

2021 Groundwater and Soil Vapour Monitoring Report McKenzie Trails Recreation Area NE and SE Portions of Section 28-037-27 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 2021 groundwater and vapour monitoring program at the former landfill located beneath the McKenzie Trails Recreation Area (McKenzie Trails), located within the NE and SE Section of 28-038-27 W4M in Red Deer, Alberta, 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 2021 monitoring and sampling program at the McKenzie Trails site included conducting semi-annual events of groundwater and vapour monitoring, annual groundwater sampling, reviewing, and updating previous recommendations for the site, and preparing an annual report.

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 and soil vapour monitoring and sampling conducted in 2021 and previous years, Tetra Tech has developed the following conclusions:

- The groundwater elevations in 2021 could not be contoured as there were no clear elevation differences in the central portion of the site, while elevations at wells away from the centre may have been influenced by water level fluctuations in the nearby Red Deer River and adjacent channel sediments. However, the inferred groundwater flow direction based on historical results was overall northerly, which is consistent with the flow direction in the Red Deer River. Groundwater elevations in 2021 were overall slightly lower than the groundwater elevations measured in 2019.
- Routine groundwater chemistry parameters and dissolved metals that exceeded the Tier 1 Guidelines at one or more monitoring wells in 2021 included total dissolved solids (TDS), sodium, ammonia, and the dissolved metals arsenic, iron, manganese, and selenium. 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 2021, the only monitoring well that exceeded the guideline value derived for ammonia in accordance with the Environmental Quality Guidelines for Alberta Surface Waters was MW-04. The calculated guideline value for the well was 10.7 mg-N/L, while the measured concentration was 11.2 mg-N/L. Groundwater near MW-04 is expected to ultimately discharge into the Red Deer River, which is approximately 90 m north of the monitoring well. Based on the measured concentration and the expected dilution effect when groundwater discharges, the environmental risk is considered low.
- Concentrations of dissolved benzene, toluene, ethylbenzene, and xylenes (BTEX) and petroleum hydrocarbon (PHC) fractions F1 to F2, were less than the analytical detection limits at most locations in 2021. MW-203 had a detectable concentration of benzene (0.00058 mg/L), marginally greater than the analytical detection limit (0.00050 mg/L). Concentrations of BTEX and PHC fractions F1 and F2 were less than the Tier 1 Guidelines at all locations.
- Concentrations of vinyl chloride were greater than the Tier 1 Guideline in the groundwater samples collected from MW-03, MW-04, and MW-203. Additionally, concentrations of 1,2-dichloroethene (cis) (cis-1,2-DCE) were detected at MW-03, MW-04, and MW-203. The concentrations of vinyl chloride and cis-1,2-DCE measured are indicators of MSW leachate impacting the groundwater below the site. However, the concentrations of both volatile organic compounds (VOCs) have been consistent since 2019, the concentrations are considered low,

and the VOC concentrations are not interpreted to impose a significant risk to the freshwater quality in the nearby Red Deer River.

- In 2021, methane was not detected at vapour well VW-01. The methane concentrations from the groundwater monitoring well headspaces were also measured and were all relatively low ranging from less than the instrument detection limit (5 parts per million [ppm]) at several wells in July and November to 190 ppm at MW-01 and MW-03 in July. For methane, 50,000 ppm, or 5% gas, is equivalent to the lower explosive limit (LEL). Additionally, methane concentrations in the on-site bathrooms were monitored, and the concentrations ranged from 10 ppm in November 2021 to 90 ppm in July 2021. The likelihood of methane accumulating in the outdoor bathrooms is low as they are open to atmospheric air along the base of the roofline.
- During the 2021 monitoring events, a site walkover was conducted to assess the thin soil cover identified in the earlier work by Tiamat Environmental Consultants Ltd. (Tiamat), to evaluate for exposed wastes and/or seepage along the riverbank. No potential exposed wastes and/or seepage was identified during the site walkovers in July 2021 and November 2021.

Based upon the results of the groundwater monitoring program in 2021 and previous years, there are residual impacts in the groundwater and buried waste remains beneath the site; therefore, ongoing risk management is required; however, the risk management can be reduced over time with consistent analytical results. Risk management is recommended to include ongoing monitoring and administrative actions. The following recommendations are made according to these risk management elements:

- Ongoing Monitoring:
 - Reduce the groundwater monitoring and sampling program to annually at the site for another year to confirm concentrations measured to date and to monitor trends. If groundwater results remain consistent, Tetra Tech proposes to reduce the monitoring events over time, as illustrated in Table 6.1 below. However, if groundwater quality drastically changes, adjustments should be made to the monitoring program accordingly.

Proposed Groundwater and Vapour Monitoring Program

Activity	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Annual Groundwater Monitoring (6 wells) and Sampling (3 wells)	X		X			X				X

- The groundwater monitoring and sampling program going forward should consist of water level monitoring at the six on-site monitoring wells (MW-01, MW-02, MW-03, MW-04, MW-05, and MW-203) and sampling of the three down-gradient monitoring wells (MW-03, MW-04, and MW-203) as per the proposed schedule.
- Based on the 2021 results, the risk of vapour migration is interpreted to be low and soil vapour headspace monitoring of all wells (groundwater and vapour) and on-site bathrooms is not recommended to continue.
- Administrative Actions:
 - Utilize 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 an 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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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 2021 groundwater and vapour 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 based on a broader program for The City's pre-1972 landfill sites. The results of that monitoring program identified indications of leachate impacts related to the former landfill operations at several monitoring wells. Based on these findings, Tetra Tech recommended conducting an additional year of soil vapour and groundwater monitoring to verify the on-site methane concentrations and conduct groundwater sampling to confirm the concentrations of leachate related parameters.

This report presents the results of the 2021 groundwater and vapour monitoring and sampling program at the site, which was undertaken based on the document 2021 Work Scope and Cost Estimate – Red Deer Pre-1972 Landfills, submitted to The City on March 2, 2021.

1.1 2019 Report – Key Findings and Recommendations

The scope of work for the 2019 monitoring program was based on the proposal submitted by Tetra Tech on January 11, 2019 to The City to conduct environmental monitoring services for the pre-1972 landfill sites.

The objectives of the project outlined in the 2019 proposal were to:

- Confirm and implement the prior recommendations, as per the request for proposal (RFP);
- Consult with the regulator on amendments to the program, as required;
- Conduct environmental monitoring and sampling for each of the eight sites, as outlined in the RFP recommendations, while incorporating any approved recommendations;
- Update the hazard quotients for each site; and
- Prepare an environmental monitoring report for each site.

The 2019 groundwater and vapour monitoring report identified that there was no evidence of significant concerns related to the former landfill operations at McKenzie Trails. However, there was evidence of residual impacts by leachate and the site does contain buried landfill waste; therefore, some risk management measures are required. Key findings of the report included the following:

- The groundwater elevations in 2019 indicated that the inferred groundwater flow direction was overall northerly, which is consistent with the groundwater flow direction from 2013 and the flow direction in the Red Deer River.
- Routine groundwater chemistry parameters and dissolved metals that exceeded the Alberta Tier 1 Soil and Groundwater Remediation Guidelines (Tier 1 Guidelines) at one or more monitoring wells in 2019 included total dissolved solids (TDS), ammonia, arsenic, copper, 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.

- 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 locations in 2019. MW-203 had a detectable concentration of benzene (0.00053 mg/L), marginally greater than the analytical detection limit (0.00050 mg/L). Concentrations of BTEX and PHC fractions F1 and F2 were less than the Tier 1 Guidelines at all locations.
- Concentrations of vinyl chloride were greater than the Tier 1 Guideline in the groundwater samples collected from MW-04 and MW-203. Concentrations of vinyl chloride were historically less than the analytical detection limit at MW-04; no historical data was available for MW-203.
- Concentrations of BTEX, hydrocarbons, and volatile organic compounds (VOCs) in the soil vapour sample were less than the calculated soil vapour screening criteria.
- Concentrations of siloxanes were less than the analytical detections limits in the vapour sample collected.
- The estimated individual and cumulative risks and hazards associated with the soil vapour sample collected in December 2019 did not exceed the corresponding target risk and hazard levels.

Based on these findings, recommendations for the 2021 monitoring program were as follows:

- Continue with a semi-annual groundwater monitoring program, with annual sampling at the hydraulically down-gradient monitoring wells (MW-03, MW-04, and MW-203) for another year to confirm trends. These wells should be sampled for routine chemistry, dissolved metals, and VOC parameters.
- Survey the elevation of MW-203 to better establish the groundwater flow pattern within the northern portion of the site.
- If the measured concentrations are stable or decreasing, discontinue monitoring and sampling at the site. If the concentrations are confirmed and remain greater than the referenced guidelines, a qualitative evaluation of risks should be made to evaluate the potential concern, if any, these concentrations pose to the adjacent Red Deer River.
- Based on the results of the soil vapour sample, there is little indication that this pathway will pose a hazard to receptors. The soil vapour concentrations were less than the levels of concern and groundwater concentrations of volatile chemicals were also less than the established Tier 1 Guidelines, except for vinyl chloride at monitoring wells MW-04 and MW-203. Historical results have not identified vinyl chloride. If the concentrations of vinyl chloride exceed the referenced guideline in groundwater during the next monitoring events, a qualitative evaluation of risks, as stated above, should be conducted.
- Conduct vapour headspace monitoring for methane at each monitoring well in conjunction with the groundwater monitoring program.
- Conduct a walkthrough of the bathroom buildings located near the centre of the site, within the waste footprint, to evaluate the potential for accumulation of methane; if the potential for accumulation is identified, indoor air monitoring could be undertaken in conjunction with the well headspace monitoring.
- Continue to monitor the riverbank during the semi-annual monitoring events for potential waste exposure and seepage due to bank erosion.

1.2 Scope of Work

Based on the 2019 findings and recommendations, the 2021 monitoring program scope of work included the following activities:

- Conducting semi-annual events of groundwater and vapour monitoring, including measuring headspace vapours and 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; and
 - Collecting groundwater samples from each well and submitting the samples for laboratory chemical analyses.
- Conducting a semi-annual walkthrough of the on-site bathrooms to assess the potential for methane accumulation.
- Conduct a semi-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 and soil vapour monitoring results.

In the 2019 groundwater and soil vapour monitoring report (Tetra Tech 2020), Tetra Tech recommended monitoring of groundwater monitoring well headspaces for methane as a useful screening tool in the absence of vapour wells in other areas of the site. Subsequently, headspace monitoring at these wells was undertaken for methane, and monitoring for VOCs and combustible vapour concentrations (CVCs) was not conducted in 2021.

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 Park. 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 Environmental Consultants Ltd. (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 on 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 (Tiamat Environmental Consultants Ltd. [Tiamat] 2014b). Cross-sections that were prepared using the wells previously installed at the site in 2013 are included in Appendix C (from 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 Parks [AEP] 2019). 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 chemical oxygen demand [COD]).	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.
		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 AEP, 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 (AEP 2019).
- 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).

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 municipal solid waste (MSW) to bedrock. Monitoring well completion details are summarized in Table 1. Most monitoring wells were reported to be in good condition in 2021. MW-03 and MW-04 appeared to have been vandalized and were repaired in November 2021. The vapour monitoring network consists of one vapour monitoring well (VW-01) near the southeast corner of the site. The vapour well was reported to be in good condition during all events in 2021.

Monitoring well MW-203 was surveyed by The City in 2021 and is now incorporated into the monitoring well network.

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

3.0 MONITORING AND SAMPLING METHODOLOGY

3.1 Groundwater Monitoring and Sampling

A discussion of the methods used for the fieldwork and laboratory testing is presented in the following sections. In 2021, Tetra Tech conducted groundwater monitoring on July 9 and July 12, and November 21. Groundwater sampling was conducted on November 21, 2021.

3.1.1 Groundwater Monitoring and Sampling Methodology

Monitoring at the groundwater monitoring wells (51 mm diameter) consisted of measuring methane in the monitoring well headspace and static groundwater levels in each monitoring well semi-annually (July and November).

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 the methane headspace concentrations in each well using an RKI Eagle Hydrocarbon Surveyor II (RKI Eagle) calibrated to methane.

- Measuring liquid levels in each monitoring well with an interface probe and recording total depths confirming absence of non-aqueous phase liquids (NAPL) and evaluating the water level relative to the screen to confirm the screen was not blinded.
- 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 and dissolved metals.
- VOCs.

3.2 Vapour Monitoring and Sampling Program

A discussion of the methods used for the fieldwork and laboratory testing is presented in the following sections. In 2021, Tetra Tech conducted vapour monitoring on July 9 and November 21.

3.2.1 Vapour Monitoring Methodology

Monitoring at the vapour monitoring probe (25 mm diameter) consisted of measuring and recording soil gas pressure, composition (methane, carbon dioxide, oxygen, hydrogen sulphide, and balance) on a percent volumetric basis, and groundwater elevation semi-annually (July and November).

The soil vapour probe was inspected for visible signs of damage and the position of the sampling labcock was noted. Soil gas pressure was recorded using a digital manometer. Once the soil gas pressure measurement was recorded, the soil gas probe was purged of three well volumes of air, or until readings stabilized. The soil vapour well on site is a small diameter soil gas probe and was purged directly with the GEM LFG analyzer.

After purging, gas composition measurements for methane, carbon dioxide, oxygen, balance gas, and hydrogen sulphide were recorded using the GEM analyzer. After recording soil gas concentrations, the probe/well depths and water levels were measured and recorded to confirm the water level within the probe was beneath the screen portion of the soil gas probe (i.e., the probe was not blinded).

After monitoring, the soil vapour probe sampling port was returned to the closed position and the well was securely locked.

4.0 RESULTS AND DISCUSSION

This section presents the results of the fieldwork conducted in 2021 at the site and discussions of these results.

4.1 Well Headspace Monitoring

The headspace vapour concentrations for 2021 are presented in Table 1 (groundwater wells) and Table 4 (soil vapour probe). Based on the style of installation, different monitoring methodologies were utilized; however, the instruments utilized were each calibrated to methane. In 2021, Tetra Tech monitored six groundwater monitoring wells (MW-01, MW-02, MW-03, MW-04, MW-05 and MW-203) semi-annually for measurements of methane in well headspace using an RKI Eagle, calibrated to methane. The RKI Eagle detection limit ranges from 5 parts per million (ppm) to 100% of the lower explosive limit (LEL). For methane, 500 ppm is equivalent to 1% LEL; 20% LEL is equivalent to 1% Gas.

At the groundwater monitoring wells, the water level was above the top of the monitoring well screen for monitoring wells MW-02 and MW-05 during both monitoring events in 2021, meaning the wells were blinded and headspace vapour measurements are not representative for in-situ soil vapours. Monitoring well MW-01 located up-gradient of the waste footprint was not blinded during the 2021 monitoring events. The top of screen elevations are unknown for MW-03, MW-04, and MW-203; consequently, it cannot be determined if the wells were blinded during the 2021 monitoring events. The vapour well (VW-01) was dry during both events in 2021 indicating the well was not blinded with groundwater.

During the July 2021 monitoring event, methane headspace concentrations at the groundwater wells (measured using the RKI) ranged from less than the instrument detection limit at down-gradient wells MW-04 and MW-203 to 190 parts per million (ppm) at MW-01 and MW-03. During the November 2021 monitoring event, methane headspace concentrations at the groundwater wells ranged from less than the instrument detection limit at MW-03, MW-04, and MW-203 to 50 ppm at MW-05. At the vapour well (VW-01), concentrations of methane (measured using the GEM) were less than the instrument detection limit during both monitoring events in 2021.

During the 2021 monitoring events, methane concentrations were measured (using the RKI) at the bathrooms located in the centre of the site and the bathroom located west of the parking lot near MW-203. The on-site bathrooms are labelled on Figure 2. The on-site bathrooms are unlocked outdoor public bathrooms that are open to atmospheric air along the base of the roofline. During the monitoring events, the instrument did not detect measurable amounts of methane in any bathroom. The manhole located next to the central bathroom was measured to have 90 ppm in July 2021 and 10 ppm in November 2021. The methane concentrations measured from the manhole are considered low and not necessarily interpreted to be related to methane migration from the landfill.

Wellhead pressures at vapour well VW-01 were negligible during both monitoring events in 2021. Carbon monoxide was detected at VW-01 in July 2021 (1.0%); however, the concentration was less than the instrument detection limit in November 2021. Concentrations of carbon dioxide, oxygen, and the balance gas were consistent during both monitoring events and with the concentrations measured in 2019.

4.2 Groundwater Elevations

The measured groundwater levels and calculated groundwater elevations for 2021 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, and 2021. Overall, groundwater elevations decreased at most monitoring wells from those measured in 2019, with the exception of MW-03 and MW-05. Groundwater levels remained fairly constant throughout 2021. Similar decreases in water levels were observed at MW-01, MW-02, MW-04, and MW-203 from July 2021 to November 2021.

In 2021, the average depth to groundwater in the monitoring wells was 2.34 m below grade (mbg) in July, and 2.56 mbg in November 2021. The groundwater elevations for July 2021 and November 2021 are shown on Figure 4 and Figure 5, respectively. In 2021, the groundwater elevations were not contoured as there were no clear elevation differences in the middle of the site, while elevations at wells away from the centre may have been influenced by water level fluctuations in the nearby Red Deer River and its historical channel sediments. The wells installed in native soils suggest an overall northern direction of flow parallel to the river; the central well installed in waste (MW-05) has a marginally greater elevation suggesting that the site may represent a localized mounding of groundwater. The historical groundwater flow is interpreted to be north-northwest towards the Red Deer River.

4.3 Groundwater Field Parameters

Field measurements for temperature, pH, and EC in November 2021 are shown in Table 2. A discussion of the results of the field tests is summarized in this section.

In 2021, groundwater temperatures ranged from 5.7°C (MW-203) to 7.9°C (MW-03).

In 2021, field pH values ranged from 6.76 (MW-203) to 7.22 (MW-03). The field pH measurements were generally less than the laboratory pH at all monitoring wells. The difference between field recorded and laboratory pH values may be due to limitations of the field equipment and differences in sample temperature.

In 2021, field EC measurements ranged from 1,062 µS/cm (MW-203) to 1,564 µS/cm (MW-03). The field EC measurements were less than the laboratory measured EC results, which may be due to limitations of field equipment or temperature differences.

4.4 Groundwater Analytical Results

The groundwater analytical data for 2021 is summarized in Table 2. The 2021 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

MW-01 and MW-02 are up-gradient of the site and may represent background groundwater quality. Monitoring wells MW-01 and MW-02 were not sampled in 2021. 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 guideline exceedances of dissolved arsenic, dissolved iron, and dissolved lead and MW-02 contained concentrations of dissolved manganese and dissolved copper 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 2021, TDS concentrations ranged from 803 mg/L (MW-203) to 1,100 mg/L (MW-03). TDS concentrations at monitoring wells MW-03, MW-04, and MW-203 were greater than the Tier 1 Guidelines (500 mg/L) in 2021. TDS concentrations measured in 2021 were consistent with the results from 2019. 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. Monitoring wells MW-03, MW-04, and MW-203 exhibited elevated concentrations of hardness (calcium and magnesium combined) and alkalinity with respect to the other site wells in 2019 and reported similar concentrations in 2021. Elevated concentrations of hardness and alkalinity is often observed when the groundwater quality is affected by leachate.

In 2021, concentrations of chloride at the site ranged from 24.0 mg/L at MW-203 to 43.2 mg/L at MW-03. The concentrations at all wells were less than the Tier 1 Guidelines (120 mg/L). Concentrations of chloride in 2021 were consistent with concentrations measured in 2013 and 2019.

In 2021, sodium concentrations increased at all monitoring wells that were analyzed. The sodium concentration at monitoring well MW-03 increased in 2021 to greater than the Tier 1 Guideline. The increase in sodium concentrations may be from variations in natural salinity of the deeper groundwater and is not interpreted to be indicative of site impacts.

Ammonia concentrations at several monitoring wells adjacent to the former waste footprint have been elevated relative to monitoring wells outside the waste (e.g., MW-01 and MW-02), and often near or greater than the referenced guideline values. In 2021, the only monitoring well that exceeded the guideline value derived in accordance with the Environmental Quality Guidelines for Alberta Surface Waters was MW-04. The calculated guideline value for the well was 10.7 mg-N/L (AEP 2018), while the measured concentration was 11.2 mg-N/L. Groundwater near MW-04 is expected to ultimately discharge into the Red Deer River, which is approximately 90 m north of the monitoring well. Based on the measured concentration and the expected dilution effect when groundwater discharges, the environmental risk is considered low.

Concentrations of nitrate and nitrite were less than the analytical detection limits at most monitoring wells, except for nitrate at MW-04 (0.301 mg-N/L) and MW-203 (0.121 mg-N/L), which were less than the Tier 1 Guideline.

4.4.3 Dissolved Metals

In 2021, the concentration of dissolved arsenic at MW-04 (0.00618 mg/L) was greater than the Tier 1 Guideline (0.005 mg/L) and dissolved selenium (0.00254 mg/L) exceeded the guideline (0.002 mg/L) at MW-203. Dissolved arsenic is strongly absorbed 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 five monitoring wells in 2019 and 2021 show a correlation between dissolved iron and dissolved arsenic concentrations. The arsenic exceedance also near the Tier 1 Guideline and may be predominantly a result of iron(hydr)oxide dissolution rather than originating from MSW leachate. The single selenium exceedance is marginal (0.00254 mg/L), may be natural occurring, and is not considered to be of concern.

Iron and manganese are redox-sensitive parameters that also 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. The dissolved manganese and iron concentrations were greater than the Tier 1 Guidelines (0.05 mg/L) at all monitoring wells during the sampling event in 2021.

4.4.4 Organic Parameters

Concentrations of BTEX and PHC fractions F1 to F2, were less than the analytical detection limits at most locations in 2021. MW-203 had a detectable concentration of benzene in 2021 (0.00058 mg/L), marginally greater than the analytical detection limit (0.00050 mg/L). The concentration was less than the Tier 1 Guideline (0.005 mg/L) and similar to the concentration measured in 2019 (0.00053 mg/L).

In 2021, VOC concentrations were less than the analytical detection limits for most parameters, except for cis-1,2-dichloroethene (cis-1,2-DCE) and vinyl chloride at MW-03, 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-03 (0.0021 mg/L), MW-04 (0.0032 mg/L), and MW-203 (0.0046 mg/L); however, the concentrations were within the same order of magnitude as the guideline (0.0011 mg/L). It should be noted that the Tier 1 Guideline for vinyl chloride is based off human vapour inhalation and there is currently no guideline pertaining to freshwater aquatic life. The VOC concentrations measured in 2021 are consistent with the concentrations measured in 2019.

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 2021 or 2019; 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 above, the well is completed within an area with MSW and was not sampled in either 2019 or 2021.

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 consistently been detected since 2019, the concentrations are relatively low. 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). It 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 present a significant 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;
- Conducting leak testing at vapour wells prior to the collection of vapour samples;
- Collecting a duplicate vapour sample during the vapour sampling event; and
- Documenting field procedures and sampling activities.

4.5.2 Results

The QA/QC results are included in Table 3. The duplicate sample 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 2021 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. Further, there are several elements of the site assessment data requiring further confirmation as detailed below.

The groundwater quality appears to be affected by leachate at several monitoring wells. Most obvious are elevated ammonia concentrations at 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 2021 at the down-gradient monitoring wells. One VOC compound (vinyl chloride) exceeded the referenced Tier 1 Guidelines at MW-03, 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. The methane headspace concentrations in the groundwater monitoring wells were measured with the RKI Eagle. The RKI Eagle detection limit ranges from 5 ppm to 100% LEL. For methane, 500 ppm is equivalent to 1% LEL; 20% LEL is equivalent to 1% Gas. In 2021, methane headspace measurements from the groundwater monitoring wells were conducted and the concentrations ranged from less than the instrument detection limit at several wells in July and November to 190 ppm at MW-01 and MW-03 in July.

Additionally, methane concentrations in the on-site bathrooms were monitored, and the concentrations were less than the instrument's detection limits. The on-site bathrooms are unlocked outdoor public bathrooms that are vented to the atmospheric air and the risk for methane accumulation in the outdoor bathrooms is considered low.

During the 2021 monitoring events, a site walkover was conducted to assess the thin soil cover identified in the earlier work by Tiamat, to evaluate for exposed wastes and/or seepage along the riverbank. No potential exposed wastes and/or seepage was identified during the site walkovers in July and November.

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

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon the results of the groundwater and soil vapour monitoring and sampling conducted in 2021 and previous years, Tetra Tech has developed the following conclusions:

- The groundwater elevations in 2021 could not be contoured as there were no clear elevation differences in the central portion of the site, while elevations at wells away from the centre may have been influenced by water level fluctuations in the nearby Red Deer River and its adjacent channel sediments. However, the inferred groundwater flow direction based on historical results was overall northerly, which is consistent with the flow direction in the Red Deer River. Groundwater elevations in 2021 were overall slightly lower than the groundwater elevations measured in 2019.
- Routine groundwater chemistry parameters and dissolved metals that exceeded the Tier 1 Guidelines at one or more monitoring wells in 2021 included TDS, sodium, ammonia, and the dissolved metals arsenic, iron, manganese, and selenium. 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 2021, the only monitoring well that exceeded the guideline value derived for ammonia in accordance with the Environmental Quality Guidelines for Alberta Surface Waters was MW-04. The calculated guideline value for the well was 10.7 mg-N/L, while the measured concentration was 11.2 mg-N/L. Groundwater near MW-04 is expected to ultimately discharge into the Red Deer River, which is approximately 90 m north of the monitoring well. Based on the measured concentration and the expected dilution effect when groundwater discharges, the environmental risk is considered low.
- Concentrations of BTEX and PHC fractions F1 to F2, were less than the analytical detection limits at most locations in 2021. MW-203 had a detectable concentration of benzene (0.00058 mg/L), marginally greater than the analytical detection limit (0.00050 mg/L). Concentrations of BTEX and PHC fractions F1 and F2 were less than the Tier 1 Guidelines at all locations.
- Concentrations of vinyl chloride were greater than the Tier 1 Guideline in the groundwater samples collected from MW-03, MW-04, and MW-203. Additionally, concentrations of cis-1,2-DCE were detected at MW-03, MW-04, and MW-203. The concentrations of vinyl chloride and cis-1,2-DCE measured are indicators of MSW leachate impacting the groundwater below the site. However, the concentrations of both VOCs have been consistent since 2019, the concentrations are considered low, and the VOC concentrations are not interpreted to impose a significant risk to the freshwater quality in the nearby Red Deer River.
- In 2021, methane was not detected at vapour well VW-01. The methane concentrations from the groundwater monitoring well headspaces were also measured and were all relatively low ranging from less than the instrument detection limit (5 ppm) at several wells in July and November to 190 ppm at MW-01 and MW-03 in July. For methane, 50,000 ppm, or 5% gas, is equivalent to the lower explosive limit. Additionally, methane concentrations in the on-site bathrooms were monitored, and the concentrations ranged from 10 ppm in November 2021 to 90 ppm in July 2021. The likelihood of methane accumulating in the outdoor bathrooms is low as they are open to atmospheric air along the base of the roofline.

- During the 2021 monitoring events, a site walkover was conducted to assess the thin soil cover identified in the earlier work by Tiamat, to evaluate for exposed wastes and/or seepage along the riverbank. No potential exposed wastes and/or seepage was identified during the site walkovers in July 2021 and November 2021.

Based upon the results of the groundwater monitoring program in 2021 and previous years, there are residual impacts in the groundwater and buried waste remains beneath the site; therefore, ongoing risk management is required; however, the risk management can be reduced over time with consistent analytical results. Risk management is recommended to include ongoing monitoring and administrative actions. The following recommendations are made according to these risk management elements:

- Ongoing Monitoring:
 - Reduce the groundwater monitoring and sampling program to annually at the site for another year to confirm concentrations measured to date and to monitor trends. If groundwater results remain consistent, Tetra Tech proposes to reduce the monitoring events over time, as illustrated in the table below. However, if groundwater quality drastically changes, adjustments should be made to the monitoring program accordingly.

Proposed Groundwater and Vapour Monitoring Program

Activity	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Annual Groundwater Monitoring (6 wells) and Sampling (3 wells)	X		X			X				X

- The groundwater monitoring and sampling program going forward should consist of water level monitoring at the six on-site monitoring wells (MW-01, MW-02, MW-03, MW-04, MW-05, and MW-203) and sampling of the three down-gradient monitoring wells (MW-03, MW-04, and MW-203) as per the proposed schedule.
- Based on the 2021 results, the risk of vapour migration is interpreted to be low and soil vapour headspace monitoring of all wells (groundwater and vapour) and on-site bathrooms is not recommended to continue.
- Administrative Actions:
 - Utilize 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 an 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.



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<p align="center">PERMIT TO PRACTICE TETRA TECH CANADA INC.</p> <p>RM SIGNATURE: _____</p> <p>RM APEGA ID #: _____</p> <p>DATE: _____</p> <p>PERMIT NUMBER: P013774 The Association of Professional Engineers and Geoscientists of Alberta (APEGA)</p>
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REFERENCES

- Agency for Toxic Substances and Disease Registry. 1996. Toxicology Profile for 1,2-Dichloroethene. Atlanta, GA.
- Alberta Environment and Parks. 2019. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Land Policy Branch, Policy and Planning Division. 198 pp.
- 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>.
- Government of Alberta. 2018. Environmental Quality Guidelines for Alberta Surface Waters. Water Policy Branch, Alberta Environment and Parks. Edmonton, Alberta.
- 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.
- Tiamat Environmental Consultants Ltd. 2013. Phase I Environmental Site Assessment, Historic Waste Disposal Site, McKenzie Trails Recreation Area, The City of Red Deer. September 24, 2013.
- 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.
- Tiamat Environmental Consultants Ltd. 2014b. Environmental Risk Management Plan, Historic Waste Disposal Sites, McKenzie Trails Recreation Area, The City of Red Deer. November 26, 2014.
- World Health Organization. 2004. Vinyl Chloride in Drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality. https://www.who.int/water_sanitation_health/dwq/chemicals/vinylchloride.pdf [accessed March 14, 2021].
- World Health Organization. 2003. 1,2-Dichloroethene in Drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality. https://www.who.int/water_sanitation_health/water-quality/guidelines/chemicals/1-2-dichloroethene-background.pdf [accessed March 14, 2021]

TABLES

Table 1	Monitoring Results – Groundwater Wells
Table 2	Groundwater Analytical Results
Table 3	Groundwater Quality Assurance/Quality Control Analytical Results
Table 4	Monitoring Results – Soil Vapour Well

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	-
Stick up (m)		0.79	0.92	0.87	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
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
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

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	21-Nov-2021 DUP	4-Dec-2019	21-Nov-2021	5-Dec-2019	21-Nov-2021
Field											
Field Temperature	°C	-	2.90	5.42	2.64	7.88	-	2.67	6.63	1.15	5.72
Field Electric Conductivity	µS/cm	-	434	381	1,017	1564	-	973	1521	510	1062
Field pH	pH Units	6.5 to 8.5	8.53	7.98	7.48	7.22	-	7.25	7.04	7.64	6.76
Routine											
pH	pH Units	6.5 to 8.5	8.13	8.22	7.77	7.85	7.89	7.53	7.71	8.03	7.79
Electrical Conductivity (EC)	µS/cm	-	617	559	1,680	1690	1650	1,660	1700	1,030	1410
Total Dissolved Solids (TDS)	mg/L	500	378	333	1,090	1100	1060	1,010	1080	633	803
Hardness as CaCO ₃	mg/L	-	289	269	646	537	534	664	714	437	421
Alkalinity (total as CaCO ₃)	mg/L	-	337	255	934	937	878	872	939	510	743
Bicarbonate	mg/L	-	411	311	1,140	1140	1070	1,060	1140	622	906
Carbonate	mg/L	-	<5.0	<5.0	<5.0	<1.0	<1.0	<5.0	<1.0	<5.0	<1.0
Hydroxide	mg/L	-	<5.0	<5.0	<5.0	<1.0	<1.0	<5.0	<1.0	<5.0	<1.0
Calcium	mg/L	-	71.7	72.2	168	144	142	168	185	119	110
Magnesium	mg/L	-	26.8	21.6	55.0	43.0	43.5	59.3	61.1	33.9	35.5
Potassium	mg/L	-	4.27	2.70	9.68	8.04	8.16	20.7	18.9	13.8	13.0
Sodium	mg/L	200	40.1	16.4	174	207	209	96.6	113	47.1	64.8
Chloride	mg/L	120	17.0	7.67	49.6	43.2	42.8	42.9	29.4	19.5	24.0
Fluoride	mg/L	1.5	0.094	0.086	<0.10	<0.100	<0.100	<0.10	<0.100	<0.10	<0.100
Phosphorus - Total	mg/L	-	0.412	0.202	0.273	-	-	0.568	-	0.35	-
Sulphate	mg/L	429 ³	16.0	59.6	69.5	64.4	63.7	94.7	71.4	93.2	78.3
Anions Total (Filtered)	meq/L	-	-	-	-	21.3	20.1	-	21.1	-	17.2
Cations Total (Filtered)	meq/L	-	-	-	-	20.4	20.4	-	20.7	-	12.5
Ionic Balance	N/A	-	102	94.0	98.6	104.4	98.5	91.1	102	95.2	138
Nutrients											
Ammonia as N	mg/L	0.309 to 29.961 ⁶	0.477	<0.050	7.00	5.51	5.23	10.4	11.2	13.3	12.9
Nitrate (as NO ₃ -N)	mg/L	3	<0.020	<0.020	<0.10	<0.100	<0.100	0.17	0.301	<0.10	0.121
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
Nitrate and Nitrite (as N)	mg/L	-	<0.022	<0.022	<0.11	-	-	0.17	-	<0.11	-
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	0.0061	0.0348	<0.0050	0.0035	0.0080
Antimony	mg/L	0.006	0.00014	0.00013	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00010	<0.00050
Arsenic	mg/L	0.005	0.00828	0.00029	0.00137	0.00158	0.00179	0.00440	0.00618	0.00796	0.00209
Barium	mg/L	1	0.421	0.152	0.309	0.371	0.372	0.253	0.278	0.188	0.211
Beryllium	mg/L	-	-	-	-	<0.000100	<0.000100	-	<0.000100	-	<0.000100
Bismuth	mg/L	-	-	-	-	<0.000250	<0.000250	-	<0.000250	-	<0.000250
Boron	mg/L	1.5	0.024	0.016	0.875	0.907	0.882	0.977	1.47	0.494	0.617
Cadmium	mg/L	0.00036 to 0.00037 ³	<0.000050	0.000148	<0.00025	0.0000286	0.0000274	0.0000830	0.000120	0.0000408	<0.0000250
Chromium	mg/L	0.05	<0.00010	<0.00010	<0.00050	<0.00250	<0.00250	<0.00050	<0.00250	0.00015	<0.00250
Cobalt	mg/L	-	-	-	-	0.00225	0.00214	-	0.00444	-	<0.00050
Copper	mg/L	0.007	<0.00020	0.00719	0.0052	<0.00100	<0.00100	<0.0010	<0.00100	<0.00020	<0.00100
Iron	mg/L	0.3	3.09	0.041	0.123	0.534	0.538	3.85	5.34	2.23	0.680
Lead	mg/L	0.0070 ³	<0.000050	0.000219	<0.00025	<0.000250	<0.000250	<0.00025	<0.000250	<0.000050	<0.000250
Lithium	mg/L	-	-	-	-	0.0499	0.0490	-	0.0304	-	0.0169
Manganese	mg/L	0.05	0.861	0.0843	1.02	0.780	0.785	1.16	1.16	0.303	0.297
Mercury	mg/L	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum	mg/L	-	-	-	-	0.00100	0.000941	-	0.00259	-	<0.000250
Nickel	mg/L	0.120 to 0.275 ³	0.00192	0.00099	0.0171	0.00532	0.00470	0.0093	0.00910	0.00054	0.00307
Phosphorus	mg/L	-	-	-	-	<0.250	<0.250	-	<0.250	-	0.977
Selenium	mg/L	0.002	0.000104	0.000132	<0.00025	<0.000250	<0.000250	<0.00025	<0.000250	0.000242	0.00254
Silicon	mg/L	-	-	-	-	6.45	6.36	-	7.02	-	4.84
Silver	mg/L	0.0001	<0.000010	<0.000010	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000010	<0.000050
Strontium	mg/L	-	-	-	-	1.80	1.77	-	1.81	-	1.21
Sulphur	mg/L	-	-	-	-	27.6	28.3	-	29.7	-	19.1
Thallium	mg/L	-	-	-	-	<0.000050	<0.000050	-	<0.000050	-	<0.000050
Tin	mg/L	-	-	-	-	<0.00050	<0.00050	-	<0.00050	-	<0.00050
Titanium	mg/L	-	-	-	-	<0.00150	<0.00150	-	<0.00150	-	<0.00150
Uranium	mg/L	0.015	0.000733	0.000851	0.00242	0.00238	0.00229	0.00297	0.00351	0.00059	0.000228
Vanadium	mg/L	-	-	-	-	<0.00250	<0.00250	-	<0.00250	-	<0.00250
Zinc	mg/L	0.03	<0.0010	0.0058	0.0247	0.0054	<0.0050	0.0097	0.0087	0.0011	<0.0050
Zirconium	mg/L	-	-	-	-	0.00141	0.00135	-	<0.00100	-	<0.00100

Notes:

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- 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	21-Nov-2021 DUP	4-Dec-2019	21-Nov-2021	5-Dec-2019	21-Nov-2021
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	0.00053	0.00058
Toluene	mg/L	0.021	<0.00050	<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
Xylenes (m & p)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.00030	<0.00030	<0.00050	<0.00030	<0.00050	<0.00030
Xylene (o)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.00040	<0.00040	<0.00050	<0.00040	<0.00050	<0.00040
Xylenes Total	mg/L	0.02	<0.00071	<0.00071	<0.00071	<0.00050	<0.00050	<0.00071	<0.00050	<0.00071	<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
F1 (C ₆ -C ₁₀)	mg/L	-	<0.10	<0.10	<0.10	-	-	<0.10	-	<0.10	-
F1 (C ₆ -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
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	-	<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
Bromochloromethane	mg/L	-	<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	<0.00050	<0.0010	<0.00050	<0.0010
Bromoform	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010
Bromomethane	mg/L	-	<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
sec-Butylbenzene	mg/L	-	<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
Carbon tetrachloride	mg/L	0.00057	<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	<0.00050	<0.0010	<0.00050	<0.0010
Chloroethane	mg/L	-	<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	<0.00050	<0.0010	<0.00050	<0.0010
Chloromethane	mg/L	-	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.0010	<0.0050	<0.0010	<0.0050
2-Chlorotoluene	mg/L	-	<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
Dibromochloromethane	mg/L	0.19	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<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
1,2-Dibromoethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010
Dibromomethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<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
1,3-Dichlorobenzene	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010
1,4-Dichlorobenzene	mg/L	0.001	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010
1,1-Dichloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<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
1,1-Dichloroethene	mg/L	0.014	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010
1,2-Dichloroethene (cis)	mg/L	-	<0.0010	<0.0010	0.0036	0.0042	0.0039	0.0083	0.0077	0.0083	0.0098
1,2-Dichloroethene (trans)	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010
Dichlorodifluoromethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010
1,2-Dichloropropane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010

Notes:

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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	21-Nov-2021 DUP	4-Dec-2019	21-Nov-2021	5-Dec-2019	21-Nov-2021
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
2,2-Dichloropropane	mg/L	-	<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
1,3-Dichloropropene	mg/L	-	-	-	-	<0.0015	<0.0015	-	<0.0015	-	<0.0015
1,3-Dichloropropene [cis]	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<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
Hexachlorobutadiene	mg/L	0.0013	<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
Methyl t-Butyl Ether (MTBE)	mg/L	0.015	-	-	-	<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
iso-Propylbenzene (cumene)	mg/L	-	<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
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
1,1,2,2-Tetrachloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010
Tetrachloroethene	mg/L	0.01	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<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
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
1,1,1-Trichloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010
1,1,2-Trichloroethane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010
Trichloroethene	mg/L	0.005	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<0.0010
Trichlorofluoromethane	mg/L	-	<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
1,2,3-Trichloropropane	mg/L	-	<0.00050	<0.00050	<0.00050	<0.0010	<0.0010	<0.00050	<0.0010	<0.00050	<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
1,3,5-Trimethylbenzene	mg/L	-	<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	0.0018	0.00643	0.0032	0.00289	0.0046

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“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-03	DUPLICATE	RPD (%)
			21-Nov-2021	21-Nov-2021	
Routine					
pH	pH Units	0.1	7.85	7.89	1
Electrical Conductivity (EC)	µS/cm	1	1690	1650	2
Total Dissolved Solids (TDS)	mg/L	1	1100	1060	4
Hardness as CaCO ₃	mg/L	0.6	537	534	1
Alkalinity (total as CaCO ₃)	mg/L	1	937	878	7
Bicarbonate	mg/L	1	1140	1070	6
Carbonate	mg/L	1	<1.0	<1.0	-
Hydroxide	mg/L	1	<1.0	<1.0	-
Calcium	mg/L	0.25	144	142	1
Magnesium	mg/L	0.5	43.0	43.5	1
Potassium	mg/L	0.5	8.04	8.16	1
Sodium	mg/L	0.25	207	209	1
Chloride	mg/L	2.5	43.2	42.8	1
Fluoride	mg/L	0.1	<0.100	<0.100	-
Sulphate	mg/L	1.5	64.4	63.7	1
Anions Total	meq/L	0.1	21.3	20.1	6
Cations Total	meq/L	0.1	20.4	20.4	0
Ionic Balance	N/A	0.01	2.16	0.741	-
Nutrients					
Ammonia as N	mg/L	0.5	5.51	5.23	5
Nitrate (as NO ₃ -N)	mg/L	0.1	<0.100	<0.100	-
Nitrite (as NO ₂ -N)	mg/L	0.05	<0.050	<0.050	-
Dissolved Metals					
Aluminum	mg/L	0.005	0.0069	0.0061	-
Antimony	mg/L	0.0005	<0.00050	<0.00050	-
Arsenic	mg/L	0.0005	0.00158	0.00179	-
Barium	mg/L	0.0005	0.371	0.372	0.3
Beryllium	mg/L	0.0001	<0.000100	<0.000100	-
Bismuth	mg/L	0.00025	<0.000250	<0.000250	-
Boron	mg/L	0.05	0.907	0.882	3
Cadmium	mg/L	0.000025	0.0000286	0.0000274	-
Chromium	mg/L	0.0025	<0.00250	<0.00250	-
Cobalt	mg/L	0.0005	0.00225	0.00214	-
Copper	mg/L	0.001	<0.00100	<0.00100	-
Iron	mg/L	0.05	0.534	0.538	1
Lead	mg/L	0.00025	<0.000250	<0.000250	-
Lithium	mg/L	0.005	0.0499	0.0490	2
Manganese	mg/L	0.0005	0.780	0.785	1
Mercury	mg/L	0.000005	<0.0000050	<0.0000050	-
Molybdenum	mg/L	0.00025	0.00100	0.000941	-
Nickel	mg/L	0.0025	0.00532	0.00470	-
Phosphorus	mg/L	0.25	<0.250	<0.250	-
Selenium	mg/L	0.00025	<0.000250	<0.000250	-
Silicon	mg/L	0.25	6.45	6.36	1
Silver	mg/L	0.00005	<0.000050	<0.000050	-
Strontium	mg/L	0.001	1.80	1.77	2
Sulphur	mg/L	2.5	27.6	28.3	3
Thallium	mg/L	0.00005	<0.000050	<0.000050	-
Tin	mg/L	0.0005	<0.00050	<0.00050	-
Titanium	mg/L	0.0015	<0.00150	<0.00150	-
Uranium	mg/L	0.00005	0.00238	0.00229	4
Vanadium	mg/L	0.0025	<0.00250	<0.00250	-
Zinc	mg/L	0.005	0.0054	<0.0050	-
Zirconium	mg/L	0.001	0.00141	0.00135	-

Notes:

RDL - Reportable detection limit

RPD - Relative Percentage Difference calculated as $RPD(\%) = \frac{|V1-V2|}{(V1+V2)/2} * 100$ 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%

Table 3: Groundwater Quality Assurance/Quality Control Analytical Results

Parameter	Unit	RDL	MW-03	DUPLICATE	RPD (%)
			21-Nov-2021	21-Nov-2021	
Hydrocarbons					
Benzene	mg/L	0.0005	<0.00050	<0.00050	-
Toluene	mg/L	0.0005	<0.00050	<0.00050	-
Ethylbenzene	mg/L	0.0005	<0.00050	<0.00050	-
Xylenes (m & p)	mg/L	0.0003	<0.00030	<0.00030	-
Xylene (o)	mg/L	0.0004	<0.00040	<0.00040	-
Xylenes Total	mg/L	0.0005	<0.00050	<0.00050	-
Styrene	mg/L	0.0005	<0.00050	<0.00050	-
Total BTEX	mg/L	0.001	<0.0010	<0.0010	-
Polycyclic Aromatic Hydrocarbons (PAHs)					
Naphthalene	mg/L	0.001	<0.0010	<0.0010	-
Volatile Organic Compounds (VOCs)					
Bromobenzene	mg/L	0.001	<0.0010	<0.0010	-
Bromochloromethane	mg/L	0.001	<0.0010	<0.0010	-
Bromodichloromethane	mg/L	0.001	<0.0010	<0.0010	-
Bromoform	mg/L	0.001	<0.0010	<0.0010	-
Bromomethane	mg/L	0.001	<0.0010	<0.0010	-
n-Butylbenzene	mg/L	0.001	<0.0010	<0.0010	-
sec-Butylbenzene	mg/L	0.001	<0.0010	<0.0010	-
tert-Butylbenzene	mg/L	0.001	<0.0010	<0.0010	-
Carbon tetrachloride	mg/L	0.0005	<0.00050	<0.00050	-
Chlorobenzene	mg/L	0.001	<0.0010	<0.0010	-
Chloroethane	mg/L	0.001	<0.0010	<0.0010	-
Chloroform	mg/L	0.001	<0.0010	<0.0010	-
Chloromethane	mg/L	0.005	<0.0050	<0.0050	-
2-Chlorotoluene	mg/L	0.001	<0.0010	<0.0010	-
4-Chlorotoluene	mg/L	0.001	<0.0010	<0.0010	-
Dibromochloromethane	mg/L	0.001	<0.0010	<0.0010	-
1,2-Dibromo-3-chloropropane	mg/L	0.001	<0.0010	<0.0010	-
1,2-Dibromoethane	mg/L	0.001	<0.0010	<0.0010	-
Dibromomethane	mg/L	0.001	<0.0010	<0.0010	-
1,2-Dichlorobenzene	mg/L	0.0005	<0.00050	<0.00050	-
1,3-Dichlorobenzene	mg/L	0.001	<0.0010	<0.0010	-
1,4-Dichlorobenzene	mg/L	0.001	<0.0010	<0.0010	-
1,1-Dichloroethane	mg/L	0.001	<0.0010	<0.0010	-
1,2-Dichloroethane	mg/L	0.001	<0.0010	<0.0010	-
1,1-Dichloroethene	mg/L	0.001	<0.0010	<0.0010	-
1,2-Dichloroethene (cis)	mg/L	0.001	0.0042	0.0039	-
1,2-Dichloroethene (trans)	mg/L	0.001	<0.0010	<0.0010	-
Dichlorodifluoromethane	mg/L	0.001	<0.0010	<0.0010	-
1,2-Dichloropropane	mg/L	0.001	<0.0010	<0.0010	-
1,3-Dichloropropane	mg/L	0.001	<0.0010	<0.0010	-
2,2-Dichloropropane	mg/L	0.001	<0.0010	<0.0010	-
1,1-Dichloropropene	mg/L	0.001	<0.0010	<0.0010	-
1,3-Dichloropropene	mg/L	0.0015	<0.0015	<0.0015	-
1,3-Dichloropropene [cis]	mg/L	0.001	<0.0010	<0.0010	-
1,3-Dichloropropene [trans]	mg/L	0.001	<0.0010	<0.0010	-
Hexachlorobutadiene	mg/L	0.001	<0.0010	<0.0010	-
p-Isopropyltoluene	mg/L	0.001	<0.0010	<0.0010	-
Methyl t-Butyl Ether (MTBE)	mg/L	0.0005	<0.00050	<0.00050	-
Methylene Chloride	mg/L	0.001	<0.0010	<0.0010	-
iso-Propylbenzene (cumene)	mg/L	0.001	<0.0010	<0.0010	-
n-Propylbenzene	mg/L	0.001	<0.0010	<0.0010	-
1,1,1,2-Tetrachloroethane	mg/L	0.001	<0.0010	<0.0010	-
1,1,2,2-Tetrachloroethane	mg/L	0.001	<0.0010	<0.0010	-
Tetrachloroethene	mg/L	0.001	<0.0010	<0.0010	-
1,2,3-Trichlorobenzene	mg/L	0.001	<0.0010	<0.0010	-
1,2,4-Trichlorobenzene	mg/L	0.001	<0.0010	<0.0010	-
1,1,1-Trichloroethane	mg/L	0.001	<0.0010	<0.0010	-
1,1,2-Trichloroethane	mg/L	0.001	<0.0010	<0.0010	-
Trichloroethene	mg/L	0.001	<0.0010	<0.0010	-
Trichlorofluoromethane	mg/L	0.001	<0.0010	<0.0010	-
Trihalomethanes	mg/L	0.002	<0.0020	<0.0020	-
1,2,3-Trichloropropane	mg/L	0.001	<0.0010	<0.0010	-
1,2,4-Trimethylbenzene	mg/L	0.001	<0.0010	<0.0010	-
1,3,5-Trimethylbenzene	mg/L	0.001	<0.0010	<0.0010	-
Vinyl chloride	mg/L	0.001	0.0021	0.0018	-

Notes:

RDL - Reportable detection limit

RPD - Relative Percentage Difference calculated as $RPD(\%) = \frac{|V1-V2|}{(V1+V2)/2} * 100$ 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%

Table 4: Monitoring Results - Soil Vapour Well

Parameter	Gas Well						
	VW-01						
	Aug-13	May-19	Jun-19	Sep-19	Dec-19	Jul-21	Nov-21
Pressure (kPa) ¹	-	0.0	0.0	0.0	0.0	0.0	0.0
CH ₄ (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO (ppm) ²	-	0.0	0.0	0.0	0.0	1.0	0.0
CO ₂ (%)	9.5	1.3	2.0	5.4	2.2	4.9	2.1
O ₂ (%)	5.8	18.8	18.2	17.4	19.3	15.3	19.6
Balance (% v/v)	84.7	79.9	79.8	77.2	78.5	79.8	78.2
Static Water Level (mbtoc) ³	-	Dry	Dry	Dry	Dry	Dry	Dry
Depth to Bottom (m)	5.50	2.56	2.56	2.56	2.67	2.62	2.63
Stick up (m)	-	0.77	0.77	0.87	0.87	0.87	0.87

Notes:

¹ kPa - Kilopascal.

² ppm - Parts per million.

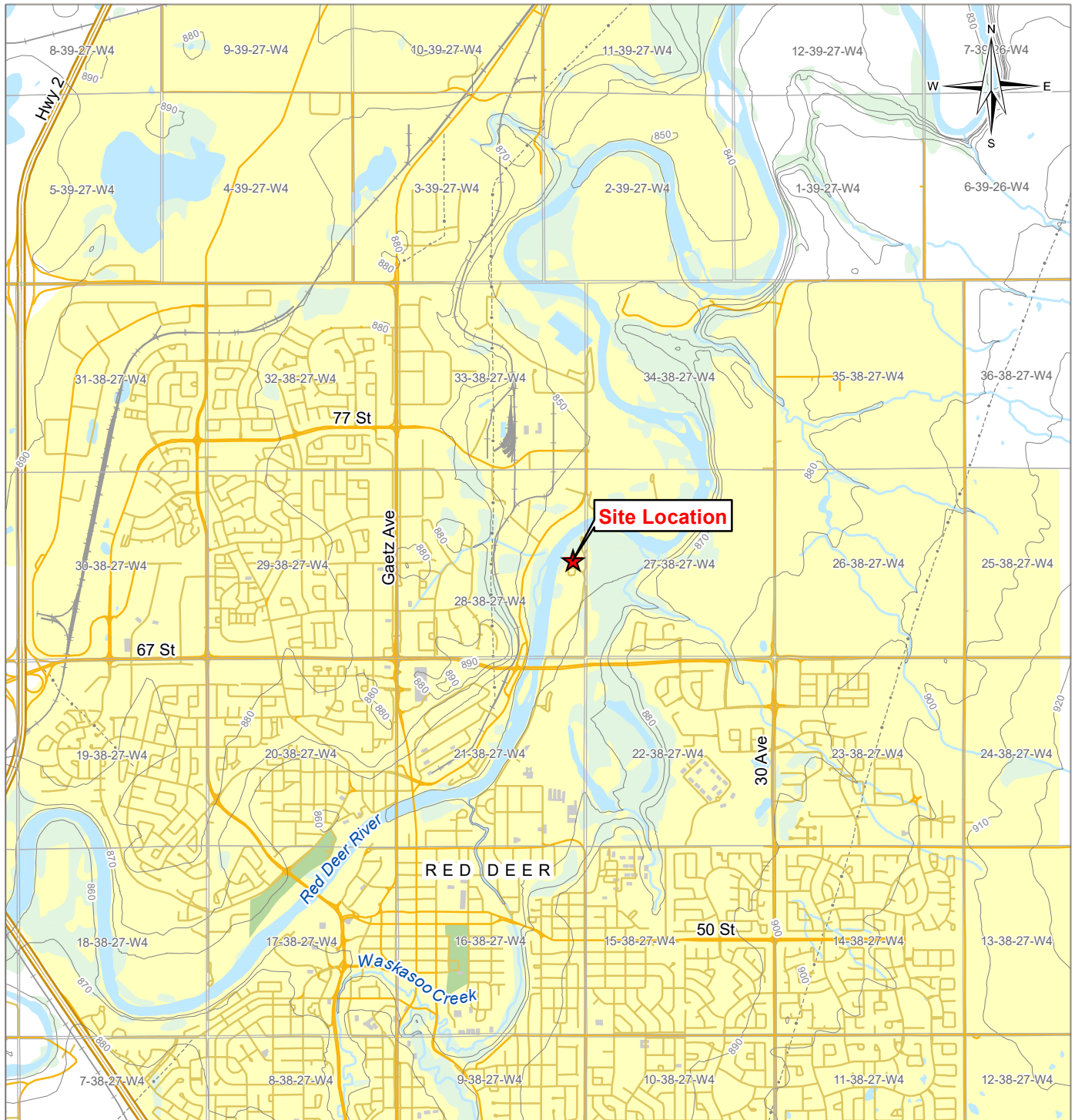
³ mbtoc - Meters below top of casing.

N/A - Not applicable - well can not be accessed to obtain measurement.

FIGURES

Figure 1	Site Location Plan
Figure 2	Site Plan and Surrounding Land Use
Figure 3	Historical Groundwater Elevations (Groundwater Monitoring Wells)
Figure 4	Groundwater Elevation Contours – July 2021
Figure 5	Groundwater Elevation Contours – November 2021

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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
- Urban Area

NOTES
Base data source: CanVec 1:50,000.

STATUS
ISSUED FOR USE

**2021 GROUNDWATER AND SOIL VAPOUR MONITORING REPORT
MCKENZIE TRAILS RECREATION AREA**

Site Location Plan

PROJECTION 3TM 114	DATUM NAD83	CLIENT
Scale: 1:50,000		
FILE NO. SWOP04071-02_Figure1_SiteLocation.mxd		
OFFICE Ti-EDM	DWN SL	CKD MRV
DATE June 14, 2022	APVD RM	REV 0
PROJECT NO. SWM.SWOP04071-02.003		Figure 1

THE CITY OF

TETRA TECH

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 ESRI; City of Red Deer (2020)
 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.

**2021 GROUNDWATER AND SOIL VAPOUR MONITORING REPORT
 MCKENZIE TRAILS RECREATION AREA**

Site Plan and Surrounding Land Use

PROJECTION 3TM 114	DATUM NAD83	CLIENT
Scale: 1:5,000		

FILE NO.
SWOP04071-02_Figure2_LandUse.mxd

OFFICE Tl-EDM	DWN SL	CKD MRV	APVD RM	REV 0
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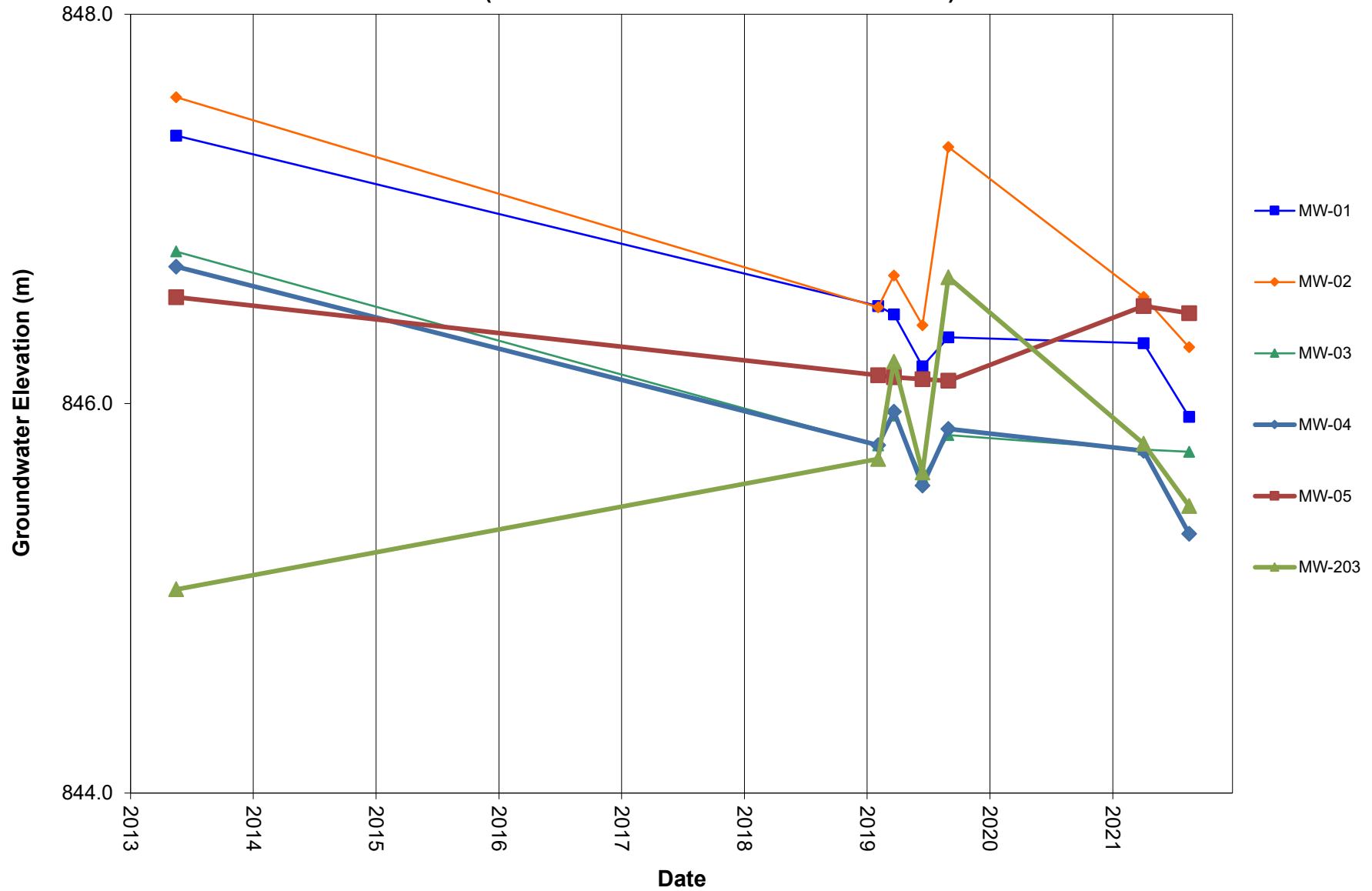
DATE June 14, 2022	PROJECT NO. SWM.SWOP04071-02.003
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TETRA TECH

Figure 2





STATUS
ISSUED FOR USE

FIGURE 3
HISTORICAL GROUNDWATER ELEVATIONS
(GROUNDWATER MONITORING WELLS)





LEGEND


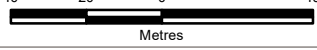

-  Monitoring Well
-  Vapour Well
- (84X.XX) Groundwater Elevation (masl)
-  Historic Waste Disposal (Provided by Tiamat, 2014)
-  Road

NOTES
 Base data source: Imagery provided by ESRI; City of Red Deer (2020)
 Roads from City of Red Deer Open Data, 2018
 masl - metres above sea level

STATUS
 ISSUED FOR USE





**2021 GROUNDWATER AND SOIL VAPOUR MONITORING REPORT
 MCKENZIE TRAILS RECREATION AREA**

**Groundwater Elevation Contours
 July 2021**

PROJECTION 3TM 114	DATUM NAD83	CLIENT 
Scale: 1:2,000		
		
FILE NO. SWOP04071-02_Figure4_GW_July2021.mxd	TETRA TECH 	
OFFICE TI-EDM	DWN SL	CKD MRV
DATE June 14, 2022	APVD RM	REV 0
PROJECT NO. SWM.SWOP04071-02.003		Figure 4



LEGEND

-  Monitoring Well
-  Vapour Well
- (84X.XX) Groundwater Elevation (masl)
-  Historic Waste Disposal (Provided by Tiamat, 2014)
-  Road

NOTES
 Base data source: Imagery provided by ESRI; City of Red Deer (2020)
 Roads from City of Red Deer Open Data, 2018
 masl - metres above sea level

STATUS
 ISSUED FOR USE

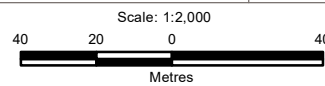
**2021 GROUNDWATER AND SOIL VAPOUR MONITORING REPORT
 MCKENZIE TRAILS RECREATION AREA**

**Groundwater Elevation Contours
 November 2021**

PROJECTION
 3TM 114

DATUM
 NAD83

CLIENT



FILE NO.
 SWOP04071-02_Figure5_GW_Nov2021.mxd

OFFICE
 TI-EDM

DWN SL	CKD MRV	APVD RM	REV 0
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DATE
 June 14, 2022

PROJECT NO.
 SWM.SWOP04071-02.003

Figure 5

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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1.2 ALTERNATIVE DOCUMENT FORMAT

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

Sections 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 4 years). The estimated age of the waste material post closure of the landfill is interpreted to be 55 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.

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.

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 Parks (AEP).

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

- Environmental Risk Management Plan (RMP), Historic Waste Disposal Sites, McKenzie Trails Recreation Area, The City of Red Deer. November 26, 2014⁵.

Two testholes (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.

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.

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.

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 municipal solid waste. 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.

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

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.

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, 2 are listed

as domestic and stock use, 21 are listed as investigation, 2 are listed as injection use, 8 are listed as industrial use, 3 are listed as “other”, 1 as observation use, and 4 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.

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:

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

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

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 (1×10^{-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 1×10^{-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 environmental risk management plan 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, 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 tolerable daily intake. 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 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 1m 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.

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.

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>.

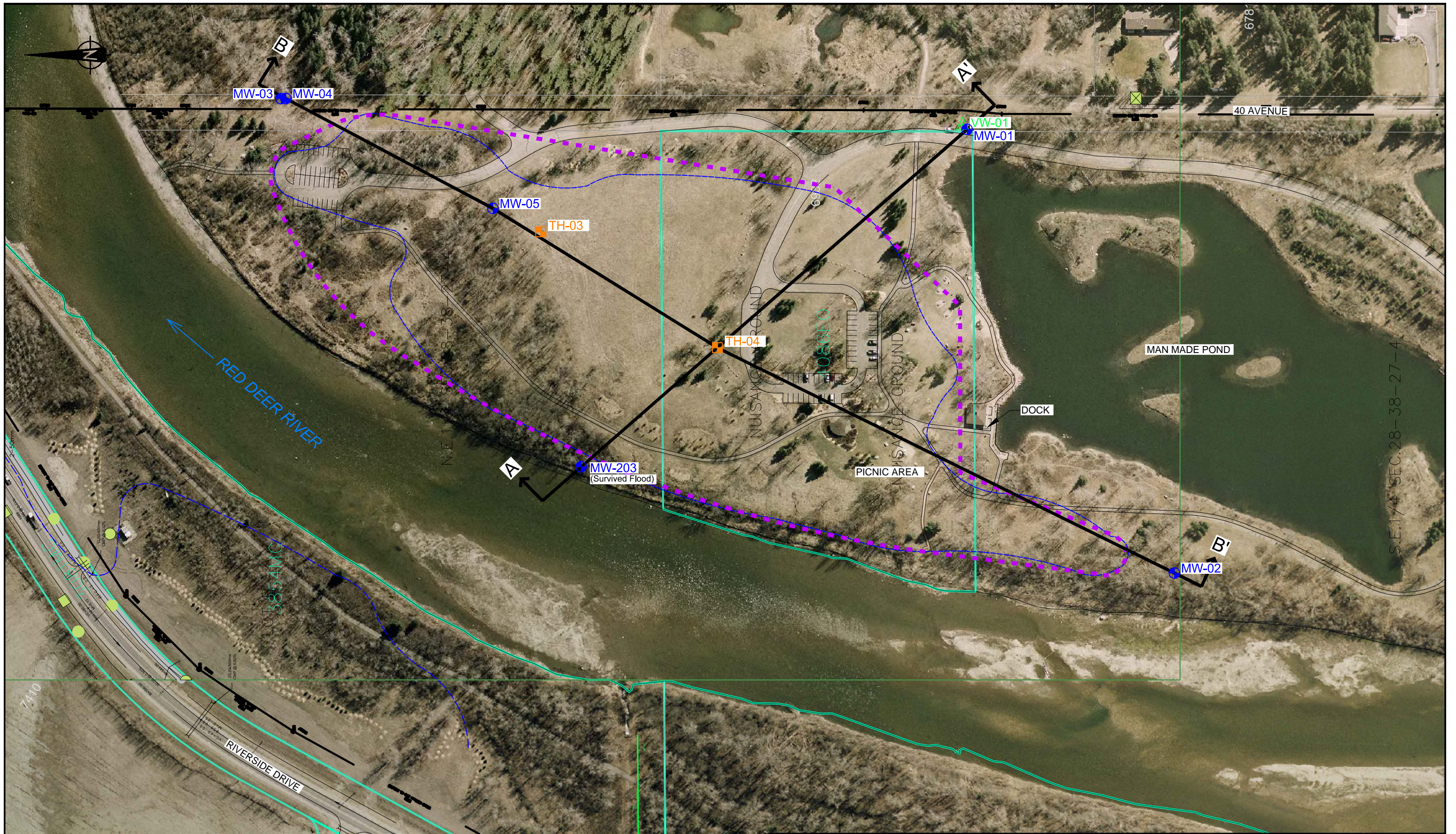
⁹ XCG Consulting Limited, 2018. Vapour Intrusion Assessment and Environmental Monitoring Report, prepared for the City of Red Deer's Montfort Landfill.

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 HG 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.

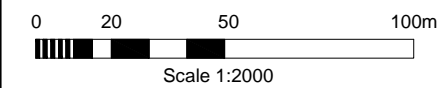
Future applications for development within the setback are subject to review by The City. The developer's team would be responsible for reviewing and verifying the available data relative to their proposed development. The mitigative measures presented above are generic and can be used as a general guide 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)



SOURCE
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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

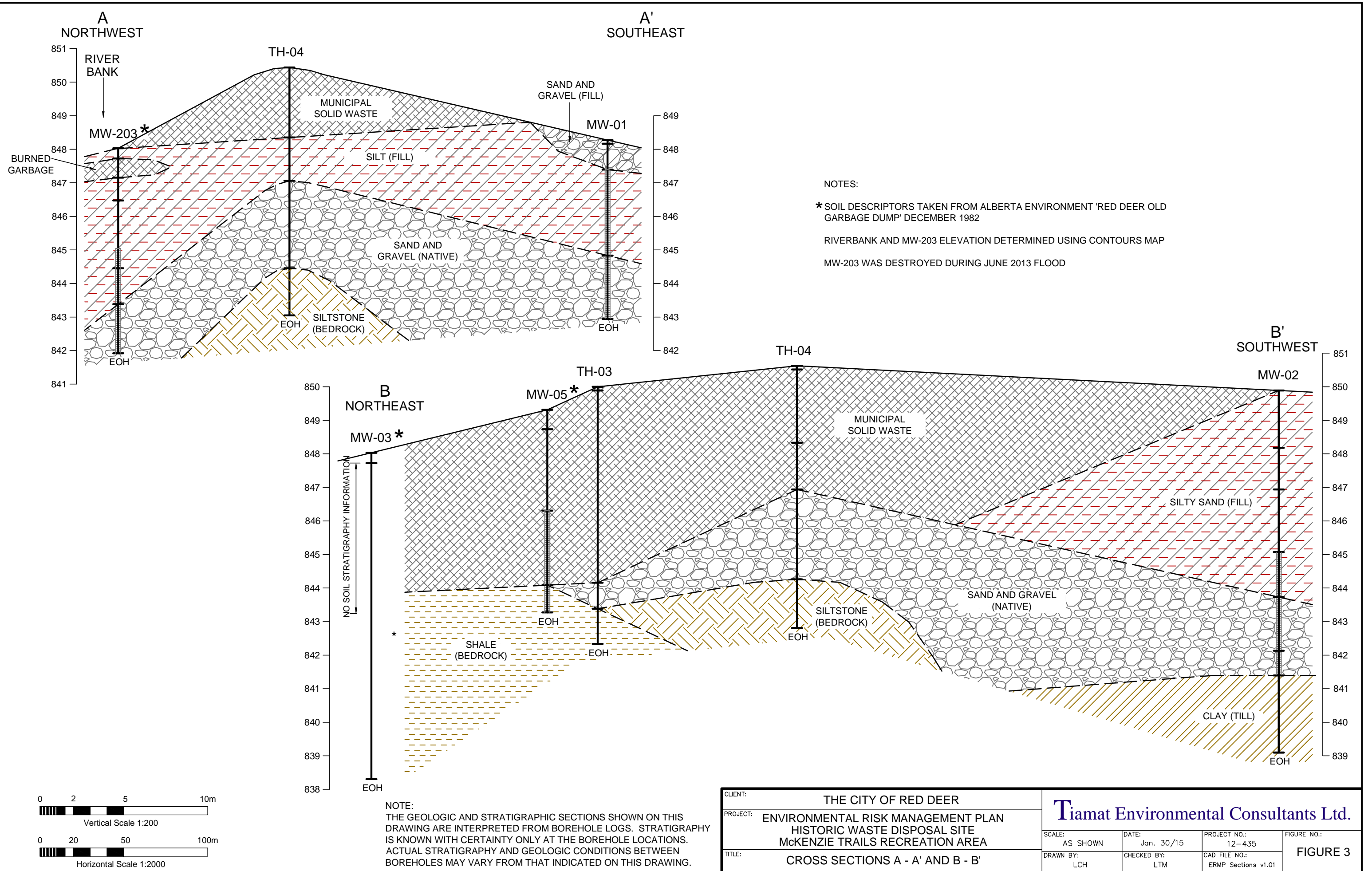
ELECTRICAL
 SANITARY
 STORM
 WATER

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.

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



NOTE:
 THE GEOLOGIC AND STRATIGRAPHIC SECTIONS SHOWN ON THIS DRAWING ARE INTERPRETED FROM BOREHOLE LOGS. STRATIGRAPHY IS KNOWN WITH CERTAINTY ONLY AT THE BOREHOLE LOCATIONS. ACTUAL STRATIGRAPHY AND GEOLOGIC CONDITIONS BETWEEN BOREHOLES MAY VARY FROM THAT INDICATED ON THIS DRAWING.

CLIENT:	THE CITY OF RED DEER			
PROJECT:	ENVIRONMENTAL RISK MANAGEMENT PLAN HISTORIC WASTE DISPOSAL SITE McKENZIE TRAILS RECREATION AREA			
TITLE:	CROSS SECTIONS A - A' AND B - B'			SCALE: AS SHOWN
		DATE: Jan. 30/15	PROJECT NO.: 12-435	FIGURE NO.:
	DRAWN BY: LCH	CHECKED BY: LTM	CAD FILE NO.: ERMP Sections v1.01	FIGURE 3

APPENDIX D

LABORATORY ANALYTICAL REPORTS



CERTIFICATE OF ANALYSIS

Work Order : CG2105892
Client : Tetra Tech Canada Inc.
Contact : Darby Madalena
Address : 115 - 200 Rivercrest Dr SE
Telephone : 403 203 3355
Project : SWM.SWOP04071-02.003
PO : SWM.SWOP04071-02.003
C-O-C number : CORD MCKENZIE TRAILS
Sampler : RYAN MILLER
Site : ----
Quote number : Q71650 City of Red Deer Pre-1972 Landfill Monitoring
No. of samples received : 4
No. of samples analysed : 4

Page : 1 of 7
Laboratory : Calgary - Environmental
Account Manager : Milica Papic
Address : 2559 29th Street NE
Telephone : +1 403 407 1800
Date Samples Received : 23-Nov-2021 05:55
Date Analysis Commenced : 23-Nov-2021
Issue Date : 01-Dec-2021 16:03

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.

Table with 3 columns: Signatories, Position, Laboratory Department. Rows include Daniel Ching, Jeanie Mark, Millicent Brentnall, Parker Sgarbossa, Sara Niroomand, Shirley Li, and Vladka Stamenova.



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).

<i>Unit</i>	<i>Description</i>
-	No Unit
%	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

<i>Qualifier</i>	<i>Description</i>
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	MW203	DUPLICATE	----
(Matrix: Water)					Client sampling date / time	21-Nov-2021 14:20	21-Nov-2021 14:30	21-Nov-2021 14:40	21-Nov-2021	----
Analyte	CAS Number	Method	LOR	Unit	CG2105892-001	CG2105892-002	CG2105892-003	CG2105892-004	-----	
					Result	Result	Result	Result	----	
Physical Tests										
alkalinity, bicarbonate (as HCO3)	71-52-3	E290	1.0	mg/L	1140	1140	906	1070	----	
alkalinity, carbonate (as CO3)	3812-32-6	E290	1.0	mg/L	<1.0	<1.0	<1.0	<1.0	----	
alkalinity, hydroxide (as OH)	14280-30-9	E290	1.0	mg/L	<1.0	<1.0	<1.0	<1.0	----	
alkalinity, total (as CaCO3)	----	E290	1.0	mg/L	937	939	743	878	----	
conductivity	----	E100	1.0	µS/cm	1690	1700	1410	1650	----	
hardness (as CaCO3), dissolved	----	EC100	0.60	mg/L	537	714	421	534	----	
pH	----	E108	0.10	pH units	7.85	7.71	7.79	7.89	----	
solids, total dissolved [TDS], calculated	----	EC103	1.0	mg/L	1100	1080	803	1060	----	
Anions and Nutrients										
ammonia, total (as N)	7664-41-7	E298	0.0050	mg/L	5.51	11.2	12.9	5.23	----	
chloride	16887-00-6	E235.Cl	0.50	mg/L	43.2	29.4	24.0	42.8	----	
fluoride	16984-48-8	E235.F	0.020	mg/L	<0.100 ^{DLDS}	<0.100 ^{DLDS}	<0.100 ^{DLDS}	<0.100 ^{DLDS}	----	
nitrate (as N)	14797-55-8	E235.NO3	0.020	mg/L	<0.100 ^{DLDS}	0.301	0.121	<0.100 ^{DLDS}	----	
nitrite (as N)	14797-65-0	E235.NO2	0.010	mg/L	<0.050 ^{DLDS}	<0.050 ^{DLDS}	<0.050 ^{DLDS}	<0.050 ^{DLDS}	----	
sulfate (as SO4)	14808-79-8	E235.SO4	0.30	mg/L	64.4	71.4	78.3	63.7	----	
Ion Balance										
anion sum	----	EC101	0.10	meq/L	21.3	21.1	17.2	20.1	----	
cation sum	----	EC101	0.10	meq/L	20.4	20.7	12.5	20.4	----	
ion balance (cation-anion difference)	----	EC101	0.010	%	2.16	0.957	15.8 ^{RRV}	0.741	----	
Dissolved Metals										
aluminum, dissolved	7429-90-5	E421	0.0010	mg/L	0.0069	<0.0050 ^{DLDS}	0.0080	0.0061	----	
antimony, dissolved	7440-36-0	E421	0.00010	mg/L	<0.00050 ^{DLDS}	<0.00050 ^{DLDS}	<0.00050 ^{DLDS}	<0.00050 ^{DLDS}	----	
arsenic, dissolved	7440-38-2	E421	0.00010	mg/L	0.00158	0.00618	0.00209	0.00179	----	
barium, dissolved	7440-39-3	E421	0.00010	mg/L	0.371	0.278	0.211	0.372	----	
beryllium, dissolved	7440-41-7	E421	0.000020	mg/L	<0.000100 ^{DLDS}	<0.000100 ^{DLDS}	<0.000100 ^{DLDS}	<0.000100 ^{DLDS}	----	
bismuth, dissolved	7440-69-9	E421	0.000050	mg/L	<0.000250 ^{DLDS}	<0.000250 ^{DLDS}	<0.000250 ^{DLDS}	<0.000250 ^{DLDS}	----	
boron, dissolved	7440-42-8	E421	0.010	mg/L	0.907	1.47	0.617	0.882	----	
cadmium, dissolved	7440-43-9	E421	0.0000050	mg/L	0.0000286	0.000120	<0.0000250 ^{DLDS}	0.0000274	----	
calcium, dissolved	7440-70-2	E421	0.050	mg/L	144	185	110	142	----	
chromium, dissolved	7440-47-3	E421	0.00050	mg/L	<0.00250 ^{DLDS}	<0.00250 ^{DLDS}	<0.00250 ^{DLDS}	<0.00250 ^{DLDS}	----	



Analytical Results

Sub-Matrix: Water (Matrix: Water)					Client sample ID	MW-03	MW-04	MW203	DUPLICATE	----
Client sampling date / time					21-Nov-2021 14:20	21-Nov-2021 14:30	21-Nov-2021 14:40	21-Nov-2021	----	
Analyte	CAS Number	Method	LOR	Unit	CG2105892-001	CG2105892-002	CG2105892-003	CG2105892-004	-----	
					Result	Result	Result	Result	----	
Dissolved Metals										
cobalt, dissolved	7440-48-4	E421	0.00010	mg/L	0.00225	0.00444	<0.00050 ^{DLDS}	0.00214	----	
copper, dissolved	7440-50-8	E421	0.00020	mg/L	<0.00100 ^{DLDS}	<0.00100 ^{DLDS}	<0.00100 ^{DLDS}	<0.00100 ^{DLDS}	----	
iron, dissolved	7439-89-6	E421	0.010	mg/L	0.534	5.34	0.680	0.538	----	
lead, dissolved	7439-92-1	E421	0.000050	mg/L	<0.000250 ^{DLDS}	<0.000250 ^{DLDS}	<0.000250 ^{DLDS}	<0.000250 ^{DLDS}	----	
lithium, dissolved	7439-93-2	E421	0.0010	mg/L	0.0499	0.0304	0.0169	0.0490	----	
magnesium, dissolved	7439-95-4	E421	0.100	mg/L	43.0	61.1	35.5	43.5	----	
manganese, dissolved	7439-96-5	E421	0.00010	mg/L	0.780	1.16	0.297	0.785	----	
mercury, dissolved	7439-97-6	E509	0.0000050	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	----	
molybdenum, dissolved	7439-98-7	E421	0.000050	mg/L	0.00100	0.00259	<0.000250 ^{DLDS}	0.000941	----	
nickel, dissolved	7440-02-0	E421	0.00050	mg/L	0.00532	0.00910	0.00307	0.00470	----	
phosphorus, dissolved	7723-14-0	E421	0.050	mg/L	<0.250 ^{DLDS}	<0.250 ^{DLDS}	0.977	<0.250 ^{DLDS}	----	
potassium, dissolved	7440-09-7	E421	0.100	mg/L	8.04	18.9	13.0	8.16	----	
selenium, dissolved	7782-49-2	E421	0.000050	mg/L	<0.000250 ^{DLDS}	<0.000250 ^{DLDS}	0.00254	<0.000250 ^{DLDS}	----	
silicon, dissolved	7440-21-3	E421	0.050	mg/L	6.45	7.02	4.84	6.36	----	
silver, dissolved	7440-22-4	E421	0.000010	mg/L	<0.000050 ^{DLDS}	<0.000050 ^{DLDS}	<0.000050 ^{DLDS}	<0.000050 ^{DLDS}	----	
sodium, dissolved	17341-25-2	E421	0.050	mg/L	207	113	64.8	209	----	
strontium, dissolved	7440-24-6	E421	0.00020	mg/L	1.80	1.81	1.21	1.77	----	
sulfur, dissolved	7704-34-9	E421	0.50	mg/L	27.6	29.7	19.1	28.3	----	
thallium, dissolved	7440-28-0	E421	0.000010	mg/L	<0.000050 ^{DLDS}	<0.000050 ^{DLDS}	<0.000050 ^{DLDS}	<0.000050 ^{DLDS}	----	
tin, dissolved	7440-31-5	E421	0.00010	mg/L	<0.00050 ^{DLDS}	<0.00050 ^{DLDS}	<0.00050 ^{DLDS}	<0.00050 ^{DLDS}	----	
titanium, dissolved	7440-32-6	E421	0.00030	mg/L	<0.00150 ^{DLDS}	<0.00150 ^{DLDS}	<0.00150 ^{DLDS}	<0.00150 ^{DLDS}	----	
uranium, dissolved	7440-61-1	E421	0.000010	mg/L	0.00238	0.00351	0.000228	0.00229	----	
vanadium, dissolved	7440-62-2	E421	0.00050	mg/L	<0.00250 ^{DLDS}	<0.00250 ^{DLDS}	<0.00250 ^{DLDS}	<0.00250 ^{DLDS}	----	
zinc, dissolved	7440-66-6	E421	0.0010	mg/L	0.0054	0.0087	<0.0050 ^{DLDS}	<0.0050 ^{DLDS}	----	
zirconium, dissolved	7440-67-7	E421	0.00020	mg/L	0.00141	<0.00100 ^{DLDS}	<0.00100 ^{DLDS}	0.00135	----	
dissolved mercury filtration location	----	EP509	-	-	Field	Field	Field	Field	----	
dissolved metals filtration location	----	EP421	-	-	Field	Field	Field	Field	----	
Volatile Organic Compounds										
benzene	71-43-2	E611E	0.50	µg/L	<0.50	<0.50	0.58	<0.50	----	
bromobenzene	108-86-1	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
bromochloromethane	74-97-5	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	



Analytical Results

Sub-Matrix: Water (Matrix: Water)					Client sample ID	MW-03	MW-04	MW203	DUPLICATE	----
Client sampling date / time					21-Nov-2021 14:20	21-Nov-2021 14:30	21-Nov-2021 14:40	21-Nov-2021	----	
Analyte	CAS Number	Method	LOR	Unit	CG2105892-001	CG2105892-002	CG2105892-003	CG2105892-004	-----	
					Result	Result	Result	Result	---	
Volatile Organic Compounds										
bromodichloromethane	75-27-4	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
bromoform	75-25-2	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
bromomethane	74-83-9	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
butylbenzene, n-	104-51-8	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
butylbenzene, sec-	135-98-8	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
butylbenzene, tert-	98-06-6	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
carbon tetrachloride	56-23-5	E611E	0.50	µg/L	<0.50	<0.50	<0.50	<0.50	----	
chlorobenzene	108-90-7	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
chloroethane	75-00-3	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
chloroform	67-66-3	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
chloromethane	74-87-3	E611E	5.0	µg/L	<5.0	<5.0	<5.0	<5.0	----	
chlorotoluene, 2-	95-49-8	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
chlorotoluene, 4-	106-43-4	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
cymene, p-	99-87-6	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dibromo-3-chloropropane, 1,2-	96-12-8	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dibromochloromethane	124-48-1	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dibromoethane, 1,2-	106-93-4	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dibromomethane	74-95-3	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichlorobenzene, 1,2-	95-50-1	E611E	0.50	µg/L	<0.50	<0.50	<0.50	<0.50	----	
dichlorobenzene, 1,3-	541-73-1	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichlorobenzene, 1,4-	106-46-7	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichlorodifluoromethane	75-71-8	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichloroethane, 1,1-	75-34-3	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichloroethane, 1,2-	107-06-2	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichloroethylene, 1,1-	75-35-4	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichloroethylene, cis-1,2-	156-59-2	E611E	1.0	µg/L	4.2	7.7	9.8	3.9	----	
dichloroethylene, trans-1,2-	156-60-5	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichloromethane	75-09-2	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichloropropane, 1,2-	78-87-5	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichloropropane, 1,3-	142-28-9	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichloropropane, 2,2-	594-20-7	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	



Analytical Results

Sub-Matrix: Water (Matrix: Water)					Client sample ID	MW-03	MW-04	MW203	DUPLICATE	----
Client sampling date / time					21-Nov-2021 14:20	21-Nov-2021 14:30	21-Nov-2021 14:40	21-Nov-2021	----	
Analyte	CAS Number	Method	LOR	Unit	CG2105892-001	CG2105892-002	CG2105892-003	CG2105892-004	-----	
					Result	Result	Result	Result	---	
Volatile Organic Compounds										
dichloropropylene, 1,1-	563-58-6	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichloropropylene, cis+trans-1,3-	542-75-6	E611E	1.5	µg/L	<1.5	<1.5	<1.5	<1.5	----	
dichloropropylene, cis-1,3-	10061-01-5	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
dichloropropylene, trans-1,3-	10061-02-6	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
ethylbenzene	100-41-4	E611E	0.50	µg/L	<0.50	<0.50	<0.50	<0.50	----	
hexachlorobutadiene	87-68-3	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
isopropylbenzene	98-82-8	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	0.50	µg/L	<0.50	<0.50	<0.50	<0.50	----	
propylbenzene, n-	103-65-1	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
styrene	100-42-5	E611E	0.50	µg/L	<0.50	<0.50	<0.50	<0.50	----	
tetrachloroethane, 1,1,1,2-	630-20-6	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
tetrachloroethane, 1,1,2,2-	79-34-5	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
tetrachloroethylene	127-18-4	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
toluene	108-88-3	E611E	0.50	µg/L	<0.50	<0.50	<0.50	<0.50	----	
trichlorobenzene, 1,2,3-	87-61-6	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
trichlorobenzene, 1,2,4-	120-82-1	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
trichloroethane, 1,1,1-	71-55-6	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
trichloroethane, 1,1,2-	79-00-5	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
trichloroethylene	79-01-6	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
trichlorofluoromethane	75-69-4	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
trichloropropane, 1,2,3-	96-18-4	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
trimethylbenzene, 1,2,4-	95-63-6	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
trimethylbenzene, 1,3,5-	108-67-8	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
vinyl chloride	75-01-4	E611E	1.0	µg/L	2.1	3.2	4.6	1.8	----	
xylene, m+p-	179601-23-1	E611E	0.40	µg/L	<0.40	<0.40	<0.40	<0.40	----	
xylene, o-	95-47-6	E611E	0.30	µg/L	<0.30	<0.30	<0.30	<0.30	----	
xylenes, total	1330-20-7	E611E	0.50	µg/L	<0.50	<0.50	<0.50	<0.50	----	
BTEX, total	----	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	
trihalomethanes [THMs], total	----	E611E	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	----	
Volatile Organic Compounds Surrogates										
bromofluorobenzene, 4-	460-00-4	E611E	1.0	%	83.5	84.0	80.5	80.9	----	



Analytical Results

Sub-Matrix: Water (Matrix: Water)					Client sample ID	MW-03	MW-04	MW203	DUPLICATE	----
Client sampling date / time					21-Nov-2021 14:20	21-Nov-2021 14:30	21-Nov-2021 14:40	21-Nov-2021	----	
Analyte	CAS Number	Method	LOR	Unit	CG2105892-001	CG2105892-002	CG2105892-003	CG2105892-004	-----	
					Result	Result	Result	Result	----	
Volatile Organic Compounds Surrogates										
difluorobenzene, 1,4-	540-36-3	E611E	1.0	%	105	103	100	103	----	
Polycyclic Aromatic Hydrocarbons										
naphthalene	91-20-3	E611E	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	----	

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

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: CG2105892	Page	: 1 of 12
Client	: Tetra Tech Canada Inc.	Laboratory	: Calgary - Environmental
Contact	: Darby Madalena	Account Manager	: Milica Pasic
Address	: 115 - 200 Rivercrest Dr SE Calgary AB Canada T2C 2X5	Address	: 2559 29th Street NE Calgary, Alberta Canada T1Y 7B5
Telephone	: 403 203 3355	Telephone	: +1 403 407 1800
Project	: SWM.SWOP04071-02.003	Date Samples Received	: 23-Nov-2021 05:55
PO	: SWM.SWOP04071-02.003	Issue Date	: 01-Dec-2021 16:03
C-O-C number	: CORD MCKENZIE TRAILS		
Sampler	: RYAN MILLER		
Site	: ----		
Quote number	: Q71650 City of Red Deer Pre-1972 Landfill Monitoring		
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 Services number is a unique identifier assigned to discrete substances.

DQO: Data Quality Objective.

LOR: Limit of Reporting (detection limit).

RPD: Relative Percent Difference.

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 Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis				
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval	
				Rec	Actual			Rec	Actual		
Anions and Nutrients : Ammonia by Fluorescence											
Amber glass total (sulfuric acid) DUPLICATE	E298	21-Nov-2021	27-Nov-2021	----	----		27-Nov-2021	28 days	6 days	✓	
Anions and Nutrients : Ammonia by Fluorescence											
Amber glass total (sulfuric acid) MW-03	E298	21-Nov-2021	27-Nov-2021	----	----		27-Nov-2021	28 days	6 days	✓	
Anions and Nutrients : Ammonia by Fluorescence											
Amber glass total (sulfuric acid) MW-04	E298	21-Nov-2021	27-Nov-2021	----	----		27-Nov-2021	28 days	6 days	✓	
Anions and Nutrients : Ammonia by Fluorescence											
Amber glass total (sulfuric acid) MW203	E298	21-Nov-2021	27-Nov-2021	----	----		27-Nov-2021	28 days	6 days	✓	
Anions and Nutrients : Chloride in Water by IC											
HDPE DUPLICATE	E235.Cl	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✓	
Anions and Nutrients : Chloride in Water by IC											
HDPE MW-03	E235.Cl	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✓	
Anions and Nutrients : Chloride in Water by IC											
HDPE MW-04	E235.Cl	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✓	



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

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis				
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval	
				Rec	Actual			Rec	Actual		
Anions and Nutrients : Chloride in Water by IC											
HDPE MW203	E235.Cl	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✔	
Anions and Nutrients : Fluoride in Water by IC											
HDPE DUPLICATE	E235.F	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✔	
Anions and Nutrients : Fluoride in Water by IC											
HDPE MW-03	E235.F	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✔	
Anions and Nutrients : Fluoride in Water by IC											
HDPE MW-04	E235.F	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✔	
Anions and Nutrients : Fluoride in Water by IC											
HDPE MW203	E235.F	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✔	
Anions and Nutrients : Nitrate in Water by IC											
HDPE DUPLICATE	E235.NO3	21-Nov-2021	----	----	----		23-Nov-2021	3 days	2 days	✔	
Anions and Nutrients : Nitrate in Water by IC											
HDPE MW-03	E235.NO3	21-Nov-2021	----	----	----		23-Nov-2021	3 days	2 days	✔	
Anions and Nutrients : Nitrate in Water by IC											
HDPE MW-04	E235.NO3	21-Nov-2021	----	----	----		23-Nov-2021	3 days	2 days	✔	
Anions and Nutrients : Nitrate in Water by IC											
HDPE MW203	E235.NO3	21-Nov-2021	----	----	----		23-Nov-2021	3 days	2 days	✔	



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

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval
				Rec	Actual			Rec	Actual	
Anions and Nutrients : Nitrite in Water by IC										
HDPE DUPLICATE	E235.NO2	21-Nov-2021	----	----	----		23-Nov-2021	3 days	2 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE MW-03	E235.NO2	21-Nov-2021	----	----	----		23-Nov-2021	3 days	2 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE MW-04	E235.NO2	21-Nov-2021	----	----	----		23-Nov-2021	3 days	2 days	✓
Anions and Nutrients : Nitrite in Water by IC										
HDPE MW203	E235.NO2	21-Nov-2021	----	----	----		23-Nov-2021	3 days	2 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE DUPLICATE	E235.SO4	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE MW-03	E235.SO4	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE MW-04	E235.SO4	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✓
Anions and Nutrients : Sulfate in Water by IC										
HDPE MW203	E235.SO4	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✓
Dissolved Metals : Dissolved Mercury in Water by CVAAS										
Glass vial dissolved (hydrochloric acid) DUPLICATE	E509	21-Nov-2021	23-Nov-2021	----	----		23-Nov-2021	28 days	2 days	✓



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

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis				
			Preparation Date	Holding Times		Eval	Analysis Date	Holding Times		Eval	
				Rec	Actual			Rec	Actual		
Dissolved Metals : Dissolved Mercury in Water by CVAAS											
Glass vial dissolved (hydrochloric acid) MW-03	E509	21-Nov-2021	23-Nov-2021	----	----		23-Nov-2021	28 days	2 days	✓	
Dissolved Metals : Dissolved Mercury in Water by CVAAS											
Glass vial dissolved (hydrochloric acid) MW-04	E509	21-Nov-2021	23-Nov-2021	----	----		23-Nov-2021	28 days	2 days	✓	
Dissolved Metals : Dissolved Mercury in Water by CVAAS											
Glass vial dissolved (hydrochloric acid) MW203	E509	21-Nov-2021	23-Nov-2021	----	----		23-Nov-2021	28 days	2 days	✓	
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS											
HDPE dissolved (nitric acid) DUPLICATE	E421	21-Nov-2021	29-Nov-2021	----	----		29-Nov-2021	180 days	8 days	✓	
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS											
HDPE dissolved (nitric acid) MW-03	E421	21-Nov-2021	29-Nov-2021	----	----		29-Nov-2021	180 days	8 days	✓	
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS											
HDPE dissolved (nitric acid) MW-04	E421	21-Nov-2021	29-Nov-2021	----	----		29-Nov-2021	180 days	8 days	✓	
Dissolved Metals : Dissolved Metals in Water by CRC ICPMS											
HDPE dissolved (nitric acid) MW203	E421	21-Nov-2021	29-Nov-2021	----	----		29-Nov-2021	180 days	8 days	✓	
Physical Tests : Alkalinity Species by Titration											
HDPE DUPLICATE	E290	21-Nov-2021	----	----	----		23-Nov-2021	14 days	2 days	✓	
Physical Tests : Alkalinity Species by Titration											
HDPE MW-03	E290	21-Nov-2021	----	----	----		23-Nov-2021	14 days	2 days	✓	



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

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec Actual		Eval	Analysis Date	Holding Times Rec Actual		Eval
Physical Tests : Alkalinity Species by Titration										
HDPE MW-04	E290	21-Nov-2021	----	----	----		23-Nov-2021	14 days	2 days	✓
Physical Tests : Alkalinity Species by Titration										
HDPE MW203	E290	21-Nov-2021	----	----	----		23-Nov-2021	14 days	2 days	✓
Physical Tests : Conductivity in Water										
HDPE DUPLICATE	E100	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✓
Physical Tests : Conductivity in Water										
HDPE MW-03	E100	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✓
Physical Tests : Conductivity in Water										
HDPE MW-04	E100	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✓
Physical Tests : Conductivity in Water										
HDPE MW203	E100	21-Nov-2021	----	----	----		23-Nov-2021	28 days	2 days	✓
Physical Tests : pH by Meter										
HDPE DUPLICATE	E108	21-Nov-2021	----	----	----		23-Nov-2021	0.25 hrs	42 hrs	* EHTR-FM
Physical Tests : pH by Meter										
HDPE MW-03	E108	21-Nov-2021	----	----	----		23-Nov-2021	0.25 hrs	43 hrs	* EHTR-FM
Physical Tests : pH by Meter										
HDPE MW-04	E108	21-Nov-2021	----	----	----		23-Nov-2021	0.25 hrs	43 hrs	* EHTR-FM



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

Analyte Group Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec Actual		Eval	Analysis Date	Holding Times Rec Actual		Eval
Physical Tests : pH by Meter										
HDPE MW203	E108	21-Nov-2021	----	----	----		23-Nov-2021	0.25 hrs	43 hrs	* EHTR-FM
Polycyclic Aromatic Hydrocarbons : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate) DUPLICATE	E611E	21-Nov-2021	23-Nov-2021	----	----		24-Nov-2021	----	----	
Polycyclic Aromatic Hydrocarbons : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate) MW-03	E611E	21-Nov-2021	23-Nov-2021	----	----		24-Nov-2021	----	----	
Polycyclic Aromatic Hydrocarbons : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate) MW-04	E611E	21-Nov-2021	23-Nov-2021	----	----		24-Nov-2021	----	----	
Polycyclic Aromatic Hydrocarbons : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate) MW203	E611E	21-Nov-2021	23-Nov-2021	----	----		24-Nov-2021	----	----	
Volatile Organic Compounds : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate) DUPLICATE	E611E	21-Nov-2021	23-Nov-2021	----	----		24-Nov-2021	14 days	3 days	✓
Volatile Organic Compounds : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate) MW-03	E611E	21-Nov-2021	23-Nov-2021	----	----		24-Nov-2021	14 days	3 days	✓
Volatile Organic Compounds : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate) MW-04	E611E	21-Nov-2021	23-Nov-2021	----	----		24-Nov-2021	14 days	3 days	✓
Volatile Organic Compounds : VOCs (Prairies List) by Headspace GC-MS										
Glass vial (sodium bisulfate) MW203	E611E	21-Nov-2021	23-Nov-2021	----	----		24-Nov-2021	14 days	3 days	✓

Legend & Qualifier Definitions

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended

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Client : Tetra Tech Canada Inc.
Project : SWM.SWOP04071-02.003



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 (%)		Evaluation
			QC	Regular	Actual	Expected	
Analytical Methods							
Laboratory Duplicates (DUP)							
Alkalinity Species by Titration	E290	350541	1	20	5.0	5.0	✔
Ammonia by Fluorescence	E298	354131	1	20	5.0	5.0	✔
Chloride in Water by IC	E235.Cl	350471	1	20	5.0	5.0	✔
Conductivity in Water	E100	350543	1	20	5.0	5.0	✔
Dissolved Mercury in Water by CVAAS	E509	350827	1	18	5.5	5.0	✔
Dissolved Metals in Water by CRC ICPMS	E421	354974	1	18	5.5	5.0	✔
Fluoride in Water by IC	E235.F	350470	1	20	5.0	5.0	✔
Nitrate in Water by IC	E235.NO3	350468	1	20	5.0	5.0	✔
Nitrite in Water by IC	E235.NO2	350469	1	20	5.0	5.0	✔
pH by Meter	E108	350542	1	20	5.0	5.0	✔
Sulfate in Water by IC	E235.SO4	350467	1	20	5.0	5.0	✔
VOCs (Prairies List) by Headspace GC-MS	E611E	350431	1	11	9.0	5.0	✔
Laboratory Control Samples (LCS)							
Alkalinity Species by Titration	E290	350541	1	20	5.0	5.0	✔
Ammonia by Fluorescence	E298	354131	1	20	5.0	5.0	✔
Chloride in Water by IC	E235.Cl	350471	1	20	5.0	5.0	✔
Conductivity in Water	E100	350543	1	20	5.0	5.0	✔
Dissolved Mercury in Water by CVAAS	E509	350827	1	18	5.5	5.0	✔
Dissolved Metals in Water by CRC ICPMS	E421	354974	1	18	5.5	5.0	✔
Fluoride in Water by IC	E235.F	350470	1	20	5.0	5.0	✔
Nitrate in Water by IC	E235.NO3	350468	1	20	5.0	5.0	✔
Nitrite in Water by IC	E235.NO2	350469	1	20	5.0	5.0	✔
pH by Meter	E108	350542	1	20	5.0	5.0	✔
Sulfate in Water by IC	E235.SO4	350467	1	20	5.0	5.0	✔
VOCs (Prairies List) by Headspace GC-MS	E611E	350431	1	11	9.0	5.0	✔
Method Blanks (MB)							
Alkalinity Species by Titration	E290	350541	1	20	5.0	5.0	✔
Ammonia by Fluorescence	E298	354131	1	20	5.0	5.0	✔
Chloride in Water by IC	E235.Cl	350471	1	20	5.0	5.0	✔
Conductivity in Water	E100	350543	1	20	5.0	5.0	✔
Dissolved Mercury in Water by CVAAS	E509	350827	1	18	5.5	5.0	✔
Dissolved Metals in Water by CRC ICPMS	E421	354974	1	18	5.5	5.0	✔
Fluoride in Water by IC	E235.F	350470	1	20	5.0	5.0	✔
Nitrate in Water by IC	E235.NO3	350468	1	20	5.0	5.0	✔
Nitrite in Water by IC	E235.NO2	350469	1	20	5.0	5.0	✔
Sulfate in Water by IC	E235.SO4	350467	1	20	5.0	5.0	✔
VOCs (Prairies List) by Headspace GC-MS	E611E	350431	1	11	9.0	5.0	✔



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

Quality Control Sample Type	Method	QC Lot #	Count		Frequency (%)		
			QC	Regular	Actual	Expected	Evaluation
<i>Analytical Methods</i>							
Matrix Spikes (MS)							
Ammonia by Fluorescence	E298	354131	1	20	5.0	5.0	✔
Chloride in Water by IC	E235.Cl	350471	1	20	5.0	5.0	✔
Dissolved Mercury in Water by CVAAS	E509	350827	1	18	5.5	5.0	✔
Dissolved Metals in Water by CRC ICPMS	E421	354974	1	18	5.5	5.0	✔
Fluoride in Water by IC	E235.F	350470	1	20	5.0	5.0	✔
Nitrate in Water by IC	E235.NO3	350468	1	20	5.0	5.0	✔
Nitrite in Water by IC	E235.NO2	350469	1	20	5.0	5.0	✔
Sulfate in Water by IC	E235.SO4	350467	1	20	5.0	5.0	✔
VOCs (Prairies List) by Headspace GC-MS	E611E	350431	1	11	9.0	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 Calgary - Environmental	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 Calgary - Environmental	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 Calgary - Environmental	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 Calgary - Environmental	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 Calgary - Environmental	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 Calgary - Environmental	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 Calgary - Environmental	Water	EPA 300.1 (mod)	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.
Alkalinity Species by Titration	E290 Calgary - Environmental	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.
Ammonia by Fluorescence	E298 Calgary - Environmental	Water	J. Environ. Monit., 2005, 7, 37-42 (mod)	Ammonia in water is analyzed by flow-injection analysis with fluorescence detection after reaction with orthophthaldialdehyde (OPA).
Dissolved Metals in Water by CRC ICPMS	E421 Calgary - Environmental	Water	APHA 3030B/EPA 6020B (mod)	Water samples are filtered (0.45 um), 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.
Dissolved Mercury in Water by CVAAS	E509 Calgary - Environmental	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 Calgary - Environmental	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.



<i>Analytical Methods</i>	<i>Method / Lab</i>	<i>Matrix</i>	<i>Method Reference</i>	<i>Method Descriptions</i>
Dissolved Hardness (Calculated)	EC100 Calgary - Environmental	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 Calgary - Environmental	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 Calgary - Environmental	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.
<i>Preparation Methods</i>	<i>Method / Lab</i>	<i>Matrix</i>	<i>Method Reference</i>	<i>Method Descriptions</i>
Preparation for Ammonia	EP298 Calgary - Environmental	Water		Sample preparation for Preserved Nutrients Water Quality Analysis.
Dissolved Metals Water Filtration	EP421 Calgary - Environmental	Water	APHA 3030B	Water samples are filtered (0.45 um), and preserved with HNO ₃ .
Dissolved Mercury Water Filtration	EP509 Calgary - Environmental	Water	APHA 3030B	Water samples are filtered (0.45 um), and preserved with HCl.
VOCs Preparation for Headspace Analysis	EP581 Calgary - Environmental	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 the GC/MS-FID system.

QUALITY CONTROL REPORT

Work Order : **CG2105892**

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Client : Tetra Tech Canada Inc.
Contact : Darby Madalena
Address : 115 - 200 Rivercrest Dr SE
 Calgary AB Canada T2C 2X5
Telephone : 403 203 3355
Project : SWM.SWOP04071-02.003
PO : SWM.SWOP04071-02.003
C-O-C number : CORD MCKENZIE TRAILS
Sampler : RYAN MILLER
Site : ----
Quote number : Q71650 City of Red Deer Pre-1972 Landfill Monitoring
No. of samples received : 4
No. of samples analysed : 4

Laboratory : Calgary - Environmental
Account Manager : Milica Papic
Address : 2559 29th Street NE
 Calgary, Alberta Canada T1Y 7B5
Telephone : +1 403 407 1800
Date Samples Received : 23-Nov-2021 05:55
Date Analysis Commenced : 23-Nov-2021
Issue Date : 01-Dec-2021 16:03

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 Percentage Difference (RPD) and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits
- Reference Material (RM) Report; Recovery and Acceptance Limits
- Method Blank (MB) Report; Recovery and Acceptance Limits
- Laboratory Control Sample (LCS) Report; Recovery and Acceptance Limits

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>
Daniel Ching	Lab Analyst	Metals, Calgary, Alberta
Jeanie Mark	Laboratory Analyst	Organics, Calgary, Alberta
Millicent Brentnall	Laboratory Analyst	Metals, Calgary, Alberta
Parker Sgarbossa	Laboratory Analyst	Inorganics, Calgary, Alberta
Sara Niroomand		Inorganics, Calgary, Alberta
Sara Niroomand		Metals, Calgary, Alberta
Shirley Li		Metals, Calgary, Alberta
Vladka Stamenova	Analyst	Inorganics, Calgary, Alberta

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Work Order : CG2105892
Client : Tetra Tech Canada Inc.
Project : SWM.SWOP04071-02.003



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 Services number is a unique identifier assigned to discrete substances.

DQO = Data Quality Objective.

LOR = Limit of Reporting (detection limit).

RPD = Relative Percentage Difference

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



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: 350541)											
CG2105814-020	Anonymous	alkalinity, total (as CaCO3)	----	E290	1.0	mg/L	644	642	0.404%	20%	----
Physical Tests (QC Lot: 350542)											
CG2105814-020	Anonymous	pH	----	E108	0.10	pH units	8.20	8.20	0.00%	4%	----
Physical Tests (QC Lot: 350543)											
CG2105814-020	Anonymous	conductivity	----	E100	1.0	µS/cm	1750	1740	0.516%	10%	----
Anions and Nutrients (QC Lot: 350467)											
CG2105814-008	Anonymous	sulfate (as SO4)	14808-79-8	E235.SO4	1.50	mg/L	179	180	0.299%	20%	----
Anions and Nutrients (QC Lot: 350468)											
CG2105814-008	Anonymous	nitrate (as N)	14797-55-8	E235.NO3	0.100	mg/L	0.129	0.121	0.008	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 350469)											
CG2105814-008	Anonymous	nitrite (as N)	14797-65-0	E235.NO2	0.050	mg/L	<0.050	<0.050	0	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 350470)											
CG2105814-008	Anonymous	fluoride	16984-48-8	E235.F	0.100	mg/L	0.139	0.132	0.007	Diff <2x LOR	----
Anions and Nutrients (QC Lot: 350471)											
CG2105814-008	Anonymous	chloride	16887-00-6	E235.Cl	2.50	mg/L	122	122	0.327%	20%	----
Anions and Nutrients (QC Lot: 354131)											
CG2105892-001	MW-03	ammonia, total (as N)	7664-41-7	E298	0.500	mg/L	5.51	5.35	3.03%	20%	----
Dissolved Metals (QC Lot: 350827)											
CG2105892-001	MW-03	mercury, dissolved	7439-97-6	E509	0.0000050	mg/L	<0.0000050	<0.0000050	0	Diff <2x LOR	----
Dissolved Metals (QC Lot: 354974)											
CG2105890-001	Anonymous	aluminum, dissolved	7429-90-5	E421	0.0050	mg/L	<0.0050	<0.0050	0	Diff <2x LOR	----
		antimony, dissolved	7440-36-0	E421	0.00050	mg/L	<0.00050	<0.00050	0	Diff <2x LOR	----
		arsenic, dissolved	7440-38-2	E421	0.00050	mg/L	<0.00050	<0.00050	0	Diff <2x LOR	----
		barium, dissolved	7440-39-3	E421	0.00050	mg/L	0.0223	0.0220	1.44%	20%	----
		beryllium, dissolved	7440-41-7	E421	0.100	mg/L	<0.100 µg/L	<0.000100	0	Diff <2x LOR	----
		bismuth, dissolved	7440-69-9	E421	0.000250	mg/L	<0.000250	<0.000250	0	Diff <2x LOR	----
		boron, dissolved	7440-42-8	E421	0.050	mg/L	<0.050	<0.050	0	Diff <2x LOR	----
		cadmium, dissolved	7440-43-9	E421	0.0250	mg/L	<0.0250 µg/L	<0.0000250	0	Diff <2x LOR	----
		calcium, dissolved	7440-70-2	E421	0.250	mg/L	228	228	0.108%	20%	----
		chromium, dissolved	7440-47-3	E421	0.00250	mg/L	<0.00250	<0.00250	0	Diff <2x LOR	----
		cobalt, dissolved	7440-48-4	E421	0.50	mg/L	2.69 µg/L	0.00272	0.00002	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: 354974) - continued											
CG2105890-001	Anonymous	copper, dissolved	7440-50-8	E421	0.00100	mg/L	<0.00100	<0.00100	0	Diff <2x LOR	----
		iron, dissolved	7439-89-6	E421	0.050	mg/L	<0.050	<0.050	0	Diff <2x LOR	----
		lead, dissolved	7439-92-1	E421	0.000250	mg/L	<0.000250	<0.000250	0	Diff <2x LOR	----
		lithium, dissolved	7439-93-2	E421	0.0050	mg/L	0.0502	0.0497	0.0005	Diff <2x LOR	----
		magnesium, dissolved	7439-95-4	E421	0.0250	mg/L	140	139	0.716%	20%	----
		manganese, dissolved	7439-96-5	E421	0.00050	mg/L	0.0422	0.0402	4.88%	20%	----
		molybdenum, dissolved	7439-98-7	E421	0.000250	mg/L	0.0158	0.0160	1.28%	20%	----
		nickel, dissolved	7440-02-0	E421	0.00250	mg/L	0.0266	0.0266	0.0322%	20%	----
		phosphorus, dissolved	7723-14-0	E421	0.250	mg/L	<0.250	<0.250	0	Diff <2x LOR	----
		potassium, dissolved	7440-09-7	E421	0.250	mg/L	4.14	4.08	1.37%	20%	----
		selenium, dissolved	7782-49-2	E421	0.250	mg/L	22.9 µg/L	0.0229	0.187%	20%	----
		silicon, dissolved	7440-21-3	E421	0.250	mg/L	3.11	3.06	1.34%	20%	----
		silver, dissolved	7440-22-4	E421	0.000050	mg/L	<0.000050	<0.000050	0	Diff <2x LOR	----
		sodium, dissolved	17341-25-2	E421	0.250	mg/L	5.97	5.92	0.946%	20%	----
		strontium, dissolved	7440-24-6	E421	0.00100	mg/L	0.320	0.316	1.49%	20%	----
		sulfur, dissolved	7704-34-9	E421	2.50	mg/L	291	288	0.956%	20%	----
		thallium, dissolved	7440-28-0	E421	0.000050	mg/L	<0.000050	<0.000050	0	Diff <2x LOR	----
		tin, dissolved	7440-31-5	E421	0.00050	mg/L	<0.00050	<0.00050	0	Diff <2x LOR	----
		titanium, dissolved	7440-32-6	E421	0.00150	mg/L	<0.00150	<0.00150	0	Diff <2x LOR	----
		uranium, dissolved	7440-61-1	E421	0.000050	mg/L	0.0118	0.0118	0.0238%	20%	----
		vanadium, dissolved	7440-62-2	E421	0.00250	mg/L	<0.00250	<0.00250	0	Diff <2x LOR	----
		zinc, dissolved	7440-66-6	E421	0.0050	mg/L	<0.0050	<0.0050	0	Diff <2x LOR	----
		zirconium, dissolved	7440-67-7	E421	0.00150	mg/L	<0.00150	<0.00150	0	Diff <2x LOR	----
Volatile Organic Compounds (QC Lot: 350431)											
CG2105892-001	MW-03	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	----



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: 350431) - continued											
CG2105892-001	MW-03	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	4.2	4.3	0.09	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	----
		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	----
		naphthalene	91-20-3	E611E	1.0	µg/L	<1.0	<1.0	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	----



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: 350431) - continued											
CG2105892-001	MW-03	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	2.1	2.1	0.01	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: 350541)						
alkalinity, total (as CaCO3)	----	E290	1	mg/L	<1.0	----
Physical Tests (QCLot: 350543)						
conductivity	----	E100	1	µS/cm	1.2	----
Anions and Nutrients (QCLot: 350467)						
sulfate (as SO4)	14808-79-8	E235.SO4	0.3	mg/L	<0.30	----
Anions and Nutrients (QCLot: 350468)						
nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	<0.020	----
Anions and Nutrients (QCLot: 350469)						
nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	<0.010	----
Anions and Nutrients (QCLot: 350470)						
fluoride	16984-48-8	E235.F	0.02	mg/L	<0.020	----
Anions and Nutrients (QCLot: 350471)						
chloride	16887-00-6	E235.Cl	0.5	mg/L	<0.50	----
Anions and Nutrients (QCLot: 354131)						
ammonia, total (as N)	7664-41-7	E298	0.005	mg/L	<0.0050	----
Dissolved Metals (QCLot: 350827)						
mercury, dissolved	7439-97-6	E509	0.000005	mg/L	<0.0000050	----
Dissolved Metals (QCLot: 354974)						
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	----
beryllium, dissolved	7440-41-7	E421	0.00002	mg/L	<0.000020	----
bismuth, dissolved	7440-69-9	E421	0.00005	mg/L	<0.000050	----
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	----
cobalt, dissolved	7440-48-4	E421	0.0001	mg/L	<0.00010	----
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	----
lithium, dissolved	7439-93-2	E421	0.001	mg/L	<0.0010	----



Sub-Matrix: Water

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Dissolved Metals (QCLot: 354974) - continued						
magnesium, dissolved	7439-95-4	E421	0.005	mg/L	<0.0050	---
manganese, dissolved	7439-96-5	E421	0.0001	mg/L	<0.00010	---
molybdenum, dissolved	7439-98-7	E421	0.00005	mg/L	<0.000050	---
nickel, dissolved	7440-02-0	E421	0.0005	mg/L	<0.00050	---
phosphorus, dissolved	7723-14-0	E421	0.05	mg/L	<0.050	---
potassium, dissolved	7440-09-7	E421	0.05	mg/L	<0.050	---
selenium, dissolved	7782-49-2	E421	0.00005	mg/L	<0.000050	---
silicon, dissolved	7440-21-3	E421	0.05	mg/L	<0.050	---
silver, dissolved	7440-22-4	E421	0.00001	mg/L	<0.000010	---
sodium, dissolved	17341-25-2	E421	0.05	mg/L	<0.050	---
strontium, dissolved	7440-24-6	E421	0.0002	mg/L	<0.00020	---
sulfur, dissolved	7704-34-9	E421	0.5	mg/L	<0.50	---
thallium, dissolved	7440-28-0	E421	0.00001	mg/L	<0.000010	---
tin, dissolved	7440-31-5	E421	0.0001	mg/L	<0.00010	---
titanium, dissolved	7440-32-6	E421	0.0003	mg/L	<0.00030	---
uranium, dissolved	7440-61-1	E421	0.00001	mg/L	<0.000010	---
vanadium, dissolved	7440-62-2	E421	0.0005	mg/L	<0.00050	---
zinc, dissolved	7440-66-6	E421	0.001	mg/L	<0.0010	---
zirconium, dissolved	7440-67-7	E421	0.0002	mg/L	<0.00020	---
Volatile Organic Compounds (QCLot: 350431)						
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	---
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	---



Sub-Matrix: Water

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Volatile Organic Compounds (QCLot: 350431) - continued						
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	---
methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	0.5	µg/L	<0.50	---
naphthalene	91-20-3	E611E	1	µg/L	<1.0	---
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	---



Sub-Matrix: **Water**

<i>Analyte</i>	<i>CAS Number</i>	<i>Method</i>	<i>LOR</i>	<i>Unit</i>	<i>Result</i>	<i>Qualifier</i>
Volatile Organic Compounds (QCLot: 350431) - continued						
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				
Analyte	CAS Number	Method	LOR	Unit	Spike	Recovery (%)	Recovery Limits (%)		Qualifier
					Concentration	LCS	Low	High	
Physical Tests (QCLot: 350541)									
alkalinity, total (as CaCO3)	----	E290	1	mg/L	500 mg/L	107	85.0	115	----
Physical Tests (QCLot: 350542)									
pH	----	E108	----	pH units	7 pH units	100	98.6	101	----
Physical Tests (QCLot: 350543)									
conductivity	----	E100	1	µS/cm	146.9 µS/cm	102	90.0	110	----
Anions and Nutrients (QCLot: 350467)									
sulfate (as SO4)	14808-79-8	E235.SO4	0.3	mg/L	100 mg/L	101	90.0	110	----
Anions and Nutrients (QCLot: 350468)									
nitrate (as N)	14797-55-8	E235.NO3	0.02	mg/L	2.5 mg/L	99.5	90.0	110	----
Anions and Nutrients (QCLot: 350469)									
nitrite (as N)	14797-65-0	E235.NO2	0.01	mg/L	0.5 mg/L	101	90.0	110	----
Anions and Nutrients (QCLot: 350470)									
fluoride	16984-48-8	E235.F	0.02	mg/L	1 mg/L	93.4	90.0	110	----
Anions and Nutrients (QCLot: 350471)									
chloride	16887-00-6	E235.Cl	0.5	mg/L	100 mg/L	99.3	90.0	110	----
Anions and Nutrients (QCLot: 354131)									
ammonia, total (as N)	7664-41-7	E298	0.005	mg/L	0.2 mg/L	100	85.0	115	----
mercury, dissolved	7439-97-6	E509	0.000005	mg/L	0.0001 mg/L	101	80.0	120	----
Dissolved Metals (QCLot: 354974)									
aluminum, dissolved	7429-90-5	E421	0.001	mg/L	2 mg/L	91.4	80.0	120	----
antimony, dissolved	7440-36-0	E421	0.0001	mg/L	1 mg/L	108	80.0	120	----
arsenic, dissolved	7440-38-2	E421	0.0001	mg/L	1 mg/L	93.6	80.0	120	----
barium, dissolved	7440-39-3	E421	0.0001	mg/L	0.25 mg/L	95.6	80.0	120	----
beryllium, dissolved	7440-41-7	E421	0.00002	mg/L	0.1 mg/L	98.7	80.0	120	----
bismuth, dissolved	7440-69-9	E421	0.00005	mg/L	1 mg/L	99.4	80.0	120	----
boron, dissolved	7440-42-8	E421	0.01	mg/L	1 mg/L	95.9	80.0	120	----
cadmium, dissolved	7440-43-9	E421	0.000005	mg/L	0.1 mg/L	93.3	80.0	120	----
calcium, dissolved	7440-70-2	E421	0.05	mg/L	50 mg/L	98.1	80.0	120	----
chromium, dissolved	7440-47-3	E421	0.0005	mg/L	0.25 mg/L	94.4	80.0	120	----
cobalt, dissolved	7440-48-4	E421	0.0001	mg/L	0.25 mg/L	95.6	80.0	120	----
copper, dissolved	7440-50-8	E421	0.0002	mg/L	0.25 mg/L	92.3	80.0	120	----
iron, dissolved	7439-89-6	E421	0.01	mg/L	1 mg/L	92.6	80.0	120	----



Sub-Matrix: **Water**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Dissolved Metals (QCLot: 354974) - continued									
lead, dissolved	7439-92-1	E421	0.00005	mg/L	0.5 mg/L	98.9	80.0	120	----
lithium, dissolved	7439-93-2	E421	0.001	mg/L	0.25 mg/L	101	80.0	120	----
magnesium, dissolved	7439-95-4	E421	0.005	mg/L	50 mg/L	90.4	80.0	120	----
manganese, dissolved	7439-96-5	E421	0.0001	mg/L	0.25 mg/L	97.4	80.0	120	----
molybdenum, dissolved	7439-98-7	E421	0.00005	mg/L	0.25 mg/L	101	80.0	120	----
nickel, dissolved	7440-02-0	E421	0.0005	mg/L	0.5 mg/L	93.1	80.0	120	----
phosphorus, dissolved	7723-14-0	E421	0.05	mg/L	10 mg/L	95.2	70.0	130	----
potassium, dissolved	7440-09-7	E421	0.05	mg/L	50 mg/L	95.9	80.0	120	----
selenium, dissolved	7782-49-2	E421	0.00005	mg/L	1 mg/L	92.6	80.0	120	----
silicon, dissolved	7440-21-3	E421	0.05	mg/L	10 mg/L	96.5	60.0	140	----
silver, dissolved	7440-22-4	E421	0.00001	mg/L	0.1 mg/L	105	80.0	120	----
sodium, dissolved	17341-25-2	E421	0.05	mg/L	50 mg/L	93.8	80.0	120	----
strontium, dissolved	7440-24-6	E421	0.0002	mg/L	0.25 mg/L	98.0	80.0	120	----
sulfur, dissolved	7704-34-9	E421	0.5	mg/L	50 mg/L	110	80.0	120	----
thallium, dissolved	7440-28-0	E421	0.00001	mg/L	1 mg/L	98.6	80.0	120	----
tin, dissolved	7440-31-5	E421	0.0001	mg/L	0.5 mg/L	96.5	80.0	120	----
titanium, dissolved	7440-32-6	E421	0.0003	mg/L	0.25 mg/L	87.7	80.0	120	----
uranium, dissolved	7440-61-1	E421	0.00001	mg/L	0.005 mg/L	105	80.0	120	----
vanadium, dissolved	7440-62-2	E421	0.0005	mg/L	0.5 mg/L	95.1	80.0	120	----
zinc, dissolved	7440-66-6	E421	0.001	mg/L	0.5 mg/L	92.1	80.0	120	----
zirconium, dissolved	7440-67-7	E421	0.0002	mg/L	0.1 mg/L	104	80.0	120	----
Volatile Organic Compounds (QCLot: 350431)									
benzene	71-43-2	E611E	0.5	µg/L	100 µg/L	110	70.0	130	----
bromobenzene	108-86-1	E611E	1	µg/L	100 µg/L	105	70.0	130	----
bromochloromethane	74-97-5	E611E	1	µg/L	100 µg/L	103	70.0	130	----
bromodichloromethane	75-27-4	E611E	1	µg/L	100 µg/L	99.0	70.0	130	----
bromoform	75-25-2	E611E	1	µg/L	100 µg/L	109	70.0	130	----
bromomethane	74-83-9	E611E	1	µg/L	100 µg/L	120	60.0	140	----
butylbenzene, n-	104-51-8	E611E	1	µg/L	100 µg/L	106	70.0	130	----
butylbenzene, sec-	135-98-8	E611E	1	µg/L	100 µg/L	112	70.0	130	----
butylbenzene, tert-	98-06-6	E611E	1	µg/L	100 µg/L	117	70.0	130	----
carbon tetrachloride	56-23-5	E611E	0.5	µg/L	100 µg/L	89.4	70.0	130	----
chlorobenzene	108-90-7	E611E	1	µg/L	100 µg/L	105	70.0	130	----
chloroethane	75-00-3	E611E	1	µg/L	100 µg/L	118	60.0	140	----
chloroform	67-66-3	E611E	1	µg/L	100 µg/L	97.0	70.0	130	----
chloromethane	74-87-3	E611E	5	µg/L	100 µg/L	101	60.0	140	----
chlorotoluene, 2-	95-49-8	E611E	1	µg/L	100 µg/L	112	70.0	130	----



Sub-Matrix: Water

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Volatile Organic Compounds (QCLot: 350431) - continued									
chlorotoluene, 4-	106-43-4	E611E	1	µg/L	100 µg/L	112	70.0	130	----
cymene, p-	99-87-6	E611E	1	µg/L	100 µg/L	125	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	97.2	70.0	130	----
dibromoethane, 1,2-	106-93-4	E611E	1	µg/L	100 µg/L	113	70.0	130	----
dibromomethane	74-95-3	E611E	1	µg/L	100 µg/L	120	70.0	130	----
dichlorobenzene, 1,2-	95-50-1	E611E	0.5	µg/L	100 µg/L	108	70.0	130	----
dichlorobenzene, 1,3-	541-73-1	E611E	1	µg/L	100 µg/L	105	70.0	130	----
dichlorobenzene, 1,4-	106-46-7	E611E	1	µg/L	100 µg/L	109	70.0	130	----
dichlorodifluoromethane	75-71-8	E611E	1	µg/L	100 µg/L	105	60.0	140	----
dichloroethane, 1,1-	75-34-3	E611E	1	µg/L	100 µg/L	99.9	70.0	130	----
dichloroethane, 1,2-	107-06-2	E611E	1	µg/L	100 µg/L	105	70.0	130	----
dichloroethylene, 1,1-	75-35-4	E611E	1	µg/L	100 µg/L	125	70.0	130	----
dichloroethylene, cis-1,2-	156-59-2	E611E	1	µg/L	100 µg/L	113	70.0	130	----
dichloroethylene, trans-1,2-	156-60-5	E611E	1	µg/L	100 µg/L	103	70.0	130	----
dichloromethane	75-09-2	E611E	1	µg/L	100 µg/L	94.2	70.0	130	----
dichloropropane, 1,2-	78-87-5	E611E	1	µg/L	100 µg/L	111	70.0	130	----
dichloropropane, 1,3-	142-28-9	E611E	1	µg/L	100 µg/L	119	70.0	130	----
dichloropropane, 2,2-	594-20-7	E611E	1	µg/L	100 µg/L	126	70.0	130	----
dichloropropylene, 1,1-	563-58-6	E611E	1	µg/L	100 µg/L	111	70.0	130	----
dichloropropylene, cis-1,3-	10061-01-5	E611E	1	µg/L	100 µg/L	112	70.0	130	----
dichloropropylene, trans-1,3-	10061-02-6	E611E	1	µg/L	100 µg/L	116	70.0	130	----
ethylbenzene	100-41-4	E611E	0.5	µg/L	100 µg/L	106	70.0	130	----
hexachlorobutadiene	87-68-3	E611E	1	µg/L	100 µg/L	99.9	70.0	130	----
isopropylbenzene	98-82-8	E611E	1	µg/L	100 µg/L	111	70.0	130	----
methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	0.5	µg/L	100 µg/L	105	70.0	130	----
naphthalene	91-20-3	E611E	1	µg/L	100 µg/L	114	70.0	130	----
propylbenzene, n-	103-65-1	E611E	1	µg/L	100 µg/L	126	70.0	130	----
styrene	100-42-5	E611E	0.5	µg/L	100 µg/L	104	70.0	130	----
tetrachloroethane, 1,1,1,2-	630-20-6	E611E	1	µg/L	100 µg/L	91.4	70.0	130	----
tetrachloroethane, 1,1,2,2-	79-34-5	E611E	1	µg/L	100 µg/L	84.9	70.0	130	----
tetrachloroethylene	127-18-4	E611E	1	µg/L	100 µg/L	116	70.0	130	----
toluene	108-88-3	E611E	0.5	µg/L	100 µg/L	124	70.0	130	----
trichlorobenzene, 1,2,3-	87-61-6	E611E	1	µg/L	100 µg/L	108	70.0	130	----
trichlorobenzene, 1,2,4-	120-82-1	E611E	1	µg/L	100 µg/L	118	70.0	130	----
trichloroethane, 1,1,1-	71-55-6	E611E	1	µg/L	100 µg/L	99.7	70.0	130	----
trichloroethane, 1,1,2-	79-00-5	E611E	1	µg/L	100 µg/L	105	70.0	130	----
trichloroethylene	79-01-6	E611E	1	µg/L	100 µg/L	112	70.0	130	----



Sub-Matrix: **Water**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Volatile Organic Compounds (QCLot: 350431) - continued									
trichlorofluoromethane	75-69-4	E611E	1	µg/L	100 µg/L	120	60.0	140	----
trichloropropane, 1,2,3-	96-18-4	E611E	1	µg/L	100 µg/L	96.9	70.0	130	----
trimethylbenzene, 1,2,4-	95-63-6	E611E	1	µg/L	100 µg/L	124	70.0	130	----
trimethylbenzene, 1,3,5-	108-67-8	E611E	1	µg/L	100 µg/L	126	70.0	130	----
vinyl chloride	75-01-4	E611E	1	µg/L	100 µg/L	106	60.0	140	----
xylene, m+p-	179601-23-1	E611E	0.4	µg/L	200 µg/L	112	70.0	130	----
xylene, o-	95-47-6	E611E	0.3	µg/L	100 µg/L	110	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.

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
Anions and Nutrients (QCLot: 350467)										
CG2105814-009	Anonymous	sulfate (as SO4)	14808-79-8	E235.SO4	ND mg/L	100 mg/L	ND	75.0	125	----
Anions and Nutrients (QCLot: 350468)										
CG2105814-009	Anonymous	nitrate (as N)	14797-55-8	E235.NO3	2.42 mg/L	2.5 mg/L	96.8	75.0	125	----
Anions and Nutrients (QCLot: 350469)										
CG2105814-009	Anonymous	nitrite (as N)	14797-65-0	E235.NO2	0.489 mg/L	0.5 mg/L	97.8	75.0	125	----
Anions and Nutrients (QCLot: 350470)										
CG2105814-009	Anonymous	fluoride	16984-48-8	E235.F	0.836 mg/L	1 mg/L	83.6	75.0	125	----
Anions and Nutrients (QCLot: 350471)										
CG2105814-009	Anonymous	chloride	16887-00-6	E235.Cl	ND mg/L	100 mg/L	ND	75.0	125	----
Anions and Nutrients (QCLot: 354131)										
CG2105892-002	MW-04	ammonia, total (as N)	7664-41-7	E298	ND mg/L	0.1 mg/L	ND	75.0	125	----
Dissolved Metals (QCLot: 350827)										
CG2105892-002	MW-04	mercury, dissolved	7439-97-6	E509	0.000104 mg/L	0.0001 mg/L	104	70.0	130	----
Dissolved Metals (QCLot: 354974)										
CG2105890-002	Anonymous	aluminum, dissolved	7429-90-5	E421	1.69 mg/L	2 mg/L	84.3	70.0	130	----
		antimony, dissolved	7440-36-0	E421	0.214 mg/L	0.2 mg/L	107	70.0	130	----
		arsenic, dissolved	7440-38-2	E421	0.174 mg/L	0.2 mg/L	87.0	70.0	130	----
		barium, dissolved	7440-39-3	E421	0.177 mg/L	0.2 mg/L	88.6	70.0	130	----
		beryllium, dissolved	7440-41-7	E421	0.379 mg/L	0.4 mg/L	94.7	70.0	130	----
		bismuth, dissolved	7440-69-9	E421	0.0952 mg/L	0.1 mg/L	95.2	70.0	130	----
		boron, dissolved	7440-42-8	E421	0.999 mg/L	1 mg/L	99.9	70.0	130	----
		cadmium, dissolved	7440-43-9	E421	0.0350 mg/L	0.04 mg/L	87.6	70.0	130	----
		calcium, dissolved	7440-70-2	E421	36.6 mg/L	40 mg/L	91.4	70.0	130	----
		chromium, dissolved	7440-47-3	E421	0.350 mg/L	0.4 mg/L	87.5	70.0	130	----
		cobalt, dissolved	7440-48-4	E421	0.176 mg/L	0.2 mg/L	88.1	70.0	130	----
		copper, dissolved	7440-50-8	E421	0.175 mg/L	0.2 mg/L	87.5	70.0	130	----
		iron, dissolved	7439-89-6	E421	17.5 mg/L	20 mg/L	87.7	70.0	130	----
		lead, dissolved	7439-92-1	E421	0.192 mg/L	0.2 mg/L	95.8	70.0	130	----
		lithium, dissolved	7439-93-2	E421	0.941 mg/L	1 mg/L	94.1	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: 354974) - continued										
CG2105890-002	Anonymous	magnesium, dissolved	7439-95-4	E421	ND mg/L	10 mg/L	ND	70.0	130	----
		manganese, dissolved	7439-96-5	E421	0.184 mg/L	0.2 mg/L	91.8	70.0	130	----
		molybdenum, dissolved	7439-98-7	E421	0.189 mg/L	0.2 mg/L	94.7	70.0	130	----
		nickel, dissolved	7440-02-0	E421	0.350 mg/L	0.4 mg/L	87.5	70.0	130	----
		phosphorus, dissolved	7723-14-0	E421	87.5 mg/L	100 mg/L	87.5	70.0	130	----
		potassium, dissolved	7440-09-7	E421	34.9 mg/L	40 mg/L	87.2	70.0	130	----
		selenium, dissolved	7782-49-2	E421	0.373 mg/L	0.4 mg/L	93.2	70.0	130	----
		silicon, dissolved	7440-21-3	E421	86.7 mg/L	100 mg/L	86.7	70.0	130	----
		silver, dissolved	7440-22-4	E421	0.0405 mg/L	0.04 mg/L	101	70.0	130	----
		sodium, dissolved	17341-25-2	E421	17.1 mg/L	20 mg/L	85.5	70.0	130	----
		strontium, dissolved	7440-24-6	E421	0.188 mg/L	0.2 mg/L	93.9	70.0	130	----
		sulfur, dissolved	7704-34-9	E421	193 mg/L	200 mg/L	96.3	70.0	130	----
		thallium, dissolved	7440-28-0	E421	0.0393 mg/L	0.04 mg/L	98.4	70.0	130	----
		tin, dissolved	7440-31-5	E421	0.177 mg/L	0.2 mg/L	88.6	70.0	130	----
		titanium, dissolved	7440-32-6	E421	0.318 mg/L	0.4 mg/L	79.4	70.0	130	----
		uranium, dissolved	7440-61-1	E421	0.0392 mg/L	0.04 mg/L	97.9	70.0	130	----
		vanadium, dissolved	7440-62-2	E421	0.867 mg/L	1 mg/L	86.7	70.0	130	----
		zinc, dissolved	7440-66-6	E421	3.48 mg/L	4 mg/L	86.9	70.0	130	----
		zirconium, dissolved	7440-67-7	E421	0.381 mg/L	0.4 mg/L	95.2	70.0	130	----
Volatile Organic Compounds (QCLot: 350431)										
CG2105892-001	MW-03	benzene	71-43-2	E611E	90.6 µg/L	100 µg/L	90.6	70.0	130	----
		bromobenzene	108-86-1	E611E	101 µg/L	100 µg/L	101	70.0	130	----
		bromochloromethane	74-97-5	E611E	84.8 µg/L	100 µg/L	84.8	70.0	130	----
		bromodichloromethane	75-27-4	E611E	79.8 µg/L	100 µg/L	79.8	70.0	130	----
		bromoform	75-25-2	E611E	105 µg/L	100 µg/L	105	70.0	130	----
		bromomethane	74-83-9	E611E	95.0 µg/L	100 µg/L	95.0	60.0	140	----
		butylbenzene, n-	104-51-8	E611E	124 µg/L	100 µg/L	124	70.0	130	----
		butylbenzene, sec-	135-98-8	E611E	100 µg/L	100 µg/L	100	70.0	130	----
		butylbenzene, tert-	98-06-6	E611E	105 µg/L	100 µg/L	105	70.0	130	----
		carbon tetrachloride	56-23-5	E611E	70.4 µg/L	100 µg/L	70.4	70.0	130	----
		chlorobenzene	108-90-7	E611E	100 µg/L	100 µg/L	100	70.0	130	----
		chloroethane	75-00-3	E611E	97.1 µg/L	100 µg/L	97.1	60.0	140	----
		chloroform	67-66-3	E611E	77.9 µg/L	100 µg/L	77.9	70.0	130	----
		chloromethane	74-87-3	E611E	79.0 µg/L	100 µg/L	79.0	60.0	140	----
		chlorotoluene, 2-	95-49-8	E611E	102 µg/L	100 µg/L	102	70.0	130	----
		chlorotoluene, 4-	106-43-4	E611E	104 µg/L	100 µg/L	104	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: 350431) - continued										
CG2105892-001	MW-03	cymene, p-	99-87-6	E611E	114 µg/L	100 µg/L	114	70.0	130	----
		dibromo-3-chloropropane, 1,2-	96-12-8	E611E	102 µg/L	100 µg/L	102	70.0	130	----
		dibromochloromethane	124-48-1	E611E	75.2 µg/L	100 µg/L	75.2	70.0	130	----
		dibromoethane, 1,2-	106-93-4	E611E	93.9 µg/L	100 µg/L	93.9	70.0	130	----
		dibromomethane	74-95-3	E611E	97.4 µg/L	100 µg/L	97.4	70.0	130	----
		dichlorobenzene, 1,2-	95-50-1	E611E	106 µg/L	100 µg/L	106	70.0	130	----
		dichlorobenzene, 1,3-	541-73-1	E611E	102 µg/L	100 µg/L	102	70.0	130	----
		dichlorobenzene, 1,4-	106-46-7	E611E	101 µg/L	100 µg/L	101	70.0	130	----
		dichlorodifluoromethane	75-71-8	E611E	78.0 µg/L	100 µg/L	78.0	60.0	140	----
		dichloroethane, 1,1-	75-34-3	E611E	79.3 µg/L	100 µg/L	79.3	70.0	130	----
		dichloroethane, 1,2-	107-06-2	E611E	84.8 µg/L	100 µg/L	84.8	70.0	130	----
		dichloroethylene, 1,1-	75-35-4	E611E	98.5 µg/L	100 µg/L	98.5	70.0	130	----
		dichloroethylene, cis-1,2-	156-59-2	E611E	94.7 µg/L	100 µg/L	94.7	70.0	130	----
		dichloroethylene, trans-1,2-	156-60-5	E611E	79.2 µg/L	100 µg/L	79.2	70.0	130	----
		dichloromethane	75-09-2	E611E	76.8 µg/L	100 µg/L	76.8	70.0	130	----
		dichloropropane, 1,2-	78-87-5	E611E	91.9 µg/L	100 µg/L	91.9	70.0	130	----
		dichloropropane, 1,3-	142-28-9	E611E	94.4 µg/L	100 µg/L	94.4	70.0	130	----
		dichloropropane, 2,2-	594-20-7	E611E	92.2 µg/L	100 µg/L	92.2	70.0	130	----
		dichloropropylene, 1,1-	563-58-6	E611E	91.9 µg/L	100 µg/L	91.9	70.0	130	----
		dichloropropylene, cis-1,3-	10061-01-5	E611E	92.2 µg/L	100 µg/L	92.2	70.0	130	----
		dichloropropylene, trans-1,3-	10061-02-6	E611E	92.7 µg/L	100 µg/L	92.7	70.0	130	----
		ethylbenzene	100-41-4	E611E	104 µg/L	100 µg/L	104	70.0	130	----
		hexachlorobutadiene	87-68-3	E611E	122 µg/L	100 µg/L	122	70.0	130	----
		isopropylbenzene	98-82-8	E611E	99.6 µg/L	100 µg/L	99.6	70.0	130	----
		methyl-tert-butyl ether [MTBE]	1634-04-4	E611E	96.0 µg/L	100 µg/L	96.0	70.0	130	----
		naphthalene	91-20-3	E611E	122 µg/L	100 µg/L	122	70.0	130	----
		propylbenzene, n-	103-65-1	E611E	118 µg/L	100 µg/L	118	70.0	130	----
		styrene	100-42-5	E611E	97.8 µg/L	100 µg/L	97.8	70.0	130	----
		tetrachloroethane, 1,1,1,2-	630-20-6	E611E	86.7 µg/L	100 µg/L	86.7	70.0	130	----
		tetrachloroethane, 1,1,2,2-	79-34-5	E611E	81.8 µg/L	100 µg/L	81.8	70.0	130	----
		tetrachloroethylene	127-18-4	E611E	89.7 µg/L	100 µg/L	89.7	70.0	130	----
		toluene	108-88-3	E611E	99.5 µg/L	100 µg/L	99.5	70.0	130	----
		trichlorobenzene, 1,2,3-	87-61-6	E611E	106 µg/L	100 µg/L	106	70.0	130	----
		trichlorobenzene, 1,2,4-	120-82-1	E611E	117 µg/L	100 µg/L	117	70.0	130	----
		trichloroethane, 1,1,1-	71-55-6	E611E	79.3 µg/L	100 µg/L	79.3	70.0	130	----
		trichloroethane, 1,1,2-	79-00-5	E611E	86.5 µg/L	100 µg/L	86.5	70.0	130	----
		trichloroethylene	79-01-6	E611E	93.3 µg/L	100 µg/L	93.3	70.0	130	----

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 Work Order : CG2105892
 Client : Tetra Tech Canada Inc.
 Project : SWM.SWOP04071-02.003



Sub-Matrix: **Water**

					<i>Matrix Spike (MS) Report</i>					
					<i>Spike</i>		<i>Recovery (%)</i>	<i>Recovery Limits (%)</i>		
<i>Laboratory sample ID</i>	<i>Client sample ID</i>	<i>Analyte</i>	<i>CAS Number</i>	<i>Method</i>	<i>Concentration</i>	<i>Target</i>	<i>MS</i>	<i>Low</i>	<i>High</i>	<i>Qualifier</i>
Volatile Organic Compounds (QCLot: 350431) - continued										
CG2105892-001	MW-03	trichlorofluoromethane	75-69-4	E611E	94.7 µg/L	100 µg/L	94.7	60.0	140	----
		trichloropropane, 1,2,3-	96-18-4	E611E	91.4 µg/L	100 µg/L	91.4	70.0	130	----
		trimethylbenzene, 1,2,4-	95-63-6	E611E	114 µg/L	100 µg/L	114	70.0	130	----
		trimethylbenzene, 1,3,5-	108-67-8	E611E	113 µg/L	100 µg/L	113	70.0	130	----
		vinyl chloride	75-01-4	E611E	94.9 µg/L	100 µg/L	94.9	60.0	140	----
		xylene, m+p-	179601-23-1	E611E	208 µg/L	200 µg/L	104	70.0	130	----
		xylene, o-	95-47-6	E611E	105 µg/L	100 µg/L	105	70.0	130	----

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 Guideline
			08/19/2013				
General Water Quality							
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	--
Trace Organics							
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 Guideline
		08/19/2013				
Volatile Organic Compounds						
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 ₃ -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
Analytcs 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: <input checked="" 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 checked="" 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: 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						
2.0	becomes wet at 2 m.					
3.0	End of hole at 2.0 m. 25 mm diameter 0.3 m length 020 PVC screen. Aboveground lockable steel casing set in concrete.					
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: <input checked="" 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 checked="" 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: 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 checked="" 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 checked="" 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 checked="" 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 checked="" 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) Sand (fill) mixed with MSW - organics, minor plastic pieces, metal, trace glass fragments, strong pungent odour, compact, silty, moist, olive brown.					
1.0						
2.0	Silt (fill) - firm, sandy, moist, olive. charred wood fragments with sand and gravel matrix at 2.4 m.					
3.0						
4.0	No obvious waste material. Sand and gravel (native) - compact, wet, olive. becomes wet at 3.8 m.					
5.0						
6.0	Siltstone (bedrock) - weak, highly weathered, moist, grey.					
7.0						
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