.5

Dissolved Aluminum = $e^{(1.6 - 3.327(\text{median pH}) + 0.402(\text{median pH})^2)}$ / The lab pH results were used for determining the maximum aluminum (dissolved) concentration for this report. If a lab pH result was not available then the field pH result was used.

Note 2.11 for Arsenic (dissolved):

The recommended guideline is for total arsenic.

Note 2.12 for Boron (dissolved):

The recommended guideline is for total boron.

Note 2.13 for Cadmium (dissolved):

The guideline for cadmium is determined on a site-specific basis according to the local water hardness. The guideline for cadmium (dissolved) in µg/L is determined by the following equations for long term exposure:

1. If hardness (as CaCO₃) is less than 3.4 mg/L then maximum is 0.0176 µg/L
2. If hardness (as CaCO₃) is from 3.4 to 285 mg/L then maximum is based on equation:
 $e^{\text{raised to the power of } \{0.736[\ln(\text{hardness})] - 4.943\}}$
3. If hardness (as CaCO₃) is greater than 285 mg/L then maximum is 0.457 µg/L.

When water hardness is greater than the upper bound (i.e., highest water hardness tested), a site-specific assessment may be required.

Note 2.14 for Cobalt (dissolved):

The interim maximum concentration for total cobalt is 110 µg/L to protect aquatic life in the freshwater environment from acute effects of cobalt.

The interim 30-day average concentration for total cobalt (based on five weekly samples) is 4 µg/L to protect aquatic life from chronic effects of cobalt.

Note 2.15 for Cobalt (total):

The interim maximum concentration for total cobalt is 110 µg/L to protect aquatic life in the freshwater environment from acute effects of cobalt.

The interim 30-day average concentration for total cobalt (based on five weekly samples) is 4 µg/L to protect aquatic life from chronic effects of cobalt.

Note 2.16 for Copper (dissolved):

The maximum concentration of total copper should not exceed at any time the numerical value (in µg/L) given by the formula " $0.094(\text{hardness})+2$ ", where water hardness is reported as mg/L CaCO₃.

The 30-day average concentration of total copper (based on a minimum of 5 approximately weekly samples) should not exceed 2 µg/L when average water hardness over the same period (expressed as mg/L CaCO₃) is less than 50 mg/L.

When average water hardness is greater than 50 mg/L the 30-day average concentration should not exceed the numerical value (in µg/L) given by the formula " $0.04(\text{average hardness})$ ", where water hardness is reported as mg/L CaCO₃.

Note 2.17 for Copper (total):

The maximum concentration of total copper should not exceed at any time the numerical value (in µg/L) given by the formula " $0.094(\text{hardness})+2$ ", where water hardness is reported as mg/L CaCO₃.

The 30-day average concentration of total copper (based on a minimum of 5 approximately weekly samples) should not exceed 2 µg/L when average water hardness over the same period (expressed as mg/L CaCO₃) is less than 50 mg/L.

When average water hardness is greater than 50 mg/L the 30-day average concentration should not exceed the numerical value (in µg/L) given by the formula " $0.04(\text{average hardness})$ ", where water hardness is reported as mg/L CaCO₃.

Note 2.18 for Lead (dissolved):

Golden Refuse Disposal Site

Water Quality Results

The maximum guideline for total lead in water, at a water hardness less than or equal to 8 mg/L as CaCO₃ is set at 3.0 µg/L. When water hardness exceeds 8.0 mg/L CaCO₃ the maximum guideline for lead at any time is given by the following equation:

Maximum Criteria (µg/L) = $\exp(1.273 \ln(\text{hardness}) - 1.460)$.

The 30-day average guideline for total lead in water, when water hardness exceeds 8 mg/L as CaCO₃, is as follows:

30-Day Average (µg/L) is less than or equal to $3.31 + \exp(1.273 \ln(\text{mean hardness}) - 4.704)$.

For hardness less than or equal to 8.0 mg/L there is no 30-day average guideline; hence the maximum concentration of 3.0 µg/L is used.

Note 2.19 for Lead (total):

The maximum guideline for total lead in water, at a water hardness less than or equal to 8 mg/L as CaCO₃ is set at 3.0 µg/L. When water hardness exceeds 8.0 mg/L CaCO₃ the maximum guideline for lead at any time is given by the following equation:

Maximum Criteria (µg/L) = $\exp(1.273 \ln(\text{hardness}) - 1.460)$.

The 30-day average guideline for total lead in water, when water hardness exceeds 8 mg/L as CaCO₃, is as follows:

30-Day Average (µg/L) is less than or equal to $3.31 + \exp(1.273 \ln(\text{mean hardness}) - 4.704)$.

For hardness less than or equal to 8.0 mg/L there is no 30-day average guideline; hence the maximum concentration of 3.0 µg/L is used.

Note 2.20 for Manganese (dissolved):

The maximum concentration of total manganese in mg/L at any time should not exceed the value as determined by the following relationship:

$0.01102 \text{ hardness} + 0.54$

where water hardness is reported as mg/L of CaCO₃.

The 30-day mean concentration of total manganese in mg/L should be less than or equal to the value as determined by the following relationship:

$0.0044 \text{ hardness} + 0.605$

where water hardness is reported as mg/L of CaCO₃.

Note 2.21 for Manganese (total):

The maximum concentration of total manganese in mg/L at any time should not exceed the value as determined by the following relationship:

$0.01102 \text{ hardness} + 0.54$

where water hardness is reported as mg/L of CaCO₃.

The 30-day mean concentration of total manganese in mg/L should be less than or equal to the value as determined by the following relationship:

$0.0044 \text{ hardness} + 0.605$

where water hardness is reported as mg/L of CaCO₃.

Note 2.22 for Mercury (dissolved):

The average concentration of total mercury in water as measured over a 30-day period (based on five weekly samples) should not exceed 0.02 µg/L when the methyl mercury (MeHg) constitutes less than or equal to 0.5% of the total mercury concentration. When the proportion of MeHg is greater than 0.5%, the guideline should be adjusted as indicated in the Table 1 and Table 4 of the BC MOE Overview Report - First Update, February 2001.

There is no guideline maximum for total mercury in water, for freshwater aquatic life.

Note 2.23 for Mercury (total):

The average concentration of total mercury in water as measured over a 30-day period (based on five weekly samples) should not exceed 0.02 µg/L when the methyl mercury (MeHg) constitutes less than or equal to 0.5% of the total mercury concentration. When the proportion of MeHg is greater than 0.5%, the guideline should be adjusted as indicated in the Table 1 and Table 4 of the BC MOE Overview Report - First Update, February 2001.

There is no guideline maximum for total mercury in water, for freshwater aquatic life.

Note 2.24 for Molybdenum (dissolved):

The maximum concentration for total molybdenum is 2 mg/L.

The 30-day average concentration for total molybdenum (based on at least five weekly samples in a period of 30 days) is less than or equal to 1 mg/L.

Note 2.25 for Molybdenum (total):

The maximum concentration for total molybdenum is 2 mg/L.

The 30-day average concentration for total molybdenum (based on at least five weekly samples in a period of 30 days) is less than or equal to 1 mg/L.

Note 2.26 for Selenium (dissolved):

The 30-day average water quality guideline for protection of aquatic life is 2 µg/L determined as the mean concentration of 5 evenly spaced samples collected over 30 days, and measured as total selenium.

The 30-day average alert concentration for the protection of aquatic life in sensitive ecosystems is 1 µg/L determined as the mean concentration of 5 evenly spaced samples collected over 30 days, and measured as total selenium.

Note 2.27 for Selenium (total):

The 30-day average water quality guideline for protection of aquatic life is 2 µg/L determined as the mean concentration of 5 evenly spaced samples collected over 30 days, and measured as total selenium.

The 30-day average alert concentration for the protection of aquatic life in sensitive ecosystems is 1 µg/L determined as the mean concentration of 5 evenly spaced samples collected over 30 days, and measured as total selenium.

Note 2.28 for Silver (dissolved):

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Water Quality Results

The guideline maximum for total silver is:

0.1 µg/L maximum if hardness less than or equal to 100 mg/L

3.0 µg/L maximum if hardness greater than 100 mg/L.

The guideline 30-day average for total silver is:

0.05 µg/L as 30-day mean if hardness less than or equal to 100 mg/L

1.5 µg/L as 30-day mean if hardness greater than 100 mg/L

Note 2.29 for Silver (total):

The guideline maximum for total silver is:

0.1 µg/L maximum if hardness less than or equal to 100 mg/L

3.0 µg/L maximum if hardness greater than 100 mg/L.

The guideline 30-day average for total silver is:

0.05 µg/L as 30-day mean if hardness less than or equal to 100 mg/L

1.5 µg/L as 30-day mean if hardness greater than 100 mg/L

Note 2.30 for Zinc (dissolved):

The Short-term Maximum concentration of total zinc (µg/L) at any time should not exceed 33 µg/L when water hardness is less than or equal to 90 mg/L as CaCO₃.

When water hardness exceeds 90 mg/L CaCO₃, the Short-term Maximum guideline in µg/L for total zinc is the value determined by the following relationship:

$$33 + 0.75 * (\text{hardness} - 90)$$

where water hardness is reported as mg/L of CaCO₃.

Short-term maximum WQG formula applies to water hardness between 90 – 500 mg/L CaCO₃.

The Long-term Average concentration of total zinc (µg/L) at any time should not exceed 7.5 µg/L when water hardness is less than or equal to 90 mg/L as CaCO₃.

When water hardness exceeds 90 mg/L CaCO₃, the Long-term Average guideline in µg/L for total zinc is the value determined by the following relationship:

$$7.5 + 0.75 * (\text{hardness} - 90)$$

where water hardness is reported as mg/L of CaCO₃.

Long-term average WQG formula applies to water hardness between 90 – 500 mg/L CaCO₃.

Note 2.31 for Zinc (total):

The maximum concentration of total zinc (µg/L) at any time should not exceed 33 µg/L when water hardness is less than or equal to 90 mg/L as CaCO₃.

When water hardness exceeds 90 mg/L CaCO₃, the guideline maximum in µg/L for total zinc is the value determined by the following relationship:

$$33 + 0.75 * (\text{hardness} - 90)$$

where water hardness is reported as mg/L of CaCO₃.

The 30-day average concentration of total zinc (µg/L) at any time should not exceed 7.5 µg/L when water hardness is less than or equal to 90 mg/L as CaCO₃.

When water hardness exceeds 90 mg/L CaCO₃, the guideline maximum in µg/L for total zinc is the value determined by the following relationship:

$$7.5 + 0.75 * (\text{hardness} - 90)$$

where water hardness is reported as mg/L of CaCO₃.

Note 2.32 for Ammonia (total, as N):

The maximum guideline for ammonia varies as a function of pH and temperature. See Table 3 in Overview Report Update September 2009.

The 30-day average guideline for ammonia varies as a function of pH and temperature. See Table 4 in Overview Report Update September 2009. / The lab pH and field temperature results were used for determining the maximum ammonia concentration for this report. If a lab pH result was not available then the field pH result was used.

Note 2.33 for Nitrate (as N):

The guideline maximum for nitrate (as N) is 32.8 mg/L.

The 30-day average guideline for nitrate (as N) is 3.0 mg /L. The 30-day average (chronic) concentration is based on 5 weekly samples collected within a 30-day period.

Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed these values.

Note 2.34 for Nitrate + Nitrite (as N) (calculated):

The guideline maximum for nitrate (as N) is 32.8 mg/L.

The 30-day average guideline for nitrate (as N) is 3.0 mg /L. The 30-day average (chronic) concentration is based on 5 weekly samples collected within a 30-day period.

Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed these values.

Note 2.35 for Nitrite (as N):

Golden Refuse Disposal Site

Water Quality Results

The guideline maximum for nitrite as N is:

0.06 mg/L if chloride less than 2 mg/L

0.12 mg/L if chloride is 2 to 4 mg/L

0.18 mg/L if chloride is 4 to 6 mg/L

0.24 mg/L if chloride is 6 to 8 mg/L

0.30 mg/L if chloride is 8 to 10 mg/L

0.60 mg/L if chloride is greater than 10 mg/L.

The guideline 30-day average for nitrite as N is:

0.02 mg/L if chloride less than 2 mg/L

0.04 mg/L if chloride is 2 to 4 mg/L

0.06 mg/L if chloride is 4 to 6 mg/L

0.08 mg/L if chloride is 6 to 8 mg/L

0.10 mg/L if chloride is 8 to 10 mg/L

0.60 mg/L if chloride is greater than 10 mg/L

Note 2.36 for Phosphorus (dissolved, by ICPMS/ICPOES):

Streams: None proposed for streams.

Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

Note 2.37 for Phosphorus (total, by ICPMS/ICPOES):

Streams: None proposed for streams.

Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

Note 2.38 for Phosphorus (dissolved, APHA 4500-P):

Streams: None proposed for streams.

Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

Appendix G: Soil Quality Report

5-Year 2018 Hydrogeological Assessment
CSRD
Golden RDF
WWAL Ref: 14-024-21



Golden Refuse Disposal Site

Soil Quality Results

Legend for Reports for CSRD Refuse Disposal Sites Soil Quality Results

<	Less than reported detection limit
>	Greater than reported upper detection limit
>=	Greater than or equal to
A	Absent
Calc	Calculated guideline or standard. The guideline or standard is dependent on the value of one or more other analytes, and is calculated from a formula or table.
CSR RL-LD (F)	BC Contaminated Sites Regulation, Numerical Soil Standards for Residential (Low Density) Land Use; Human Health Protection (Intake of contaminated soils) and Environmental Protection (Toxicity to soil invertebrates and plants) (2017 and updates). Note, Groundwater for drinking water does not apply here, as there is no surficial aquifer and the bedrock aquifer is not likely hydraulically connected to the surface.
L	Laboratory reading type (Lab result)
m asl	metres above sea level
N	Narrative type of guideline or standard, or Result Note.
ND	Non-detect. Result is less than lower detection limit.
NG	No Guideline
NR	No Result
NS	No Standard
NT	Not Tested
OG	Overgrown
P	Present
PR	Presumptive
TK	Test kit reading type (Field result)
TNTC	Too numerous to count

	Highlighted value has a lower detection limit that is greater than the guideline/standard maximum and/or the guideline/standard minimum, or has an upper detection limit that is less than the guideline/standard maximum and/or the guideline/standard minimum.
CSR RL-LD (F)	Highlighted value exceeds CSR RL-LD (F)
SL Criteria Override	Highlighted value exceeds sampling location criteria override

Golden Refuse Disposal Site
Soil Quality Results

Sampling Location			LOC-1	LOC-10	LOC-11	LOC-11	LOC-12	LOC-13	LOC-14	LOC-15	LOC-16	LOC-18 (1.5 ft)	LOC-18 (1.5 ft)	LOC-18 (Surface)	LOC-19	LOC-2	LOC-20	LOC-21	LOC-22	LOC-23	LOC-24
Date Sampled			25-Jun-18	27-Jun-18	27-Jun-18	10-Sep-18	10-Sep-18	10-Sep-18	10-Sep-18	10-Sep-18	10-Sep-18	10-Sep-18	10-Sep-18	10-Sep-18	10-Sep-18	25-Jun-18	10-Sep-18	10-Sep-18	10-Sep-18	10-Sep-18	10-Sep-18
Lab Sample ID			8062810-01	8062810-10	8062810-11	8091272-04	8091272-05	8091272-06	8091272-07	8091272-08	8091272-09	8091272-10	8091272-11	8091272-12	8091272-13	8062810-02	8091272-14	8091272-15	8091272-16	8091272-17	8091272-18
Analyte	Unit	Guideline																			
		CSR RL-LD (F)																			
Lab Results																					
General																					
Water-soluble bromide (mass/mass)	µg/g	NG																			
Water-soluble chloride (mass/mass)	µg/g	NG																			
Chloride (in saturated paste)	mg/L	NG	23.6	30.6	17.1												315				
Chloride ion	µg/g	350 ^{1.1}	<25	<25	<25												302.4				
Conductivity (in 5:1 water:soil mixture)	µS/cm	NG	409	193	132												206				
Water-soluble fluoride (mass/mass)	µg/g	NG																			
Moisture	% wet	NG																			
Water-soluble nitrate (as N) (mass/mass)	µg/g	NG																			
Water-soluble nitrite (as N) (mass/mass)	µg/g	NG																			
pH (in 2:1 water:soil mixture)		NG	6.57	7.18	7.38												6.90				
Total phosphorus (as P, SM 4500-P)	µg/g	NG																			
Percent saturation	%	NG	86.0	50.0	48.6												96.0				
Water-soluble sulphate (mass/mass)	µg/g	NG																			
Metals																					
Aluminum	µg/g	40000	13100	11700	7390								20500	17500			14500				
Antimony	µg/g	20 ^{1.2}	0.16	0.46	0.20								0.16	0.19			0.18				
Arsenic	µg/g	10 ^{1.3}	2.12	4.34	3.46								3.53	2.64			2.40				
Barium	µg/g	700 ^{1.4}	190	111	75.1								238	215			174				
Beryllium	µg/g	Calc ^{1.5}	0.36	0.43	0.31								0.57	0.47			0.44				
Bismuth	µg/g	NG	0.15	0.13	0.10								0.15	0.15			0.14				
Boron	µg/g	8500	2.8	4.9	3.8								2.5	5.3			4.7				
Cadmium	µg/g	Calc ^{1.6}	0.075	0.067	0.068								0.049	0.088			0.139				
Calcium	µg/g	NG	7820	81900	116000								13200	12700			19000				
Chromium	µg/g	60 ^{1.7}	9.4	12.6	11.2								12.9	16.6			10.1				
Cobalt	µg/g	25 ^{1.8}	4.08	7.16	6.05								5.43	3.97			5.16				
Copper	µg/g	Calc ^{1.9}	4.00	12.8	12.0								8.37	7.79			8.28				
Iron	µg/g	35000	15300	19900	17400								22700	15200			18100				
Lead	µg/g	120 ^{1.10}	15.8	14.1	14.2								14.7	38.3			18.8				
Lithium	µg/g	30	12.1	15.5	10.9								18.3	14.0			13.0				
Magnesium	µg/g	NG	3410	13900	20100								6320	3580			4690				
Manganese	µg/g	2000 ^{1.11}	551	404	428	381	728	548	641	658	702	607	832	593	931	579	327	398	429	409	902
Mercury	µg/g	10 ^{1.12}	0.075	0.112	0.073								<0.040	<0.040		0.086					
Molybdenum	µg/g	3 ^{1.13}	0.78	0.59	0.61								0.54	0.84		0.60					
Nickel	µg/g	Calc ^{1.14}	9.78	16.2	13.6								15.4	11.4		13.0					
Phosphorus	µg/g	NG	554	551	612								407	1020		437					
Potassium	µg/g	NG	1140	1270	780								758	1060		1420					
Selenium	µg/g	1 ^{1.15}	<0.20	<0.20	<0.20								<0.20	<0.20		<0.20					
Silver	µg/g	20 ^{1.16}	<0.10	<0.10	<0.10								<0.10	<0.10		<0.10					
Sodium	µg/g	NG	131	119	97								293	290		102					
Strontium	µg/g	9500	28.0	162	215								32.7	33.0		43.9					
Sulphur	µg/g	NG	2000	3650	3860								<1000	<1000		2650					
Tellurium	µg/g	NG	<0.10	<0.10	<0.10								<0.10	<0.10		<0.10					
Thallium	µg/g	g ^{1.17}	<0.10	<0.10	<0.10								<0.10	<0.10		<0.10					
Thorium	µg/g	NG	2.48	3.73	3.00								4.47	2.48		3.22					
Tin	µg/g	50 ^{1.18}	0.47	0.52	0.30								0.50	0.73		0.43					
Titanium	µg/g	NG	218	109	67.5								279	290		192					
Tungsten	µg/g	15	<0.20	<0.20	<0.20								<0.20	<0.20		<0.20					
Uranium	µg/g	15 ^{1.19}	0.181	0.317	0.258								0.195	0.160		0.171					
Vanadium	µg/g	100 ^{1.20}	11.1	10.3	7.8								12.4	10.0		9.4					
Zinc	µg/g	Calc ^{1.21}	55.3	51.7	44.8								47.1	60.6		51.1					
Zirconium	µg/g	NG	4.4	<2.0	<2.0								10.7	6.0		8.5					



Golden Refuse Disposal Site
Soil Quality Results

Sa		LOC-25 (1-3 ft)	LOC-25 (Surface)	LOC-26 (1-3 ft)	LOC-26 (Surface)	LOC-27 (1-3 ft)	LOC-27 (Surface)	LOC-28 (1-3 ft)	LOC-28 (Surface)	LOC-29 (1-3 ft)	LOC-29 (Surface)	LOC-3	LOC-4	LOC-5	LOC-6	LOC-6	LOC-6 (1.5 ft)	LOC-6 (3 ft)	LOC-8	LOC-9	MW18-11 360 ft (soil)
		10-Sep-18 8091272-20	10-Sep-18 8091272-19	10-Sep-18 8091272-22	10-Sep-18 8091272-21	10-Sep-18 8091272-24	10-Sep-18 8091272-23	10-Sep-18 8091272-26	10-Sep-18 8091272-25	10-Sep-18 8091272-28	10-Sep-18 8091272-27	25-Jun-18 8062810-03	25-Jun-18 8062810-04	25-Jun-18 8062810-05	25-Jun-18 8062810-06	10-Sep-18 8091272-01	10-Sep-18 8091272-02	10-Sep-18 8091272-03	25-Jun-18 8062810-08	25-Jun-18 8062810-09	27-Jun-18 8062805-04 Normal
Analyte	Unit																				
Lab Results																					
General																					
Water-soluble bromide (mass/mass)	µg/g																				<5.00
Water-soluble chloride (mass/mass)	µg/g																				15.6
Chloride (in saturated paste)	mg/L											15.3	33.7	13.2	13.8				20.4	12.7	
Chloride ion	µg/g											<25	94.7	<25	<25				<25	<25	
Conductivity (in 5:1 water:soil mixture)	µS/cm											311	158	133	300				115	215	
Water-soluble fluoride (mass/mass)	µg/g																				<5.00
Moisture	% wet																				17.1
Water-soluble nitrate (as N) (mass/mass)	µg/g																				<0.500
Water-soluble nitrite (as N) (mass/mass)	µg/g																				<0.500
pH (in 2:1 water:soil mixture)												7.25	5.68	7.97	6.58				6.06	6.84	
Total phosphorus (as P, SM 4500-P)	µg/g																				48.9
Percent saturation	%											69.0	281	46.5	142				56.7	81.4	
Water-soluble sulphate (mass/mass)	µg/g																				69.3
Metals																					
Aluminum	µg/g	23200	13900	20800	13800	22200	22300	22500	3890	26200	1420	15800	5160	10900	12300	22200	6780	2890	25100	10400	16300
Antimony	µg/g	0.14	0.37	0.17	0.30	0.24	0.21	0.22	0.55	0.16	0.42	0.27	0.46	0.34	0.48	0.21	0.14	0.12	0.19	0.40	0.41
Arsenic	µg/g	3.42	2.57	3.20	2.06	4.01	2.88	3.45	1.65	3.31	1.38	4.46	1.36	5.28	2.81	2.32	2.34	1.71	3.63	3.52	4.77
Barium	µg/g	231	274	192	249	233	227	207	227	290	109	165	178	77.9	406	227	70.6	38.5	258	105	104
Beryllium	µg/g	0.63	0.34	0.65	0.36	0.72	0.66	0.68	0.14	0.72	<0.10	0.53	0.14	0.41	0.33	0.56	0.37	0.24	0.68	0.39	0.37
Bismuth	µg/g	0.18	0.20	0.18	0.19	0.19	0.20	0.18	0.12	0.19	<0.10	0.15	0.13	0.12	0.21	0.19	<0.10	<0.10	0.17	0.11	0.15
Boron	µg/g	2.4	5.4	2.9	4.9	2.5	2.9	2.8	14.0	2.2	5.1	5.8	4.6	6.3	6.9	2.6	<2.0	<2.0	3.5	4.6	2.2
Cadmium	µg/g	0.057	0.189	0.068	0.224	0.076	0.081	0.053	0.280	0.046	0.087	0.062	0.168	0.060	0.346	0.059	0.057	<0.040	0.062	0.187	0.050
Calcium	µg/g	11300	15400	12000	14500	22200	9170	11200	31000	4800	17600	49100	15600	124000	18000	7210	130000	154000	6250	88900	123000
Chromium	µg/g	14.8	10.2	15.3	10.3	15.7	15.2	14.5	5.9	14.6	3.1	14.6	4.6	15.6	9.2	10.6	8.9	4.2	14.3	11.1	20.1
Cobalt	µg/g	6.34	4.19	6.78	4.64	7.39	6.85	6.59	2.17	6.18	0.93	8.06	1.97	9.23	5.22	4.72	4.50	3.02	6.30	6.07	10.2
Copper	µg/g	8.44	7.08	10.9	6.16	10.9	8.89	10.1	10.4	9.78	5.12	13.1	5.40	14.0	7.40	5.64	10.7	10.3	6.93	15.3	40.2
Iron	µg/g	24800	14200	26700	15000	26500	24500	24400	5960	22400	2580	21800	5980	22500	14300	17200	15900	10000	22500	18300	27100
Lead	µg/g	16.1	31.8	17.7	31.9	18.0	19.3	15.3	27.5	14.2	30.2	14.5	25.4	15.0	35.9	14.2	8.85	4.89	15.6	34.3	14.4
Lithium	µg/g	21.2	12.7	21.0	13.0	20.3	20.3	19.2	5.00	20.3	1.49	18.9	4.72	19.3	11.4	16.1	10.6	4.91	18.4	12.3	21.9
Magnesium	µg/g	5750	3570	8210	3780	8900	5680	5360	3800	4850	1870	9690	2170	18800	3630	3300	21300	13700	4230	14400	29600
Manganese	µg/g	775	1210	655	1790	832	706	610	885	568	155	439	539	430	2910	460	353	448	696	456	509
Mercury	µg/g	<0.040	0.083	<0.040	0.070	<0.040	<0.040	<0.040	0.109	<0.040	0.083	0.079	0.158	0.070	0.133	<0.040	<0.040	<0.040	0.094	0.086	0.084
Molybdenum	µg/g	0.68	1.10	0.60	1.03	0.64	0.52	0.66	0.91	0.47	0.54	0.82	1.05	0.53	1.06	0.54	0.37	0.19	0.73	0.49	2.02
Nickel	µg/g	17.5	10.8	18.7	11.9	19.2	17.9	17.6	6.12	17.4	2.58	18.4	5.14	20.4	12.2	12.3	12.8	6.89	16.7	13.4	22.5
Phosphorus	µg/g	335	614	362	493	340	307	467	904	447	454	571	505	573	784	288	256	277	828	619	571
Potassium	µg/g	905	1030	982	1060	809	1070	871	1020	768	536	1940	700	1620	1020	830	342	216	1140	991	963
Selenium	µg/g	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Silver	µg/g	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium	µg/g	316	283	263	258	288	301	346	236	341	222	143	73	123	154	329	227	201	188	143	183
Strontium	µg/g	27.5	45.1	23.5	38.7	38.2	23.9	30.0	84.4	21.7	47.7	110	54.5	267	61.4	24.3	169	203	25.6	153	277
Sulphur	µg/g	<1000	1320	<1000	<1000	<1000	<1000	<1000	1720	<1000	1120	3990	3990	3660	2950	<1000	1050	1230	<1000	3920	4180
Tellurium	µg/g	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Thallium	µg/g	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Thorium	µg/g	5.42	2.25	5.93	2.46	6.13	5.75	5.36	0.72	5.23	<0.50	4.40	1.07	6.05	2.53	3.19	3.24	1.24	4.40	3.02	7.55
Tin	µg/g	0.85	1.10	0.58	1.08	0.68	0.67	0.60	1.22	0.66	0.85	0.39	0.66	0.29	0.79	0.70	<0.20	<0.20	0.68	0.75	0.26
Titanium	µg/g	367	221	305	239	325	367	360	54.1	477	26.0	184	114	50.3	256	385	70.2	26.0	509	148	109
Tungsten	µg/g	<0.20	0.34	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<					



Guideline Notes for Reports for CSRD Refuse Disposal Sites Soil Quality Results**1. Notes for BC Contaminated Sites Regulation, Soil Standards for Residential (Low Density) Land Use; Environmental Protection, Toxicity to soil invertebrates and plants (2017 and updates) (CSR RL-LD (F))****General Notes:**

Soil Standards from Schedule 3.1 for residential (low density) land use have been applied.

Schedule 3.1 includes three parts: Part 1 – Matrix numerical soil standards; Part 2 – Generic numerical soil standards to protect human health; and Part 3 – Generic numerical soil standards to protect environmental health.

The most stringent standards in Schedule 3.1, including consideration for freshwater aquatic life (but not marine aquatic life), were used. This means that the Part 1 standards for “Environmental Protection, Groundwater flow to surface water used by freshwater aquatic life” were considered. The Part 1 standards for “Environmental Protection, Groundwater flow to surface water used by marine aquatic life” were not considered.

The Schedule 3.1 – Part 1 standards that were used, along with the site-specific factor, are included in the notes for the relevant analytes. For generic numerical soil standards, the Schedule 3.1 – Part 2 generic numerical soil standards were used unless noted otherwise in the notes for the relevant analytes.

Note 1.1 for Chloride ion:

Contaminated Site Regulation Schedule 3.1, Part 1, Matrix 8 Numerical Soil Standards for Environmental Protection

Note 1.2 for Antimony:

Schedule 3.1, Part 3, Standard to Protect Ecological Health.

Note 1.3 for Arsenic:

Schedule 3.1, Part 1. The most stringent standards are as follows:

Human Health Protection, Groundwater used for drinking water: 10 µg/g

Environmental Protection, Groundwater flow to surface water used by aquatic life: 10 µg/g

Environmental Protection, Groundwater used for irrigation: 10 µg/g

Note 1.4 for Barium:

Schedule 3.1, Part 1, Environmental Protection (Toxicity to Soil Invertebrates and Plants).

Note 1.5 for Beryllium:

Schedule 3.1, Part 1. The most stringent combination of standards is as follows:

The standard for Beryllium varies with the pH of the soil at a site, as follows.

Human Health Protection, Intake of contaminated soil: 85 µg/g

Human Health Protection, Groundwater used for drinking water:

1 µg/g if pH < 5.5

Environmental Protection, Groundwater flow to surface water used by freshwater aquatic life:

1 µg/g if pH < 6.5;

4 µg/g if 6.5 ≤ pH < 7.0;

30 µg/g if 7.0 ≤ pH < 7.5;

Note 1.6 for Cadmium:

Schedule 3.1, Part 1. The most stringent combination of standards is as follows.

The standard for cadmium varies with the pH of the soil at a site, as follows.

Human Health Protection, Intake of contaminated soil: 20 µg/g

Human Health Protection, Groundwater used for drinking water:

1 µg/g if pH < 7.0

Environmental Protection, Groundwater flow to surface water used by freshwater aquatic life:

1 µg/g if pH < 7.0;

3 µg/g if 7.0 ≤ pH < 7.5;

20 µg/g if 7.5 ≤ pH < 8.0;

Standard varies with receiving water hardness (H). H = 150 to < 210 mg/L as CaCO₃ is assumed. Consult a director for further advice.

Environmental Protection, Groundwater used for irrigation:

1 µg/g if pH < 7.0

Note 1.7 for Chromium:

Schedule 3.1, Part 1, Matrix 9 – Chromium provides standards for chromium, hexavalent; chromium, trivalent; and chromium (all species).

The most stringent standards for chromium, hexavalent are:

Human Health Protection, Groundwater used for drinking water: 60 µg/g

Environmental Protection, Groundwater flow to surface water used by aquatic life: 60 µg/g

Environmental Protection, Groundwater used for irrigation: 60 µg/g

The most stringent standard for chromium, trivalent is:

Human Health Protection, Intake of contaminated soil: 100 µg/g

The standard of 60 µg/g was used for chromium in this report to demonstrate compliance with the standards of this matrix.

Note 1.8 for Cobalt:

Schedule 3.1, Part 1. The most stringent standards are as follows:

Human Health Protection, Intake of contaminated soil: 25 µg/g

Human Health Protection, Groundwater used for drinking water: 25 µg/g

Environmental Protection, Groundwater flow to surface water used by aquatic life: 25 µg/g

Environmental Protection, Groundwater used for irrigation: 25 µg/g

Note 1.9 for Copper:

Golden Refuse Disposal Site

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Schedule 3.1, Part 1. The most stringent combination of standards is as follows:

The standard for copper varies with the pH of the soil at a site, as follows.

Environmental protection, Toxicity to soil invertebrates and plants:

150 µg/g

Environmental Protection, Groundwater flow to surface water used by freshwater aquatic life:

75 µg/g if pH < 5.5;

100 µg/g if $5.5 \leq \text{pH} < 6.0$;

Standard varies with receiving water hardness (H). $H \geq 200$ mg/L as CaCO₃ is assumed. Consult a director for further advice.

Environmental Protection, Groundwater used for irrigation:

75 µg/g if pH < 5.5

Note 1.10 for Lead:

Schedule 3.1, Part 1. The most stringent combination of standards is as follows:

Human Health Protection, Intake of contaminated soil:

120 µg/g

Human Health Protection, Groundwater used for drinking water:

120 µg/g if pH < 5.5:

Note 1.11 for Manganese:

Schedule 3.1, Part 1. The most stringent standards are as follows:

Human Health Protection, Groundwater used for drinking water: 2,000 µg/g.

Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as (a) item B1, or (b) item C1, C3 or C4, (c) item D2, D3, D5 or D6, (d) item E4, or (e) item H3 or H14.

Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as item H11 or H20 but only if the site was used for that purpose or activity in conjunction with or as a result of the site being used for at least one of the purposes or activities set out in the above note.

Environmental Protection, Toxicity to soil invertebrates and plants: 2,000 µg/g

Environmental Protection, Groundwater used for irrigation: 2,000 µg/g

Note 1.12 for Mercury:

Schedule 3.1, Part 1, Human Health Protection, Intake of contaminated soil

Note 1.13 for Molybdenum:

Schedule 3.1, Part 1, Environmental Protection, Groundwater used for irrigation

Note 1.14 for Nickel:

Schedule 3.1, Part 1. The most stringent combination of standards is as follows:

The standard for nickel varies with the pH of the soil at a site, as follows.

Human Health Protection, Groundwater used for drinking water:

70 µg/g if pH < 7.5;

Environmental Protection, Toxicity to soil invertebrates and plants:

150 µg/g

Environmental Protection, Groundwater used for irrigation:

70 µg/g if pH < 7.0

Note 1.15 for Selenium:

Schedule 3.1, Part 1. The most stringent standards are as follows:

Human Health Protection, Groundwater used for drinking water: 1 µg/g

Environmental Protection, Groundwater flow to surface water used by aquatic life: 1 µg/g

Environmental Protection, Groundwater used for irrigation: 1 µg/g

Note 1.16 for Silver:

Schedule 3.1, Part 3, Standard to Protect Ecological Health.

Note 1.17 for Thallium:

Schedule 3.1, Part 3, Standard to Protect Ecological Health.

Note 1.18 for Tin:

Schedule 3.1, Part 3, Standard to Protect Ecological Health.

Note 1.19 for Uranium:

Schedule 3.1, Part 1, EP, Groundwater used for irrigation.

Note 1.20 for Vanadium:

Schedule 3.1, Part 1, Human Health Protection, Groundwater used for drinking water.

Note 1.21 for Zinc:

Schedule 3.1, Part 1. The most stringent combination of standards is as follows:

The standard for zinc varies with the pH of the soil at a site, as follows.

Environmental Protection, Toxicity to soil invertebrates and plants:

450 µg/g

Environmental Protection, Groundwater flow to surface water used by freshwater aquatic life:

150 µg/g if pH < 6.0;

250 µg/g if $6.0 \leq \text{pH} < 6.5$;

350 µg/g if $6.5 \leq \text{pH} < 7.0$;

Standard varies with receiving water hardness (H). $H = 200$ to < 300 mg/L as CaCO₃ is assumed. Consult director for further advice.

Environmental Protection, Groundwater used for irrigation: 150 µg/g if pH < 6.0

Appendix H: Site Photos (drilling and soil sampling)

5-Year 2018 Hydrogeological Assessment
CSRD
Golden RDF
WWAL Ref: 14-024-21





Photograph 1. Drilling of MW18-10, located on the southern border of the Golden Landfill
(June 2018)



Photograph 2. Location of soil sample LOC-6, sampled in June 2018



Photograph 3. Drilling of MW18-11 located on the SW corner of the Golden Landfill outside of the landfill perimeter (June 2018)



Photograph 4. Flush mount well MW10-08 sampled for the first time in 2018 since 2015 (September 2018)



Photograph 5. Drilling of MW18-11 located on the SW corner of the Golden Landfill outside of the landfill perimeter (December 2018)



Photograph 6. Development water sampled from 145 m (475 ft) at MW18-11 (December 2018)

Appendix I: Estimates of Hydraulic Conductivity for MW18-10

5-Year 2018 Hydrogeological Assessment
CSRD
Golden RDF
WWAL Ref: 14-024-21



Introduction

Hydraulic testing was performed on a newly drilled well located on the southern boundary of the Golden Landfill in order to determine the hydraulic conductivity (a property that describes the ease in which water can move through the pore space of the subsurface soils) of the aquifer in the area surrounding the well (MW18-10). This is especially important when investigating potential contamination due to waste storage and disposal.

Method and Results

The type of hydraulic testing performed at the site was slug and bail testing. The procedure involves disturbing the water column by lowering and raising a cylindrical rod (“slug”) in and out of the water column within the monitoring well while measuring the water level displacement during each slug (placing rod into the water) and bail (taking rod out of the water). Water level measurements were recorded at ten second intervals using a water level transducer placed in the well prior to commencing the slug and bail testing. The water level data is collected from the transducer, graphed on a head ratio (ratio of the change in water level over initial water level change) versus time graph, and a mathematical formula is used to determine the hydraulic conductivity value (k-value) during each test.

In order to determine the k-value the Hvorslev method was used, which is typically used when the well is drilled within an unconfined aquifer and where the screen does not fully penetrate the aquifer. Once the results are graphed the following equation is used to determine the conductivity of the subsurface soils within the aquifer.

$$k = \frac{r^2 \ln(L/R)}{2LT_o}$$

Where **k** is the hydraulic conductivity (m/s), **r** denotes the well radius (m), **L** denotes the length of filter pack (m), **R** denotes the radius of the screen and filter pack combined (m), and **T_o** indicates the time (sec) it takes for the water level to rise or fall to 37% of the initial change. Once the k-value is determined for each test, the outliers are discarded and the geometric mean of all the remaining k-values is used as the estimate the hydraulic conductivity of aquifer at the well site (MW18-10). The estimated hydraulic conductivity of the aquifer at the well site was determined to be 1.94×10^{-6} m/s. Figure 1 shows graphed results for three slug tests and Table 1 indicates the resultant hydraulic conductivity for each test.

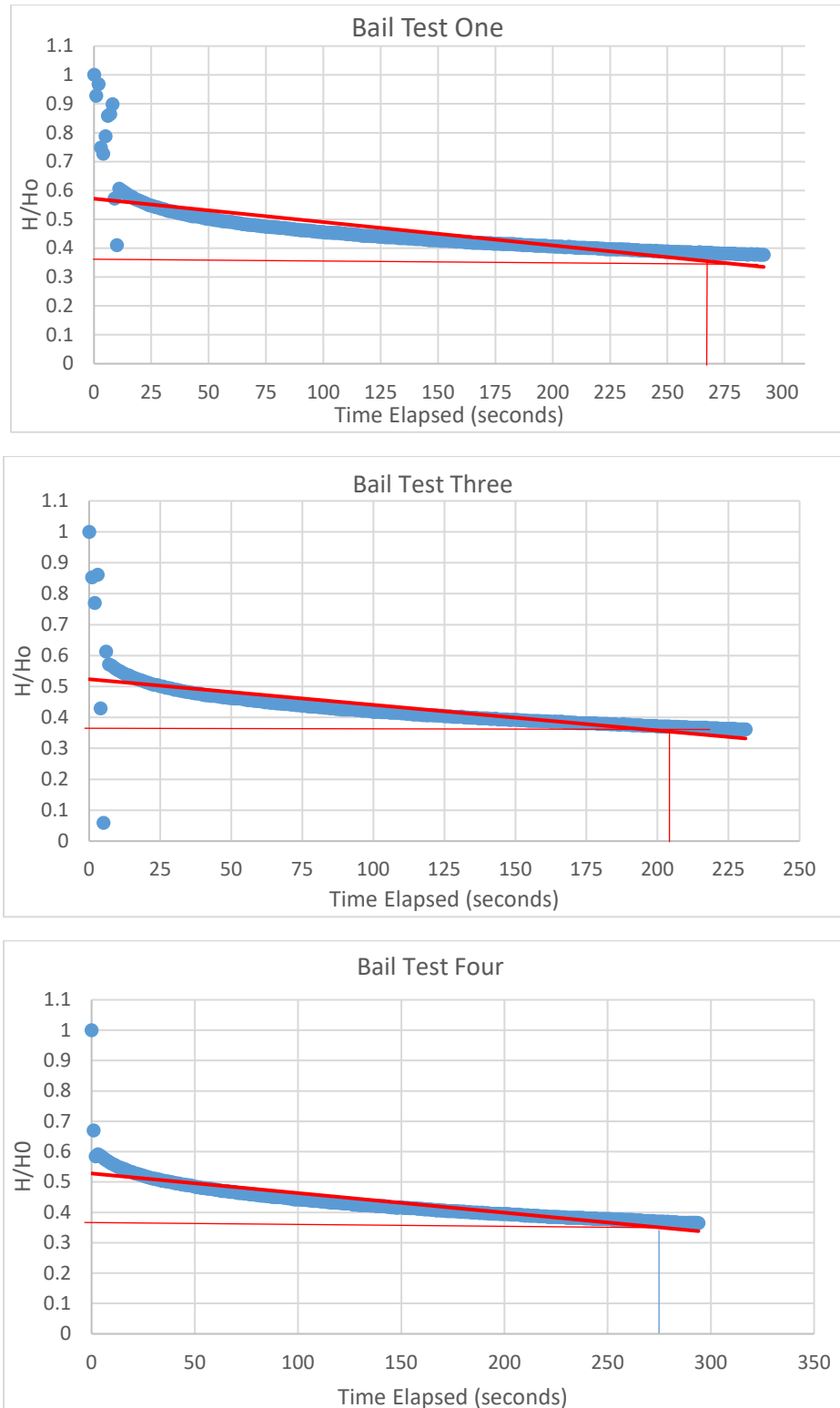
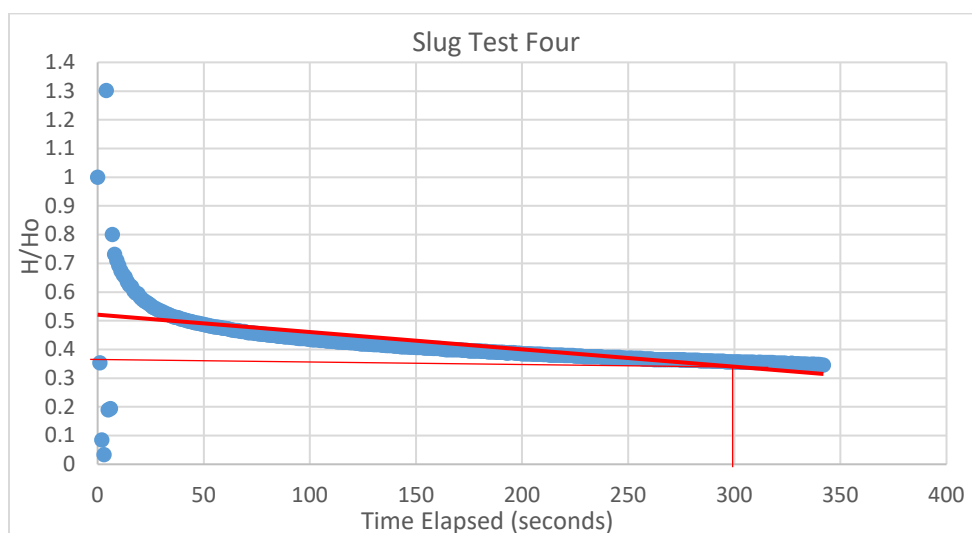
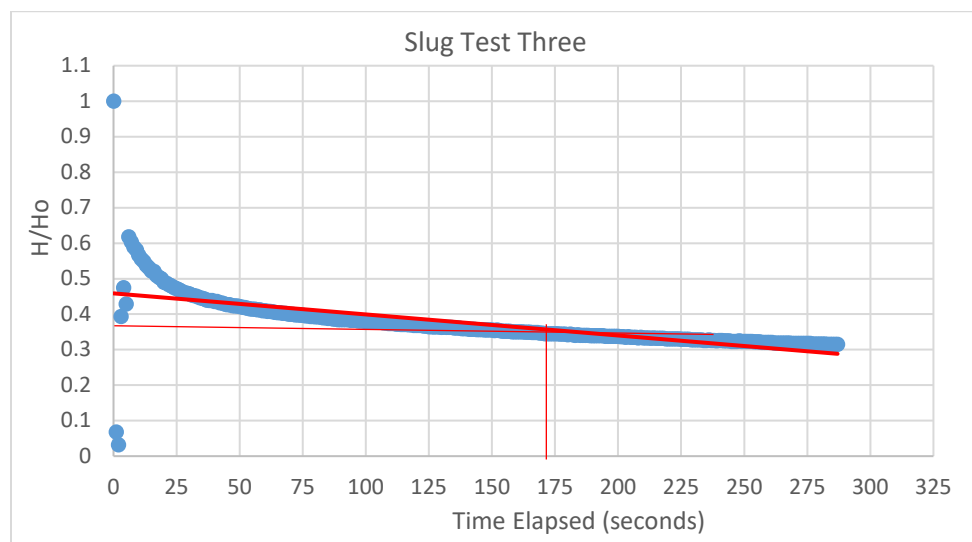
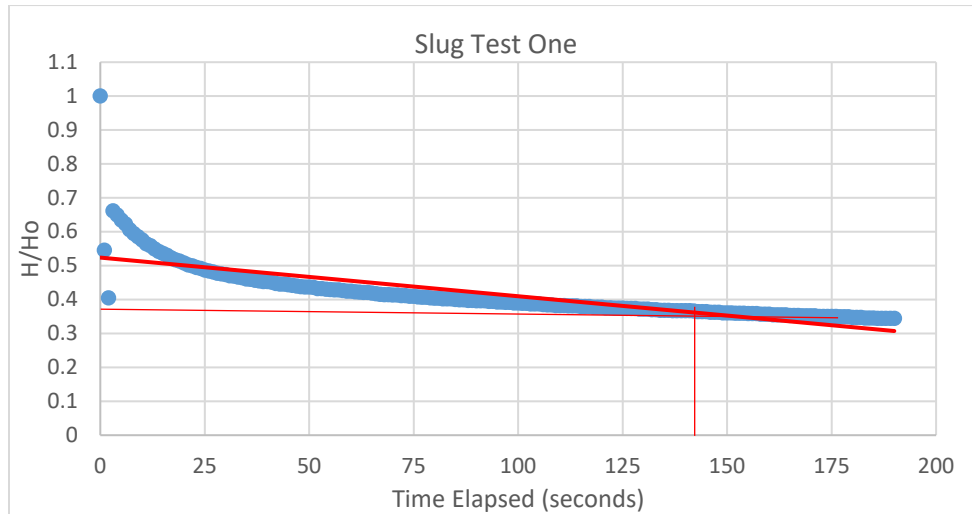


Figure I – Head Ratio versus Time for Bail Testing Monitoring Well MW18-10



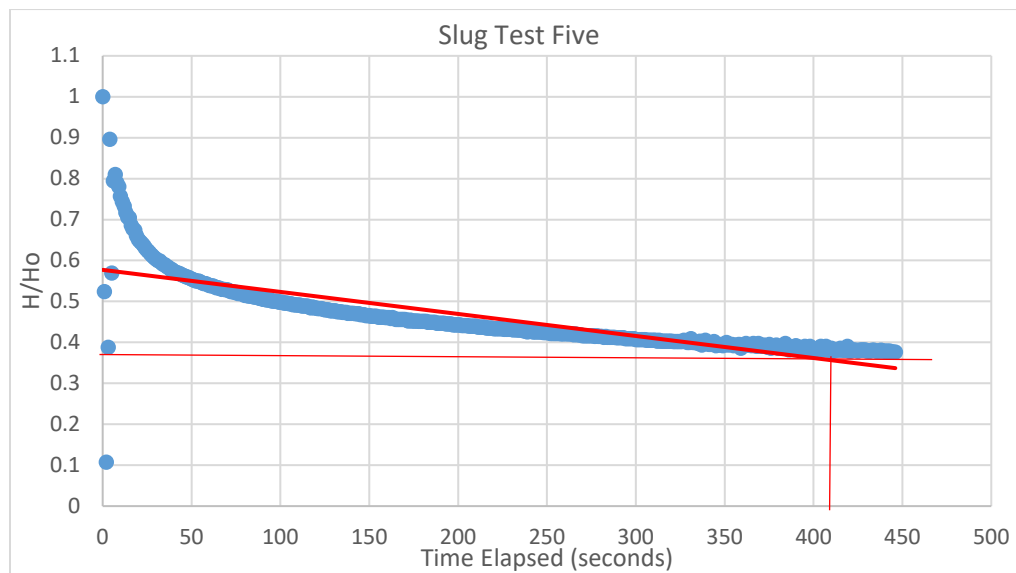


Figure 2 – Head Ratio versus Time for Slug Testing Monitoring Well MW18-10

Table I- Summary of Hydraulic Conductivity Values Using the Hvorslev Method (MW18-10)

Hydraulic Conductivity for Slug Test 1 (Top), 3 -4 (Middle) and 5 (Bottom) (m/s)	Hydraulic Conductivity for Bail Test 1 (Top), 3 (Middle) and 4 (Bottom) (m/s)
3.10E-06	1.66992E-06
2.55E-06	2.11795E-06
1.45E-06	1.73672E-06
1.45E-06	--
Geometric Mean	1.93591E-06

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