

2024 Groundwater Monitoring Report McKenzie Trails Recreation Area NE and SE Portions of Section 28-038-27 W4M



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City of Red Deer

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EXECUTIVE SUMMARY

The City of Red Deer (The City) retained Tetra Tech Canada Inc. (Tetra Tech) to conduct the 2024 groundwater monitoring program at the former landfill located beneath the McKenzie Trails Recreation Area (McKenzie Trails), located within the NE and SE Sections of 28-038-27 W4M, hereafter referred to as the site. The objective of the monitoring program is to identify potential environmental concerns related to former operations at the site.

Tetra Tech's scope of work for the 2024 monitoring and sampling program at the McKenzie Trails site included conducting an annual groundwater monitoring and sampling event, reviewing, and updating previous recommendations for the site, and preparing an annual report. Soil vapour monitoring or sampling was not proposed for 2024.

The groundwater monitoring network at the site consists of six monitoring wells (MW-01 to MW-05 and MW-203). MW-03 (deep) and MW-04 (shallow) are a nested pair located in the northeast section of the site. Most of the wells are screened within the native sand and gravel. MW-05 is screened within the municipal solid waste (MSW) to bedrock. The vapour monitoring network consists of one vapour monitoring well (VW-01) near the southeast corner of the site.

Based upon the results of the groundwater monitoring and sampling conducted in 2024 and previous years, Tetra Tech has developed the following conclusions:

- The groundwater elevations in 2024 indicated that the inferred groundwater flow direction was to the north-northeast, following the flow direction of the Red Deer River. The average horizontal hydraulic gradient at the site in September 2024 was approximately 0.003 m/m, which is consistent with previous findings.
- Routine groundwater chemistry parameters and dissolved metals that exceeded the Tier 1 Guidelines at one or more monitoring wells in 2024 included total dissolved solids (TDS), sodium, and the dissolved metals arsenic, iron, and manganese. The measured concentrations of one or more of these parameters suggest leachate has impacted the groundwater quality at MW-03, MW-04, and MW-203, each hydraulically down-gradient of the waste disposal area.
- In 2024, due to a miscommunication, the analytical suite of parameters included routine water quality tests, but ammonia was not specified or analyzed. However, given the minimal overall changes in water chemistry observed in the other parameters during the 2024 monitoring event, it is likely that the ammonia concentrations also remained relatively unchanged. In previous years, monitoring wells MW-03, MW-04, and MW-203 have exceeded the guideline value on one or more occasions, in accordance with the Environmental Quality Guidelines for Alberta Surface Waters. Groundwater near MW-203 and MW-04 is expected to eventually discharge into the Red Deer River, as these wells are located approximately 30 m and 90 m from the river, respectively. However, based on the previous measured concentrations and the expected dilution effect when the groundwater discharges, the environmental risk is considered to be low.
- Concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX) and petroleum hydrocarbon (PHC) fractions F1 to F2, were less than the analytical detection limits at most monitoring wells. MW-03 had a detectable concentration of toluene (0.00052 mg/L), marginally greater than the analytical detection limit (0.00050 mg/L) and less than the Tier 1 Guideline (0.021 mg/L). As toluene was not detected at MW-03 in previous years, the current result is considered anomalous and will be re-evaluated during the next sampling event.

- Concentrations of the volatile organic compound (VOC) vinyl chloride were greater than the Tier 1 Guideline in the groundwater samples collected from MW-04 and MW-203. Additionally, cis-1,2-dichloroethene was detected at MW-04 and MW-203. These VOCs are indicators of MSW leachate impacting the groundwater below the site. However, the concentrations of both compounds have been consistent since 2019. The concentrations are considered low and not anticipated to impact water quality in the nearby Red Deer River.
- During the September 2024 monitoring event, a site walkover was conducted to assess the thin soil cover identified in earlier work by Tiamat Environmental Consultants Ltd. (Tiamat) and to check for any exposed waste or seepage along the riverbank. The site was reported to be dry overall, and no potential exposed waste or seepage were identified during the walkover in areas where the riverbank was accessible.

Based upon the results of the groundwater monitoring program in 2024 and previous years, there are residual impacts in the groundwater and buried waste remains beneath the site; therefore, ongoing risk management is required, including ongoing monitoring and administrative actions. The following recommendations are made according to these risk management elements:

- Ongoing Monitoring:
 - The groundwater results in 2024 remained consistent with previous results from 2019, 2021, and 2022. Consequently, Tetra Tech recommends following the table below that was originally proposed in the 2021 Groundwater and Soil Vapour Monitoring Report (Tetra Tech 2022) and conducting the next annual groundwater monitoring and sampling event in 2027. The proposed frequency should be re-evaluated at the time of each event based on ongoing results evaluation.
 - It is recommended that the annual site walkover take place during the spring/summer to adequately assess the soil cover and the riverbank. During the walkover, the condition of the wells should also be evaluated. If any repairs are needed, these should be documented and, if feasible, completed during the same visit.

Proposed Groundwater Monitoring Program

Activity	2024	2025	2026	2027	2028	2029	2030	2031
Annual Groundwater Monitoring (six wells; MW-01, MW-02, MW-03, MW-04, MW-05, and MW-203)	☑			X				X
Annual Groundwater Sampling (three wells; MW-03, MW-04, and MW-203)	☑			X				X
Annual Site Walkover in Spring/Summer	☑	X	X	X	X	X	X	X

- Administrative Actions:
 - Use the revised generic mitigative measures (when evaluating applications for development within the setback).
 - Ensure that the site is clearly identified within The City’s Land Use Bylaw and appropriate administrative requirements are met for the site in accordance with City policies.

Further to the above recommendations, as noted, the site remains a historical landfill. It presently appears to be well maintained and capped. The City should review this status on an ongoing basis to ensure that the cover remains intact and drainage remains positive; repairs or maintenance should be undertaken as required to maintain the site.

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- Appendix B Site History, Historical Information, Site Setting, 2019 Hazard Quotients, and 2014 Risk Management Plan Review
- Appendix C Cross-Sections (Tiamat 2014A)
- Appendix D Laboratory Analytical Report
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- Appendix F Borehole Logs

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of The City of Red Deer and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than The City of Red Deer, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in Appendix A or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

The City of Red Deer (The City) retained Tetra Tech Canada Inc. (Tetra Tech) to conduct the 2024 groundwater monitoring program at the former landfill located beneath the McKenzie Trails Recreation Area (McKenzie Trails), located within the NE and SE Sections of 28-038-27 W4M, hereafter referred to as the site.

Tetra Tech previously undertook groundwater and soil vapour monitoring at the site in 2019, 2021, and 2022, based on a broader program for The City's pre-1972 landfill sites. The results of the monitoring program conducted in 2022 (Tetra Tech 2023), indicated the groundwater results remained consistent with previous results from 2019 and 2021, and recommended conducting the next annual groundwater monitoring and sampling event in 2024. It was also recommended that the annual site walkover take place during the spring/summer to adequately assess the soil cover and riverbank.

This report presents the results of the 2024 groundwater monitoring and sampling program at the site, which was undertaken based on the document 2024 Work Scope and Cost Estimate Pre-1972 Landfills – Red Deer, AB, submitted to The City on May 31, 2024 (Tetra Tech 2024).

1.1 Scope of Work

Based on the 2022 findings and recommendations, the 2024 monitoring program scope of work included the following activities:

- Conducting an annual groundwater monitoring event, including measuring groundwater levels within each monitoring well and observing monitoring well integrity.
- Conducting annual groundwater sampling of monitoring wells MW-03, MW-04, and MW-203 by:
 - Purging shallow groundwater monitoring wells and deep groundwater monitoring wells until practically dry or until a minimum of three well volumes had been removed and allowing the water levels in the wells to recover.
 - Measuring field parameters (pH, electrical conductivity [EC], and water temperature) at the time of sampling.
 - Collecting groundwater samples from each well and submitting the samples for laboratory chemical analyses.
- Conducting an annual site walkover along the riverbank to evaluate the potential for waste exposure and seepage due to bank erosion.
- Conducting monitoring well repairs, as required.
- Preparing an annual report summarizing the field activities undertaken for the year and interpreting the groundwater monitoring and analytical results.

The project was completed under Tetra Tech's Limitations on the Use of this Document for conducting environment work. A copy of these conditions is provided in Appendix A.

2.0 BACKGROUND INFORMATION

2.1 General Information

The site is located within the NE and SE portions of 28-038-27 W4M, within Plan 4086EO and 3081MC. The site is zoned P1 – Parks and Recreation and is located within the McKenzie Trails Recreation Area. The site is located on the east bank of the Red Deer River, north of 67 Street and east of Riverside Drive. The Red Deer River is adjacent to the west boundary of the site and flows in a northeasterly direction. A site location plan is shown on Figure 1. The site has been redeveloped, and includes a picnic shelter, man-made pond, playground, paved walking trails, surface parking, and two year-round washroom facilities. The Phase I environmental site assessment (ESA) by Tiamat (2013) identified a non-potable water well as providing water for the public washroom facilities. Based on further discussions with The City, the water for the public washroom facilities is supplied by tanks, which are filled periodically by a water truck. The surrounding land use consists of Environmental Preservation District, Future Urban Development District, and Parks and Recreation District. A residential subdivision is located adjacent to the east side of the park. Natural areas of the site consist of grasses, trees, and wetlands. Figure 2 shows the site location with surrounding land use.

Additional information on the site history, historical groundwater monitoring investigations, site setting, 2019 hazard quotient calculations, and 2014 risk management plan (RMP) review can be found in Appendix B. Cross-sections that were prepared using the wells previously installed at the site in 2013 are included in Appendix C (Tiamat 2014a). The available borehole logs for the vapour and groundwater monitoring wells are attached in Appendix F.

2.2 Conceptual Site Model Summary

The selection of comparative guidelines is based on the conceptual site model (CSM), which outlines the rationale for the selection of applicable exposure pathways and receptors at the site. This evaluation is based on guidance presented in the Alberta Tier 1 Guidelines (Alberta Environment and Protected Areas [Alberta EPA] 2024). The CSM that was developed for the site in the 2019 Groundwater and Soil Vapour Monitoring Report (Tetra Tech 2020) included the following items:

- Description of identified environmental issues including a description of processes or activities undertaken at or near the site and a listing of chemicals of potential concern (COPCs) identified in earlier investigations.
- Description of known and reported historical releases, including locations and status of any subsequent ESAs and remediation.
- Identification of applicable exposure pathways and receptors.

The following table presents a summary of the relevant exposure pathways and receptors identified in the CSM.

Summary of Conceptual Site Model

Release Mechanism	COPC	Migration/Exposure Pathway	Potential Receptor
Leachate infiltration from buried waste into foundation or through cover	Inorganic parameters and nutrients, metals, PHCs, VOCs, and other indicator parameters (i.e., biological oxygen demand [BOD] and	Direct soil contact.	Human users of the parkland; ecological plants and soil invertebrates.
		Groundwater ingestion (drinking water).	Domestic use aquifer (DUA) drinking water; freshwater aquatic life in the Red Deer River.

Release Mechanism	COPC	Migration/Exposure Pathway	Potential Receptor
	chemical oxygen demand [COD]).	Off-site surface migration (wind or water erosion).	Adjacent sites of more sensitive land use.
		Nutrient and energy cycling.	Microbial functioning of the soil.
Landfill gas (LFG) emissions from buried waste	VOCs, methane, BTEX, and PHC fractions, and siloxanes.	Vapour inhalation.	Human users of the parkland.
	Methane.	Accumulation to explosive levels in presence of an ignition source.	Enclosed spaces.

As recommended by Alberta EPA, the soil vapour results obtained during the 2019 investigation were evaluated using the Canadian Council of Minister of the Environment's (CCME's) document A Protocol for the Derivation of Soil Vapour Quality Guidelines for Protection of Human Exposures Via Inhalation of Vapours (CCME 2014). To determine the appropriate vapour guidelines, indoor air risk calculations were undertaken, and hazard quotients were calculated. Potential explosive risk was evaluated through relative comparison of the measured concentrations to the lower explosive limit (LEL) for methane (5% gas by volume).

The CSM determined that the most applicable guidelines for groundwater and vapour results for the site were as follows:

- Groundwater concentrations at the site were compared to the Alberta Tier 1 Guidelines under residential and parkland land use for coarse-grained soils (Alberta EPA 2024).
- Soil vapour analytical results were compared to A Protocol for the Derivation of Soil Vapour Quality Guidelines for Protection of Human Exposures Via Inhalation of Vapours under residential land use for both slab-on-grade and basement for coarse-grained soils (CCME 2014).

Based on the 2019 and 2021 soil vapour results, the risk of vapour migration was interpreted to be low, and it was recommended that soil vapour monitoring be discontinued in the following monitoring events.

2.3 Monitoring Well Network

The groundwater monitoring network at the site consists of six monitoring wells (MW-01 to MW-05 and MW-203). MW-03 (deep) and MW-04 (shallow) are a nested pair located in the northeast section of the site. Most of the wells are screened to the bottom of the well within the native sand and gravel. MW-05 is screened within MSW to bedrock. Monitoring well completion details are summarized in Table 1. The vapour monitoring network consists of one vapour monitoring well (VW-01) near the southeast corner of the site.

During the 2024 event, most monitoring wells were reported to be in fair condition. However, some damage was noted in wells MW-03 and MW-04. Monitoring well MW-03 was found to be missing a cap or J-plug at the top of the stick-up; a new J-plug was installed and secured with a lock during the monitoring event. At MW-04, duct tape was observed holding together two sections of the PVC casing. While this can be used as a temporary measure, the tape's adhesive contains organic compounds and should not be a long-term repair on a well that is being sampled for organics. Either a more substantial repair or replacement of the well is needed.

Groundwater and vapour monitoring well locations are shown on Figure 2.

3.0 MONITORING AND SAMPLING METHODOLOGY

A discussion of the methods used for the fieldwork and laboratory testing is presented in the following sections.

3.1 Groundwater Monitoring and Sampling

Tetra Tech conducted groundwater monitoring on September 5, 2024. Subsequently, groundwater samples were collected on September 6, 2024.

3.1.1 Groundwater Monitoring and Sampling Methodology

Monitoring at the groundwater monitoring wells (51 mm diameter) consisted of measuring static groundwater levels in each monitoring well annually (September).

The methodology for monitoring and sampling at the groundwater monitoring wells included the following:

- Observing the integrity of each well and noting drainage and site conditions near the well that may have an effect on monitoring results or groundwater quality.
- Measuring liquid levels in each monitoring well with an interface probe and recording total depths confirming absence of non-aqueous phase liquids (NAPLs).
- Recording of field data on standardized forms as documented in Tetra Tech standard operating practices.
- Purging each monitoring well requiring sampling using dedicated polyethylene bailers or Waterra tubing with inertial pump foot valves of at least three well volumes of water, or until the well was practically dry.

Following the completion of groundwater monitoring and purging, groundwater samples were collected from the required wells using the procedures identified below:

- Groundwater samples were collected from three monitoring wells (MW-03, MW-04, and MW-203). Samples were collected and placed into appropriate laboratory supplied, sterile glass and plastic vials and bottles for the required analytical package. Samples were filtered and/or preserved in the field, as required.
- Field measurements were taken for pH, EC, and temperature at the time of sampling.
- Samples were submitted in coolers with ice to ALS Laboratory Group (ALS) in Calgary, Alberta for laboratory analysis under a chain-of-custody (COC) documentation.

3.1.2 Groundwater Sampling Analytical Program

The analytical program for the groundwater monitoring wells was developed based on the recommendations in Section 1.1 and is summarized below:

- Routine water chemistry.
- Dissolved metals.
- VOCs.

4.0 RESULTS AND DISCUSSION

This section presents the results of the fieldwork conducted in 2024 at the site and discussions of these results.

4.1 Site Walkover

During the September 2024 monitoring event, a site walkover was conducted to assess the thin soil cover identified in earlier work by Tiamat and to check for any exposed waste or seepage along the riverbank. The site was reported to be dry overall, and no potential exposed waste or seepage were identified during the walkover in the areas where the riverbank was accessible.

4.2 Groundwater Elevations

The measured groundwater levels and calculated groundwater elevations for September 2024 are presented in Table 1.

Figure 3 presents the groundwater elevation trends (hydrographs) for the groundwater monitoring wells. This figure shows the groundwater elevations in 2013, 2019, 2021, 2022, and 2024. Overall, groundwater elevations showed a slight decrease at all monitoring wells from those measured in 2022.

In September 2024, the average depth to groundwater in the monitoring wells was 2.66 m below grade (mbg). The groundwater elevations are shown on Figure 4. The groundwater elevations in 2024 indicated that the inferred groundwater flow direction was to the north-northeast, following the flow direction of the Red Deer River. The horizontal hydraulic gradient was relatively flat across a majority of the site (0.001 m/m), steepening at the north end (0.004 m/m) resulting in an average of 0.003 m/m. The nested wells MW-03 and MW-04 demonstrate an upward hydraulic gradient.

4.3 Groundwater Field Parameters

Field measurements for temperature, pH, and EC in September 2024 are shown in Table 2. A discussion of the results of the field tests is summarized in this section.

In 2024, groundwater temperatures ranged from 10.5°C (MW-203) to 13.3°C (MW-04).

In 2024, field pH values ranged from 6.77 (MW-04) to 7.53 (MW-03). The field pH measurements were generally less than the laboratory pH at wells MH-03, MH-04, and MH-203. The difference between field recorded and laboratory pH values may be due to limitations of the field equipment and differences in sample temperature.

In 2024, field EC measurements ranged from 1,028 µS/cm (MW-203) to 1,727 µS/cm (MW-03). The field EC measurements were less than the laboratory measured EC results, which may also be due to limitations of field equipment or temperature differences.

4.4 Groundwater Analytical Results

The groundwater analytical data for 2024 is summarized in Table 2. The 2024 laboratory analytical reports are included in Appendix D. Historical data from the 2013 Phase II ESA are included in Appendix E.

4.4.1 Background Groundwater Quality

Monitoring wells MW-01 and MW-02 are hydraulically up-gradient of the site and may represent background groundwater quality. MW-01 and MW-02 were not sampled in 2024. The 2019 results at MW-01 and MW-02 suggest that both up-gradient wells had low concentrations of chloride (17.0 mg/L and 7.67 mg/L, respectively), MW-01 had Tier 1 Guideline exceedances of dissolved arsenic, dissolved iron, and dissolved manganese and MW-02 contained concentrations of dissolved copper and dissolved manganese greater than the Tier 1 Guidelines. Concentrations of BTEX, PHC fractions F1 and F2, and VOCs were less than the analytical detection limits at MW-01 and MW-02 in 2019.

4.4.2 Routine Water Chemistry Parameters

In 2024, total dissolved solids (TDS) concentrations ranged from 565 mg/L (MW-203) to 1,050 mg/L (MW-03). TDS concentrations at monitoring wells MW-03, MW-04, and MW-203 were greater than the Tier 1 Guideline (500 mg/L) and were consistent with the results from previous years. Elevated TDS concentrations often occur in groundwater as a result of the dissolution of naturally occurring salts and minerals, and do not necessarily indicate groundwater quality impact related to the former landfill.

Hardness (calcium and magnesium combined) concentrations ranged from 87 mg/L (MW-03) to 702 mg/L (MW-04). Monitoring wells MW-04 and MW-203 exhibited elevated concentrations consistent with those measured in previous years, while MW-03 showed a marked decrease in hardness, possibly due to ion exchange, where calcium and magnesium were replaced by sodium ions. Alkalinity remained elevated, consistent with the values reported in previous years. Elevated concentrations of hardness and alkalinity are often observed when groundwater quality is affected by leachate.

In 2024, concentrations of chloride at the site ranged from 11.8 mg/L at MW-203 to 63.5 mg/L at MW-03. The concentrations at all wells were less than the Tier 1 Guidelines (120 mg/L). Concentrations of chloride were consistent with concentrations measured in 2013, 2019, 2021, and 2022.

In 2024, sodium concentrations decreased at monitoring well MW-203 (54.1 mg/L), increased at MW-03 (391 mg/L), and remained the same at MW-04 (110 mg/L). MW-03 sodium concentration was greater than the Tier 1 Guideline (200 mg/L), exhibiting the highest values measured to date. The elevated sodium concentration at MW-03 may be from variations in natural salinity of the deeper groundwater and is not necessarily indicative of groundwater quality impact.

Ammonia concentrations at several monitoring wells adjacent to the former waste footprint have been elevated compared to those in wells located outside the waste area (e.g., MW-01 and MW-02) and have often been at or above the referenced guideline values. In 2024, due to a miscommunication, the analytical suite of parameters included routine water quality tests, but ammonia was not specified or analyzed. However, given the minimal overall changes in water chemistry observed in the other parameters during the 2024 monitoring event, it is likely that the ammonia concentrations also remained relatively unchanged. In previous years, ammonia concentrations at monitoring wells MW-03, MW-04, and MW-203 have exceeded the Tier 1 Guideline on one or more occasions, in accordance with the Environmental Quality Guidelines for Alberta Surface Waters. Groundwater near MW-203 and MW-04 is expected to eventually discharge into the Red Deer River, as these wells are located approximately 30 m and 90 m from the river, respectively. However, based on the previous measured concentrations and the expected dilution effect when the groundwater discharges, the environmental risk is considered to be low.

Concentrations of nitrate and nitrite were less than the analytical detection limits at most monitoring wells, except for a low concentration of nitrate at MW-04 (0.122 mg-N/L), which was less than the Tier 1 Guideline of 3 mg/L.

4.4.3 Dissolved Metals

In 2024, the concentrations of dissolved arsenic at MW-04 (0.00549 mg/L) and MW-203 (0.0161 mg/L) were greater than the Tier 1 Guideline (0.005 mg/L). Dissolved arsenic is strongly adsorbed into iron(hydr)oxides, which are naturally occurring in most Alberta soils. If these iron precipitates dissolve under anoxic conditions, arsenic is mobilized. The results for the monitoring wells in 2024 and in previous years show a correlation between dissolved iron and dissolved arsenic concentrations. Therefore, the arsenic exceedance of the Tier 1 Guideline may be predominantly a result of iron(hydr)oxide dissolution rather than originating from MSW leachate. For reference, arsenic was also measured in 2019 at a concentration of 0.00828 mg/L, marginally exceeding the Tier 1 Guideline of 0.005 mg/L at upgradient background well MW-01.

Dissolved manganese and iron concentrations were greater than the Tier 1 Guidelines at most monitoring wells during the sampling event in 2024, with the exception of dissolved iron at MW-03. Iron and manganese are redox-sensitive parameters that naturally occur in groundwater under anaerobic conditions and can help determine whether the groundwater quality is affected by biodegradation reactions, for instance related to landfill leachate. In 2019, upgradient background well MW-01 also exhibited manganese and iron concentrations above Tier 1 Guidelines, with values of 0.861 mg/L and 3.09 mg/L, respectively.

4.4.4 Organic Parameters

In 2024, concentrations of BTEX and PHC fractions F1 to F2 were less than the analytical detection limits at most monitoring wells. MW-03 had a detectable concentration of toluene (0.00052 mg/L), marginally greater than the analytical detection limit (0.00050 mg/L) and less than the Tier 1 Guideline (0.021 mg/L).

In 2024, VOC concentrations were less than the analytical detection limits for most parameters, except for cis-1,2-DCE and vinyl chloride at MW-04 and MW-203. A Tier 1 Guideline value has not been established for cis-1,2-DCE. Vinyl chloride exceeded the Tier 1 Guideline at MW-04 (0.0034 mg/L), and MW-203 (0.0018 mg/L); however, the concentrations were within the same order of magnitude as the Tier 1 Guideline (0.0011 mg/L). It should be noted that the Tier 1 Guideline for vinyl chloride is based on human vapour inhalation and there is currently no guideline pertaining to freshwater aquatic life. The VOC concentrations measured in 2024 are consistent with the concentrations measured in previous years.

Cis-1,2-DCE is a known breakdown product of dry-cleaning liquids (i.e., tetrachloroethene [PCE] or trichloroethene [TCE]). It typically further degrades to form vinyl chloride. PCE or TCE were not detected in 2019, 2021, 2022, or 2024; however, in 2013, a PCE concentration of 0.0033 mg/L was measured at MW-05. MW-05 also contained a trace concentration (0.0007 mg/L) of vinyl chloride in 2013. As stated in Section 2.3, MW-05 is completed within an area containing MSW and was not sampled in either 2019, 2021, 2022, or 2024.

The measured concentrations of vinyl chloride and cis-1,2-DCE are indicators of MSW leachate impacting the groundwater hydraulically down-gradient from the site. Although both VOCs have been detected since 2019, the concentrations remain relatively low, with vinyl chloride concentration falling below the detection limit in 2024 at monitoring well MW-03. Vinyl chloride and cis-1,2-DCE exhibit distinctly different properties. Vinyl chloride is a gaseous substance with a boiling point of -13.4°C and a relatively low water solubility. Although there is evidence of carcinogenicity of vinyl chloride, owing to its high volatility, vinyl chloride has rarely been detected in surface water (World Health Organization [WHO] 2004). There is limited information on the toxicity of cis-1,2-DCE; however, the data suggest the compound has less toxicological concerns than vinyl chloride (WHO 2003). Cis-1,2-DCE is a dense liquid and when released to surface water, volatilization is expected to be the primary fate process, with a published estimated half-life of less than one day (Agency for Toxic Substances and Disease Registry [ATSDR] 1996). Based on the measured concentrations, and the published information on the properties and environmental

fate of both VOCs, they are not interpreted to pose a notable risk to the freshwater quality in the nearby Red Deer River.

4.5 Quality Assurance/Quality Control

4.5.1 Methods

Tetra Tech's groundwater quality assurance/quality control (QA/QC) procedures include reviewing the data collected for precision and accuracy and following the appropriate field protocols.

The field procedures for QA/QC involved:

- Changing nitrile gloves between sample collections;
- Using sample containers provided by the laboratory;
- Cleaning monitoring and sampling tools between sample locations;
- Filling sample containers for PHC analysis with no headspace (air) when the containers were closed; and
- Documenting field procedures and sampling activities.

4.5.2 Results

The QA/QC results are included in Table 3. In September 2024, a duplicate sample taken at monitoring well MW-04 was submitted for analysis of the same parameters as the original sample.

The duplicate analysis is compared by relative percent difference (RPD). The RPD is calculated using the following equation:

$$RPD = \frac{(V_1 - V_2)}{\frac{(V_1 + V_2)}{2}} * 100\%$$

Where:

V_1 = Parent Sample

V_2 = Duplicate Sample

Chemical parameters were considered as having passed the QA/QC reproducibility procedure if the RPD was less than or equal to 20%, indicating a close correlation between the sample-duplicate pair.

RPD values were not calculated if one or both of the sample-duplicate concentrations were between the reportable detection limit (RDL) and five times the RDL. In these cases, chemical parameters were still considered as having passed the QA/QC reproducibility procedure if the sample duplicate concentration difference was less than one RDL value.

Duplicate RPDs were less than 20% for all the reportable concentrations. Based on the QA/QC results, the sample methods and results are considered acceptable.

5.0 EVALUATION OF SITE CONDITIONS

Based on the 2024 and historical data for the site, there is no evidence that there are significant concerns related to the former landfill operations at McKenzie Trails. However, there is evidence of residual impacts by leachate and the site does contain buried landfill waste; therefore, some risk management measures are required.

The groundwater quality appears to be affected by leachate at the monitoring wells. The most notable indicator is the elevated ammonia concentrations measured in previous years at monitoring wells MW-03, MW-04, and MW-203. Chloride and boron, which are often elevated in MSW leachate, did not exceed the referenced guidelines at the monitoring wells that were sampled. Two chlorinated VOCs were detected in 2024 at the down-gradient monitoring wells. One VOC compound (vinyl chloride) exceeded the referenced Tier 1 Guidelines at MW-04 and MW-203.

The site only contains one vapour well (VW-01), which is located between the waste footprint and the building to the southeast. Methane concentrations were measured in 2019 and 2021 from VW-01 and headspace monitoring at the on-site monitoring wells. These concentrations were determined not to be of concern as methane was measured below the instrument's detection limit (0.0% Gas) at VW-01 from 2019 to 2021 and a maximum headspace concentration of 190 ppm (equivalent to 0.02% Gas) was measured at the monitoring wells (July 2021). Subsequently, headspace vapour measurements at VW-01 and the groundwater wells were discontinued and have not been included in the monitoring scope since the 2022 program.

During the September 2024 monitoring event, a site walkover was conducted to assess the thin soil cover identified in earlier work by Tiamat and to check for any exposed waste or seepage along the riverbank. The site was reported to be dry overall, and no potential exposed waste or seepage were identified during the walkover in areas where the riverbank was accessible.

The proximity of the Red Deer River warrants the groundwater flow pattern and trends in groundwater quality to continue to be monitored as outlined in Section 6.0 below.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon the results of the groundwater and soil vapour monitoring and sampling conducted in 2024 and previous years, Tetra Tech has developed the following conclusions:

- The groundwater elevations in 2024 indicated that the inferred groundwater flow direction was to the north-northeast, following the flow direction of the Red Deer River. The average horizontal hydraulic gradient at the site in September 2024 was approximately 0.003 m/m, which is consistent with previous findings.
- Routine groundwater chemistry parameters and dissolved metals that exceeded the Tier 1 Guidelines at one or more monitoring wells in 2024 included TDS, sodium, and the dissolved metals arsenic, iron, and manganese. The measured concentrations of one or more of these parameters suggest leachate has impacted the groundwater quality at MW-03, MW-04, and MW-203, each hydraulically down-gradient of the waste disposal area.
- In 2024, due to a miscommunication, the analytical suite of parameters included routine water quality tests, but ammonia was not specified or analyzed. However, given the minimal overall changes in water chemistry observed in the other parameters during the 2024 monitoring event, it is likely that the ammonia concentrations also remained relatively unchanged. In previous years, monitoring wells MW-03, MW-04, and MW-203 have exceeded the guideline value on one or more occasions, in accordance with the Environmental Quality Guidelines for Alberta Surface Waters. Groundwater near MW-203 and MW-04 is expected to eventually

discharge into the Red Deer River, as these wells are located approximately 30 m and 90 m from the river, respectively. However, based on the previous measured concentrations and the expected dilution effect when the groundwater discharges, the environmental risk is considered to be low.

- Concentrations of BTEX and PHC fractions F1 to F2 were less than the analytical detection limits at most monitoring wells. MW-03 had a detectable concentration of toluene (0.00052 mg/L), marginally greater than the analytical detection limit (0.00050 mg/L) and less than the Tier 1 Guideline (0.021 mg/L). As toluene was not detected at MW-03 in previous years, the current result is considered anomalous and will be re-evaluated during the next sampling event.
- Concentrations of the VOC vinyl chloride were greater than the Tier 1 Guideline in the groundwater samples collected from MW-04 and MW-203. Additionally, cis-1,2-dichloroethene was detected at MW-04 and MW-203. These VOCs are indicators of MSW leachate impacting the groundwater below the site. However, the concentrations of both compounds have been consistent since 2019. The concentrations are considered low and not anticipated to impact water quality in the nearby Red Deer River.
- During the September 2024 monitoring event, a site walkover was conducted to assess the thin soil cover identified in earlier work by Tiamat and to check for any exposed waste or seepage along the riverbank. The site was reported to be dry overall, and no potential exposed waste or seepage were identified during the walkover in areas where the riverbank was accessible.

Based upon the results of the groundwater monitoring program in 2024 and previous years, there are residual impacts in the groundwater and buried waste remains beneath the site; therefore, ongoing risk management is required, including ongoing monitoring and administrative actions. The following recommendations are made according to these risk management elements:

- Ongoing Monitoring:
 - The groundwater results in 2024 remained consistent with previous results from 2019, 2021, and 2022. Consequently, Tetra Tech recommends following the table below that was originally proposed in the 2021 Groundwater and Soil Vapour Monitoring Report (Tetra Tech 2022) and conducting the next annual groundwater monitoring and sampling event in 2027. The proposed frequency should be re-evaluated at the time of each event based on ongoing results evaluation.
 - It is recommended that the annual site walkover take place during the spring/summer to adequately assess the soil cover and the riverbank. During the walkover, the condition of the wells should also be evaluated. If any repairs are needed, these should be documented and, if feasible, completed during the same visit.

Proposed Groundwater Monitoring Program

Activity	2024	2025	2026	2027	2028	2029	2030	2031
Annual Groundwater Monitoring (six wells; MW-01, MW-02, MW-03, MW-04, MW-05, and MW-203)	☑			X				X
Annual Groundwater Sampling (three wells; MW-03, MW-04, and MW-203)	☑			X				X
Annual Site Walkover in Spring/Summer	☑	X	X	X	X	X	X	X

- Administrative Actions:
 - Use the revised generic mitigative measures (when evaluating applications for development within the setback).

- Ensure that the site is clearly identified within The City's Land Use Bylaw and appropriate administrative requirements are met for the site in accordance with City policies.

Further to the above recommendations, as noted, the site remains a historical landfill. It presently appears to be well maintained and capped. The City should review this status on an ongoing basis to ensure that the cover remains intact and drainage remains positive; repairs or maintenance should be undertaken as required to maintain the site.

7.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact Frans Hettinga at our Calgary office.

Respectfully submitted,
Tetra Tech Canada Inc.

FILE: 704-SWM.SWOP04071-04.003
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TABLES

Table 1	Monitoring Results – Groundwater Wells
Table 2	Groundwater Analytical Results
Table 3	Groundwater Quality Assurance/Quality Control Analytical Results

Table 1: Monitoring Results - Groundwater Wells

Monitoring Well		MW-01	MW-02	MW-03	MW-04	MW-05	MW-203
Total Drilled Depth (m)		5.5	10.6	9.1	3.8	6.1	5.3
Top of Screened Interval (mbg)		0.9	6.9	-	-	3.1	-
Bottom of Screened Interval (mbg)		5.5	10.6	9.1	3.8	6.1	4.8
Stick up (m)		0.79	0.92	0.45	0.77	0.86	0.51
Ground Elevation (m)		848.29	849.75	847.47	847.48	849.38	848.61
TPC Elevation (m)		849.09	850.67	848.34	848.25	850.24	849.17
Depth to Groundwater (mBTPC)	Aug-13	1.71	3.10	1.56	1.55	3.69	4.12
	May-19	2.59	4.18	2.55	2.46	4.10	3.46
	Jun-19	2.63	4.01	2.40	2.29	4.11	2.96
	Sep-19	2.89	4.27	2.72	2.67	4.12	3.52
	Dec-19	2.75	3.35	2.50	2.38	4.12	2.52
	Jul-21	2.78	4.12	2.58	2.17	3.74	3.38
	Nov-21	3.15	4.38	2.59	2.51	3.78	3.70
	Dec-22	2.90	4.14	2.65	2.73	3.91	3.34
	Sep-24	3.07	4.20	2.45	2.87	4.26	3.41
Groundwater Elevation (m)	Aug-13	847.38	847.57	846.78	846.70	846.55	845.05
	May-19	846.50	846.49	845.79	845.79	846.15	845.72
	Jun-19	846.46	846.66	845.94	845.96	846.14	846.22
	Sep-19	846.19	846.40	845.62	845.58	846.13	845.65
	Dec-19	846.34	847.32	845.84	845.87	846.12	846.65
	Jul-21	846.31	846.55	845.76	845.76	846.50	845.79
	Nov-21	845.93	846.29	845.75	845.33	846.46	845.47
	Dec-22	846.19	846.53	845.69	845.52	846.33	845.83
	Sep-24	846.02	846.47	845.47	845.38	845.99	845.77
Volatile Organic Compounds* (VOCs) (ppm)	May-19	ND	ND	ND	ND	ND	ND
	Jun-19	ND	ND	ND	ND	ND	ND
	Sep-19	ND	ND	ND	ND	ND	ND
	Dec-19	ND	1	1	1	1	1
Combustible Vapour Concentrations* (CVCs) (ppm)	May-19	ND	ND	ND	ND	ND	ND
	Jun-19	ND	ND	ND	ND	ND	ND
	Sep-19	35	15	ND	ND	170	100
	Dec-19	ND	20	ND	ND	5	20
Methane Concentrations** (ppm)	Jul-21	190	15	190	ND	45	ND
	Nov-21	5	10	ND	ND	50	ND
	Sep-24	ND	ND	ND	ND	ND	ND

Notes:

mbg - Metres below grade.

mBTPC - Metres below top of plastic pipe casing.

ppm - Parts per million.

ND - Non-detect.

- Unavailable.

*- Measured using an RKI Eagle II calibrated to hexane (CVCs) and isobutylene (VOCs) and operated in methane elimination mode.

** - Measured using an RKI Eagle II calibrated to methane.

Table 2: Groundwater Analytical Results

Parameter	Unit	Tier 1 Guideline ^{1,2}	MW-01	MW-02	MW-03 (Deep Well)				MW-04				MW-203			
			4-Dec-2019	4-Dec-2019	4-Dec-2019	21-Nov-2021	08-Dec-2022	06-Sep-2024	4-Dec-2019	21-Nov-2021	08-Dec-2022	06-Sep-2024	5-Dec-2019	21-Nov-2021	08-Dec-2022	06-Sep-2024
Field																
Field pH	pH Units	6.5 to 8.5	8.53	7.98	7.48	7.22	7.33	7.53	7.25	7.04	7.08	6.77	7.64	6.76	7.11	7.01
Field Electric Conductivity	µS/cm	-	434	381	1,017	1,564	1,130	1,727	973	1,521	1,043	1,687	510	1,062	876	1,028
Field Temperature	°C	-	2.90	5.42	2.64	7.88	5.98	12	2.67	6.63	6.68	13.3	1.15	5.72	5.69	10.5
Routine																
pH	pH Units	6.5 to 8.5	8.13	8.22	7.77	7.85	7.77	8.25	7.53	7.71	7.62	7.58	8.03	7.79	7.71	7.81
Electrical Conductivity (EC)	µS/cm	-	617	559	1,680	1,690	1,660	1,640	1,660	1,700	1,610	1,590	1,030	1,410	1,350	949
Total Dissolved Solids (TDS)	mg/L	500	378	333	1,090	1,100	1,080	1,050	1,010	1,080	1,040	1,040	633	803	858	565
Hardness as CaCO ₃	mg/L	-	289	269	646	537	544	87	664	714	668	702	437	421	529	366
Alkalinity (total as CaCO ₃)	mg/L	-	337	255	934	937	934	891	872	939	920	910	510	743	735	482
Bicarbonate	mg/L	-	411	311	1,140	1,140	1,140	1,090	1,060	1,140	1,120	1,110	622	906	896	588
Carbonate	mg/L	-	<5.0	<5.0	<5.0	<1.0	<1.0	<1.0	<5.0	<1.0	<1.0	<1.0	<5.0	<1.0	<1.0	<1.0
Hydroxide	mg/L	-	<5.0	<5.0	<5.0	<1.0	<1.0	<1.0	<5.0	<1.0	<1.0	<1.0	<5.0	<1.0	<1.0	<1.0
Calcium	mg/L	-	71.7	72.2	168	144	134	23.5	168	185	162	182	119	110	130	95.3
Magnesium	mg/L	-	26.8	21.6	55.0	43.0	50.8	6.88	59.3	61.1	64.0	60.2	33.9	35.5	49.7	31
Potassium	mg/L	-	4.27	2.70	9.68	8.04	8.49	3.14	20.7	18.9	19.3	16.7	13.8	13.0	13.7	11.6
Sodium	mg/L	200	40.1	16.4	174	207	190	391	96.6	113	110	110	47.1	64.8	80.2	54.1
Chloride	mg/L	120	17.0	7.67	49.6	43.2	41.4	63.5	42.9	29.4	28.1	32.2	19.5	24.0	22.9	11.8
Fluoride	mg/L	1.5	0.094	0.086	<0.10	<0.100	0.157	<0.100	<0.10	<0.100	0.233	<0.100	<0.10	<0.100	0.218	<0.100
Phosphorus - Total	mg/L	-	0.412	0.0202	0.273				0.568				0.35			
Sulphate	mg/L	429 ³	16.0	59.6	69.5	64.4	69.6	11.2	94.7	71.4	64.8	71.8	93.2	78.3	85.3	53.2
Anions Total (Filtered)	meq/L	-	-	-		21.3	21.3	19.8		21.1	20.5	20.6		17.2	17.1	11.1
Cations Total (Filtered)	meq/L	-	-	-		20.4	19.8	2.59		20.7	19.6	3		12.5	15.5	4.72
Ionic Balance	N/A	-	102	94.0	98.6	104.4	93.0	94.9	91.1	102	95.6	94.2	95.2	138	90.6	91
Nutrients																
Ammonia as N	mg/L	0.309 to 15.73 ⁶	0.477	<0.050	7.00	5.51	5.57		10.4	11.2	11.0		13.3	12.9	14.1	
Nitrate (as NO ₃ -N)	mg/L	3	<0.020	<0.020	<0.10	<0.100	0.152	<0.100	0.17	0.301	<0.100	0.122	<0.10	0.121	<0.100	<0.100
Nitrite (as NO ₂ -N)	mg/L	0.08 to 0.20 ⁴	<0.010	<0.010	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Nitrate and Nitrite (as N)	mg/L	-	<0.022	<0.022	<0.11		0.152	<0.112	0.17		<0.112	0.122	<0.11		<0.112	<0.112
Total Kjeldahl Nitrogen (TKN)	mg/L	-	1.29	0.23	8.2				13.3				15			
Carbon																
Dissolved Organic Carbon (DOC)	mg/L	-	5.4	4.6	11.4				20.7				9.5			
Dissolved Metals																
Aluminum	mg/L	0.050 ⁵	0.0033	0.0074	<0.0050	0.0069	0.0036	0.0044	0.0348	<0.0050	0.0036	<0.0010	0.0035	0.0080	0.0060	0.001
Antimony	mg/L	0.006	0.00014	0.00013	<0.00050	<0.00050	<0.00010	0.00031	<0.00050	<0.00050	0.00012	<0.00010	<0.00010	<0.00050	<0.00010	0.00015
Arsenic	mg/L	0.005	0.00828	0.00029	0.00137	0.00158	0.00130	0.00299	0.00440	0.00618	0.00398	0.00549	0.00796	0.00209	0.00396	0.0161
Barium	mg/L	2	0.421	0.152	0.309	0.371	0.360	0.173	0.253	0.278	0.277	0.316	0.188	0.211	0.243	0.27
Beryllium	mg/L	-	-	-		<0.000100				<0.000100				<0.000100		
Bismuth	mg/L	-	-	-		<0.000250				<0.000250				<0.000250		
Boron	mg/L	1.5	0.024	0.016	0.875	0.907	0.791	0.27	0.977	1.47	1.06	1.31	0.494	0.617	0.534	0.534
Cadmium	mg/L	0.00036 to 0.00037 ³	<0.0000050	0.000148	<0.000025	0.0000286	0.0000830	0.0000092	0.0000830	0.000120	0.0000098	0.0000058	0.0000408	<0.0000250	<0.0000050	<0.0000050
Chromium	mg/L	0.05	<0.00010	<0.00010	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.000015	<0.00050	<0.00050	<0.00050
Cobalt	mg/L	-	-	-		0.00225				0.00444				<0.00050		
Copper	mg/L	0.007	<0.00020	0.00719	0.0052	<0.00100	0.00051	0.00057	<0.0010	<0.00100	0.00134	<0.00020	<0.00020	<0.00100	<0.00020	0.00024
Iron	mg/L	0.3	3.09	0.041	0.123	0.534	0.029	0.026	3.85	5.34	3.70	4.48	2.23	0.680	0.753	3.33
Lead	mg/L	0.0070 ³	<0.000050	0.000219	<0.00025	<0.000250	<0.000050	<0.000050	<0.00025	<0.000250	<0.000050	<0.000050	<0.000050	<0.000250	<0.000050	<0.000050
Lithium	mg/L	-	-	-		0.0499				0.0304				0.0169		
Manganese	mg/L	0.02	0.861	0.0843	1.02	0.780	0.796	0.108	1.16	1.16	1.06	1.2	0.303	0.297	0.358	0.279
Mercury	mg/L	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum	mg/L	-	-	-		0.00100				0.00259				<0.000250		
Nickel	mg/L	0.120 to 0.275 ³	0.00192	0.00099	0.0171	0.00532	0.00467	0.00122	0.0093	0.00910	0.0112	0.00787	0.00054	0.00307	0.00182	0.00164
Phosphorus	mg/L	-	-	-		<0.250				<0.250				0.977		
Selenium	mg/L	0.002	0.000104	0.000132	<0.00025	<0.000250	0.000063	0.000175	<0.00025	<0.000250	0.000064	0.000067	0.000242	0.00254	0.00360	<0.000050
Silicon	mg/L	-	-	-		6.45				7.02				4.84		
Silver	mg/L	0.00025	<0.000010	<0.000010	<0.000050	<0.000050	<0.000010	<0.000010	<0.000050	<0.000050	<0.000010	<0.000010	<0.000010	<0.000050	<0.000010	<0.000010
Strontium	mg/L	-	-	-		1.80				1.81				1.21		
Sulphur	mg/L	-	-	-		27.6				29.7				19.1		
Thallium	mg/L	-	-	-		<0.000050				<0.000050				<0.000050		
Tin	mg/L	-	-	-		<0.00050				<0.00050				<0.00050		
Titanium	mg/L	-	-	-		<0.00150				<0.00150				<0.00150		
Uranium	mg/L	0.015	0.000733	0.000851	0.00242	0.00238	0.00212	0.000423	0.00297	0.00351	0.00291	0.00304	0.00059	0.000228	0.000473	0.000696
Vanadium	mg/L	-	-	-		<0.00250				<0.00250				<0.00250		
Zinc	mg/L	0.03	<0.0010	0.0058	0.0247	0.0054	0.0021	0.0031	0.0097	0.0087	0.0028	0.0013	0.0011	<0.0050	0.0019	0.003
Zirconium	mg/L	-	-	-		0.00141				<0.00100				<0.00100		

Notes:

¹ Alberta Environment and Protected Areas (Alberta EPA). 2024. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. LaLand Policy and Programs Branch, Lands Division. ISBN 978-1-4601-6067-1. Referenced guidelines are for coarse-textured soils under Residential/Parkland land use.

² Alberta Environment and Parks (AEP). Environmental Quality Guidelines for Alberta Surface Waters. March 2018. Table 1 Surface water quality guidelines for the protection of freshwater aquatic life (FAL). Most conservative values applied (chronic or acute).

³ Guideline varies with hardness. Values shown based on site hardness range of 269 mg/L to 714 mg/L.

⁴ Guideline varies with chloride. Values shown based on site chloride range of 7.70 mg/L to 49.6 mg/L.

⁵ Guideline varies with pH. Values shown based on site pH range of 6.76 to 8.53.

⁶ Guideline varies with pH and temperature. Values shown based on pH range of 6.76 to 8.53 and temperature range of 1.15°C to 7.88°C.

"-" No applicable guideline or not analyzed.

"ND" Non-detected.

BOLD - Greater than Tier 1 Guideline.

N/A - Not applicable.

Table 2: Groundwater Analytical Results

Parameter	Unit	Tier 1 Guideline ^{1,2}	MW-01	MW-02	MW-03 (Deep Well)				MW-04				MW-203			
			4-Dec-2019	4-Dec-2019	4-Dec-2019	21-Nov-2021	08-Dec-2022	06-Sep-2024	4-Dec-2019	21-Nov-2021	08-Dec-2022	06-Sep-2024	5-Dec-2019	21-Nov-2021	08-Dec-2022	06-Sep-2024
Organics																
AOX	mg/L	-	ND	ND	ND					ND				ND		
Hydrocarbons																
Benzene	mg/L	0.005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00053	0.00058	0.00079	<0.00050
Toluene	mg/L	0.021	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00052	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Ethylbenzene	mg/L	0.0016	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Xylenes (m & p)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.00030	<0.00030	<0.00030	<0.00050	<0.00030	<0.00030	<0.00030	<0.00050	<0.00030	<0.00030	<0.00030
Xylene (o)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.00040	<0.00040	<0.00040	<0.00050	<0.00040	<0.00040	<0.00040	<0.00050	<0.00040	<0.00040	<0.00040
Xylenes Total	mg/L	0.02	<0.00071	<0.00071	<0.00071	<0.00050	<0.00050	<0.00050	<0.00071	<0.00050	<0.00050	<0.00050	<0.00071	<0.00050	<0.00050	<0.00050
Styrene	mg/L	0.072	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
F1 (C ₈ -C ₁₀)	mg/L	-	<0.10	<0.10	<0.10				<0.10				<0.10			
F1 (C ₈ -C ₁₀) - BTEX	mg/L	0.81	<0.10	<0.10	<0.10				<0.10				<0.10			
F2 (C ₁₀ -C ₁₆)	mg/L	1.1	<0.10	<0.10	<0.10				<0.10				<0.10			
Total BTEX	mg/L	-	-	-		<0.0010	<0.0010	<0.0010		<0.0010	<0.0010	<0.0010		<0.0010	<0.0010	<0.0010
Volatile Fatty/Carboxylic Acids																
Acetic Acid	mg/L	-	<10	<10	<10				<10				<10			
Butyric Acid	mg/L	-	<1.0	<1.0	<1.0				<1.0				<1.0			
Formic Acid	mg/L	-	<50	<50	<50				<50				<50			
Hexanoic Acid	mg/L	-	<1.0	<1.0	<1.0				<1.0				<1.0			
iso-Butyric Acid	mg/L	-	<1.0	<1.0	<1.0				<1.0				<1.0			
Isovaleric Acid	mg/L	-	<1.0	<1.0	<1.0				<1.0				<1.0			
Propanoic Acid	mg/L	-	<5.0	<5.0	<5.0				<5.0				<5.0			
Valeric Acid	mg/L	-	<1.0	<1.0	<1.0				<1.0				<1.0			
Polycyclic Aromatic Hydrocarbons (PAHs)																
Naphthalene	mg/L	0.001	-	-		<0.0010				<0.0010				<0.0010		
Volatile Organic Compounds (VOCs)																
Bromobenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Bromochloromethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Bromodichloromethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
Bromoform	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
Bromomethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
n-Butylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
sec-Butylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
tert-Butylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Carbon tetrachloride	mg/L	0.00029	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chlorobenzene	mg/L	0.0013	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
Chloroethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Chloroform	mg/L	0.018	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
Chloromethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.0050	<0.0010	<0.0050	<0.0050	<0.0050	<0.0010	<0.0050	<0.0050	<0.0050
2-Chlorotoluene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
4-Chlorotoluene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Dibromochloromethane	mg/L	0.19	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
1,2-Dibromo-3-chloropropane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,2-Dibromoethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
Dibromomethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
1,2-Dichlorobenzene	mg/L	0.0007	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
1,3-Dichlorobenzene	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
1,4-Dichlorobenzene	mg/L	0.001	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
1,1-Dichloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
1,2-Dichloroethane	mg/L	0.005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,1-Dichloroethene	mg/L	0.014	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
1,2-Dichloroethene (cis)	mg/L	-	<0.0010	<0.0010	0.0036	0.0042	0.0049	<0.0010	0.0083	0.0077	0.0102	0.0089	0.0083	0.0098	0.0106	0.0109
1,2-Dichloroethene (trans)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
Dichlorodifluoromethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
1,2-Dichloropropane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010

Notes:

¹ Alberta Environment and Protected Areas (Alberta EPA). 2024. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. LaLand Policy and Programs Branch, Lands Division. ISBN 978-1-4601-6067-1. Referenced guidelines are for coarse-textured soils under Residential/Parkland land use.

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³ Guideline varies with hardness. Values shown based on site hardness range of 269 mg/L to 714 mg/L.

⁴ Guideline varies with chloride. Values shown based on site chloride range of 7.70 mg/L to 49.6 mg/L.

⁵ Guideline varies with pH. Values shown based on site pH range of 6.76 to 8.53.

⁶ Guideline varies with pH and temperature. Values shown based on pH range of 6.76 to 8.53 and temperature range of 1.15°C to 7.88°C.

"-" No applicable guideline or not analyzed.

"ND" Non-detected.

BOLD - Greater than Tier 1 Guideline.

N/A - Not applicable.

Table 2: Groundwater Analytical Results

Parameter	Unit	Tier 1 Guideline ^{1,2}	MW-01	MW-02	MW-03 (Deep Well)				MW-04				MW-203			
			4-Dec-2019	4-Dec-2019	4-Dec-2019	21-Nov-2021	08-Dec-2022	06-Sep-2024	4-Dec-2019	21-Nov-2021	08-Dec-2022	06-Sep-2024	5-Dec-2019	21-Nov-2021	08-Dec-2022	06-Sep-2024
Volatile Organic Compounds (VOCs)																
1,3-Dichloropropane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
2,2-Dichloropropane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,1-Dichloropropene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,3-Dichloropropene	mg/L	-	-	-		<0.0015	<0.0015	<0.0015		<0.0015	<0.0015	<0.0015		<0.0015	<0.0015	<0.0015
1,3-Dichloropropene [cis]	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
1,3-Dichloropropene [trans]	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Hexachlorobutadiene	mg/L	0.0013	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
p-Isopropyltoluene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Methyl t-Butyl Ether (MTBE)	mg/L	0.015	-	-		<0.00050	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050		<0.00050	<0.00050	<0.00050
Methylene Chloride	mg/L	0.05	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
iso-Propylbenzene (cumene)	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
n-Propylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,1,1,2-Tetrachloroethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,1,2,2-Tetrachloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
Tetrachloroethene	mg/L	0.01	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
1,2,3-Trichlorobenzene	mg/L	0.008	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,2,4-Trichlorobenzene	mg/L	0.015	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,1,1-Trichloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
1,1,2-Trichloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
Trichloroethene	mg/L	0.00032	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
Trichlorofluoromethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Trihalomethanes	mg/L	0.1	-	-		<0.0020	<0.0020	<0.0020		<0.0020	<0.0020	<0.0020		<0.0020	<0.0020	<0.0020
1,2,3-Trichloropropane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010	<0.00050	<0.0010	<0.0010	<0.0010
1,2,4-Trimethylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
1,3,5-Trimethylbenzene	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Vinyl chloride	mg/L	0.0011	<0.00050	<0.00050	0.00070	0.0021	0.0016	<0.0010	0.00643	0.0032	0.0037	0.0034	0.00289	0.0046	0.0062	0.0018

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⁵ Guideline varies with pH. Values shown based on site pH range of 6.76 to 8.53.
⁶ Guideline varies with pH and temperature. Values shown based on pH range of 6.76 to 8.53 and temperature range of 1.15°C to 7.88°C.
"-": No applicable guideline or not analyzed.
"ND": Non-detected.

BOLD - Greater than Tier 1 Guideline.
N/A - Not applicable.

Table 3: Groundwater Quality Assurance/Quality Control Analytical Results

Parameter	Unit	RDL	MW-04		RPD (%)
			06-Sep-2024	06-Sep-2024 DUP	
Routine					
pH	pH Units	0.1	7.58	7.63	0.7
Electrical Conductivity (EC)	µS/cm	1	1,590	1,610	1
Total Dissolved Solids (TDS)	mg/L	1	1,040	1,010	3
Hardness as CaCO ₃	mg/L	0.5	702	686	2
Alkalinity (total as CaCO ₃)	mg/L	1	910	868	4.7
Bicarbonate	mg/L	1	1,110	1,060	5
Carbonate	mg/L	1	<1.0	<1.0	-
Hydroxide	mg/L	1	<1.0	<1.0	-
Calcium	mg/L	0.05	182	176	3
Magnesium	mg/L	0.005	60.2	59.8	1
Potassium	mg/L	0.05	16.7	16.4	2
Sodium	mg/L	0.05	110	112	2
Chloride	mg/L	2.5	32.2	32	1
Fluoride	mg/L	0.1	<0.100	<0.100	-
Sulphate	mg/L	1.5	71.8	72.1	0
Ionic Balance	N/A	0.01	94.2	97	3
Nutrients					
Nitrate (as NO ₃ -N)	mg/L	0.1	0.122	0.122	-
Nitrite (as NO ₂ -N)	mg/L	0.05	<0.050	<0.050	-
Nitrate and Nitrite (as N)	mg/L	0.112	0.122	0.122	-
Dissolved Metals					
Aluminum	mg/L	0.001	<0.0010	0.001	-
Antimony	mg/L	0.0001	<0.00010	<0.00010	-
Arsenic	mg/L	0.0001	0.00549	0.00569	4
Barium	mg/L	0.0001	0.316	0.314	1
Boron	mg/L	0.01	1.31	1.29	2
Cadmium	mg/L	0.000005	0.0000058	0.0000136	-
Chromium	mg/L	0.0005	<0.00050	<0.00050	-
Copper	mg/L	0.0002	<0.00020	<0.00020	-
Iron	mg/L	0.01	4.48	4.34	3
Lead	mg/L	0.00005	<0.000050	<0.000050	-
Manganese	mg/L	0.0001	1.2	1.2	0
Mercury	mg/L	0.000005	<0.0000050	<0.0000050	-
Nickel	mg/L	0.0005	0.00787	0.00808	2.6
Selenium	mg/L	0.00005	0.000067	0.000065	-
Silver	mg/L	0.00001	<0.000010	<0.000010	-
Uranium	mg/L	0.00001	0.00304	0.00316	4
Zinc	mg/L	0.001	0.0013	0.0015	-

Notes:

RDL - Reportable detection limit.

RPD - Relative Percentage Difference calculated as $RPD(\%) = \frac{|V1-V2|}{[(V1+V2)/2]} \times 100$ where V1,V2 = concentrations of parent and duplicate sample, respectively.

"-" Indicates RPD not calculated. RPDs have only been considered where both concentrations are greater than 5 times the RDL.

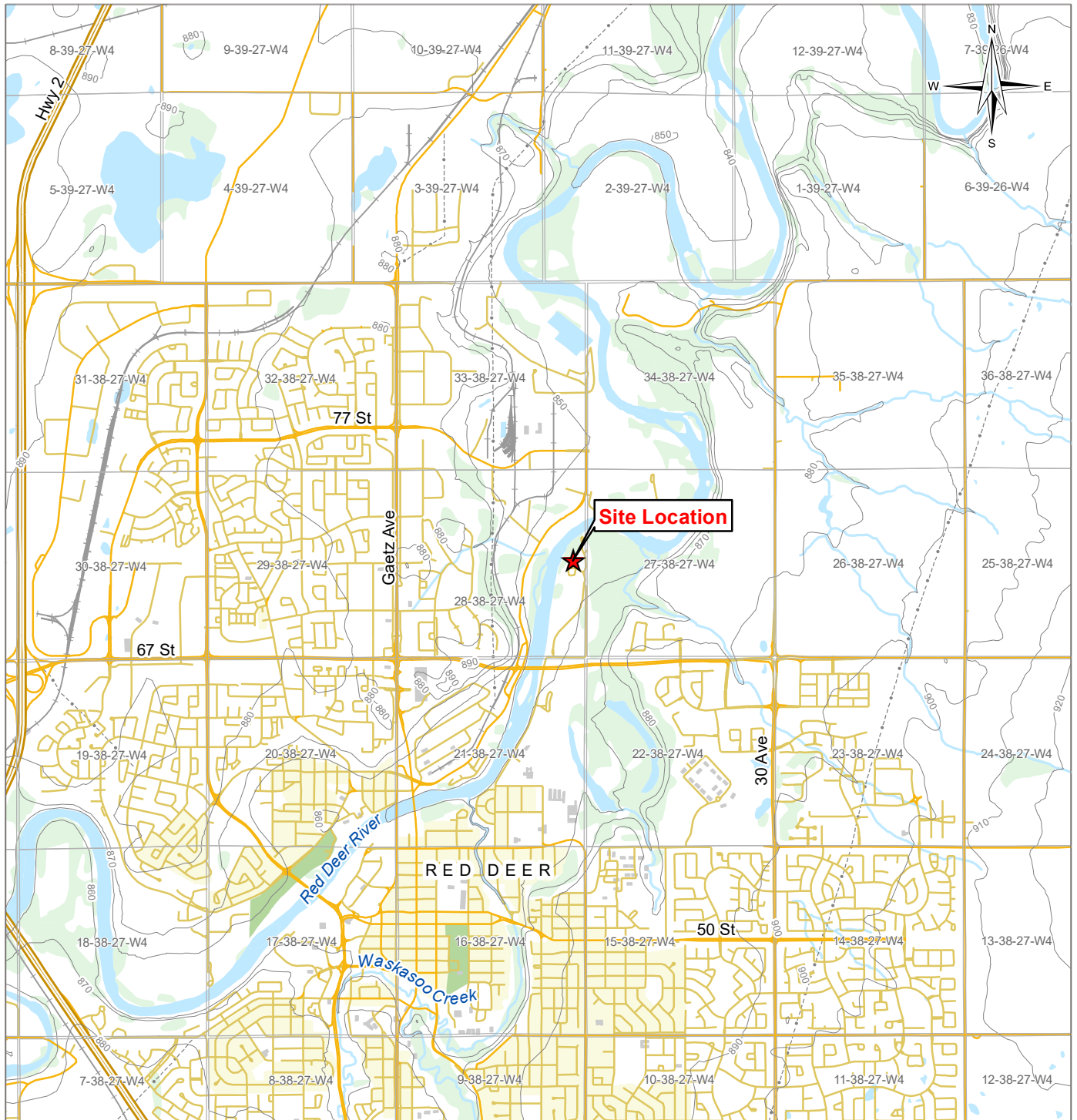
N/A - Not applicable.

BOLD - RPD value greater than 20%.

FIGURES

Figure 1	Site Location Plan
Figure 2	Site Plan and Surrounding Land Use
Figure 3	Groundwater Monitoring Well Hydrographs
Figure 4	Groundwater Elevation Contours September 2024

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LEGEND

- Site Location
- Highway
- Main Road
- Local Road
- Resource/Recreational Road
- Railway
- Power Line
- Building
- Park
- Residential Area
- Contour (10 m)
- Watercourse
- Waterbody
- Wooded Area

NOTES

Base data source: CanVec 1:50,000.

2024 GROUNDWATER MONITORING REPORT MCKENZIE TRAILS RECREATION AREA

Site Location Plan

PROJECTION

3TM 114

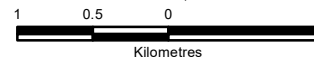
DATUM

NAD83

CLIENT



Scale: 1:50,000



FILE NO.

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OFFICE

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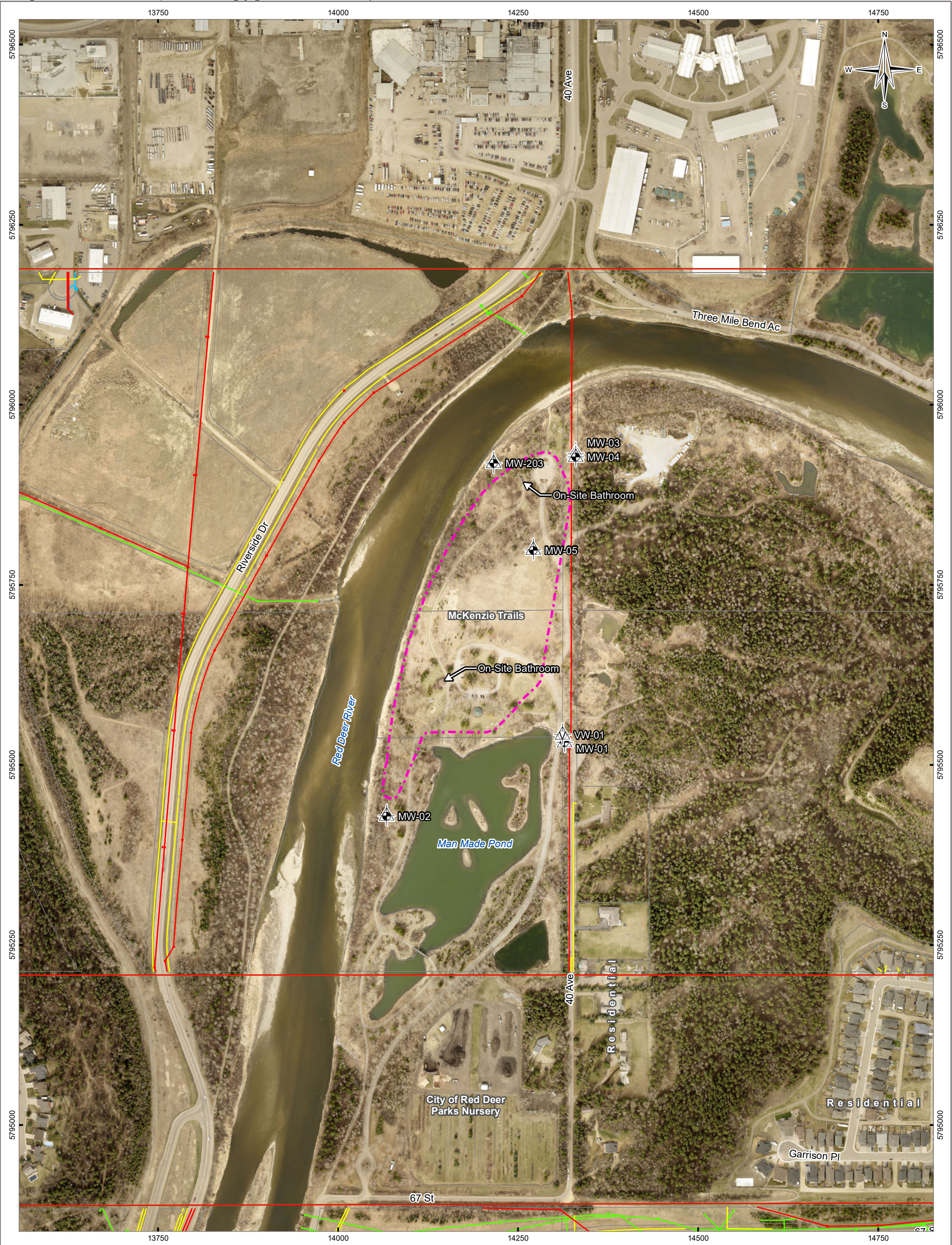
February 27, 2025

PROJECT NO.

SWM.SWOP04071-04.003



Figure 1



LEGEND

- Monitoring Well
- Vapour Well
- Historic Waste Disposal
(Provided by Tiamat, 2014)

- Lot Boundary
- Utilities
- Electrical
 - Sanitary
 - Storm
 - Water

NOTES

Base data source: Imagery provided by City of Red Deer (2022)

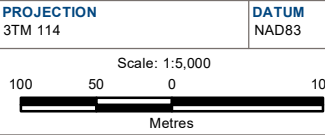
Roads from City of Red Deer Open Data, 2018

Utilities provided by City of Red Deer.

Locations have not been field verified, and should not be used for construction or other intrusive field activities.

2024 GROUNDWATER MONITORING REPORT
MCKENZIE TRAILS RECREATION AREA

Site Plan and
Surrounding Land Use



FILE NO. SWOP04071-04_Fig02_LandUse.mxd				
OFFICE TI-EDM	DWN DS	CKD MRB	APVD RM	REV 0
DATE February 27, 2025	PROJECT NO. SWM.SWOP04071-04.003			

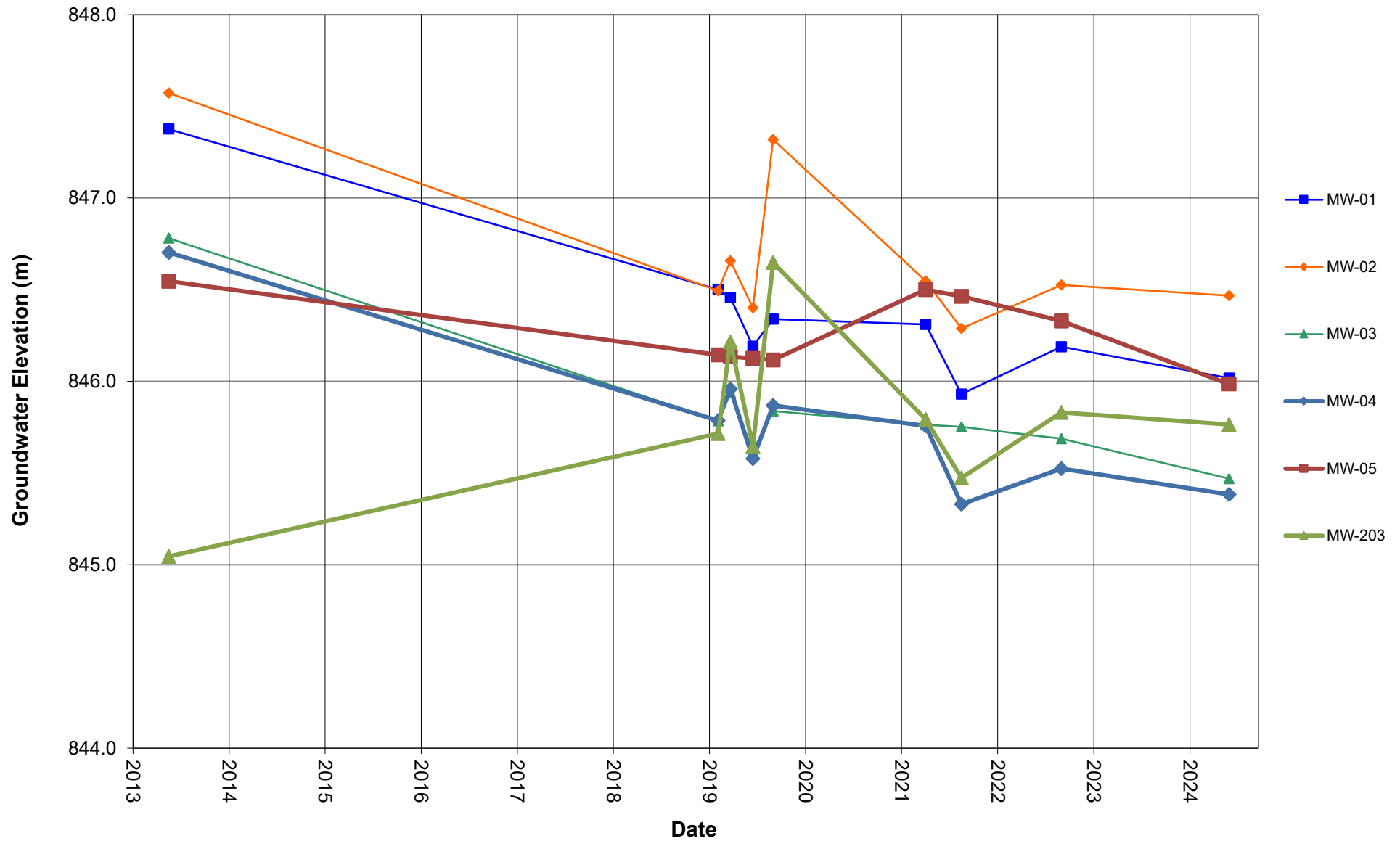
CLIENT

THE CITY OF Red Deer

TETRA TECH

Figure 2

FIGURE 3
GROUNDWATER MONITORING WELL HYDROGRAPHS





LEGEND

- Monitoring Well
- Vapour Well
- Groundwater Flow Direction
- Groundwater Elevation Contour (0.20 masl)
- (84X.XX) Groundwater Elevation (measured on September 5, 2024; masl)
- (84X.XX)* Groundwater Elevation (not contoured; masl)
- Historic Waste Disposal (Provided by Tiamat, 2014)
- Road

NOTES
Base data source: Imagery provided by City of Red Deer (2022)
Roads from City of Red Deer Open Data, 2018
masl - metres above sea level

2024 GROUNDWATER MONITORING REPORT
MCKENZIE TRAILS RECREATION AREA

Groundwater Elevation Contours
September 2024

PROJECTION 3TM 114	DATUM NAD83	CLIENT
Scale: 1:2,000 		
FILE NO. SWOP04071-04_Fig04_GW_Sept2024.mxd		
OFFICE TI-EDM	DWN DS	CKD MRB
DATE March 17, 2025	APVD RM	REV 0
PROJECT NO. SWM.SWOP04071-04.003	Figure 4	

APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOENVIRONMENTAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

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The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

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Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner

consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by TETRA TECH in its reasonably exercised discretion.

APPENDIX B

SITE HISTORY, HISTORICAL INFORMATION, SITE SETTING, 2019 HAZARD QUOTIENTS, AND 2014 RISK MANAGEMENT PLAN REVIEW

SITE HISTORY, HISTORICAL INFORMATION, SITE SETTING, 2019 HAZARD QUOTIENTS, AND 2014 RISK MANAGEMENT PLAN REVIEW

Section 1.0 to Section 4.0 are a summary from the 2019 Groundwater and Soil Vapour Monitoring Report – McKenzie Trails Recreation Area¹.

1.0 SITE HISTORY

Municipal records indicate that the waste disposal at the site occurred in two phases. Disposal in the southern portion occurred from 1930 to 1959 (approximately 29 years) and in the northern portion from 1960 to 1964 (approximately four years). The estimated age of the waste material post closure of the landfill is interpreted to be 55 years to 60 years. Historical information indicates the waste as being municipal solid waste (MSW) including a mixture of plastics, cans, paper, scrap metals, wires, and glass. Bricks, wood, and ash were also encountered during the Phase II investigation².

Historical waste disposal was identified during the 2014 Phase II environmental site assessment (ESA) to be north of the man-made pond area. The waste area extends to the north end of the recreation area and to the west towards the Red Deer River. The Phase II ESA estimated the total area of buried waste at approximately 64,250 m². The status of the former landfill is inactive and closed.

Results of the 2014 Phase II ESA conducted by Tiamat Environmental Consultants Ltd. (Tiamat) indicate that surface material of sod and loam was overlying the buried MSW material. There were no indications of a formal barrier layer (e.g., clay) overlying the waste. The thickness of the layer of sod and loam varied between 8 cm and 15 cm. The MSW was mixed with fill consisting of sand, gravel, silt, and clay, located below the sod to a depth of approximately 5 m in the north-central area of the site. A portion of the waste material consists of burned garbage. The waste material was overlying silt (fill), sand and gravel (native), and siltstone (bedrock) in the northwest to southeast and the MSW was overlying silty sand (fill), sand and gravel (native), and siltstone and shale (bedrock) in the northeast to southwest with some clay (till) in the southwest. The base of the MSW material is similar to the level of the adjacent Red Deer River.

2.0 HISTORICAL GROUNDWATER MONITORING AND INVESTIGATION SUMMARY

Alberta Environment³ (AENV) installed monitoring wells in 1982, including seven groundwater monitoring wells within and beside the waste material boundary. In June 2013, the Red Deer River experienced flooding and the west side of the site was impacted. Groundwater monitoring wells located on the east riverbank were damaged or destroyed, with the exception of MW-203.

¹ Tetra Tech Canada Inc. 2020. 2019 Groundwater and Soil Vapour Monitoring Report – McKenzie Trails Recreation Area. Prepared for The City of Red Deer. October 2020. Project Number: 704-SWM.SWOP04071-01.003.

² Tiamat Environmental Consultants Ltd. 2014a. Phase II Environmental Site Assessment, Historic Waste Disposal Site, McKenzie Trails Recreation Area, The City of Red Deer. February 12, 2014.

³ Currently Alberta Environment and Protected Areas (Alberta EPA).

Previous reports prepared by Tiamat for the site include the following:

- Phase I ESA, Historic Waste Disposal Site, McKenzie Trail, The City of Red Deer. September 24, 2013⁴.
- Phase II ESA, Historic Waste Disposal Site, McKenzie Trails Recreation Area, The City of Red Deer. February 12, 2014².
- Environmental Risk Management Plan (RMP), Historic Waste Disposal Sites, McKenzie Trails Recreation Area, The City of Red Deer. November 26, 2014⁵.

Two test holes (TH-03 and TH-04) were advanced in June 2013 as part of the Phase II ESA; one vapour well (VW-01) and one monitoring well (MW-01) were installed.

The results of the Phase II ESA conducted by Tiamat in 2014 indicated the following:

- There were no obvious activities that pose a high potential to adversely impact the site from activities on adjacent developments. The historical waste area is within the boundaries of the park.
- The waste area underlies the park space north of the man-made pond and extends to a setback from the Red Deer River. The plan area of the waste was calculated to be approximately 64,520 m², calculated from aerial photography and site observations based on topography.
- Groundwater samples demonstrated a varying level of contamination for petroleum hydrocarbons (PHCs), volatile organic compounds (VOCs), and chlorinated hydrocarbons.

A soil vapour sample indicated VOCs, aliphatic and aromatic hydrocarbons, and siloxanes. The concentrations were considered trace to low and not identified as an environmental concern to the residential developments southeast of the area.

The recommendations of the program were as follows:

- Monitor groundwater elevations and soil vapour data quarterly for one hydrogeological cycle.
- Determine if surface water sampling should be included along with additional groundwater monitoring locations to determine exposure from leachate contaminants.
- Collect an additional set of soil vapour and groundwater analytical data, groundwater elevations, and volatile headspace measurement during the winter months to determine seasonal changes in soil vapour concentrations.
- Develop a RMP to consider future land uses and address environmental concerns.
- Review all data to update the RMP with new information.

⁴ Tiamat Environmental Consultants Ltd. 2013. Phase I Environmental Site Assessment, Historic Waste Disposal Site, McKenzie Trail, The City of Red Deer. September 24, 2013.

⁵ Tiamat Environmental Consultants Ltd. 2014. Environmental Risk Management Plan, Historic Waste Disposal Sites, McKenzie Trails Recreation Area, The City of Red Deer. November 26, 2014.

The results of the subsequent RMP conducted by Tiamat in 2014 indicated the following:

- Information in the preliminary quantitative risk assessment (PQRA) should be updated as new site information is obtained.
- A review of the RMP should be completed when the PQRA information is updated if there are changes to the chemicals of potential concern (COPCs).
- The RMP should be reviewed and updated at five-year intervals.

3.0 SITE SETTING

The following section presents an overview of the regional and local setting for the site.

3.1 Geology

The following sections summarize the regional and local geology.

3.1.1 Geological Setting and Stratigraphy

The following description of regional geological setting was obtained from Tiamat's 2013 Phase I report⁴:

"The City of Red Deer and area are located within the Red Deer River drainage basin in the western Alberta Plains. The Red Deer River valley is the principal drainage way. The fertile black soil in the region (Penhold Loam) is of alluvial lacustrine origin. The Penhold Loam is a well-drained fine sandy loam classified as Chernozemic. It is generally stone free and in natural areas, is typically 1.5 m thick, more or less.

The local topography is characterized with gentle slopes bordered on the east and west by uplands and incised at its lowest part by the valley of the Red Deer River. The Tertiary bedrock consists of sequences of alternating shales and sandstones of the Paskapoo Formation whereas the Quaternary deposits consist of drift deposits of clay, silt, gravel and sand. Published information indicates the banks of the Red Deer River comprise of dirty gravel with thickness ranging from 6 to 12 m, more or less. The Paskapoo Formation underlies the gravel sediments. This non-marine bedrock is composed of mudstone, siltstone and sandstone. The formation of the Rocky Mountains subjected the Paskapoo Formation to a regional stress-induced fracture pattern.

Generally, the fracture pattern resembles a series of vertical fractures that trend southwest to northeast, perpendicular to the Rocky Mountains. A report from the Alberta Energy and Utilities Board EUB/AGS Earth Sciences Report 2002-04, suggest the pattern of fractures may be complemented with sub-horizontal fractures resulting from conjugate fracture patterns, differential stress release or pressure release events. In the valley, lies preglacial Saskatchewan gravels and sand. Terrace gravels hydraulically connected to the Red Deer River are a known groundwater resource.

Surficial soils comprise largely of poorly to moderately sorted sand, silt and gravel with a varying amount of clay. The fluvial sediments generally have obscure bedding planes. Medium to coarse sized gravel with cross-bedded sand have been documented."

3.1.2 Local Geology

Based on the findings from the 2014 Phase II ESA, McKenzie Trails Park consisted of 8 cm to 15 cm of sod and loam overlying MSW. The MSW is overlying a mix of silt (fill), sand and gravel (native), and siltstone and shale (bedrock). The maximum depth of waste encountered was approximately 6 m. There are no indications of a prepared landfill foundation (e.g., compacted clay liner) based on the drilling logs.

Mapping by the Alberta Geological Survey⁶ indicates that a buried valley could be present approximately 300 m east of the site trending in a north-northeast direction; however, the width of the valley is not defined.

3.2 Hydrogeology

The following sections summarize the regional and local hydrogeology.

3.2.1 Regional Hydrogeology

The following description is taken from regional hydrogeology information from Tiamat's 2013 Phase I report⁴:

"A significant buried valley and aquifer resource trending northeastward through the city has been partially mapped and lies in the SE 28-38-27 W4M (MacKenzie Trail and Riverside). This buried valley extends to a depth of 21 m, more or less and may extend to the south into north portions of 21-28-27 W4M."

"The dominant type of near-surface groundwater in the Paskapoo Formation in the area of assessment is sodium bicarbonate. Notable concentrations of sodium sulfate type groundwater have also been reported. The quality of groundwater for potable use is generally suitable to depths of 300 m on the west side of Red Deer and decreases to 90 m, more or less in the east."

Areas of recharge (downward flow) in unsaturated heterogeneous sediments include most areas above the river and creek valleys, whereas; the river valleys will generally exhibit discharge. The distribution of groundwater in the area can also be influenced by the local geology, topographic relief, areas of artesian flow, springs and reasonable yielding water source wells.

Numerous permanent surface water features within The City of Red Deer and vicinity include Red Deer River, Waskasoo Creek, Gaetz Lakes, Hazlett Lake, Bower Ponds (result of formerly mining gravel resources), various sloughs in the fringe areas of the city and an assortment of other smaller creeks and springs. These water bodies can be relevant to the environmental sensitivity of the site assessment."

There is a hydrologic relation between the gravel deposit and the Red Deer River. Depending on local sediments and flow dynamics, some sections of the Red Deer River may experience an influent flow pattern and river water may enter the gravel beds and remain as riverbank storage. The bank storage is typically gradually released when the river becomes effluent, usually between July and August. These seasonal fluctuations of the river level have notable influences with the magnitude and direction of groundwater. Discharges generally occur at some point downstream from the point of entry.

The regional groundwater generally follows the bedrock topography. It should be noted that local topography, geology, land development, and soil disturbances may influence the local movement and pattern of groundwater and in conjunction, groundwater levels may fluctuate seasonally and in response to climatic conditions. The shallow pattern of flow can also be influenced by the physical attributes of the fluvial sediments and the glacially formed Red Deer River Valley.

3.2.2 Local Hydrogeology

The Red Deer River is located on the west and north sides of McKenzie Trails Park and flows in a northerly direction. Shallow groundwater is assumed to flow towards or parallel to the river. A man-made pond is located in the central portion of McKenzie Trails Park, south of the closed landfill, and collects some of the site drainage.

⁶ Andriashek, L. comp. (2018): Thalwegs of bedrock valleys, Alberta (GIS data, line features); Alberta Energy Regulator, AER/AGS Digital Data 2018-0001.

3.3 Groundwater Resource Usage

A search of the Alberta Water Well Database conducted in January 2020 for groundwater users within a 1 km radius of the McKenzie Trails area identified 65 groundwater wells; 24 of the wells are listed as domestic use, two are listed as domestic and stock use, 21 are listed as investigation, two are listed as injection use, eight are listed as industrial use, three are listed as “other”, one as observation use, and four are listed as unknown use⁷.

The nearest water well identified through the Water Well Database to site is located approximately 100 m west of site and the Red Deer River. The proposed well use was for investigation purposes. The water wells within a 1 km radius of site range from 2.4 m to 190 m deep. The status and use of the surrounding groundwater wells were not confirmed, and they were not field verified.

4.0 HAZARD QUOTIENTS

4.1 2019 Hazard Quotient Calculations

Using the soil vapour screening levels described above and the soil vapour sampling results, estimated cancer risks (for carcinogens), and estimated hazard quotients (HQs; for non-carcinogens) were calculated for the site.

Estimated risks were calculated by dividing the soil vapour concentration by the corresponding soil vapour screening level for carcinogenic effects and multiplying the ratio by the target risk level of 1×10^{-5} . Similarly, the estimated HQs represent the soil vapour concentration divided by the corresponding soil vapour screening level for non-carcinogenic effects.

Risk estimates for non-carcinogenic COPCs are defined as HQ. HQs are calculated based on a ratio of the estimated exposure and the toxicity reference values identified as the tolerable daily intake (TDI) or tolerable concentration (TC) according to the following equation:

$$\text{Hazard Quotient} = \frac{\text{Estimated Daily Dose (mg/kg-day or mg/m}^3\text{)}}{\text{Tolerable Daily Intake (mg/kg-day) or Tolerable Concentration (mg/m}^3\text{)}}$$

Non-carcinogenic risk characterization in the assessment was completed for all COPCs.

When the HQ is greater than the target risk value, the scenario poses a potential concern and requires further evaluation or risk management. It is important to note that HQs greater than the target risk value do not necessarily indicate that adverse health effects will occur. This is because of the conservative assumptions used in estimating concentrations and in setting the target values. HQs that are less than the target risk value indicate that exposure is within acceptable levels and no further risk management is necessary. HQs greater than the target risk value suggest that further investigation or risk management (e.g., remediation) may be warranted.

For non-carcinogens, the cumulative target risk value used was 1.0. This target risk value accounts for additional exposure to the chemicals of concern from sources other than the site. Therefore, the cumulative target risk value of 1.0 represents an allocation of 20% of a person's daily exposure from site sources and the remaining 80% would come from other sources. Other sources of exposure include ambient air, household products, and soil and water contact from locations other than the site.

⁷ Alberta Environment and Parks. 2019b. Water Well Database. Information obtained http://www.telusgeomatics.com/tgpub/ag_water

For carcinogens, the risk of cancer is assumed to be proportional to dose with the assumption that any exposure results in a nonzero probability of risk. Carcinogenic risk probabilities were calculated by multiplying the estimated exposure level by the route-specific cancer slope factor (SF) or unit risk factor (URF) for each carcinogen:

$$R = E \times SF \text{ (or URF)}$$

Where:

R = Estimated individual excess lifetime cancer risk;

E = Exposure level for each chemical of potential concern (mg/kg/day or mg/m³); and

SF = Route- and chemical-specific SF (mg/kg/day)⁻¹ or URF ((mg/m³)⁻¹).

Risk probabilities determined for each carcinogen were also considered to be additive over all exposure pathways so that an overall risk of cancer was estimated for each group of potentially exposed receptors.

When assessing risks posed by exposure to carcinogenic substances, Health Canada and other regulatory agencies assume that any level of exposure is associated with some hypothetical cancer risk. As a result, it is necessary for regulatory agencies to specify an acceptable risk level. Per Health Canada guidance (2010a, 2010b), cancer risks are deemed essentially negligible where the estimated cumulative incremental lifetime cancer risk is less than or equal to 1 in 100,000 (1 x 10⁻⁵).

For this evaluation, target risk and hazard levels were determined in accordance with the Alberta Tier 2 Guidelines. For carcinogens, the cumulative target risk level is 1 x 10⁻⁵, as this value is considered by Health Canada to represent a negligible risk. For non-carcinogens, a cumulative target hazard level of 1 is used as potential exposures that result in hazard indices equal to or less than 1 signify negligible potential for adverse health effects. Each sampling location was screened individually for every chemical detected.

A cumulative risk level for carcinogens was not calculated as none of the carcinogenic parameters were detected greater than the laboratory detection limits. A cumulative hazard level identified in the sample and its duplicate collected for the non-carcinogens ranged between 0.001 to 0.003.

The estimated cumulative risks and hazards associated with the soil vapour samples collected in December 2019 did not exceed the corresponding target risk and hazard levels.

4.2 Review of the 2014 Hazard Quotients from the Risk Management Plan

The following section is a review of the 2014 RMP⁵ for the site that was completed by Tiamat. The review of the 2014 RMP was completed for the 2019 groundwater and soil vapour monitoring report¹.

The 2014 RMP presented a proposed site-specific RMP as a tool to assist with the review of future subdivision applications on lands lying within the regulated setback distance from the site (300 m). The focus was on potential ingress of soil gas for COPCs with a HQ greater than 1.0. Residential land use was considered most sensitive, and exposure ratings for other land uses (e.g., school, public institutions, commercial complexes) were considered to not be greater than residential; however, unique exceptions would have to be reviewed and addressed on a site-specific basis⁵. Further, underground utility workers and subsurface utility infrastructure were considered relevant to potential exposure.

The RMP applied a 10x factor of safety to the HQs to address uncertainties. HQs from the RMP ranged up to 566 (including the 10x factor of safety). Based on these, the RMP then provided recommended generic mitigative measures based on the calculated HQs, ranging from passive to active measures, recognizing that the ultimate approach would require a design professional for the proposed development.

Following the 2014 RMP, Canadian Council of Minister of the Environment (CCME) released the document A Protocol for the Derivation of Soil Vapour Quality Guidelines for Protection of Human Exposures Via Inhalation of Vapours⁸, designed to provide guidance for developing site-appropriate soil vapour quality guidelines. The guidelines developed using the methods outlined in the CCME document were used for this current study and are included with the vapour sampling results in Table 4. HQs were calculated using estimated dose (based on concentrations measured at the site) and divided by TDI. Soil vapour concentrations from the Phase II ESA conducted in 2013 were not compared to soil vapour quality guidelines; however, spot checks of five target compounds with the highest HQs in the 2013 work (benzene, tetrachloroethylene, chloromethane, 1,2,4--trimethylbenzene, and styrene) identified that none of the 2013 concentrations would have unacceptable HQs using the updated CCME methodology.

The 2014 RMP was prepared concurrent to RMPs at several other former City landfills, and a common set of mitigative measures was applied based on the HQs. Subsequent to the 2014 RMP and to the release of the CCME Protocol document, The City of Red Deer (The City) undertook additional assessment at another former City landfill (Montfort); as part of that work, their consultant XCG Consulting Limited (XCG) revised the 2014 RMP criteria ranges for each generic mitigative measure category to include a Cancer Risk range to allow comparison of the 2014 RMP ranges with the HQ and Cancer Risks calculated by XCG⁹. From that work, XCG identified the following generic mitigative measures for developments within a 300 m setback of these landfills (based on Tiamat 2014), and these have been adopted for this site:

Passive Measures

1. Passive Measures – Level A: for Cancer Risk of $> 1E^{-5}$ and $< 5E^{-5}$ and/or HQ > 0.2 and < 1 .

Compacted clay liner with a minimum thickness of 1 m and confirmed maximum hydraulic conductivity of 10^{-6} cm/sec.

2. Passive Measures – Level B: for Cancer Risk of $> 5E^{-5}$ and $< 5E^{-4}$ and/or HQ > 1 and < 5 .

Synthetic liner with type of material, thickness, and installation details dependent on the design professional.

3. Passive Measures – Level C: for Cancer Risk of $> 5E^{-4}$ and $< 1E^{-3}$ and/or HQ > 5 and < 50 .

Passive sub-slab depressurization (SSD) system with a minimum depressurization of 4 Pa to 10 Pa. In some instances (such as a pervious subgrade), the actual depressurization necessary may require an active SSD or alternative active ventilation system.

⁸ Canadian Council of Ministers of the Environment. 2014. A Protocol for the Derivation of Soil Vapour Quality Guidelines for Exposure Protection of Human Exposures via Inhalation of Vapours. Available online: <http://ceqg-rcqe.ccme.ca/en/index.html#void>.

⁹ XCG Consulting Limited, 2018. Vapour Intrusion Assessment and Environmental Monitoring Report, prepared for the City of Red Deer's Montfort Landfill.

Active Measures

Field verify the presence of the identified chemicals of concern and other potential chemicals in the soil gas state at the development site. If confirmed, determine the most appropriate manner to prevent soil vapour intrusion.

1. Active Measures – Level D: for Cancer Risk of $> 1E^{-3}$ and $< 2E^{-3}$ and/or HQ values >50 and <100 .

Active SSD must be configured to compensate for depressurization of the building and have adequate negative pressure gradients across the entire footprint of the foundation.

2. Active Measures – Level E: for Cancer Risk of $>2E^{-3}$ and/or HQ values >100 .

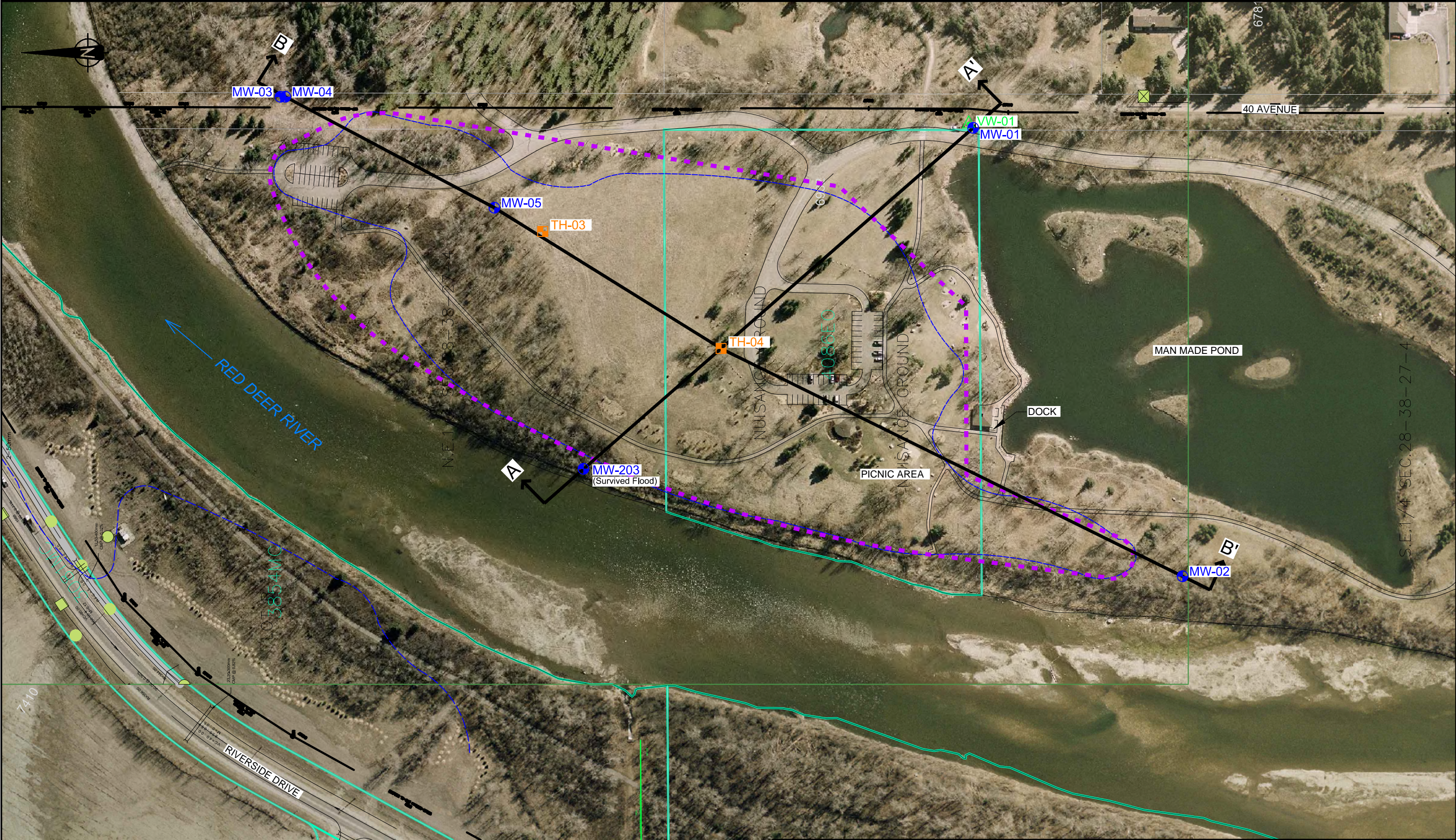
Installation of geomembrane and active soil vapour extraction with system fault notification alarm.

For consistency with XCG's approach from 2017, we compared individual HQs with the individual target hazard level (0.2). Based on the 2019 program, the greatest HQ calculated for the site was 0.001 (vs. target individual hazard level of 0.2) and the estimated cancer risk was not calculated as no carcinogenic parameters were detected above the detection limits. The greatest cumulative HQ calculated for the site was 0.003 (vs. target cumulative hazard level of 1.0). While development at the site is not currently proposed, for illustrative purposes, based on these HQs calculated from the 2019 vapour data, no passive or active measures would be required for the site. It is noted that even if the 10x factor of safety is applied, mitigative measures would still not be required. It should also be noted that assumptions made in the calculations of HQs and cancer risk above are inherently conservative; therefore, applying a factor of safety is not needed.

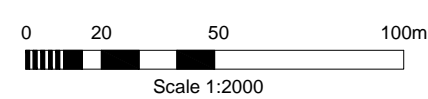
Future applications for development within the setback are subject to review by The City. The developer's team would be responsible for reviewing and verifying the available data relative to their proposed development. The mitigative measures presented above are generic and can be used as a general guide for expectations by The City; ultimately, the developer's design engineer would be responsible for developing measures specific to the intended development based on the above or an appropriate equivalent. Protection of workers (e.g., construction and utility) should form part of any development plan.

APPENDIX C

CROSS-SECTIONS (TIAMAT 2014A)



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PHASE II TEST LOCATIONS
● MW-## GROUNDWATER MONITORING WELL (5)
■ TH-## TESTHOLE (2)
▲ VP-## SOIL VAPOUR MONITORING WELL (1)
REFER TO TABLE 1 FOR TESTHOLE INFORMATION

LEGEND
- - - - - HISTORIC WASTE DISPOSAL
- - - - - LOT BOUNDARY
- - - - - 100 YEAR FLOOD LINE
- - - - - CROSS SECTION LOCATION

NOTE:
LOCATION OF BURIED UTILITIES ARE APPROXIMATE.
ACTUAL LOCATIONS OF THE SHALLOW UTILITIES
AND ANY OTHER UTILITIES SHOULD BE VERIFIED
PRIOR TO ANY GROUND DISTURBANCE ACTIVITY.

— ELECTRICAL
— SANITARY
— STORM
— WATER

CLIENT:

THE CITY OF RED DEER

PROJECT:

ENVIRONMENTAL RISK MANAGEMENT PLAN
HISTORIC WASTE DISPOSAL SITE
MCKENZIE TRAILS RECREATION AREA

TITLE:

SITE PLAN SHOWING INTERPRETED EXTENT OF WASTE

Tiamat Environmental Consultants Ltd.

SCALE:
1 : 2000

DATE:
June 24/14

PROJECT NO.:
12-435

FIGURE NO.:

DRAWN BY:
LCH

CHECKED BY:
LTM

CAD FILE NO.:
ERMP v1.00.dwg

FIGURE 2

APPENDIX D

LABORATORY ANALYTICAL REPORT

CERTIFICATE OF ANALYSIS

Work Order : **CG2412809**
Client : **Tetra Tech Canada Inc.**
Contact : Darby Madalena
Address : 110, 140 Quarry Park Blvd SE
Calgary AB Canada T2C 3G3
Telephone : 403 203 3355
Project : SWM.SWOP04071-04.003
PO : SWM.SWOP04071-04.003
C-O-C number : CORD MCKENZIE TRAILS
Sampler : WV
Site : ----
Quote number : CG22-EBAE100-0021 City of Red Deer (CORD) Pre-1972
Landfill Sites
No. of samples received : 4
No. of samples analysed : 4

Page : 1 of 6
Laboratory : ALS Environmental - Calgary
Account Manager : Patryk Wojciak
Address : 2559 29th Street NE
Calgary AB Canada T1Y 7B5
Telephone : +1 403 407 1800
Date Samples Received : 06-Sep-2024 15:00
Date Analysis Commenced : 08-Sep-2024
Issue Date : 12-Sep-2024 22:41

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Laboratory Department</i>
Anthony Calero	Supervisor - Inorganic	Inorganics, Calgary, Alberta
Gurvinder Kour	Lab Assistant	Metals, Calgary, Alberta
Harpreet Chawla	Team Leader - Inorganics	Inorganics, Calgary, Alberta
Harpreet Chawla	Team Leader - Inorganics	Metals, Calgary, Alberta
Katarzyna Glinka	Analyst	Inorganics, Calgary, Alberta
Kevin Baxter	Team Leader - Inorganics	Inorganics, Calgary, Alberta
Kevin Baxter	Team Leader - Inorganics	Metals, Calgary, Alberta
Nguyen Tran	Laboratory Analyst	Organics, Calgary, Alberta
Parker Sgarbossa	Laboratory Analyst	Metals, Calgary, Alberta
Shirley Li	Team Leader - Inorganics	Inorganics, Calgary, Alberta



General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	Description
-	no units
%	percent
µg/L	micrograms per litre
µS/cm	microsiemens per centimetre
meq/L	milliequivalents per litre
mg/L	milligrams per litre
pH units	pH units

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

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

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Qualifiers

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
RRV	Reported result verified by repeat analysis.



Analytical Results

Sub-Matrix: Water					Client sample ID	MW-03	MW-04	MW-203	DUPLICATE	----
(Matrix: Water)										
					Client sampling date / time	06-Sep-2024 10:00	06-Sep-2024 10:10	06-Sep-2024 10:30	06-Sep-2024 08:00	----
Analyte	CAS Number	Method/Lab	LOR	Unit	CG2412809-001	CG2412809-002	CG2412809-003	CG2412809-004	-----	
					Result	Result	Result	Result	----	
Physical Tests										
Alkalinity, bicarbonate (as HCO3)	71-52-3	E290/CG	1.0	mg/L	1090	1110	588	1060	----	
Alkalinity, carbonate (as CO3)	3812-32-6	E290/CG	1.0	mg/L	<1.0	<1.0	<1.0	<1.0	----	
Alkalinity, hydroxide (as OH)	14280-30-9	E290/CG	1.0	mg/L	<1.0	<1.0	<1.0	<1.0	----	
Alkalinity, total (as CaCO3)	----	E290/CG	1.0	mg/L	891	910	482	868	----	
Conductivity	----	E100/CG	1.0	µS/cm	1640	1590	949	1610	----	
Hardness (as CaCO3), dissolved	----	EC100/CG	0.50	mg/L	87.0	702	366	686	----	
pH	----	E108/CG	0.10	pH units	8.25	7.58	7.81	7.63	----	
Solids, total dissolved [TDS], calculated	----	EC103/CG	1.0	mg/L	1050	1040	565	1010	----	
Anions and Nutrients										
Chloride	16887-00-6	E235.Cl/CG	0.50	mg/L	63.5	32.2	11.8	32.0	----	
Fluoride	16984-48-8	E235.F/CG	0.020	mg/L	<0.100 ^{DLDS}	<0.100 ^{DLDS}	<0.100 ^{DLDS}	<0.100 ^{DLDS}	----	
Nitrate (as N)	14797-55-8	E235.NO3/CG	0.020	mg/L	<0.100 ^{DLDS}	0.122	<0.100 ^{DLDS}	0.122	----	
Nitrate + Nitrite (as N)	----	EC235.N+N/C G	0.0032	mg/L	<0.112	0.122	<0.112	0.122	----	
Nitrite (as N)	14797-65-0	E235.NO2/CG	0.010	mg/L	<0.050 ^{DLDS}	<0.050 ^{DLDS}	<0.050 ^{DLDS}	<0.050 ^{DLDS}	----	
Sulfate (as SO4)	14808-79-8	E235.SO4/CG	0.30	mg/L	11.2	71.8	53.2	72.1	----	
Ion Balance										
Anion sum	----	EC101/CG	0.10	meq/L	19.8	20.6	11.1	19.8	----	
Cation sum	----	EC101/CG	0.10	meq/L	18.8	19.4	10.1	19.2	----	
Ion balance (APHA)	----	EC101/CG	0.01	%	-2.59	-3.00	-4.72	-1.54	----	
Ion balance (cations/anions)	----	EC101/CG	0.010	%	94.9	94.2	91.0	97.0	----	
Dissolved Metals										
Aluminum, dissolved	7429-90-5	E421/CG	0.0010	mg/L	0.0044	<0.0010	0.0010	0.0010	----	
Antimony, dissolved	7440-36-0	E421/CG	0.00010	mg/L	0.00031	<0.00010	0.00015	<0.00010	----	
Arsenic, dissolved	7440-38-2	E421/CG	0.00010	mg/L	0.00299	0.00549	0.0161	0.00569	----	
Barium, dissolved	7440-39-3	E421/CG	0.00010	mg/L	0.173	0.316	0.270	0.314	----	
Boron, dissolved	7440-42-8	E421/CG	0.010	mg/L	0.270	1.31	0.534	1.29	----	
Cadmium, dissolved	7440-43-9	E421/CG	0.0000050	mg/L	0.0000092	0.0000058	<0.0000050	0.0000136	----	
Calcium, dissolved	7440-70-2	E421/CG	0.050	mg/L	23.5	182	95.3	176	----	



Analytical Results

Sub-Matrix: Water					Client sample ID	MW-03	MW-04	MW-203	DUPLICATE	----
(Matrix: Water)										
Client sampling date / time					06-Sep-2024 10:00	06-Sep-2024 10:10	06-Sep-2024 10:30	06-Sep-2024 08:00	----	
Analyte	CAS Number	Method/Lab	LOR	Unit	CG2412809-001	CG2412809-002	CG2412809-003	CG2412809-004	-----	
					Result	Result	Result	Result	----	
Dissolved Metals										
Chromium, dissolved	7440-47-3	E421/CG	0.00050	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	----	----
Copper, dissolved	7440-50-8	E421/CG	0.00020	mg/L	0.00057	<0.00020	0.00024	<0.00020	----	----
Iron, dissolved	7439-89-6	E421/CG	0.010	mg/L	0.026	4.48	3.33	4.34	----	----
Lead, dissolved	7439-92-1	E421/CG	0.000050	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	----	----
Magnesium, dissolved	7439-95-4	E421/CG	0.0050	mg/L	6.88	60.2	31.0	59.8	----	----
Manganese, dissolved	7439-96-5	E421/CG	0.00010	mg/L	0.108	1.20	0.279	1.20	----	----
Mercury, dissolved	7439-97-6	E509/CG	0.0000050	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	----	----
Nickel, dissolved	7440-02-0	E421/CG	0.00050	mg/L	0.00122	0.00787	0.00164	0.00808	----	----
Potassium, dissolved	7440-09-7	E421/CG	0.050	mg/L	3.14	16.7	11.6	16.4	----	----
Selenium, dissolved	7782-49-2	E421/CG	0.000050	mg/L	0.000175	0.000067	<0.000050	0.000065	----	----
Silver, dissolved	7440-22-4	E421/CG	0.000010	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	----	----
Sodium, dissolved	7440-23-5	E421/CG	0.050	mg/L	391 ^{RRV}	110	54.1	112	----	----
Uranium, dissolved	7440-61-1	E421/CG	0.000010	mg/L	0.000423	0.00304	0.000696	0.00316	----	----
Zinc, dissolved	7440-66-6	E421/CG	0.0010	mg/L	0.0031	0.0013	0.0030	0.0015	----	----
Dissolved mercury filtration location	----	EP509/CG	-	-	Field	Field	Field	Field	----	----
Dissolved metals filtration location	----	EP421/CG	-	-	Field	Field	Field	Field	----	----
Volatile Organic Compounds										
Benzene	71-43-2	E611E/CG	0.50	µg/L	<0.50	<0.50	<0.50	----	----	----
Bromobenzene	108-86-1	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	----
Bromochloromethane	74-97-5	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	----
Bromodichloromethane	75-27-4	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	----
Bromoform	75-25-2	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	----
Bromomethane	74-83-9	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	----
Butylbenzene, n-	104-51-8	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	----
Butylbenzene, sec-	135-98-8	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	----
Butylbenzene, tert-	98-06-6	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	----
Carbon tetrachloride	56-23-5	E611E/CG	0.50	µg/L	<0.50	<0.50	<0.50	----	----	----
Chlorobenzene	108-90-7	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	----
Chloroethane	75-00-3	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	----
Chloroform	67-66-3	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	----



Analytical Results

Sub-Matrix: Water					Client sample ID	MW-03	MW-04	MW-203	DUPLICATE	----
(Matrix: Water)					Client sampling date / time	06-Sep-2024 10:00	06-Sep-2024 10:10	06-Sep-2024 10:30	06-Sep-2024 08:00	----
Analyte	CAS Number	Method/Lab	LOR	Unit	CG2412809-001	CG2412809-002	CG2412809-003	CG2412809-004	-----	
					Result	Result	Result	Result	----	
Volatile Organic Compounds										
Chloromethane	74-87-3	E611E/CG	5.0	µg/L	<5.0	<5.0	<5.0	----	----	
Chlorotoluene, 2-	95-49-8	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Chlorotoluene, 4-	106-43-4	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Cymene, p-	99-87-6	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dibromo-3-chloropropane, 1,2-	96-12-8	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dibromochloromethane	124-48-1	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dibromoethane, 1,2-	106-93-4	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dibromomethane	74-95-3	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichlorobenzene, 1,2-	95-50-1	E611E/CG	0.50	µg/L	<0.50	<0.50	<0.50	----	----	
Dichlorobenzene, 1,3-	541-73-1	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichlorobenzene, 1,4-	106-46-7	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichlorodifluoromethane	75-71-8	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichloroethane, 1,1-	75-34-3	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichloroethane, 1,2-	107-06-2	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichloroethylene, 1,1-	75-35-4	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichloroethylene, cis-1,2-	156-59-2	E611E/CG	1.0	µg/L	<1.0	8.9	10.9	----	----	
Dichloroethylene, trans-1,2-	156-60-5	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichloromethane	75-09-2	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichloropropane, 1,2-	78-87-5	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichloropropane, 1,3-	142-28-9	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichloropropane, 2,2-	594-20-7	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichloropropylene, 1,1-	563-58-6	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichloropropylene, cis+trans-1,3-	542-75-6	E611E/CG	1.5	µg/L	<1.5	<1.5	<1.5	----	----	
Dichloropropylene, cis-1,3-	10061-01-5	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Dichloropropylene, trans-1,3-	10061-02-6	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Ethylbenzene	100-41-4	E611E/CG	0.50	µg/L	<0.50	<0.50	<0.50	----	----	
Hexachlorobutadiene	87-68-3	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Isopropylbenzene	98-82-8	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	
Methyl-tert-butyl ether [MTBE]	1634-04-4	E611E/CG	0.50	µg/L	<0.50	<0.50	<0.50	----	----	
Propylbenzene, n-	103-65-1	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0	----	----	



Analytical Results

Sub-Matrix: Water					Client sample ID	MW-03	MW-04	MW-203	DUPLICATE	----
(Matrix: Water)										
					Client sampling date / time	06-Sep-2024 10:00	06-Sep-2024 10:10	06-Sep-2024 10:30	06-Sep-2024 08:00	----
Analyte	CAS Number	Method/Lab	LOR	Unit	CG2412809-001	CG2412809-002	CG2412809-003	CG2412809-004	-----	
					Result	Result	Result	Result	Result	----
Volatile Organic Compounds										
Styrene	100-42-5	E611E/CG	0.50	µg/L	<0.50	<0.50	<0.50		----	----
Tetrachloroethane, 1,1,1,2-	630-20-6	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Tetrachloroethane, 1,1,2,2-	79-34-5	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Tetrachloroethylene	127-18-4	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Toluene	108-88-3	E611E/CG	0.50	µg/L	0.52	<0.50	<0.50		----	----
Trichlorobenzene, 1,2,3-	87-61-6	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Trichlorobenzene, 1,2,4-	120-82-1	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Trichloroethane, 1,1,1-	71-55-6	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Trichloroethane, 1,1,2-	79-00-5	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Trichloroethylene	79-01-6	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Trichlorofluoromethane	75-69-4	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Trichloropropane, 1,2,3-	96-18-4	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Trimethylbenzene, 1,2,4-	95-63-6	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Trimethylbenzene, 1,3,5-	108-67-8	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Vinyl chloride	75-01-4	E611E/CG	1.0	µg/L	<1.0	3.4	1.8		----	----
Xylene, m+p-	179601-23-1	E611E/CG	0.40	µg/L	<0.40	<0.40	<0.40		----	----
Xylene, o-	95-47-6	E611E/CG	0.30	µg/L	<0.30	<0.30	<0.30		----	----
Xylenes, total	1330-20-7	E611E/CG	0.50	µg/L	<0.50	<0.50	<0.50		----	----
BTEX, total	----	E611E/CG	1.0	µg/L	<1.0	<1.0	<1.0		----	----
Trihalomethanes [THMs], total	----	E611E/CG	2.0	µg/L	<2.0	<2.0	<2.0		----	----
Volatile Organic Compounds Surrogates										
Bromofluorobenzene, 4-	460-00-4	E611E/CG	1.0	%	70.2	71.6	70.4		----	----
Difluorobenzene, 1,4-	540-36-3	E611E/CG	1.0	%	102	102	102		----	----

Please refer to the General Comments section for an explanation of any result qualifiers detected.

Please refer to the Accreditation section for an explanation of analyte accreditations.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: CG2412809	Page	: 1 of 12
Client	: Tetra Tech Canada Inc.	Laboratory	: ALS Environmental - Calgary
Contact	: Darby Madalena	Account Manager	: Patryk Wojciak
Address	: 110, 140 Quarry Park Blvd SE Calgary AB Canada T2C 3G3	Address	: 2559 29th Street NE Calgary, Alberta Canada T1Y 7B5
Telephone	: 403 203 3355	Telephone	: +1 403 407 1800
Project	: SWM.SWOP04071-04.003	Date Samples Received	: 06-Sep-2024 15:00
PO	: SWM.SWOP04071-04.003	Issue Date	: 12-Sep-2024 22:42
C-O-C number	: CORD MCKENZIE TRAILS		
Sampler	: WV		
Site	: ----		
Quote number	: CG22-EBAE100-0021 City of Red Deer (CORD) Pre-1972 Landfill Sites		
No. of samples received	: 4		
No. of samples analysed	: 4		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.

CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.

DQO: Data Quality Objective.

LOR: Limit of Reporting (detection limit).

RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "----" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike outliers occur.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.



Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Water** Evaluation: ✖ = Holding time exceedance ; ✔ = Within Holding Time

Analyte Group : Analytical Method	Method	Sampling Date	Extraction / Preparation				Analysis			
Container / Client Sample ID(s)			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Anions and Nutrients : Chloride in Water by IC										
HDPE DUPLICATE	E235.Cl	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓
Anions and Nutrients : Chloride in Water by IC										
HDPE MW-03	E235.Cl	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓
Anions and Nutrients : Chloride in Water by IC										
HDPE MW-04	E235.Cl	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓
Anions and Nutrients : Chloride in Water by IC										
HDPE MW-203	E235.Cl	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓
Anions and Nutrients : Fluoride in Water by IC										
HDPE DUPLICATE	E235.F	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓
Anions and Nutrients : Fluoride in Water by IC										
HDPE MW-03	E235.F	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓
Anions and Nutrients : Fluoride in Water by IC										
HDPE MW-04	E235.F	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓



Matrix: **Water** Evaluation: ✖ = Holding time exceedance ; ✔ = Within Holding Time

Analyte Group : Analytical Method	Method	Sampling Date	Extraction / Preparation				Analysis			
Container / Client Sample ID(s)			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Anions and Nutrients : Fluoride in Water by IC										
HDPE MW-203	E235.F	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE DUPLICATE	E235.NO3	06-Sep-2024	08-Sep-2024	3 days	2 days	✓	08-Sep-2024	3 days	2 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE MW-03	E235.NO3	06-Sep-2024	08-Sep-2024	3 days	2 days	✓	08-Sep-2024	3 days	2 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE MW-04	E235.NO3	06-Sep-2024	08-Sep-2024	3 days	2 days	✓	08-Sep-2024	3 days	2 days	✓
Anions and Nutrients : Nitrate in Water by IC										
HDPE MW-203	E235.NO3	06-Sep-2024	08-Sep-2024	3 days	2 days	✓	08-Sep-2024	3 days	2 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE DUPLICATE	E235.NO2	06-Sep-2024	08-Sep-2024	3 days	2 days	✓	08-Sep-2024	3 days	2 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE MW-03	E235.NO2	06-Sep-2024	08-Sep-2024	3 days	2 days	✓	08-Sep-2024	3 days	2 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE MW-04	E235.NO2	06-Sep-2024	08-Sep-2024	3 days	2 days	✓	08-Sep-2024	3 days	2 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE MW-203	E235.NO2	06-Sep-2024	08-Sep-2024	3 days	2 days	✓	08-Sep-2024	3 days	2 days	✓



Matrix: **Water** Evaluation: ✖ = Holding time exceedance ; ✔ = Within Holding Time

Analyte Group : Analytical Method	Method	Sampling Date	Extraction / Preparation				Analysis			
Container / Client Sample ID(s)			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Anions and Nutrients : Sulfate in Water by IC										
HDPE DUPLICATE	E235.SO4	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE MW-03	E235.SO4	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE MW-04	E235.SO4	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE MW-203	E235.SO4	06-Sep-2024	08-Sep-2024	28 days	2 days	✓	08-Sep-2024	28 days	2 days	✓
Dissolved Metals : Dissolved Mercury in Water by CVAAS										
Glass vial dissolved (hydrochloric acid) DUPLICATE	E509	06-Sep-2024	10-Sep-2024	28 days	4 days	✓	10-Sep-2024	28 days	4 days	✓
Dissolved Metals : Dissolved Mercury in Water by CVAAS										
Glass vial dissolved (hydrochloric acid) MW-03	E509	06-Sep-2024	10-Sep-2024	28 days	4 days	✓	10-Sep-2024	28 days	4 days	✓
Dissolved Metals : Dissolved Mercury in Water by CVAAS										
Glass vial dissolved (hydrochloric acid) MW-04	E509	06-Sep-2024	10-Sep-2024	28 days	4 days	✓	10-Sep-2024	28 days	4 days	✓
Dissolved Metals : Dissolved Mercury in Water by CVAAS										
Glass vial dissolved (hydrochloric acid) MW-203	E509	06-Sep-2024	10-Sep-2024	28 days	4 days	✓	10-Sep-2024	28 days	4 days	✓
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE - dissolved (lab preserved) DUPLICATE	E421	06-Sep-2024	10-Sep-2024	180 days	4 days	✓	11-Sep-2024	180 days	5 days	✓



Matrix: **Water** Evaluation: ✖ = Holding time exceedance ; ✔ = Within Holding Time

Analyte Group : Analytical Method	Method	Sampling Date	Extraction / Preparation				Analysis			
Container / Client Sample ID(s)			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE dissolved (nitric acid) MW-03	E421	06-Sep-2024	10-Sep-2024	180 days	4 days	✓	11-Sep-2024	180 days	5 days	✓
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE dissolved (nitric acid) MW-04	E421	06-Sep-2024	10-Sep-2024	180 days	4 days	✓	11-Sep-2024	180 days	5 days	✓
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS										
HDPE dissolved (nitric acid) MW-203	E421	06-Sep-2024	10-Sep-2024	180 days	4 days	✓	11-Sep-2024	180 days	5 days	✓
Physical Tests : Alkalinity Species by Titration										
HDPE DUPLICATE	E290	06-Sep-2024	09-Sep-2024	14 days	3 days	✓	09-Sep-2024	14 days	3 days	✓
Physical Tests : Alkalinity Species by Titration										
HDPE MW-03	E290	06-Sep-2024	09-Sep-2024	14 days	3 days	✓	09-Sep-2024	14 days	3 days	✓
Physical Tests : Alkalinity Species by Titration										
HDPE MW-04	E290	06-Sep-2024	09-Sep-2024	14 days	3 days	✓	09-Sep-2024	14 days	3 days	✓
Physical Tests : Alkalinity Species by Titration										
HDPE MW-203	E290	06-Sep-2024	09-Sep-2024	14 days	3 days	✓	09-Sep-2024	14 days	3 days	✓
Physical Tests : Conductivity in Water										
HDPE DUPLICATE	E100	06-Sep-2024	09-Sep-2024	28 days	3 days	✓	09-Sep-2024	28 days	3 days	✓
Physical Tests : Conductivity in Water										
HDPE MW-03	E100	06-Sep-2024	09-Sep-2024	28 days	3 days	✓	09-Sep-2024	28 days	3 days	✓



Matrix: **Water** Evaluation: * = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method	Method	Sampling Date	Extraction / Preparation				Analysis			
Container / Client Sample ID(s)			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Physical Tests : Conductivity in Water										
HDPE MW-04	E100	06-Sep-2024	09-Sep-2024	28 days	3 days	✓	09-Sep-2024	28 days	3 days	✓
Physical Tests : Conductivity in Water										
HDPE MW-203	E100	06-Sep-2024	09-Sep-2024	28 days	3 days	✓	09-Sep-2024	28 days	3 days	✓
Physical Tests : pH by Meter										
HDPE MW-203	E108	06-Sep-2024	09-Sep-2024	0.25 hrs	71 hrs	✗ EHTR-FM	09-Sep-2024	0.25 hrs	71 hrs	✗ EHTR-FM
Physical Tests : pH by Meter										
HDPE MW-03	E108	06-Sep-2024	09-Sep-2024	0.25 hrs	72 hrs	✗ EHTR-FM	09-Sep-2024	0.25 hrs	72 hrs	✗ EHTR-FM
Physical Tests : pH by Meter										
HDPE MW-04	E108	06-Sep-2024	09-Sep-2024	0.25 hrs	72 hrs	✗ EHTR-FM	09-Sep-2024	0.25 hrs	72 hrs	✗ EHTR-FM
Physical Tests : pH by Meter										
HDPE DUPLICATE	E108	06-Sep-2024	09-Sep-2024	0.25 hrs	74 hrs	✗ EHTR-FM	09-Sep-2024	0.25 hrs	74 hrs	✗ EHTR-FM
Volatile Organic Compounds : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate) MW-03	E611E	06-Sep-2024	08-Sep-2024	14 days	2 days	✓	08-Sep-2024	14 days	2 days	✓
Volatile Organic Compounds : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate) MW-04	E611E	06-Sep-2024	08-Sep-2024	14 days	2 days	✓	08-Sep-2024	14 days	2 days	✓
Volatile Organic Compounds : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate) MW-203	E611E	06-Sep-2024	08-Sep-2024	14 days	2 days	✓	08-Sep-2024	14 days	2 days	✓

[Legend & Qualifier Definitions](#)

Page : 8 of 12
Work Order : CG2412809
Client : Tetra Tech Canada Inc.
Project : SWM.SWOP04071-04.003



EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended
Rec. HT: ALS recommended hold time (see units).



Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Water** Evaluation: ✖ = QC frequency outside specification; ✔ = QC frequency within specification.

Quality Control Sample Type	Method	QC Lot #	Count		Frequency (%)		
Analytical Methods			QC	Regular	Actual	Expected	Evaluation
Laboratory Duplicates (DUP)							
Alkalinity Species by Titration	E290	1640302	1	20	5.0	5.0	✔
Chloride in Water by IC	E235.Cl	1639143	1	20	5.0	5.0	✔
Conductivity in Water	E100	1640301	1	20	5.0	5.0	✔
Dissolved Mercury in Water by CVAAS	E509	1642122	1	15	6.6	5.0	✔
Dissolved Metals in Water by CRC ICPMS	E421	1643008	2	25	8.0	5.0	✔
Fluoride in Water by IC	E235.F	1639142	1	20	5.0	5.0	✔
Nitrate in Water by IC	E235.NO3	1639139	2	25	8.0	5.0	✔
Nitrite in Water by IC	E235.NO2	1639146	2	25	8.0	5.0	✔
pH by Meter	E108	1640300	1	20	5.0	5.0	✔
Sulfate in Water by IC	E235.SO4	1639144	1	20	5.0	5.0	✔
VOCs (Prairies List) by Headspace GC-MS	E611E	1639168	1	8	12.5	5.0	✔
Laboratory Control Samples (LCS)							
Alkalinity Species by Titration	E290	1640302	1	20	5.0	5.0	✔
Chloride in Water by IC	E235.Cl	1639143	1	20	5.0	5.0	✔
Conductivity in Water	E100	1640301	1	20	5.0	5.0	✔
Dissolved Mercury in Water by CVAAS	E509	1642122	1	15	6.6	5.0	✔
Dissolved Metals in Water by CRC ICPMS	E421	1643008	2	25	8.0	5.0	✔
Fluoride in Water by IC	E235.F	1639142	1	20	5.0	5.0	✔
Nitrate in Water by IC	E235.NO3	1639139	2	25	8.0	5.0	✔
Nitrite in Water by IC	E235.NO2	1639146	2	25	8.0	5.0	✔
pH by Meter	E108	1640300	1	20	5.0	5.0	✔
Sulfate in Water by IC	E235.SO4	1639144	1	20	5.0	5.0	✔
VOCs (Prairies List) by Headspace GC-MS	E611E	1639168	1	8	12.5	5.0	✔
Method Blanks (MB)							
Alkalinity Species by Titration	E290	1640302	1	20	5.0	5.0	✔
Chloride in Water by IC	E235.Cl	1639143	1	20	5.0	5.0	✔
Conductivity in Water	E100	1640301	1	20	5.0	5.0	✔
Dissolved Mercury in Water by CVAAS	E509	1642122	1	15	6.6	5.0	✔
Dissolved Metals in Water by CRC ICPMS	E421	1643008	2	25	8.0	5.0	✔
Fluoride in Water by IC	E235.F	1639142	1	20	5.0	5.0	✔
Nitrate in Water by IC	E235.NO3	1639139	2	25	8.0	5.0	✔
Nitrite in Water by IC	E235.NO2	1639146	2	25	8.0	5.0	✔
Sulfate in Water by IC	E235.SO4	1639144	1	20	5.0	5.0	✔
VOCs (Prairies List) by Headspace GC-MS	E611E	1639168	1	8	12.5	5.0	✔
Matrix Spikes (MS)							



Matrix: **Water**

Evaluation: ✖ = QC frequency outside specification; ✔ = QC frequency within specification.

Quality Control Sample Type			Count		Frequency (%)		
<i>Analytical Methods</i>	<i>Method</i>	<i>QC Lot #</i>	<i>QC</i>	<i>Regular</i>	<i>Actual</i>	<i>Expected</i>	<i>Evaluation</i>
Matrix Spikes (MS) - Continued							
Chloride in Water by IC	E235.Cl	1639143	1	20	5.0	5.0	✔
Dissolved Mercury in Water by CVAAS	E509	1642122	1	15	6.6	5.0	✔
Dissolved Metals in Water by CRC ICPMS	E421	1643008	2	25	8.0	5.0	✔
Fluoride in Water by IC	E235.F	1639142	1	20	5.0	5.0	✔
Nitrate in Water by IC	E235.NO3	1639139	2	25	8.0	5.0	✔
Nitrite in Water by IC	E235.NO2	1639146	2	25	8.0	5.0	✔
Sulfate in Water by IC	E235.SO4	1639144	1	20	5.0	5.0	✔
VOCs (Prairies List) by Headspace GC-MS	E611E	1639168	1	8	12.5	5.0	✔



Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Conductivity in Water	E100 ALS Environmental - Calgary	Water	APHA 2510 (mod)	Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a water sample. Conductivity measurements are temperature-compensated to 25°C.
pH by Meter	E108 ALS Environmental - Calgary	Water	APHA 4500-H (mod)	pH is determined by potentiometric measurement with a pH electrode, and is conducted at ambient laboratory temperature (normally 20 ± 5°C). For high accuracy test results, pH should be measured in the field within the recommended 15 minute hold time.
Chloride in Water by IC	E235.Cl ALS Environmental - Calgary	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Fluoride in Water by IC	E235.F ALS Environmental - Calgary	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Nitrite in Water by IC	E235.NO2 ALS Environmental - Calgary	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Nitrate in Water by IC	E235.NO3 ALS Environmental - Calgary	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Sulfate in Water by IC	E235.SO4 ALS Environmental - Calgary	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Alkalinity Species by Titration	E290 ALS Environmental - Calgary	Water	APHA 2320 B (mod)	Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.
Dissolved Metals in Water by CRC ICPMS	E421 ALS Environmental - Calgary	Water	APHA 3030B/EPA 6020B (mod)	Water samples are filtered (0.45 µm), preserved with nitric acid, and analyzed by Collision/Reaction Cell ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.



Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Dissolved Mercury in Water by CVAAS	E509 ALS Environmental - Calgary	Water	APHA 3030B/EPA 1631E (mod)	Water samples are filtered (0.45 um), preserved with HCl, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS.
VOCs (Prairies List) by Headspace GC-MS	E611E ALS Environmental - Calgary	Water	EPA 8260D (mod)	Volatile Organic Compounds (VOCs) are analyzed by static headspace GC-MS. Samples are prepared in headspace vials and are heated and agitated on the headspace autosampler, causing VOCs to partition between the aqueous phase and the headspace in accordance with Henry's law.
Dissolved Hardness (Calculated)	EC100 ALS Environmental - Calgary	Water	APHA 2340B	"Hardness (as CaCO ₃), dissolved" is calculated from the sum of dissolved Calcium and Magnesium concentrations, expressed in CaCO ₃ equivalents. "Total Hardness" refers to the sum of Calcium and Magnesium Hardness. Hardness is normally or preferentially calculated from dissolved Calcium and Magnesium concentrations, because it is a property of water due to dissolved divalent cations.
Ion Balance using Dissolved Metals	EC101 ALS Environmental - Calgary	Water	APHA 1030E	Cation Sum, Anion Sum, and Ion Balance are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Dissolved species are used where available. Minor ions are included where data is present. Ion Balance cannot be calculated accurately for waters with very low electrical conductivity (EC).
TDS in Water (Calculation)	EC103 ALS Environmental - Calgary	Water	APHA 1030E (mod)	Total Dissolved Solids is calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Dissolved species are used where available. Minor ions are included where data is present.
Nitrate and Nitrite (as N) (Calculation)	EC235.N+N ALS Environmental - Calgary	Water	EPA 300.0	Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).
Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Dissolved Metals Water Filtration	EP421 ALS Environmental - Calgary	Water	APHA 3030B	Water samples are filtered (0.45 um), and preserved with HNO ₃ .
Dissolved Mercury Water Filtration	EP509 ALS Environmental - Calgary	Water	APHA 3030B	Water samples are filtered (0.45 um), and preserved with HCl.
VOCs Preparation for Headspace Analysis	EP581 ALS Environmental - Calgary	Water	EPA 5021A (mod)	Samples are prepared in headspace vials and are heated and agitated on the headspace autosampler. An aliquot of the headspace is then injected into a GC-MS-FID.

QUALITY CONTROL REPORT

Work Order	: CG2412809	Page	: 1 of 18
Client	: Tetra Tech Canada Inc.	Laboratory	: ALS Environmental - Calgary
Contact	: Darby Madalena	Account Manager	: Patryk Wojciak
Address	: 110, 140 Quarry Park Blvd SE Calgary AB Canada T2C 3G3	Address	: 2559 29th Street NE Calgary, Alberta Canada T1Y 7B5
Telephone	: 403 203 3355	Telephone	: +1 403 407 1800
Project	: SWM.SWOP04071-04.003	Date Samples Received	: 06-Sep-2024 15:00
PO	: SWM.SWOP04071-04.003	Date Analysis Commenced	: 08-Sep-2024
C-O-C number	: CORD MCKENZIE TRAILS	Issue Date	: 12-Sep-2024 22:41
Sampler	: WV		
Site	: ---		
Quote number	: CG22-EBAE100-0021 City of Red Deer (CORD) Pre-1972 Landfill Sites		
No. of samples received	: 4		
No. of samples analysed	: 4		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.
This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Matrix Spike (MS) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	Position	Laboratory Department
Anthony Calero	Supervisor - Inorganic	Calgary Inorganics, Calgary, Alberta
Gurvinder Kour	Lab Assistant	Calgary Metals, Calgary, Alberta
Harpreet Chawla	Team Leader - Inorganics	Calgary Inorganics, Calgary, Alberta
Harpreet Chawla	Team Leader - Inorganics	Calgary Metals, Calgary, Alberta
Katarzyna Glinka	Analyst	Calgary Inorganics, Calgary, Alberta
Kevin Baxter	Team Leader - Inorganics	Calgary Inorganics, Calgary, Alberta
Kevin Baxter	Team Leader - Inorganics	Calgary Metals, Calgary, Alberta
Nguyen Tran	Laboratory Analyst	Calgary Organics, Calgary, Alberta
Parker Sgarbossa	Laboratory Analyst	Calgary Metals, Calgary, Alberta
Shirley Li	Team Leader - Inorganics	Calgary Inorganics, Calgary, Alberta



General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.

CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.

DQO = Data Quality Objective.

LOR = Limit of Reporting (detection limit).

RPD = Relative Percent Difference

= Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.



Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: Water					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Physical Tests (QC Lot: 1640300)											
CG2412804-001	Anonymous	pH	----	E108	0.10	pH units	7.85	7.97	1.52%	4%	----
Physical Tests (QC Lot: 1640301)											
CG2412804-001	Anonymous	Conductivity	----	E100	1.0	µS/cm	1180	1190	1.18%	10%	----
Physical Tests (QC Lot: 1640302)											
CG2412804-001	Anonymous	Alkalinity, total (as CaCO3)	----	E290	1.0	mg/L	550	556	1.14%	20%	----
Anions and Nutrients (QC Lot: 1639139)											
CG2412803-001	Anonymous	Nitrate (as N)	14797-55-8	E235.NO3	0.020	mg/L	<0.020	<0.020	0	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 1639140)											
CG2412803-001	Anonymous	Nitrite (as N)	14797-65-0	E235.NO2	0.010	mg/L	<0.010	<0.010	0	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 1639142)											
CG2412803-001	Anonymous	Fluoride	16984-48-8	E235.F	0.020	mg/L	0.068	0.069	0.001	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 1639143)											
CG2412803-001	Anonymous	Chloride	16887-00-6	E235.Cl	0.50	mg/L	16.1	16.2	0.351%	20%	----
Anions and Nutrients (QC Lot: 1639144)											
CG2412803-001	Anonymous	Sulfate (as SO4)	14808-79-8	E235.SO4	0.30	mg/L	14.2	14.3	0.473%	20%	----
Anions and Nutrients (QC Lot: 1639145)											
CG2412813-002	Anonymous	Nitrate (as N)	14797-55-8	E235.NO3	0.100	mg/L	0.703	0.701	0.002	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 1639146)											
CG2412813-002	Anonymous	Nitrite (as N)	14797-65-0	E235.NO2	0.050	mg/L	<0.050	<0.050	0	Diff <2x LOR	----
Dissolved Metals (QC Lot: 1642122)											
CG2412803-007	Anonymous	Mercury, dissolved	7439-97-6	E509	0.0000050	mg/L	<0.0000050	<0.0000050	0	Diff <2x LOR	----
Dissolved Metals (QC Lot: 1643007)											
CG2412792-001	Anonymous	Aluminum, dissolved	7429-90-5	E421	0.0020	mg/L	<0.0020	<0.0020	0	Diff <2x LOR	----
		Antimony, dissolved	7440-36-0	E421	0.00020	mg/L	<0.00020	<0.00020	0	Diff <2x LOR	----
		Arsenic, dissolved	7440-38-2	E421	0.00020	mg/L	0.0228	0.0232	1.76%	20%	----
		Barium, dissolved	7440-39-3	E421	0.00020	mg/L	0.616	0.633	2.78%	20%	----
		Boron, dissolved	7440-42-8	E421	0.020	mg/L	0.073	0.074	0.0005	Diff <2x LOR	----
		Cadmium, dissolved	7440-43-9	E421	0.0000100	mg/L	<0.0000100	<0.0000100	0	Diff <2x LOR	----
		Calcium, dissolved	7440-70-2	E421	0.100	mg/L	153	158	3.15%	20%	----
		Chromium, dissolved	7440-47-3	E421	0.00100	mg/L	<0.00100	<0.00100	0	Diff <2x LOR	----



Sub-Matrix: Water					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Dissolved Metals (QC Lot: 1643007) - continued											
CG2412792-001	Anonymous	Copper, dissolved	7440-50-8	E421	0.00040	mg/L	<0.00040	<0.00040	0	Diff <2x LOR	----
		Iron, dissolved	7439-89-6	E421	0.020	mg/L	25.3	24.9	1.79%	20%	----
		Lead, dissolved	7439-92-1	E421	0.000100	mg/L	<0.000100	<0.000100	0	Diff <2x LOR	----
		Magnesium, dissolved	7439-95-4	E421	0.0100	mg/L	98.5	97.8	0.713%	20%	----
		Manganese, dissolved	7439-96-5	E421	0.00020	mg/L	1.86	1.92	3.34%	20%	----
		Nickel, dissolved	7440-02-0	E421	0.00100	mg/L	0.0137	0.0136	0.549%	20%	----
		Potassium, dissolved	7440-09-7	E421	0.100	mg/L	7.71	7.74	0.458%	20%	----
		Selenium, dissolved	7782-49-2	E421	0.000100	mg/L	0.000116	0.000104	0.000012	Diff <2x LOR	----
		Silver, dissolved	7440-22-4	E421	0.000020	mg/L	<0.000020	<0.000020	0	Diff <2x LOR	----
		Sodium, dissolved	7440-23-5	E421	0.100	mg/L	214	218	1.84%	20%	----
		Uranium, dissolved	7440-61-1	E421	0.000020	mg/L	0.00287	0.00275	4.32%	20%	----
		Zinc, dissolved	7440-66-6	E421	0.0020	mg/L	<0.0020	<0.0020	0	Diff <2x LOR	----
Dissolved Metals (QC Lot: 1643008)											
CG2412809-003	MW-203	Aluminum, dissolved	7429-90-5	E421	0.0010	mg/L	0.0010	<0.0010	0.00003	Diff <2x LOR	----
		Antimony, dissolved	7440-36-0	E421	0.00010	mg/L	0.00015	0.00014	0.000007	Diff <2x LOR	----
		Arsenic, dissolved	7440-38-2	E421	0.00010	mg/L	0.0161	0.0158	1.67%	20%	----
		Barium, dissolved	7440-39-3	E421	0.00010	mg/L	0.270	0.262	3.29%	20%	----
		Boron, dissolved	7440-42-8	E421	0.010	mg/L	0.534	0.528	1.07%	20%	----
		Cadmium, dissolved	7440-43-9	E421	0.0000050	mg/L	<0.0000050	<0.0000050	0	Diff <2x LOR	----
		Calcium, dissolved	7440-70-2	E421	0.050	mg/L	95.3	94.7	0.566%	20%	----
		Chromium, dissolved	7440-47-3	E421	0.00050	mg/L	<0.00050	<0.00050	0	Diff <2x LOR	----
		Copper, dissolved	7440-50-8	E421	0.00020	mg/L	0.00024	0.00023	0.000008	Diff <2x LOR	----
		Iron, dissolved	7439-89-6	E421	0.010	mg/L	3.33	3.38	1.57%	20%	----
		Lead, dissolved	7439-92-1	E421	0.000050	mg/L	<0.000050	<0.000050	0	Diff <2x LOR	----
		Magnesium, dissolved	7439-95-4	E421	0.0050	mg/L	31.0	31.1	0.294%	20%	----
		Manganese, dissolved	7439-96-5	E421	0.00010	mg/L	0.279	0.276	1.18%	20%	----
		Nickel, dissolved	7440-02-0	E421	0.00050	mg/L	0.00164	0.00160	0.00004	Diff <2x LOR	----
		Potassium, dissolved	7440-09-7	E421	0.050	mg/L	11.6	11.6	0.471%	20%	----
		Selenium, dissolved	7782-49-2	E421	0.000050	mg/L	<0.000050	<0.000050	0	Diff <2x LOR	----
		Silver, dissolved	7440-22-4	E421	0.000010	mg/L	<0.000010	<0.000010	0	Diff <2x LOR	----
		Sodium, dissolved	7440-23-5	E421	0.050	mg/L	54.1	54.4	0.443%	20%	----
		Uranium, dissolved	7440-61-1	E421	0.000010	mg/L	0.000696	0.000684	1.77%	20%	----
		Zinc, dissolved	7440-66-6	E421	0.0010	mg/L	0.0030	0.0029	0.00008	Diff <2x LOR	----
Volatile Organic Compounds (QC Lot: 1639168)											



Sub-Matrix: Water					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Volatile Organic Compounds (QC Lot: 1639168) - continued											
CG2412804-001	Anonymous	Benzene	71-43-2	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		Bromobenzene	108-86-1	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Bromochloromethane	74-97-5	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Bromodichloromethane	75-27-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Bromoform	75-25-2	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Bromomethane	74-83-9	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Butylbenzene, n-	104-51-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Butylbenzene, sec-	135-98-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Butylbenzene, tert-	98-06-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Carbon tetrachloride	56-23-5	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		Chlorobenzene	108-90-7	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Chloroethane	75-00-3	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Chloroform	67-66-3	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Chloromethane	74-87-3	E611E	5.0	µg/L	<5.0	<5.0	0	Diff <2x LOR	----
		Chlorotoluene, 2-	95-49-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Chlorotoluene, 4-	106-43-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Cymene, p-	99-87-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dibromo-3-chloropropane, 1,2-	96-12-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dibromochloromethane	124-48-1	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dibromoethane, 1,2-	106-93-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dibromomethane	74-95-3	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichlorobenzene, 1,2-	95-50-1	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		Dichlorobenzene, 1,3-	541-73-1	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichlorobenzene, 1,4-	106-46-7	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichlorodifluoromethane	75-71-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichloroethane, 1,1-	75-34-3	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichloroethane, 1,2-	107-06-2	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichloroethylene, 1,1-	75-35-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichloroethylene, cis-1,2-	156-59-2	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichloroethylene, trans-1,2-	156-60-5	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichloromethane	75-09-2	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichloropropane, 1,2-	78-87-5	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichloropropane, 1,3-	142-28-9	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichloropropane, 2,2-	594-20-7	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----



Sub-Matrix: Water					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Volatile Organic Compounds (QC Lot: 1639168) - continued											
CG2412804-001	Anonymous	Dichloropropylene, 1,1-	563-58-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichloropropylene, cis-1,3-	10061-01-5	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Dichloropropylene, trans-1,3-	10061-02-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Ethylbenzene	100-41-4	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		Hexachlorobutadiene	87-68-3	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Isopropylbenzene	98-82-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		Propylbenzene, n-	103-65-1	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Styrene	100-42-5	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		Tetrachloroethane, 1,1,1,2-	630-20-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Tetrachloroethane, 1,1,2,2-	79-34-5	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Tetrachloroethylene	127-18-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Toluene	108-88-3	E611E	0.50	µg/L	<0.50	<0.50	0	Diff <2x LOR	----
		Trichlorobenzene, 1,2,3-	87-61-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Trichlorobenzene, 1,2,4-	120-82-1	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Trichloroethane, 1,1,1-	71-55-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Trichloroethane, 1,1,2-	79-00-5	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Trichloroethylene	79-01-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Trichlorofluoromethane	75-69-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Trichloropropane, 1,2,3-	96-18-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Trimethylbenzene, 1,2,4-	95-63-6	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Trimethylbenzene, 1,3,5-	108-67-8	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Vinyl chloride	75-01-4	E611E	1.0	µg/L	<1.0	<1.0	0	Diff <2x LOR	----
		Xylene, m+p-	179601-23-1	E611E	0.40	µg/L	<0.40	<0.40	0	Diff <2x LOR	----
		Xylene, o-	95-47-6	E611E	0.30	µg/L	<0.30	<0.30	0	Diff <2x LOR	----



Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: Water

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Physical Tests (QCLot: 1640301)						
Conductivity	----	E100	1	µS/cm	<1.0	----
Physical Tests (QCLot: 1640302)						
Alkalinity, total (as CaCO3)	----	E290	1	mg/L	<1.0	----
Anions and Nutrients (QCLot: 1639139)						
Nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	<0.020	----
Anions and Nutrients (QCLot: 1639140)						
Nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	<0.010	----
Anions and Nutrients (QCLot: 1639142)						
Fluoride	16984-48-8	E235.F	0.02	mg/L	<0.020	----
Anions and Nutrients (QCLot: 1639143)						
Chloride	16887-00-6	E235.Cl	0.5	mg/L	<0.50	----
Anions and Nutrients (QCLot: 1639144)						
Sulfate (as SO4)	14808-79-8	E235.SO4	0.3	mg/L	<0.30	----
Anions and Nutrients (QCLot: 1639145)						
Nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	<0.020	----
Anions and Nutrients (QCLot: 1639146)						
Nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	<0.010	----
Dissolved Metals (QCLot: 1642122)						
Mercury, dissolved	7439-97-6	E509	0.000005	mg/L	<0.0000050	----
Dissolved Metals (QCLot: 1643007)						
Aluminum, dissolved	7429-90-5	E421	0.001	mg/L	<0.0010	----
Antimony, dissolved	7440-36-0	E421	0.0001	mg/L	<0.00010	----
Arsenic, dissolved	7440-38-2	E421	0.0001	mg/L	<0.00010	----
Barium, dissolved	7440-39-3	E421	0.0001	mg/L	<0.00010	----
Boron, dissolved	7440-42-8	E421	0.01	mg/L	<0.010	----
Cadmium, dissolved	7440-43-9	E421	0.000005	mg/L	<0.0000050	----
Calcium, dissolved	7440-70-2	E421	0.05	mg/L	<0.050	----
Chromium, dissolved	7440-47-3	E421	0.0005	mg/L	<0.00050	----
Copper, dissolved	7440-50-8	E421	0.0002	mg/L	<0.00020	----
Iron, dissolved	7439-89-6	E421	0.01	mg/L	<0.010	----
Lead, dissolved	7439-92-1	E421	0.00005	mg/L	<0.000050	----
Magnesium, dissolved	7439-95-4	E421	0.005	mg/L	<0.0050	----



Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Dissolved Metals (QCLot: 1643007) - continued						
Manganese, dissolved	7439-96-5	E421	0.0001	mg/L	<0.00010	----
Nickel, dissolved	7440-02-0	E421	0.0005	mg/L	<0.00050	----
Potassium, dissolved	7440-09-7	E421	0.05	mg/L	<0.050	----
Selenium, dissolved	7782-49-2	E421	0.00005	mg/L	<0.000050	----
Silver, dissolved	7440-22-4	E421	0.00001	mg/L	<0.000010	----
Sodium, dissolved	7440-23-5	E421	0.05	mg/L	<0.050	----
Uranium, dissolved	7440-61-1	E421	0.00001	mg/L	<0.000010	----
Zinc, dissolved	7440-66-6	E421	0.001	mg/L	<0.0010	----
Dissolved Metals (QCLot: 1643008)						
Aluminum, dissolved	7429-90-5	E421	0.001	mg/L	<0.0010	----
Antimony, dissolved	7440-36-0	E421	0.0001	mg/L	<0.00010	----
Arsenic, dissolved	7440-38-2	E421	0.0001	mg/L	<0.00010	----
Barium, dissolved	7440-39-3	E421	0.0001	mg/L	<0.00010	----
Boron, dissolved	7440-42-8	E421	0.01	mg/L	<0.010	----
Cadmium, dissolved	7440-43-9	E421	0.000005	mg/L	<0.0000050	----
Calcium, dissolved	7440-70-2	E421	0.05	mg/L	<0.050	----
Chromium, dissolved	7440-47-3	E421	0.0005	mg/L	<0.00050	----
Copper, dissolved	7440-50-8	E421	0.0002	mg/L	<0.00020	----
Iron, dissolved	7439-89-6	E421	0.01	mg/L	<0.010	----
Lead, dissolved	7439-92-1	E421	0.00005	mg/L	<0.000050	----
Magnesium, dissolved	7439-95-4	E421	0.005	mg/L	<0.0050	----
Manganese, dissolved	7439-96-5	E421	0.0001	mg/L	<0.00010	----
Nickel, dissolved	7440-02-0	E421	0.0005	mg/L	<0.00050	----
Potassium, dissolved	7440-09-7	E421	0.05	mg/L	<0.050	----
Selenium, dissolved	7782-49-2	E421	0.00005	mg/L	<0.000050	----
Silver, dissolved	7440-22-4	E421	0.00001	mg/L	<0.000010	----
Sodium, dissolved	7440-23-5	E421	0.05	mg/L	<0.050	----
Uranium, dissolved	7440-61-1	E421	0.00001	mg/L	<0.000010	----
Zinc, dissolved	7440-66-6	E421	0.001	mg/L	<0.0010	----
Volatile Organic Compounds (QCLot: 1639168)						
Benzene	71-43-2	E611E	0.5	µg/L	<0.50	----
Bromobenzene	108-86-1	E611E	1	µg/L	<1.0	----
Bromochloromethane	74-97-5	E611E	1	µg/L	<1.0	----
Bromodichloromethane	75-27-4	E611E	1	µg/L	<1.0	----
Bromoform	75-25-2	E611E	1	µg/L	<1.0	----



Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Volatile Organic Compounds (QCLot: 1639168) - continued						
Bromomethane	74-83-9	E611E	1	µg/L	<1.0	----
Butylbenzene, n-	104-51-8	E611E	1	µg/L	<1.0	----
Butylbenzene, sec-	135-98-8	E611E	1	µg/L	<1.0	----
Butylbenzene, tert-	98-06-6	E611E	1	µg/L	<1.0	----
Carbon tetrachloride	56-23-5	E611E	0.5	µg/L	<0.50	----
Chlorobenzene	108-90-7	E611E	1	µg/L	<1.0	----
Chloroethane	75-00-3	E611E	1	µg/L	<1.0	----
Chloroform	67-66-3	E611E	1	µg/L	<1.0	----
Chloromethane	74-87-3	E611E	5	µg/L	<5.0	----
Chlorotoluene, 2-	95-49-8	E611E	1	µg/L	<1.0	----
Chlorotoluene, 4-	106-43-4	E611E	1	µg/L	<1.0	----
Cymene, p-	99-87-6	E611E	1	µg/L	<1.0	----
Dibromo-3-chloropropane, 1,2-	96-12-8	E611E	1	µg/L	<1.0	----
Dibromochloromethane	124-48-1	E611E	1	µg/L	<1.0	----
Dibromoethane, 1,2-	106-93-4	E611E	1	µg/L	<1.0	----
Dibromomethane	74-95-3	E611E	1	µg/L	<1.0	----
Dichlorobenzene, 1,2-	95-50-1	E611E	0.5	µg/L	<0.50	----
Dichlorobenzene, 1,3-	541-73-1	E611E	1	µg/L	<1.0	----
Dichlorobenzene, 1,4-	106-46-7	E611E	1	µg/L	<1.0	----
Dichlorodifluoromethane	75-71-8	E611E	1	µg/L	<1.0	----
Dichloroethane, 1,1-	75-34-3	E611E	1	µg/L	<1.0	----
Dichloroethane, 1,2-	107-06-2	E611E	1	µg/L	<1.0	----
Dichloroethylene, 1,1-	75-35-4	E611E	1	µg/L	<1.0	----
Dichloroethylene, cis-1,2-	156-59-2	E611E	1	µg/L	<1.0	----
Dichloroethylene, trans-1,2-	156-60-5	E611E	1	µg/L	<1.0	----
Dichloromethane	75-09-2	E611E	1	µg/L	<1.0	----
Dichloropropane, 1,2-	78-87-5	E611E	1	µg/L	<1.0	----
Dichloropropane, 1,3-	142-28-9	E611E	1	µg/L	<1.0	----
Dichloropropane, 2,2-	594-20-7	E611E	1	µg/L	<1.0	----
Dichloropropylene, 1,1-	563-58-6	E611E	1	µg/L	<1.0	----
Dichloropropylene, cis-1,3-	10061-01-5	E611E	1	µg/L	<1.0	----
Dichloropropylene, trans-1,3-	10061-02-6	E611E	1	µg/L	<1.0	----
Ethylbenzene	100-41-4	E611E	0.5	µg/L	<0.50	----
Hexachlorobutadiene	87-68-3	E611E	1	µg/L	<1.0	----
Isopropylbenzene	98-82-8	E611E	1	µg/L	<1.0	----



Sub-Matrix: **Water**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Volatile Organic Compounds (QCLot: 1639168) - continued						
Methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	0.5	µg/L	<0.50	----
Propylbenzene, n-	103-65-1	E611E	1	µg/L	<1.0	----
Styrene	100-42-5	E611E	0.5	µg/L	<0.50	----
Tetrachloroethane, 1,1,1,2-	630-20-6	E611E	1	µg/L	<1.0	----
Tetrachloroethane, 1,1,2,2-	79-34-5	E611E	1	µg/L	<1.0	----
Tetrachloroethylene	127-18-4	E611E	1	µg/L	<1.0	----
Toluene	108-88-3	E611E	0.5	µg/L	<0.50	----
Trichlorobenzene, 1,2,3-	87-61-6	E611E	1	µg/L	<1.0	----
Trichlorobenzene, 1,2,4-	120-82-1	E611E	1	µg/L	<1.0	----
Trichloroethane, 1,1,1-	71-55-6	E611E	1	µg/L	<1.0	----
Trichloroethane, 1,1,2-	79-00-5	E611E	1	µg/L	<1.0	----
Trichloroethylene	79-01-6	E611E	1	µg/L	<1.0	----
Trichlorofluoromethane	75-69-4	E611E	1	µg/L	<1.0	----
Trichloropropane, 1,2,3-	96-18-4	E611E	1	µg/L	<1.0	----
Trimethylbenzene, 1,2,4-	95-63-6	E611E	1	µg/L	<1.0	----
Trimethylbenzene, 1,3,5-	108-67-8	E611E	1	µg/L	<1.0	----
Vinyl chloride	75-01-4	E611E	1	µg/L	<1.0	----
Xylene, m+p-	179601-23-1	E611E	0.4	µg/L	<0.40	----
Xylene, o-	95-47-6	E611E	0.3	µg/L	<0.30	----



Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: Water

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Target Concentration	LCS	Low	High	Qualifier
Physical Tests (QCLot: 1640300)									
pH	----	E108	----	pH units	7 pH units	101	98.0	102	----
Physical Tests (QCLot: 1640301)									
Conductivity	----	E100	1	µS/cm	147 µS/cm	99.2	90.0	110	----
Physical Tests (QCLot: 1640302)									
Alkalinity, total (as CaCO3)	----	E290	1	mg/L	500 mg/L	95.3	85.0	115	----
Anions and Nutrients (QCLot: 1639139)									
Nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	2.5 mg/L	98.5	90.0	110	----
Anions and Nutrients (QCLot: 1639140)									
Nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	0.5 mg/L	99.1	90.0	110	----
Anions and Nutrients (QCLot: 1639142)									
Fluoride	16984-48-8	E235.F	0.02	mg/L	1 mg/L	97.2	90.0	110	----
Anions and Nutrients (QCLot: 1639143)									
Chloride	16887-00-6	E235.Cl	0.5	mg/L	100 mg/L	98.2	90.0	110	----
Anions and Nutrients (QCLot: 1639144)									
Sulfate (as SO4)	14808-79-8	E235.SO4	0.3	mg/L	100 mg/L	99.9	90.0	110	----
Anions and Nutrients (QCLot: 1639145)									
Nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	2.5 mg/L	98.2	90.0	110	----
Anions and Nutrients (QCLot: 1639146)									
Nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	0.5 mg/L	99.0	90.0	110	----
Mercury, dissolved	7439-97-6	E509	0.000005	mg/L	0 mg/L	107	80.0	120	----
Dissolved Metals (QCLot: 1643007)									
Aluminum, dissolved	7429-90-5	E421	0.001	mg/L	2 mg/L	102	80.0	120	----
Antimony, dissolved	7440-36-0	E421	0.0001	mg/L	1 mg/L	96.1	80.0	120	----
Arsenic, dissolved	7440-38-2	E421	0.0001	mg/L	1 mg/L	101	80.0	120	----
Barium, dissolved	7440-39-3	E421	0.0001	mg/L	0.25 mg/L	105	80.0	120	----
Boron, dissolved	7440-42-8	E421	0.01	mg/L	1 mg/L	91.8	80.0	120	----
Cadmium, dissolved	7440-43-9	E421	0.000005	mg/L	0.1 mg/L	96.9	80.0	120	----
Calcium, dissolved	7440-70-2	E421	0.05	mg/L	50 mg/L	91.7	80.0	120	----
Chromium, dissolved	7440-47-3	E421	0.0005	mg/L	0.25 mg/L	99.6	80.0	120	----
Copper, dissolved	7440-50-8	E421	0.0002	mg/L	0.25 mg/L	94.6	80.0	120	----



Sub-Matrix: Water					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		Qualifier
					Target Concentration	LCS	Low	High	
Analyte	CAS Number	Method	LOR	Unit	Target Concentration	LCS	Low	High	Qualifier
Dissolved Metals (QCLot: 1643007) - continued									
Iron, dissolved	7439-89-6	E421	0.01	mg/L	1 mg/L	96.8	80.0	120	----
Lead, dissolved	7439-92-1	E421	0.00005	mg/L	0.5 mg/L	104	80.0	120	----
Magnesium, dissolved	7439-95-4	E421	0.005	mg/L	50 mg/L	98.3	80.0	120	----
Manganese, dissolved	7439-96-5	E421	0.0001	mg/L	0.25 mg/L	96.8	80.0	120	----
Nickel, dissolved	7440-02-0	E421	0.0005	mg/L	0.5 mg/L	97.0	80.0	120	----
Potassium, dissolved	7440-09-7	E421	0.05	mg/L	50 mg/L	99.8	80.0	120	----
Selenium, dissolved	7782-49-2	E421	0.00005	mg/L	1 mg/L	89.6	80.0	120	----
Silver, dissolved	7440-22-4	E421	0.00001	mg/L	0.1 mg/L	90.4	80.0	120	----
Sodium, dissolved	7440-23-5	E421	0.05	mg/L	50 mg/L	98.6	80.0	120	----
Uranium, dissolved	7440-61-1	E421	0.00001	mg/L	0.005 mg/L	100	80.0	120	----
Zinc, dissolved	7440-66-6	E421	0.001	mg/L	0.5 mg/L	94.1	80.0	120	----
Dissolved Metals (QCLot: 1643008)									
Aluminum, dissolved	7429-90-5	E421	0.001	mg/L	2 mg/L	101	80.0	120	----
Antimony, dissolved	7440-36-0	E421	0.0001	mg/L	1 mg/L	96.3	80.0	120	----
Arsenic, dissolved	7440-38-2	E421	0.0001	mg/L	1 mg/L	102	80.0	120	----
Barium, dissolved	7440-39-3	E421	0.0001	mg/L	0.25 mg/L	97.0	80.0	120	----
Boron, dissolved	7440-42-8	E421	0.01	mg/L	1 mg/L	96.0	80.0	120	----
Cadmium, dissolved	7440-43-9	E421	0.000005	mg/L	0.1 mg/L	96.7	80.0	120	----
Calcium, dissolved	7440-70-2	E421	0.05	mg/L	50 mg/L	92.9	80.0	120	----
Chromium, dissolved	7440-47-3	E421	0.0005	mg/L	0.25 mg/L	99.5	80.0	120	----
Copper, dissolved	7440-50-8	E421	0.0002	mg/L	0.25 mg/L	96.0	80.0	120	----
Iron, dissolved	7439-89-6	E421	0.01	mg/L	1 mg/L	98.0	80.0	120	----
Lead, dissolved	7439-92-1	E421	0.00005	mg/L	0.5 mg/L	97.4	80.0	120	----
Magnesium, dissolved	7439-95-4	E421	0.005	mg/L	50 mg/L	93.9	80.0	120	----
Manganese, dissolved	7439-96-5	E421	0.0001	mg/L	0.25 mg/L	99.3	80.0	120	----
Nickel, dissolved	7440-02-0	E421	0.0005	mg/L	0.5 mg/L	97.8	80.0	120	----
Potassium, dissolved	7440-09-7	E421	0.05	mg/L	50 mg/L	97.9	80.0	120	----
Selenium, dissolved	7782-49-2	E421	0.00005	mg/L	1 mg/L	91.6	80.0	120	----
Silver, dissolved	7440-22-4	E421	0.00001	mg/L	0.1 mg/L	89.8	80.0	120	----
Sodium, dissolved	7440-23-5	E421	0.05	mg/L	50 mg/L	94.0	80.0	120	----
Uranium, dissolved	7440-61-1	E421	0.00001	mg/L	0.005 mg/L	98.3	80.0	120	----
Zinc, dissolved	7440-66-6	E421	0.001	mg/L	0.5 mg/L	98.0	80.0	120	----
Volatile Organic Compounds (QCLot: 1639168)									
Benzene	71-43-2	E611E	0.5	µg/L	100 µg/L	95.9	70.0	130	----
Bromobenzene	108-86-1	E611E	1	µg/L	100 µg/L	90.8	70.0	130	----



Sub-Matrix: Water

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Target Concentration	LCS	Low	High	Qualifier
Volatile Organic Compounds (QCLot: 1639168) - continued									
Bromochloromethane	74-97-5	E611E	1	µg/L	100 µg/L	99.2	70.0	130	----
Bromodichloromethane	75-27-4	E611E	1	µg/L	100 µg/L	109	70.0	130	----
Bromoform	75-25-2	E611E	1	µg/L	100 µg/L	87.3	70.0	130	----
Bromomethane	74-83-9	E611E	1	µg/L	100 µg/L	109	60.0	140	----
Butylbenzene, n-	104-51-8	E611E	1	µg/L	100 µg/L	86.0	70.0	130	----
Butylbenzene, sec-	135-98-8	E611E	1	µg/L	100 µg/L	75.5	70.0	130	----
Butylbenzene, tert-	98-06-6	E611E	1	µg/L	100 µg/L	70.2	70.0	130	----
Carbon tetrachloride	56-23-5	E611E	0.5	µg/L	100 µg/L	70.8	70.0	130	----
Chlorobenzene	108-90-7	E611E	1	µg/L	100 µg/L	109	70.0	130	----
Chloroethane	75-00-3	E611E	1	µg/L	100 µg/L	87.0	60.0	140	----
Chloroform	67-66-3	E611E	1	µg/L	100 µg/L	100	70.0	130	----
Chloromethane	74-87-3	E611E	5	µg/L	100 µg/L	94.6	60.0	140	----
Chlorotoluene, 2-	95-49-8	E611E	1	µg/L	100 µg/L	86.2	70.0	130	----
Chlorotoluene, 4-	106-43-4	E611E	1	µg/L	100 µg/L	85.2	70.0	130	----
Cymene, p-	99-87-6	E611E	1	µg/L	100 µg/L	70.9	70.0	130	----
Dibromo-3-chloropropane, 1,2-	96-12-8	E611E	1	µg/L	100 µg/L	109	70.0	130	----
Dibromochloromethane	124-48-1	E611E	1	µg/L	100 µg/L	98.3	70.0	130	----
Dibromoethane, 1,2-	106-93-4	E611E	1	µg/L	100 µg/L	120	70.0	130	----
Dibromomethane	74-95-3	E611E	1	µg/L	100 µg/L	99.3	70.0	130	----
Dichlorobenzene, 1,2-	95-50-1	E611E	0.5	µg/L	100 µg/L	89.9	70.0	130	----
Dichlorobenzene, 1,3-	541-73-1	E611E	1	µg/L	100 µg/L	83.4	70.0	130	----
Dichlorobenzene, 1,4-	106-46-7	E611E	1	µg/L	100 µg/L	85.8	70.0	130	----
Dichlorodifluoromethane	75-71-8	E611E	1	µg/L	100 µg/L	98.4	60.0	140	----
Dichloroethane, 1,1-	75-34-3	E611E	1	µg/L	100 µg/L	104	70.0	130	----
Dichloroethane, 1,2-	107-06-2	E611E	1	µg/L	100 µg/L	129	70.0	130	----
Dichloroethylene, 1,1-	75-35-4	E611E	1	µg/L	100 µg/L	87.9	70.0	130	----
Dichloroethylene, cis-1,2-	156-59-2	E611E	1	µg/L	100 µg/L	112	70.0	130	----
Dichloroethylene, trans-1,2-	156-60-5	E611E	1	µg/L	100 µg/L	96.1	70.0	130	----
Dichloromethane	75-09-2	E611E	1	µg/L	100 µg/L	114	70.0	130	----
Dichloropropane, 1,2-	78-87-5	E611E	1	µg/L	100 µg/L	112	70.0	130	----
Dichloropropane, 1,3-	142-28-9	E611E	1	µg/L	100 µg/L	127	70.0	130	----
Dichloropropane, 2,2-	594-20-7	E611E	1	µg/L	100 µg/L	75.6	70.0	130	----
Dichloropropylene, 1,1-	563-58-6	E611E	1	µg/L	100 µg/L	81.1	70.0	130	----
Dichloropropylene, cis-1,3-	10061-01-5	E611E	1	µg/L	100 µg/L	95.0	70.0	130	----
Dichloropropylene, trans-1,3-	10061-02-6	E611E	1	µg/L	100 µg/L	94.2	70.0	130	----
Ethylbenzene	100-41-4	E611E	0.5	µg/L	100 µg/L	73.0	70.0	130	----



Sub-Matrix: Water

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Target Concentration	LCS	Low	High	Qualifier
Volatile Organic Compounds (QCLot: 1639168) - continued									
Hexachlorobutadiene	87-68-3	E611E	1	µg/L	100 µg/L	89.9	70.0	130	----
Isopropylbenzene	98-82-8	E611E	1	µg/L	100 µg/L	83.4	70.0	130	----
Methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	0.5	µg/L	100 µg/L	100	70.0	130	----
Propylbenzene, n-	103-65-1	E611E	1	µg/L	100 µg/L	72.9	70.0	130	----
Styrene	100-42-5	E611E	0.5	µg/L	100 µg/L	88.7	70.0	130	----
Tetrachloroethane, 1,1,1,2-	630-20-6	E611E	1	µg/L	100 µg/L	90.0	70.0	130	----
Tetrachloroethane, 1,1,2,2-	79-34-5	E611E	1	µg/L	100 µg/L	127	70.0	130	----
Tetrachloroethylene	127-18-4	E611E	1	µg/L	100 µg/L	73.6	70.0	130	----
Toluene	108-88-3	E611E	0.5	µg/L	100 µg/L	83.1	70.0	130	----
Trichlorobenzene, 1,2,3-	87-61-6	E611E	1	µg/L	100 µg/L	71.3	70.0	130	----
Trichlorobenzene, 1,2,4-	120-82-1	E611E	1	µg/L	100 µg/L	86.2	70.0	130	----
Trichloroethane, 1,1,1-	71-55-6	E611E	1	µg/L	100 µg/L	73.9	70.0	130	----
Trichloroethane, 1,1,2-	79-00-5	E611E	1	µg/L	100 µg/L	121	70.0	130	----
Trichloroethylene	79-01-6	E611E	1	µg/L	100 µg/L	71.2	70.0	130	----
Trichlorofluoromethane	75-69-4	E611E	1	µg/L	100 µg/L	85.3	60.0	140	----
Trichloropropane, 1,2,3-	96-18-4	E611E	1	µg/L	100 µg/L	121	70.0	130	----
Trimethylbenzene, 1,2,4-	95-63-6	E611E	1	µg/L	100 µg/L	79.9	70.0	130	----
Trimethylbenzene, 1,3,5-	108-67-8	E611E	1	µg/L	100 µg/L	80.4	70.0	130	----
Vinyl chloride	75-01-4	E611E	1	µg/L	100 µg/L	86.4	60.0	140	----
Xylene, m+p-	179601-23-1	E611E	0.4	µg/L	200 µg/L	86.0	70.0	130	----
Xylene, o-	95-47-6	E611E	0.3	µg/L	100 µg/L	79.3	70.0	130	----



Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND – Recovery not determined, background level >= 1x spike level.

Laboratory sample ID					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		Qualifier
					Concentration	Target	MS	Low	High	
Client sample ID	Analyte	CAS Number	Method							
Anions and Nutrients (QCLot: 1639139)										
CG2412803-002	Anonymous	Nitrate (as N)	14797-55-8	E235.NO3	2.48 mg/L	2.5 mg/L	99.3	75.0	125	----
Anions and Nutrients (QCLot: 1639140)										
CG2412803-002	Anonymous	Nitrite (as N)	14797-65-0	E235.NO2	0.496 mg/L	0.5 mg/L	99.2	75.0	125	----
Anions and Nutrients (QCLot: 1639142)										
CG2412803-002	Anonymous	Fluoride	16984-48-8	E235.F	0.981 mg/L	1 mg/L	98.1	75.0	125	----
Anions and Nutrients (QCLot: 1639143)										
CG2412803-002	Anonymous	Chloride	16887-00-6	E235.Cl	98.8 mg/L	100 mg/L	98.8	75.0	125	----
Anions and Nutrients (QCLot: 1639144)										
CG2412803-002	Anonymous	Sulfate (as SO4)	14808-79-8	E235.SO4	98.2 mg/L	100 mg/L	98.2	75.0	125	----
Anions and Nutrients (QCLot: 1639145)										
CG2412813-003	Anonymous	Nitrate (as N)	14797-55-8	E235.NO3	2.49 mg/L	2.5 mg/L	99.5	75.0	125	----
Anions and Nutrients (QCLot: 1639146)										
CG2412813-003	Anonymous	Nitrite (as N)	14797-65-0	E235.NO2	0.502 mg/L	0.5 mg/L	100	75.0	125	----
Dissolved Metals (QCLot: 1642122)										
CG2412803-008	Anonymous	Mercury, dissolved	7439-97-6	E509	0.000116 mg/L	0 mg/L	116	70.0	130	----
Dissolved Metals (QCLot: 1643007)										
CG2412792-002	Anonymous	Aluminum, dissolved	7429-90-5	E421	2.01 mg/L	2 mg/L	101	70.0	130	----
		Antimony, dissolved	7440-36-0	E421	0.192 mg/L	0.2 mg/L	96.1	70.0	130	----
		Arsenic, dissolved	7440-38-2	E421	0.191 mg/L	0.2 mg/L	95.5	70.0	130	----
		Barium, dissolved	7440-39-3	E421	0.192 mg/L	0.2 mg/L	96.1	70.0	130	----
		Boron, dissolved	7440-42-8	E421	0.882 mg/L	1 mg/L	88.2	70.0	130	----
		Cadmium, dissolved	7440-43-9	E421	0.0375 mg/L	0.04 mg/L	93.7	70.0	130	----
		Calcium, dissolved	7440-70-2	E421	ND mg/L	----	ND	70.0	130	----
		Chromium, dissolved	7440-47-3	E421	0.379 mg/L	0.4 mg/L	94.8	70.0	130	----
		Copper, dissolved	7440-50-8	E421	0.189 mg/L	0.2 mg/L	94.6	70.0	130	----
		Iron, dissolved	7439-89-6	E421	18.8 mg/L	20 mg/L	93.9	70.0	130	----
		Lead, dissolved	7439-92-1	E421	0.187 mg/L	0.2 mg/L	93.6	70.0	130	----
		Magnesium, dissolved	7439-95-4	E421	ND mg/L	----	ND	70.0	130	----
		Manganese, dissolved	7439-96-5	E421	ND mg/L	----	ND	70.0	130	----
		Nickel, dissolved	7440-02-0	E421	0.373 mg/L	0.4 mg/L	93.2	70.0	130	----
		Potassium, dissolved	7440-09-7	E421	39.0 mg/L	40 mg/L	97.4	70.0	130	----
		Selenium, dissolved	7782-49-2	E421	0.358 mg/L	0.4 mg/L	89.6	70.0	130	----
		Silver, dissolved	7440-22-4	E421	0.0360 mg/L	0.04 mg/L	90.0	70.0	130	----
		Sodium, dissolved	7440-23-5	E421	ND mg/L	----	ND	70.0	130	----
		Uranium, dissolved	7440-61-1	E421	ND mg/L	----	ND	70.0	130	----



Sub-Matrix: Water					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Dissolved Metals (QCLot: 1643007) - continued										
CG2412792-002	Anonymous	Zinc, dissolved	7440-66-6	E421	3.67 mg/L	4 mg/L	91.7	70.0	130	----
Dissolved Metals (QCLot: 1643008)										
CG2412809-004	DUPLICATE	Aluminum, dissolved	7429-90-5	E421	1.94 mg/L	2 mg/L	97.1	70.0	130	----
		Antimony, dissolved	7440-36-0	E421	0.194 mg/L	0.2 mg/L	96.8	70.0	130	----
		Arsenic, dissolved	7440-38-2	E421	0.192 mg/L	0.2 mg/L	96.2	70.0	130	----
		Barium, dissolved	7440-39-3	E421	ND mg/L	----	ND	70.0	130	----
		Boron, dissolved	7440-42-8	E421	ND mg/L	----	ND	70.0	130	----
		Cadmium, dissolved	7440-43-9	E421	0.0378 mg/L	0.04 mg/L	94.4	70.0	130	----
		Calcium, dissolved	7440-70-2	E421	ND mg/L	----	ND	70.0	130	----
		Chromium, dissolved	7440-47-3	E421	0.385 mg/L	0.4 mg/L	96.3	70.0	130	----
		Copper, dissolved	7440-50-8	E421	0.188 mg/L	0.2 mg/L	94.1	70.0	130	----
		Iron, dissolved	7439-89-6	E421	18.5 mg/L	20 mg/L	92.4	70.0	130	----
		Lead, dissolved	7439-92-1	E421	0.187 mg/L	0.2 mg/L	93.7	70.0	130	----
		Magnesium, dissolved	7439-95-4	E421	ND mg/L	----	ND	70.0	130	----
		Manganese, dissolved	7439-96-5	E421	ND mg/L	----	ND	70.0	130	----
		Nickel, dissolved	7440-02-0	E421	0.382 mg/L	0.4 mg/L	95.5	70.0	130	----
		Potassium, dissolved	7440-09-7	E421	37.2 mg/L	40 mg/L	93.1	70.0	130	----
		Selenium, dissolved	7782-49-2	E421	0.371 mg/L	0.4 mg/L	92.7	70.0	130	----
		Silver, dissolved	7440-22-4	E421	0.0366 mg/L	0.04 mg/L	91.6	70.0	130	----
		Sodium, dissolved	7440-23-5	E421	ND mg/L	----	ND	70.0	130	----
		Uranium, dissolved	7440-61-1	E421	0.0378 mg/L	0.04 mg/L	94.4	70.0	130	----
				Zinc, dissolved	7440-66-6	E421	3.83 mg/L	4 mg/L	95.7	70.0
Volatile Organic Compounds (QCLot: 1639168)										
CG2412804-001	Anonymous	Benzene	71-43-2	E611E	113 µg/L	100 µg/L	113	70.0	130	----
		Bromobenzene	108-86-1	E611E	103 µg/L	100 µg/L	103	70.0	130	----
		Bromochloromethane	74-97-5	E611E	114 µg/L	100 µg/L	114	70.0	130	----
		Bromodichloromethane	75-27-4	E611E	125 µg/L	100 µg/L	125	70.0	130	----
		Bromoform	75-25-2	E611E	98.1 µg/L	100 µg/L	98.1	70.0	130	----
		Bromomethane	74-83-9	E611E	126 µg/L	100 µg/L	126	60.0	140	----
		Butylbenzene, n-	104-51-8	E611E	76.8 µg/L	100 µg/L	76.8	70.0	130	----
		Butylbenzene, sec-	135-98-8	E611E	78.1 µg/L	100 µg/L	78.1	70.0	130	----
		Butylbenzene, tert-	98-06-6	E611E	80.7 µg/L	100 µg/L	80.7	70.0	130	----
		Carbon tetrachloride	56-23-5	E611E	74.0 µg/L	100 µg/L	74.0	70.0	130	----
		Chlorobenzene	108-90-7	E611E	128 µg/L	100 µg/L	128	70.0	130	----
		Chloroethane	75-00-3	E611E	102 µg/L	100 µg/L	102	60.0	140	----
		Chloroform	67-66-3	E611E	116 µg/L	100 µg/L	116	70.0	130	----
		Chloromethane	74-87-3	E611E	110 µg/L	100 µg/L	110	60.0	140	----
		Chlorotoluene, 2-	95-49-8	E611E	99.1 µg/L	100 µg/L	99.1	70.0	130	----
		Chlorotoluene, 4-	106-43-4	E611E	98.1 µg/L	100 µg/L	98.1	70.0	130	----
		Cymene, p-	99-87-6	E611E	82.3 µg/L	100 µg/L	82.3	70.0	130	----
		Dibromo-3-chloropropane, 1,2-	96-12-8	E611E	122 µg/L	100 µg/L	122	70.0	130	----
		Dibromochloromethane	124-48-1	E611E	113 µg/L	100 µg/L	113	70.0	130	----
		Dibromoethane, 1,2-	106-93-4	E611E	128 µg/L	100 µg/L	128	70.0	130	----



Sub-Matrix: Water					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Volatile Organic Compounds (QCLot: 1639168) - continued										
CG2412804-001	Anonymous	Dibromomethane	74-95-3	E611E	114 µg/L	100 µg/L	114	70.0	130	----
		Dichlorobenzene, 1,2-	95-50-1	E611E	104 µg/L	100 µg/L	104	70.0	130	----
		Dichlorobenzene, 1,3-	541-73-1	E611E	96.0 µg/L	100 µg/L	96.0	70.0	130	----
		Dichlorobenzene, 1,4-	106-46-7	E611E	98.4 µg/L	100 µg/L	98.4	70.0	130	----
		Dichlorodifluoromethane	75-71-8	E611E	113 µg/L	100 µg/L	113	60.0	140	----
		Dichloroethane, 1,1-	75-34-3	E611E	121 µg/L	100 µg/L	121	70.0	130	----
		Dichloroethane, 1,2-	107-06-2	E611E	122 µg/L	100 µg/L	122	70.0	130	----
		Dichloroethylene, 1,1-	75-35-4	E611E	103 µg/L	100 µg/L	103	70.0	130	----
		Dichloroethylene, cis-1,2-	156-59-2	E611E	126 µg/L	100 µg/L	126	70.0	130	----
		Dichloroethylene, trans-1,2-	156-60-5	E611E	111 µg/L	100 µg/L	111	70.0	130	----
		Dichloromethane	75-09-2	E611E	127 µg/L	100 µg/L	127	70.0	130	----
		Dichloropropane, 1,2-	78-87-5	E611E	121 µg/L	100 µg/L	121	70.0	130	----
		Dichloropropane, 1,3-	142-28-9	E611E	129 µg/L	100 µg/L	129	70.0	130	----
		Dichloropropane, 2,2-	594-20-7	E611E	80.3 µg/L	100 µg/L	80.3	70.0	130	----
		Dichloropropylene, 1,1-	563-58-6	E611E	95.8 µg/L	100 µg/L	95.8	70.0	130	----
		Dichloropropylene, cis-1,3-	10061-01-5	E611E	109 µg/L	100 µg/L	109	70.0	130	----
		Dichloropropylene, trans-1,3-	10061-02-6	E611E	107 µg/L	100 µg/L	107	70.0	130	----
		Ethylbenzene	100-41-4	E611E	86.1 µg/L	100 µg/L	86.1	70.0	130	----
		Hexachlorobutadiene	87-68-3	E611E	82.7 µg/L	100 µg/L	82.7	70.0	130	----
		Isopropylbenzene	98-82-8	E611E	97.7 µg/L	100 µg/L	97.7	70.0	130	----
		Methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	111 µg/L	100 µg/L	111	70.0	130	----
		Propylbenzene, n-	103-65-1	E611E	86.3 µg/L	100 µg/L	86.3	70.0	130	----
		Styrene	100-42-5	E611E	102 µg/L	100 µg/L	102	70.0	130	----
		Tetrachloroethane, 1,1,1,2-	630-20-6	E611E	105 µg/L	100 µg/L	105	70.0	130	----
		Tetrachloroethane, 1,1,2,2-	79-34-5	E611E	128 µg/L	100 µg/L	128	70.0	130	----
		Tetrachloroethylene	127-18-4	E611E	76.7 µg/L	100 µg/L	76.7	70.0	130	----
		Toluene	108-88-3	E611E	98.1 µg/L	100 µg/L	98.1	70.0	130	----
		Trichlorobenzene, 1,2,3-	87-61-6	E611E	83.9 µg/L	100 µg/L	83.9	70.0	130	----
		Trichlorobenzene, 1,2,4-	120-82-1	E611E	74.7 µg/L	100 µg/L	74.7	70.0	130	----
		Trichloroethane, 1,1,1-	71-55-6	E611E	87.0 µg/L	100 µg/L	87.0	70.0	130	----
		Trichloroethane, 1,1,2-	79-00-5	E611E	122 µg/L	100 µg/L	122	70.0	130	----
		Trichloroethylene	79-01-6	E611E	83.1 µg/L	100 µg/L	83.1	70.0	130	----
		Trichlorofluoromethane	75-69-4	E611E	81.7 µg/L	100 µg/L	81.7	60.0	140	----
		Trichloropropane, 1,2,3-	96-18-4	E611E	125 µg/L	100 µg/L	125	70.0	130	----
		Trimethylbenzene, 1,2,4-	95-63-6	E611E	79.7 µg/L	100 µg/L	79.7	70.0	130	----
		Trimethylbenzene, 1,3,5-	108-67-8	E611E	79.7 µg/L	100 µg/L	79.7	70.0	130	----
		Vinyl chloride	75-01-4	E611E	107 µg/L	100 µg/L	107	60.0	140	----
		Xylene, m+p-	179601-23-1	E611E	201 µg/L	200 µg/L	100	70.0	130	----
		Xylene, o-	95-47-6	E611E	93.0 µg/L	100 µg/L	93.0	70.0	130	----





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APPENDIX E

HISTORICAL ANALYTICAL DATA

Table 4A
Groundwater Indices Measured at Time of Sampling

Monitoring Well	pH	Electrical Conductivity (µg/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Total Dissolved Solid (mg/L)	Redox (±mV)
MW-01	7.50	449.5	12.9	0.58	379.60	-121.2
MW-02	7.59	423.3	13.7	3.87	347.75	-21.9
MW-03	7.97	1,078	7.9	3.24	1,040.00	-133.4
MW-04	--	--	--	--	--	--
MW-05	7.22	1,585	9.7	3.53	1,438.50	-139.3

Notes:

- 1) Measurement of groundwater indices by YSI Pro Plus.
- 2) Groundwater sampled on Monday, August 19, 2013.

Table 4B
Analytical Results - Groundwater - General Water Quality

Parameter	Unit	Detection Limit	MW-01	MW-02	MW-03	MW-05	Tier 1
			08/19/2013				Guideline
<u>General Water Quality</u>							
Biochemical Oxygen Demand (BOD)	mg/L	2	14	3.8	ND	38	--
Chemical Oxygen Demand (COD)	mg/L	5.0 - 25	150	32	47	200	--
Conductivity	µS/cm	1	590	560	1,700	2,200	--
pH	Unitless	N/A	7.88	7.82	8.07	7.89	6.5-8.5
Total Organic Carbon (C)	mg/L	0.50 - 2.5	15	13	21	38	--
Dissolved Cadmium (Cd)	µg/L	0.005	0.012	NT	0.037	0.097	--
Total Cadmium (Cd)	µg/L	0.005	0.73	0.33	0.98	0.79	0.060*
Alkalinity (Total as CaCO ₃)	mg/L	0.5	280	260	800	740	--
Bicarbonate (HCO ₃)	mg/L	0.5	340	320	980	910	--
Carbonate (CO ₃)	mg/L	0.5	ND	ND	ND	ND	--
Hydroxide (OH)	mg/L	0.5	ND	ND	ND	ND	--
Sulphate (SO ₄)	mg/L	1.0 - 5.0	17	27	32	450	--
Chloride (Cl)	mg/L	1	9.3	7.2	70	62	--
Total Ammonia (N)	mg/L	0.050 - 0.50	0.47	ND	6.3	30	1.37*
Total Phosphorus (P)	mg/L	0.0030 - 0.030	1.5	0.068	0.38	2.1	--
Total Nitrogen (N)	mg/L	0.05	2.1	0.58	6.9	35	--
Total Kjeldahl Nitrogen	mg/L	0.050 - 1.3	2.1	0.57	6.9	35	--
Nitrite (as N)	mg/L	0.003	ND	ND	0.010	0.018	--
Nitrate (as N)	mg/L	0.003	0.015	0.0079	0.017	0.054	--
Nitrate plus Nitrite (N)	mg/L	0.0003	0.015	0.0080	0.027	0.072	--
<u>Trace Organics</u>							
Acetic Acid	mg/L	50	ND	NT	ND	ND	--
Formic Acid	mg/L	50	ND	NT	ND	ND	--
Propionic Acid	mg/L	50	ND	NT	ND	ND	--
Adsorbable Organic halogens	mg/L	0.02	0.03	NT	0.07	0.04	--

Notes:

- 1) Tier 1 Guideline - Alberta Tier 1 Soil and Groundwater Remediation Guidelines, December 2010 and amendments. Coarse-grained criteria for residential/parkland land use.
- 2) * Surface Water Quality Guidelines for Use in Alberta (AENV, 1999) on aquatic life pathway. Canadian Council of Ministers of the Environment (CCME) guidelines are referenced.
- 3) ND - Not Detected, less than the limit of method detection.
- 4) NT - Not Tested
- 5) -- No value established in the reference criteria.
- 6) Bold & Shaded - Exceeds the referenced Alberta Tier 1 Guidelines and CCME guidelines.
- 7) For further laboratory information, refer to the specific laboratory report in Appendix A.

Table 4C
Analytical Results - Groundwater - Metals

Parameter	Detection Limit	MW-01	MW-02	MW-03	MW-05	Tier 1 Guideline
08/19/2013						
Total Metals						
Aluminum (Al)	0.0030	10	0.73	7.9	0.37	0.1*
Antimony (Sb)	0.00060	0.00063	ND	ND	0.0017	0.006
Arsenic (As)	0.00020	0.015	0.0011	0.0071	0.0089	0.005
Barium (Ba)	0.010	0.72	0.015	0.5	0.37	1
Beryllium (Be)	0.0010	ND	ND	ND	ND	--
Boron (B)	0.020	0.041	0.022	0.43	1.8	1.5
Calcium (Ca)	0.30	120	78	150	240	--
Chromium (Cr)	0.0010	0.018	0.0035	0.014	0.003	0.001*
Cobalt (Co)	0.00030	0.011	0.00087	0.008	0.012	--
Copper (Cu)	0.00020	0.042	0.0043	0.023	0.026	0.003*
Iron (Fe)	0.060	25	1.6	19	22	0.3
Lead (Pb)	0.00020	0.019	0.0017	0.012	0.11	0.004*
Lithium (Li)	0.020	0.025	ND	0.075	0.031	--
Magnesium (Mg)	0.20	46	22	40	91	--
Manganese (Mn)	0.0040	1.4	0.1	0.9	0.6	0.05
Molybdenum (Mo)	0.00020	0.004	0.0025	0.0017	0.0021	--
Nickel (Ni)	0.00050	0.0340	0.0035	0.025	0.012	0.11*
Phosphorus (P)	0.10	1.10	ND	1.2	0.94	--
Potassium (K)	0.30	6.8	3.5	6.2	45	--
Selenium (Se)	0.00020	0.00074	ND	0.00076	0.0004	0.001
Silicon (Si)	0.10	22	5.6	20	8.4	--
Silver (Ag)	0.00010	0.0002	ND	0.00022	ND	0.0001*
Sodium (Na)	0.50	45	20	310	110	--
Strontium (Sr)	0.020	0.45	0.38	1.1	1.3	--
Sulphur (S)	0.20	5.1	7.8	15	130	--
Thallium (Tl)	0.00020	ND	ND	ND	ND	--
Tin (Sn)	0.0010	0.0015	0.003	0.0021	0.0065	--
Titanium (Ti)	0.0010	0.14	0.025	0.0174	0.007	--
Uranium (U)	0.00010	0.0018	0.0012	0.0022	0.0017	0.02
Vanadium (V)	0.0010	0.03	0.0024	0.021	0.0015	--
Zinc (Zn)	0.0030	0.11	0.078	0.25	0.12	0.03
Dissolved Metals						
Aluminum (Al)	0.0030	0.0067	NT	0.040	0.0052	--
Antimony (Sb)	0.00060	ND	NT	ND	0.00076	--
Arsenic (As)	0.00020	0.0062	NT	0.0021	0.0079	--
Barium (Ba)	0.010	0.28	NT	0.42	0.33	--
Beryllium (Be)	0.0010	ND	NT	ND	ND	--
Boron (B)	0.020	0.044	NT	0.64	1.9	--
Calcium (Ca)	0.30	49	NT	110	230	--
Chromium (Cr)	0.0010	ND	NT	ND	ND	--
Cobalt (Co)	0.00030	0.00066	NT	0.0013	0.0048	--
Copper (Cu)	0.00020	0.00027	NT	0.00098	0.00044	--
Iron (Fe)	0.060	3	NT	0.52	17	--
Lead (Pb)	0.00020	ND	NT	ND	0.00027	--
Lithium (Li)	0.020	ND	NT	0.062	0.03	--
Magnesium (Mg)	0.20	24	NT	34	92	--
Manganese (Mn)	0.0040	0.84	NT	0.63	0.67	--
Molybdenum (Mo)	0.00020	0.0042	NT	0.0025	0.00088	--
Nickel (Ni)	0.00050	0.0014	NT	0.0032	0.0042	--
Phosphorus (P)	0.10	ND	NT	0.16	ND	--
Potassium (K)	0.30	4.5	NT	7.0	40	--
Selenium (Se)	0.00020	0.00047	NT	ND	0.0002	--
Silicon (Si)	0.10	5	NT	6	8	--
Silver (Ag)	0.00010	ND	NT	ND	ND	--
Sodium (Na)	0.50 - 2.5	43	NT	280	120	--
Strontium (Sr)	0.020	0.34	NT	1.3	1.40	--
Sulphur (S)	0.20 -1.0	4.5	NT	17	150	--
Thallium (Tl)	0.00020	ND	NT	ND	ND	--
Tin (Sn)	0.0010	ND	NT	ND	0.0018	--
Titanium (Ti)	0.0010	ND	NT	ND	ND	--
Uranium (U)	0.00010	0.00048	NT	0.0024	0.00085	--
Vanadium (V)	0.0010	ND	NT	0.0011	ND	--
Zinc (Zn)	0.0030	ND	NT	ND	0.02	--

Notes:

- 1) Tier 1 Guideline - Alberta Tier 1 Soil and Groundwater Remediation Guidelines, December 2010 and amendments. Coarse-grained criteria for residential/parkland land use.
- 2) * Surface Water Quality Guidelines for Use in Alberta (AENV, 1999) on aquatic life pathway. Canadian Council of Ministers of the Environment (CCME) guidelines are referenced.
- 3) ND - Not Detected, less than the limit of method detection.
- 4) NT - Not Tested.
- 5) Unless specified all units are mg/L.
- 6) -- No value established in the reference criteria.
- 7) Bold & Shaded - Exceeds the referenced Alberta Tier 1 and CCME guidelines.
- 8) For further laboratory information, refer to the specific laboratory report in Appendix A.

Table 4D
Analytical Results - Groundwater -VOCs

Parameter	Detection Limit	MW-01	MW-02	MW-03	MW-05	Tier 1
		08/19/2013				Guideline
<u>Volatile Organic Compounds</u>						
Benzene	0.00040	ND	ND	ND	0.0014	0.005
Toluene	0.00040	ND	ND	0.0011	0.00063	0.024
Ethylbenzene	0.00040	ND	ND	ND	ND	0.0024
Xylenes (Total)	0.00080	ND	ND	ND	ND	0.3
F1 (C ₆ -C ₁₀)	0.10	ND	ND	ND	ND	0.81
F2 (C ₁₀ -C ₁₆)	0.10	ND	ND	ND	ND	1.1
Total Trihalomethanes	0.0020	ND	ND	ND	ND	0.1
Bromodichloromethane	0.00050	ND	ND	ND	ND	--
Bromoform	0.00050	ND	ND	ND	ND	--
Bromomethane	0.0020	ND	ND	ND	ND	--
Carbon tetrachloride	0.00050	ND	ND	ND	ND	0.00056
Chlorobenzene	0.00050	ND	ND	ND	ND	0.0013
Chlorodibromomethane	0.0010	ND	ND	ND	ND	--
Chloroethane	0.0010	ND	ND	ND	ND	--
Chloroform	0.00050	ND	ND	ND	ND	0.0018
Chloromethane	0.0020	ND	ND	ND	ND	--
1,2-dibromoethane	0.00050	ND	ND	ND	ND	--
1,2-dichlorobenzene	0.00050	ND	ND	ND	ND	0.0007
1,3-dichlorobenzene	0.00050	ND	ND	ND	ND	--
1,4-dichlorobenzene	0.00050	ND	ND	ND	ND	0.001
1,1-dichloroethane	0.00050	ND	ND	ND	ND	--
1,2-dichloroethane	0.00050	ND	ND	ND	ND	0.005
1,1-dichloroethene	0.00050	ND	ND	ND	ND	0.014
cis-1,2-dichloroethene	0.00050	ND	ND	0.0012	0.0037	--
trans-1,2-dichloroethene	0.00050	ND	ND	ND	ND	--
Dichloromethane	0.0020	ND	ND	ND	ND	0.05
1,2-dichloropropane	0.00050	ND	ND	ND	ND	--
cis-1,3-dichloropropene	0.00050	ND	ND	ND	ND	--
trans-1,3-dichloropropene	0.00050	ND	ND	ND	ND	--
Methyl methacrylate	0.00050	ND	ND	ND	ND	0.47
Methyl-tert-butylether (MTBE)	0.00050	ND	ND	ND	ND	0.015
Styrene	0.00050	ND	ND	ND	ND	0.072
1,1,1,2-tetrachloroethane	0.0020	ND	ND	ND	ND	--
1,1,2,2-tetrachloroethane	0.0020	ND	ND	ND	ND	--
Tetrachloroethene	0.00050	ND	ND	ND	0.0033	0.03
1,2,3-trichlorobenzene	0.0010	ND	ND	ND	ND	0.008
1,2,4-trichlorobenzene	0.0010	ND	ND	ND	ND	0.015
1,3,5-trichlorobenzene	0.00050	ND	ND	ND	ND	0.014
1,1,1-trichloroethane	0.00050	ND	ND	ND	ND	--
1,1,2-trichloroethane	0.00050	ND	ND	ND	ND	--
Trichloroethene	0.00050	ND	ND	ND	ND	0.005
Trichlorofluoromethane	0.00050	ND	ND	ND	ND	--
1,2,4-trimethylbenzene	0.00050	ND	ND	ND	ND	--
1,3,5-trimethylbenzene	0.00050	ND	ND	ND	ND	--
Vinyl chloride	0.00050	ND	ND	ND	0.0007	0.0011

Notes:

- 1) Tier 1 Guideline - Alberta Tier 1 Soil and Groundwater Remediation Guidelines, December 2010 and amendments. Coarse-grained criteria for residential/parkland land use.
- 2) ND - Not Detected, less than the limit of method detection.
- 3) Unless specified all units are mg/L
- 4) -- No value established in the reference criteria.
- 5) Bold & Shaded - Exceeds the referenced Alberta Tier 1 Guidelines.
- 6) For further laboratory information, refer to the specific laboratory report in Appendix A.

Table 5A
Summary of Monitoring Parameters During Sampling of Soil Vapour

Parameter Unit	Well Diameter (mm)	Well Depth (m)	Headspace Volume (cm ³)	Purge Rate (cm ³ /min)	Purge Time (min)	Pressure	
						Ambient (psi)	Vapour Well (psi)
VW-01	25	5.5	2,700.0	943.3	5	15.00	15.00

Notes:

- 1) Measurement of pressure by digital Cole-Parmer absolute pressure gauge.
- 2) Purge time is elapsed time prior to the collection of a soil vapour sample.
- 3) Soil Vapour sampling was completed on August 19, 2013.

Table 5B
Analytical Results - Soil Vapour - General Indices

Parameter	Unit	Detection Limit	VW-01
<u>Gauge Pressure</u>			
Following sampling	psi	--	
Reported by laboratory	psi	--	(-4.0)
<u>Fixed Gases</u>			
Oxygen	% v/v	0.2	5.8
Nitrogen	% v/v	0.2	84.7
Carbon monoxide	% v/v	0.2	ND
Methane	% v/v	0.2	ND
Carbon dioxide	% v/v	0.2	9.5

Notes:

- 1) Soil vapour sample collected on Saturday, August 17, 2013.
- 2) ND - Not Detected, less than the limit of method detection.
- 3) -- No value established in the detection limit and reference criteria.
- 4) For further information, the reader should refer to the laboratory report in Appendix A.

Table 5C
Analytical Results - Soil Vapour - VOCs

Parameter	Unit	Detection Limit	VW-01
			08/17/2013
Hydrocarbon Fractions			
Aliphatic >C ₇ -C ₆	µg/m ³	5.0	6.3
Aliphatic >C ₆ -C ₈	µg/m ³	5.0	37.4
Aliphatic >C ₈ -C ₁₀	µg/m ³	5.0	36.9
Aliphatic >C ₁₀ -C ₁₂	µg/m ³	5.0	55.2
Aliphatic >C ₁₂ -C ₁₆	µg/m ³	5.0	18.4
Aromatic >C ₇ -C ₈ (TEX Excluded)	µg/m ³	5.0	ND
Aromatic >C ₈ -C ₁₀	µg/m ³	5.0	10.2
Aromatic >C ₁₀ -C ₁₂	µg/m ³	5.0	10.0
Aromatic >C ₁₂ -C ₁₆	µg/m ³	5.0	ND
Select Volatile Gases			
Acetylene	ppm	0.2	ND
Ethane	ppm	0.2	ND
Ethylene	ppm	0.2	ND
Methane	ppm	4.1	ND
n-Butane	ppm	0.41	ND
n-Pentane	ppm	0.2	ND
Propane	ppm	0.2	ND
Propene	ppm	0.2	ND
Propyne	ppm	0.41	ND
Volatile Organic Compounds			
Dichlorodifluoromethane (FREON 12)	ppbv	0.20	0.74
1,2-Dichlorotetrafluoroethane	ppbv	0.17	ND
Chloromethane	ppbv	0.30	0.92
Vinyl chloride	ppbv	0.18	ND
Chloroethane	ppbv	0.30	ND
1,3-Butadiene	ppbv	0.50	ND
Trichlorofluoromethane (FREON 11)	ppbv	0.20	0.31
Ethanol (ethyl alcohol)	ppbv	2.3	104
Trichlorotrifluoroethane	ppbv	0.15	0.18
2-propanol	ppbv	3.0	ND
2-Propanone	ppbv	0.80	26
Methyl ethyl ketone (MEK) (2-Butanone)	ppbv	3.0	ND
Methyl isobutyl ketone	ppbv	3.2	ND
Methyl butyl ketone (MBK) (2-Hexanone)	ppbv	2.0	ND
Methyl t-butyl ether (MTBE)	ppbv	0.20	ND
Ethyl acetate	ppbv	2.2	ND
1,1-Dichloroethylene	ppbv	0.25	ND
cis-1,2-Dichloroethylene	ppbv	0.19	ND
trans-1,2-Dichloroethylene	ppbv	0.20	ND
Methylene chloride(Dichloromethane)	ppbv	0.80	ND
Chloroform	ppbv	0.15	0.24
Carbon tetrachloride	ppbv	0.30	ND
1,1-Dichloroethane	ppbv	0.20	ND
1,2-Dichloroethane	ppbv	0.20	ND
Ethylene dibromide	ppbv	0.17	ND
1,1,1-Trichloroethane	ppbv	0.30	ND
1,1,2-Trichloroethane	ppbv	0.15	ND
1,1,2,2-Tetrachloroethane	ppbv	0.20	ND
cis-1,3-Dichloropropene	ppbv	0.18	ND
trans-1,3-Dichloropropene	ppbv	0.17	ND
1,2-Dichloropropane	ppbv	0.40	ND
Bromomethane	ppbv	0.18	ND
Bromoform	ppbv	0.20	ND
Bromodichloromethane	ppbv	0.20	ND
Dibromochloromethane	ppbv	0.20	ND
Trichloroethylene (TCE)	ppbv	0.30	ND
Tetrachloroethylene (PCE)	ppbv	0.20	ND
Benzene	ppbv	0.18	2.42
Toluene	ppbv	0.20	7.53
Ethylbenzene	ppbv	0.20	0.94
p+m-xylene	ppbv	0.37	4.38
o-xylene	ppbv	0.20	1.5
Styrene	ppbv	0.20	0.21
4-ethyltoluene	ppbv	2.2	ND
1,3,5-Trimethylbenzene	ppbv	0.50	ND
1,2,4-Trimethylbenzene	ppbv	0.50	0.58
Chlorobenzene	ppbv	0.20	ND
Benzyl chloride	ppbv	1.0	ND
1,3-Dichlorobenzene	ppbv	0.40	ND
1,4-Dichlorobenzene	ppbv	0.40	ND
1,2-Dichlorobenzene	ppbv	0.40	ND
1,2,4-Trichlorobenzene	ppbv	2.0	ND
Hexachlorobutadiene	ppbv	3.0	ND
Hexane	ppbv	0.30	1.99
Heptane	ppbv	0.30	1.88
Cyclohexane	ppbv	0.20	0.36
Tetrahydrofuran	ppbv	0.40	4.46
1,4-Dioxane	ppbv	2.0	ND
Xylene (Total)	ppbv	0.60	5.88
Vinyl bromide	ppbv	0.20	ND
Propene	ppbv	0.30	ND
2,2,4-Trimethylpentane	ppbv	0.20	0.41
Carbon disulfide	ppbv	0.50	8.70
Vinyl acetate	ppbv	0.20	ND

Notes:

- 1) Results are from sampling performed on Saturday, August 17, 2013.
- 2) ND - Not Detected, less than the limit of method detection.
- 3) - - No value established in the detection limit and reference criteria.
- 4) For further information, the reader should refer to the laboratory report in Appendix A.

Table 5D
Analytics Results - Soil Vapour - Siloxanes

Parameter	Detection Limit		VW-01	
	mg/m ³	ppm	08/17/2013	
			mg/m ³	ppm
Trimethylsilyl Fluoride	--	--	0.0007	0.0002
Tetramethylsilane	0.0001	0.0001	ND	ND
Methoxytrimethylsilane	0.0018	0.0004	ND	ND
Ethoxytrimethylsilane	0.0017	0.0004	ND	ND
Trimethylsilanol	--	--	0.0394	0.0107
Isopropoxytrimethylsilane	0.0007	0.0001	ND	ND
Trimethoxymethyl Silane #	--	--	ND	ND
Hexamethyl Disiloxane - L2	--	--	0.0005	0.0001
Propoxytrimethylsilane	0.002	0.0004	ND	ND
1-Methylbutoxytrimethylsilane *	--	--	ND	ND
Butoxytrimethylsilane *	--	--	ND	ND
Trimethoxyvinyl Silane #	--	--	ND	ND
Hexamethyl Cyclotrisiloxane - D3	--	--	0.0074	0.0008
Octamethyl Trisiloxane - L3	0.0001	0.0001	ND	ND
Triethoxyvinyl Silane #	--	--	ND	ND
Triethoxyethyl Silane #	--	--	ND	ND
Octamethyl Cyclotetrasiloxane - D4	--	--	0.0071	0.0006
Decamethyl Tetrasiloxane - L4	0.0002	0.0001	ND	ND
Tetraethylsilicate #	--	--	ND	ND
Decamethyl Cyclopentasiloxane - D5	--	--	0.0160	0.0011
Dodecamethyl Pentasiloxane - L5	0.0017	0.0006	ND	ND
Dodecamethyl Cyclohexasiloxane - D6	--	--	0.1747	0.0096
Sum	--	--	0.2541	0.0245












Notes:

- 1) Soil vapour samples collected on Saturday, August 17, 2013.
- 2) ND - Not Detected, less than the limit of method detection.
- 3) -- No value established in the detection limit and reference criteria.
- 4) V=200 mL, where V is volume of air/gas sampled.
- 5) * - Semiquantitative (response factor set at 5).
- 6) # - Unstable, poor detectability, commercial standards tested.
- 7) For further information, the reader should refer to the laboratory report in Appendix A.

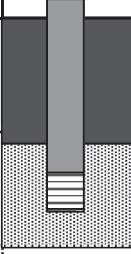
APPENDIX F

BOREHOLE LOGS

PROJECT: Phase II ESA Historic Waste Disposal Sites	BOREHOLE No.: VW-01
PROJECT No.: 12-435	DRILL TYPE: SS Auger
LOCATION: McKenzie Trails Recreation Area	GROUND ELEVATION: 853.853 m
CLIENT: The City of Red Deer	COMPLETION DATE: 06/20/2013












Sample Type:	 Shelby Tube	 Split Spoon	 Core	 Disturbed	 No Recovery	
Backfill Type:	 Bentonite	 Silica Sand	 Grout	 Pea Gravel	 Drill Cuttings	 Bentonite : Sand

Notes: Soil Vapour Well on east side of the park road (near the northeast quadrant of the pond)

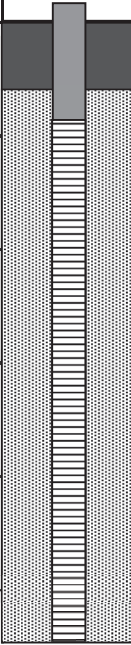
Depth (m)	Soil Description	Sample Type	Sample No.	SPT (N)	Combustible Soil Vapours (ppm)	Well Details
0.0	Sod and loam (fill) - loose, silty, sandy, trace rootlets, moist, dark olive. (~ 15 m thick).					
	Sand and gravel (fill) - compact, silty, trace rootlets, trace organics, moist, dark olive.					
1.0						
	becomes wet at 2 m.					
2.0	End of hole at 2.0 m. 25 mm diameter 0.3 m length 020 PVC screen. Aboveground lockable steel casing set in concrete.					
3.0						
4.0						
5.0						
6.0						
7.0						
8.0						
9.0						
10.0						
11.0						
12.0						

Tiamat Environmental Consultants Ltd.	Slough :	None	Completion Depth (m): 2
	Depth to Groundwater :		Checked By: LTM
	Logged By:	LTM	Page: 1 of 1

PROJECT: Phase II ESA Historic Waste Disposal Sites	BOREHOLE No.: MW-01
PROJECT No.: 12-435	DRILL TYPE: SS Auger/ODEX
LOCATION: McKenzie Trails Recreation Area	GROUND ELEVATION: 848.292 m
CLIENT: The City of Red Deer	COMPLETION DATE: 06/20/2013

Sample Type:	 Shelby Tube	 Split Spoon	 Core	 Disturbed	 No Recovery	
Backfill Type:	 Bentonite	 Silica Sand	 Grout	 Pea Gravel	 Drill Cuttings	 Bentonite : Sand

Notes: Groundwater Monitoring Well near VW-01

Depth (m)	Soil Description	Sample Type	Sample No.	SPT (N)	Combustible Soil Vapours (ppm)	Well Details
0.0	Sod and loam (fill) - loose, silty, sandy, moist, dark olive. (~ 15 cm thick).					
	Sand and gravel (fill) - loose, silty, trace organics, moist, dark olive.					
1.0						
2.0	becomes wet at 2 m.					
3.0						
4.0	Sand and gravel (native) - compact, trace silt, wet, olive.					
5.0						
6.0	End of hole at 5.5 m. 51 mm diameter 4.6 m length 010 PVC screen. Aboveground lockable steel casing set in concrete.					
7.0						
8.0						
9.0						
10.0						
11.0						
12.0						

Tiamat Environmental Consultants Ltd.	Slough :	None	Completion Depth (m): 5.5
	Depth to Groundwater :		Checked By: LTM
	Logged By:	JAL/LTM	Page: 1 of 1

PROJECT: Phase II ESA Historic Waste Disposal Sites				BOREHOLE No.: TH-03			
PROJECT No.: 12-435				DRILL TYPE: SS Auger			
LOCATION: McKenzie Trails Recreation Area				GROUND ELEVATION: 850.002 m			
CLIENT: The City of Red Deer				COMPLETION DATE: 06/20/2013			
Sample Type: <input type="checkbox"/> Shelby Tube <input checked="" type="checkbox"/> Split Spoon <input type="checkbox"/> Core <input type="checkbox"/> Disturbed <input type="checkbox"/> No Recovery							
Backfill Type: <input type="checkbox"/> Bentonite <input type="checkbox"/> Silica Sand <input type="checkbox"/> Grout <input type="checkbox"/> Pea Gravel <input type="checkbox"/> Drill Cuttings <input type="checkbox"/> Bentonite : Sand							
Notes: Testhole in north central area of waste; south of north parking lot and east of park maintenance storage							
Depth (m)	Soil Description	Sample Type	Sample No.	SPT (N)	Combustible Soil Vapours (ppm)		Well Details
0.0	Sod and loam (fill) - loose, sand, silty, trace rootlets, damp, olive. (~ 10 cm thick)						
1.0	Silt (fill) mixed with MSW - some organics, masonry brick fragments, ash, some plastic, grass clippings, news print, magazines, wood fragments, wire, glass, tin can, soft, loamy, trace rootlets, trace clay, damp, olive brown.						
2.0							
3.0	becomes wet at 3 m.						
4.0							
5.0							
6.0	Silt (native) - firm, trace sand, moist, olive brown. No obvious waste material.						
7.0	Shale (bedrock) - weak, highly weathered, damp, grey.						
8.0	End of hole at 7.6 m. Backfilled with bentonite chips to 5.5 m; ~ 50:50 bentonite and silica sand to surface.						
9.0							
10.0							
11.0							
12.0							
Tiamat Environmental Consultants Ltd.		Slough : None				Completion Depth (m): 7.6	
		Depth to Groundwater :				Checked By: LTM	
		Logged By: LTM				Page: 1 of 1	

PROJECT: Phase II ESA Historic Waste Disposal Sites				BOREHOLE No.: TH-04			
PROJECT No.: 12-435				DRILL TYPE: SS Auger			
LOCATION: McKenzie Trails Recreation Area				GROUND ELEVATION: 850.580 m			
CLIENT: The City of Red Deer				COMPLETION DATE: 07/11/2013			
Sample Type: <input type="checkbox"/> Shelby Tube <input checked="" type="checkbox"/> Split Spoon <input type="checkbox"/> Core <input type="checkbox"/> Disturbed <input type="checkbox"/> No Recovery							
Backfill Type: <input type="checkbox"/> Bentonite <input type="checkbox"/> Silica Sand <input type="checkbox"/> Grout <input type="checkbox"/> Pea Gravel <input type="checkbox"/> Drill Cuttings <input type="checkbox"/> Bentonite : Sand							
Notes: TH-04 near the parking lot for the picnic area							
Depth (m)	Soil Description	Sample Type	Sample No.	SPT (N)	Combustible Soil Vapours (ppm)	Well Details	
0.0	Sod and loam (fill) - sandy, trace silt, damp, olive. (~ 8 cm thick)						
1.0	Sand (fill) mixed with MSW - organics, minor plastic pieces, metal, trace glass fragments, strong pungent odour, compact, silty, moist, olive brown.						
2.0	Silt (fill) - firm, sandy, moist, olive.						
3.0	charred wood fragments with sand and gravel matrix at 2.4 m.						
4.0	No obvious waste material.						
5.0	Sand and gravel (native) - compact, wet, olive.						
6.0	becomes wet at 3.8 m.						
7.0	Siltstone (bedrock) - weak, highly weathered, moist, grey.						
8.0	End of hole at 7.6 m. Backfilled with ~ 50:50 bentonite and silica sand.						
9.0							
10.0							
11.0							
12.0							
Tiamat Environmental Consultants Ltd.		Slough : None				Completion Depth (m): 7.6	
		Depth to Groundwater :				Checked By: LTM	
		Logged By: LTM				Page: 1 of 1	