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2014 BAR U RANCH WASTE MIDDENS GROUNDWATER MONITORING AND SAMPLING REPORT

BAR U RANCH NATIONAL HISTORIC SITE LONGVIEW, ALBERTA

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SUMMARY SHEET

Site and Adjacent Land Conditions

Location	Bar U Ranch National Historic Site Longview, AB
Type of facility	Former Waste Middens
Adjacent land use	Agricultural
Aquifer usage in 100-m radius	Yes
Dates of on-site sampling	December 16 and 18, 2014
Number of boreholes drilled (on-site)	Not applicable
Number of wells installed in boreholes (on-site)	Not applicable

Field Work Summary

Groundwater monitoring and sampling was conducted on eight existing monitoring wells. Hydraulic conductivity testing was also completed on two shallow groundwater monitoring wells.

Site Hydrogeology

Depth to groundwater (upper zone)	0.89 – 2.77 mbtoc
Light non-aqueous phase liquids	Not detected in any of the wells monitored
Hydraulic Conductivity (K)	K = 1.0×10^{-8} m/s at MW7 (shallow) K = 8.0×10^{-9} m/s at MW8 (shallow)

Selected Groundwater Guidelines

- Groundwater analytical results for Benzene, Toluene, Ethylbenzene, Xylenes (BTEX), routine water quality parameters, dissolved and total metals, polycyclic aromatic hydrocarbon and organochlorinated pesticide/herbicide parameters were compared to the *Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life* (1999), *CCME Water Quality Guidelines for the Protection of Agricultural Water Uses* (1999) and *Health Canada Guidelines for Canadian Drinking Water Quality (CDWQ)* (Health Canada 2014). Groundwater analytical results for Petroleum Hydrocarbon (PHC) Fractions F1 to F2 were compared to the *Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites* (2014) for agricultural land use, fine-grained soils (based on previous logs and hydraulic conductivity values) and all water use pathways included.

Summary of Results

- Groundwater samples from monitoring wells within both Waste Middens showed exceedances of the CCME aesthetic objectives for dissolved sodium, dissolved sulphate and Total Dissolved Solids (TDS)
- Groundwater samples showed exceedances of the applicable guidelines for dissolved copper, dissolved iron, dissolved manganese, dissolved selenium and dissolved uranium.
- Groundwater samples showed exceedances of the applicable guidelines for numerous total metals parameters.
- Six monitoring wells exceeded the CCME Water Quality Guidelines for the Protection of Aquatic Life for pyrene and two monitoring wells exceeded the guidelines for fluoranthene.

- Concentrations in all of the samples analyzed for BTEX and PHC Fractions F1 to F2 were below the reportable detection limits, and therefore below the applicable guidelines.
- All results for Organochlorinated pesticides were below the reported detection limits, and therefore no groundwater samples exceeded the applicable guidelines.
- The site has a letter grade of “C” for the CCME National Classification System for Contaminated Sites (NCSCS). The percentage of questions answered with certainty was 81%, and 5% of the questions were answered with “do not know”. The total NCSCS Score for the site is 58.8; therefore, the site is classified as Class 2, medium priority for action.
- The Site Closure Tool (SCT) provides guidance for federal government departments, agencies and custodians for steps 6 to 10 of the 10-step approach to contaminated sites process. The SCT helps track progress of the remediation of contaminated sites and standardizes the remediation/risk and closure process as well as documenting the activities that were conducted on the site. Because of the presence of contaminants in excess of applicable federal guidelines, the site cannot be closed in its current state. To achieve site closure, the following is required: a Health and Ecological Risk Assessment is completed and confirms that the existing levels of contamination do not pose a risk, or the parameters are below the applicable guidelines. Risk management may also include the development of site specific guidelines, derived from site-specific data, current and future land use considerations and potential exposure pathways to contaminants of concern on the site.

Conclusions and Recommendations

- There was a decreasing trend in the concentration of toluene for MW1 and MW2. The remaining monitoring wells have a stable trend in the concentration of toluene. The detections of toluene correlate with MW1 and MW2 locations (within and downgradient of the Waste Midden 1, respectively). F2 detection was observed at MW12, which is located downgradient of the Waste Midden 2.
- MW1, MW8 and MW9 show a decreasing trend in concentrations for dissolved sodium, dissolved sulphate and TDS. The monitoring wells are located within the Waste Midden 1. MW3, MW6 and MW7 show an increasing trend in concentrations for dissolved sodium, dissolved sulphate and TDS. These monitoring wells are located at various locations on-site, respectively downgradient of the Waste Midden 1, within the Waste Midden 2 and upgradient of the Waste Midden 1.
- MW2 and MW4 show an increasing trend in concentrations for dissolved iron and dissolved manganese. The monitoring wells are located downgradient of Waste Midden 1 and within Waste Midden 2, respectively. MW1, MW8 and MW12 show an increasing trend in concentration for dissolved manganese. The monitoring wells are located within Waste Midden 1 and downgradient of Waste Midden 2, respectively. Selenium and uranium results are considered representative of background values.
- The frequency and concentrations of PAH detections across the site have been relatively stable, with the majority of the parameters below detection limit. MW6 (located within Waste Midden 2) showed the most detections and/or exceedances of PAHs (anthracene, chrysene, fluoranthene, phenanthrene and pyrene).
- There is insufficient data at this time to conclude on the trends in concentrations of chemicals of concern, as only one sampling event (2014) has been conducted since installation of the midden caps.

Therefore, we recommend the following:

- Complete additional groundwater sampling twice annually, one in the spring when there is high recharge and one in the fall during low recharge.
- Attempt to find the remaining monitoring wells during the spring when there is no snow cover or tall grass. The monitoring wells should be flagged to allow for easy identification.
- The long-term objective is to achieve closure for this site. Therefore, we recommend assessing additional information needs and potential data gaps using the Site Closure Tool for Federal Contaminated Sites. This assessment will help direct any additional works required. Additionally, since the removal of contamination is not practical at the site, a risk assessment update will be undertaken to determine whether the contamination levels on the site are posing a risk to human and ecological receptors.

Analytical Results Exceeding Selected Groundwater Guidelines

APECs	Sampling Location	Parameters
Downgradient of Waste Midden 1	MW2	Dissolved sulphate, Total Dissolved Solids (TDS), numerous dissolved and total metals, pyrene
	MW3	Dissolved sodium, dissolved sulphate, TDS, numerous dissolved and total metals, fluoranthene, pyrene
Upgradient of Waste Midden 1	MW7	Dissolved sodium, dissolved sulphate, TDS, numerous dissolved and total metals
Downgradient of Waste Midden 2	MW12	Dissolved sulphate, TDS, numerous dissolved and total metals, pyrene
Waste Midden 1	MW1	Dissolved sodium, dissolved sulphate, TDS, numerous dissolved and total metals
	MW8	Dissolved sodium, dissolved sulphate, TDS, numerous dissolved and total metals, pyrene
	MW9	Dissolved sulphate, TDS, pyrene
Waste Midden 2	MW6	Dissolved sodium, dissolved sulphate, TDS, numerous dissolved and total metals, fluoranthene, pyrene

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1.0 INTRODUCTION

Golder Associates Ltd. was retained by Parks Canada to conduct a groundwater monitoring and sampling program at the Bar U Ranch National Historic Site located approximately 13 km south of Longview, Alberta (Figures 1, 2 and 3). The purpose of the groundwater monitoring and sampling was to determine the effectiveness of capping the Waste Middens to reduce water infiltration into the waste. The reduction of water infiltration is expected to translate into a decrease in concentrations of contaminants of concern in the groundwater immediately downgradient of the Waste Middens.

2.0 SCOPE OF WORK

Based on previous environmental reports and discussions with Parks Canada, Golder developed a monitoring and sampling program for the assessment of the groundwater conditions in the areas of each Waste Midden. The groundwater monitoring and sampling program included the following activities:

- Monitoring 17 on-site wells for organic vapour concentrations, groundwater depth, and if present, thickness of Non-Aqueous Phase Liquids (NAPLs);
- Collecting groundwater samples from all 17 wells using the standard one-volume purge sampling method
- Performing hydraulic conductivity testing on two shallow monitoring wells
- Submitting all selected groundwater samples to the laboratory for analysis of contaminants of concern;
- Conducting Quality Assurance/Quality Control (QA/QC) sampling; and
- Preparing a groundwater monitoring and sampling report documenting and detailing the methods and results of the investigation activities, as well as recommendations for further action.

3.0 SITE DESCRIPTION

Bar U Ranch National historic Site is located approximately 13 km south of Longview, AB. The property is situated within the Grasslands Natural Region and the Foothills Fescue Subregion. Land within the proximity of the Site is primarily undulating agricultural land used for grazing. Pekisko Creek passes through the property and is used for watering livestock.

There are two waste disposal middens located in the northern portion of Bar U Ranch approximately 300 m southeast of Pekisko Creek. Midden # 1 is furthest to the west and measures approximately 35 m x 8 m. Midden # 2 is the easterly of the two middens and measures approximately 60 m x 10 m. The Waste Middens are roughly 100 m apart and slope towards the southeast. Waste generated by historic ranching activities at Bar U Ranch during its 100+ years of operation has been placed in these natural coulees. The waste middens potentially contain waste oil and fuel containers, pesticide and herbicide containers, glycol, batteries, creosote treated lumber, scrap metal, vehicles and paint containers. (AECOM 2009).

In 2008, the middens were capped with clay fill material. The ground contour of the final clay cap blended in with the natural grades of the adjacent slopes, with a positive drainage away from the waste middens.

The native surficial soils at the Site consist of till of even thickness. Fine sediments consisting of sand, silt and clay with minor gravel beds are adjacent to Pekisko Creek. Regional surface drainage is southeast towards Pekisko Creek (AECOM 2009).

There are twenty-two water wells within a 1 km radius of the Site. It was previously confirmed that privately-owned groundwater wells are located within 500 m of the Site and Parks Canada drinking water wells are approximately 700 m from the middens (AECOM 2009).

Site plans are presented in Figures 4. Site photographs are presented in Appendix A.

4.0 SELECTED GUIDELINES

Federal contaminated sites are generally evaluated using the *Canadian Environmental Quality Guidelines* (CEQG) (CCME 2014) developed by the CCME. The CEQGs are primarily risk-based numerical guidelines set at levels at which it is believed that unacceptable adverse effects on environmental or human health will not occur.

The Site is located within federal property and governance by Parks Canada Agency. Environmental concerns, including drinking water protection, are federally governed at the Site with specific guidelines provided and published by Health Canada.

The *Canadian Water Quality Guidelines for Protection of Aquatic Life and Agricultural Water Uses* (CCME 1999) as well as Health Canada “*Guidelines for Canadian Drinking Water Quality* (CDWQ)” (Health Canada 2014) were used for comparison of water quality data across the Site.

The Federal Contaminated Sites Action Plan identified federal interim groundwater quality guidelines for federal contaminated sites in May 2010. The guidelines were developed to assist in the assessment and management of contaminated sites. It is expected that the generic guidelines will be protective of the majority of federal contaminated sites. The guidelines are based on several considerations including groundwater transport to surface water, direct contact of soil organisms with contaminated groundwater, use of groundwater for irrigation or livestock watering, ingestion by wildlife, and migration of contaminant vapours to indoor air and subsequent inhalation by humans. These generic guidelines were applied in addition to the CCME guidelines to groundwater across the Site for comparison purposes.

The *Guidelines for Canadian Drinking Water Quality* are established by the Federal-Provincial-Territorial Committee on Drinking Water (CDW) and published by Health Canada. Each guideline was established based on current, published scientific research related to health effects, aesthetic effects, and operational considerations. Health-based guidelines are established on the basis of comprehensive review of the known health effects associated with each contaminant, on exposure levels and on the availability of treatment and analytical technologies. Aesthetic effects (e.g., taste, odour) are taken into account when these play a role in determining whether consumers will consider the water drinkable. Operational considerations are factored in when the presence of a substance may interfere with or impair a treatment process or technology (e.g., turbidity interfering with chlorination or UV disinfection) or adversely affect drinking water infrastructure (e.g., corrosion of pipes).

4.1 Applicable Site Guidelines

4.1.1 Land Use

Based on the current on-site and adjacent land uses (Section 3.0), the Site is zoned as agricultural.

4.1.2 Exposure Pathway Applicability

Site-specific data collected during this investigation were analyzed to exclude exposure pathways that were not applicable. Excluding these exposure pathways results in modification of the generic guideline values.

Protection of the Aquifer Exposure Pathway

The *Guidelines for Canadian Drinking Water Quality* apply for potable water sources. While they are intended to be applied at the point of exposure (e.g., tap), it is recommended that, at federal contaminated sites, these guidelines be used when investigating groundwater that could be used as a potable water source.

There are twenty-two water wells within a 1 km radius of the Site. It was previously confirmed that privately owned groundwater wells are located within 500 m of the Site and Parks Canada drinking water wells are approximately 700 m from the middens (AECOM 2009).

Based on the above information, the Guidelines for Canadian Drinking Water are applicable at this site

Protection of the Freshwater Aquatic Life Exposure Pathway

The *Canadian Water Quality Guidelines for the Protection of Aquatic Life*, summarized in the *Canadian Environmental Quality Guidelines* (CCME 1999, updated in 2006) should be applied to the receiving water body, groundwater within 10 m of a surface water body, and to the groundwater-surface water transition zone. These guidelines are site-specific, and are focused on protecting all freshwater and marine life forms from anthropogenic stressors, such as chemical inputs, and to limit changes to the physical water conditions (such as pH and temperature). The closest surface water body is Pekisko Creek which is 300 m southeast of the Waste Middens. Therefore, these surface water guidelines are considered to be applicable.

4.1.3 Selected Assessment Guidelines

Based on the land use and applicable exposure pathways, the groundwater analytical results for BTEX, routine water quality parameters, dissolved metals, total metals, polycyclic aromatic hydrocarbon and organochlorinated pesticide/herbicide were compared to CCME *Water Quality Guidelines for the Protection of Freshwater Aquatic Life*, CCME *Water Quality Guidelines for the Protection of Agricultural Water Uses* and Health Canada *Guidelines for Canadian Drinking Water Quality*. Groundwater analytical results for Petroleum Hydrocarbon (PHC) Fractions F1 to F2 were compared to the *Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites* (2014) for agricultural land use, fine-grained soils (based on previous logs and hydraulic conductivity values), all water use pathways included.

5.0 FIELD WORK AND FIELD METHODS

5.1 Groundwater Monitoring and Sampling

On December 16 and 18, 2014, groundwater monitoring and sampling was completed on a total of 10 existing monitoring wells. A summary of the well monitoring is provided in Table 1. Site plans showing monitoring well locations are provided in Figure 4.

Groundwater monitoring activities included:

- Measuring headspace organic vapour concentrations using an RKI Eagle® Combustible organic vapour monitor (OVM) with methane elimination. Vapour concentrations were taken from inside each well casing by placing the OVM nozzle

about 15 to 30 cm below the Top of Casing (TOC) and recording the peak reading on the OVM. The OVM was bump tested daily to 15% LEL using a hexane standard. If the bump test differed more than 10% from the known concentration, the OVM was adjusted to match the exact concentration of the calibration gas. Calibrations were logged at the start of each day.

- Measuring depth to groundwater and, if present, the thickness of NAPLs using a Heron oil/water interface probe. Prior to use in each well, the interface probe was cleaned using a laboratory-grade detergent (Alconox) and water solution and rinsed with distilled water to minimize the potential for cross-contamination. Depth measurements were taken from the TOC.
- Completing hydraulic conductivity testing on groundwater monitoring wells MW7 and MW8.

All groundwater samples were collected using the one-volume purge method using Waterra® High Density Polyethylene (HDPE) tubing and Waterra® Inertial Pump foot valves.

Field measurements for pH, electrical conductivity and temperature were performed using a Hanna Instruments® Meter. The meter was placed in a container of groundwater and the temperature, pH and EC parameters were recorded after stabilizing. The meter was calibrated daily using a two point calibration for pH (using pH 4, pH 7 and/or pH 10 calibration standards) and a single point calibration for electrical conductivity using a 1,413 microSiemens per centimetre ($\mu\text{S}/\text{cm}$) calibration standard.

Twelve samples, including one duplicate, two field blank, one trip blank and eight groundwater samples from monitoring wells, were collected and submitted to Maxxam Analytics Inc (Maxxam) for analysis of BTEX, PHC Fractions F1 and F2, routine water quality parameters, dissolved and total metals, polycyclic aromatic hydrocarbon and organochlorinated pesticides parameters. Monitoring wells MW4 and MW5 were not sampled due to insufficient volume of water. Seven monitoring well could not be located and therefore were not sampled.

Groundwater samples for BTEX and PHC Fraction F1 analysis were placed in 44-mL clear glass vials provided by the laboratory and preserved with sodium bisulphate as a microbial inhibitor. The groundwater samples for PHC Fraction F2 analysis were placed in 250-mL amber glass bottles and preserved with sodium bisulphate. Groundwater samples for routine water quality analysis were placed in 1-L High Density Polyethylene (HDPE) bottles, with no chemical preservative.

Groundwater samples for dissolved metals analysis were filtered in the field through a 0.45 μ filter, placed in 250-mL HDPE bottles and preserved with nitric acid. Groundwater samples for total metals analysis were placed in 250-mL HDPE bottles and preserved with nitric acid.

Groundwater samples for PAH analysis were placed in 250-mL amber glass bottles and preserved with sodium bisulphate. Groundwater samples for phenoxyalkyl acid pesticide analysis were placed in 1-L clear glass bottle. Groundwater samples for VOC analysis were placed in 44-mL clear glass vials provided by the laboratory and preserved with sodium bisulphate as a microbial inhibitor. All sample containers were filled to capacity with zero headspace, placed in an ice-filled cooler and submitted under chain-of-custody to Maxxam in Calgary, Alberta for analysis.

5.2 Groundwater Hydraulic Conductivity Testing

Hydraulic conductivity testing was conducted on December 18, 2014, at monitoring wells MW7 (shallow) and MW8 (shallow). To complete this testing, a known volume of water was removed (rising head test) from each monitoring well and the water level was

allowed to stabilize. Measurement of the recovery was documented using a datalogger. Measurements were recorded at predetermined intervals. The results are comparable to the result obtained by Meridian (2007). Results were 4.3×10^{-9} m/s (MW10, shallow), 1.1×10^{-5} m/s (MW12, shallow) and 7.8×10^{-6} m/s (MW13, shallow). MW12 and MW13 are located downgradient of the middens, closer to the Pekisko Creek, where more sand and gravel was observed in the boreholes. Details of hydraulic conductivity testing can be found in Appendix B.

6.0 RESULTS AND DISCUSSION

6.1 Site Hydrogeology

The groundwater monitoring results are presented in Table 1 and summarized as follows:

- Headspace vapour concentrations ranged from below the detection limit to the highest reading of 65 parts per million by volume (ppmv) in monitoring well MW3.
- No NAPLs were detected in any of the wells monitored.

Groundwater elevations were not surveyed; therefore groundwater flow direction cannot be determined at this time. However, it is most likely following the site topography, which is downgradient towards the southeast (based on AECOM 2009 and site observations). Groundwater depth at the Waste Midden 1 was 0.89 mbtoc. Groundwater depth at Waste Midden 2 ranges between 1.67 and 2.77 mbtoc.

6.2 Field and Laboratory Quality Assurance / Quality Control

A QA/QC program was followed to manage and quantify the quality of the investigation results. The program included field procedures, laboratory procedures and the use of QC samples to quantify the results of the program. One field duplicate, two field blank and one trip blank were also submitted to the laboratory as part of the groundwater QC program. A discussion of the QA/QC program is included in Appendix D.

The data quality issues identified in Appendix D did not have a material effect on the reliability of the data presented in this report, based on limits of uncertainty, limits of precision, acceptance ranges and results compared to applicable guidelines. The data are considered suitable for the purpose of this report.

6.3 Groundwater Analytical Results

This section presents the results of the completed groundwater analyses. The current results, along with historical results are summarized in Tables 2 to 7. Copies of the laboratory certificates of analysis are included in Appendix C.

6.3.1 Petroleum Hydrocarbon Parameters

Eight groundwater samples were submitted and analyzed for BTEX and PHC Fractions F1 and F2. Concentrations in all of the samples analyzed were below the reportable detection limits, and therefore below the applicable guidelines. There was a decreasing trend in the concentration of toluene for MW1 and MW2. The remaining monitoring wells have a stable trend in the concentration of toluene. The detections of toluene correlate with MW1 and MW2 locations (within and downgradient of the Waste Midden 1, respectively). F2 detection was observed at MW12, which is located downgradient of the Waste Midden 2.

The groundwater results for BTEX and PHC Fractions F1 and F2 are presented in Table 2.

6.3.2 Routine Water Quality Parameters

A total of eight groundwater samples were collected and analyzed for routine water quality parameters. Locations with samples exceeding the applicable guidelines for the Site are listed in the following table.

APECs	Sampling Location	Routine Water Quality Parameters
Downgradient of Waste Midden 1	MW2	Dissolved sulphate, TDS
	MW3	Dissolved sodium, dissolved sulphate, TDS
Upgradient of Waste Midden 1	MW7	Dissolved sodium, dissolved sulphate, TDS
Downgradient of Waste Midden 2	MW12	Dissolved sulphate, TDS
Waste Midden 1	MW1	Dissolved sodium, dissolved sulphate, TDS
	MW8	Dissolved sodium, dissolved sulphate, TDS
	MW9	Dissolved sulphate, TDS
Waste Midden 2	MW6	Dissolved sodium, dissolved sulphate, TDS

MW1, MW8 and MW9 show a decreasing trend in concentrations for dissolved sodium, dissolved sulphate and TDS. The monitoring wells are located within the Waste Midden 1. MW3, MW6 and MW7 show an increasing trend in concentrations for dissolved sodium, dissolved sulphate and TDS. These monitoring wells are located at various locations on-site, respectively downgradient of the Waste Midden 1, within the Waste Midden 2 and upgradient of the Waste Midden 1. Additional data are required in order to confirm the increase of concentrations, especially regarding the monitoring well located upgradient of the Waste Midden.

The groundwater results for routine water quality parameters are presented in Table 3 and Figure 6.

6.3.3 Dissolved Metals Parameters

A total of seven groundwater samples were collected and analyzed for dissolved metals. Monitoring well MW9 had insufficient water volume, and therefore dissolved metals were not collected at this location. Locations with samples exceeding the applicable guidelines for the Site are listed in the following table.

APECs	Sampling Location	Dissolved Metals Parameters
Downgradient of Waste Midden 1	MW2	Iron, manganese, uranium
	MW3	Manganese, uranium
Upgradient of Waste Midden 1	MW7	Copper, selenium, uranium
Downgradient of Waste Midden 2	MW12	Manganese, uranium
Waste Midden 1	MW1	Manganese, selenium, uranium
	MW8	Manganese, uranium
Waste Midden 2	MW6	Arsenic, iron, manganese, selenium

MW2 and MW4 show an increasing trend in concentrations for dissolved iron and dissolved manganese. The monitoring wells are located downgradient of Waste Midden 1 and within Waste Midden 2, respectively. MW8 and MW12 show an increasing trend in concentration for dissolved manganese. The monitoring wells are located within Waste Midden 1 and downgradient of Waste Midden 2, respectively. Copper, selenium and uranium results are considered representative of background values as MW7 is located upgradient of the Waste Midden 1.

The groundwater results for dissolved metals are presented in Table 4 and Figure 7.

6.3.4 Total Metals Parameters

A total of seven groundwater samples were collected and analyzed for total metals. Monitoring well MW9 had insufficient water volume, and therefore no total metals sample was collected. Locations with samples exceeding the applicable guidelines for the Site are listed in the following table.

APECs	Sampling Location	Total Metals Parameters
Downgradient of Waste Midden 1	MW2	Aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, silver, uranium, zinc
Downgradient of Waste Midden 1	MW3	Aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, selenium, silver, uranium, zinc
Upgradient of Waste Midden 1	MW7	Aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, selenium, silver, uranium, zinc
Downgradient of Waste Midden 2	MW12	Aluminum, arsenic, barium, cadmium, chromium, iron, lead, manganese, selenium, silver, uranium, zinc
Waste Midden 1	MW1	Aluminum, copper, iron, manganese, uranium
	MW8	Aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, selenium, silver, uranium, zinc
Waste Midden 2	MW6	Aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, silver, uranium, zinc

Total metals parameters were sampled in 2014 only. As a result, trends cannot be determined.

The groundwater results for total metals are presented in Table 5 and Figure 8.

6.3.5 Polycyclic Aromatic Hydrocarbon Parameters

A total of eight groundwater samples were collected and analyzed for polycyclic aromatic hydrocarbons. Locations with samples exceeding the applicable guidelines for the Site are listed in the following table.

APECs	Sampling Location	Polycyclic Aromatic Hydrocarbons Parameters
Downgradient of Waste Midden 1	MW2	Pyrene
	MW3	Fluoranthene, pyrene
Downgradient of Waste Midden 2	MW12	Pyrene
Waste Midden 1	MW8	Pyrene
	MW9	Pyrene
Waste Midden 2	MW6	Fluoranthene, pyrene

The frequency and concentrations of PAH detections across the site have been relatively stable, with the majority of the parameters below detection limit. MW6 (located within Waste Midden 2) showed the most detections and/or exceedances of PAHs (anthracene, chrysene, fluoranthene, phenanthrene and pyrene).

The groundwater results for polycyclic aromatic hydrocarbon are presented in Table 6 and Figure 9.

6.3.6 Organochlorinated Pesticide Parameters

A total of seven groundwater samples were collected and analyzed for organochlorinated pesticides. Monitoring well MW3 had insufficient water volume, and therefore no organochlorinated pesticide sample was collected. All results were below the reported detection limits, and therefore no groundwater samples exceeded the applicable guidelines.

The groundwater results for organochlorinated pesticides are presented in Table 7.

7.0 NATIONAL CLASSIFICATION SYSTEM FOR CONTAMINATED SITES

The site has a letter grade of “C” for the CCME National Classification System for Contaminated Sites (NCSCS). The percentage of questions answered with certainty was 81%, and 5% of the questions were answered with “do not know”. The total NCSCS Score for the site is 58.8; therefore, the site is classified as Class 2, medium priority for action.

The CCME NCSCS form can be found in Appendix E.

8.0 CONCLUSIONS

A groundwater monitoring and sampling program was completed at Bar U Ranch National Historic Site in Longview, AB. The activities included monitoring and sampling from 17 existing monitoring wells on site and conducting two hydraulic conductivity tests, however seven monitoring wells could not be located and therefore were not monitored or sampled. Two monitoring wells were not sampled due to insufficient volume of water. Groundwater samples were submitted for benzene, toluene, ethylbenzene, xylenes, Petroleum Hydrocarbon (PHC) Fractions F1 to F4, routine water quality parameters, dissolved and total metals, polycyclic aromatic hydrocarbon and organochlorinated pesticide groundwater. The following is a summary of the general conclusions and recommendations from the investigation activities:

- Hydraulic conductivity analysis was completed on two shallow monitoring wells (MW7 and MW8). The hydraulic conductivity values obtained were 1.0×10^{-8} m/s and 8.0×10^{-9} m/s, respectively.
- Light non-aqueous phase liquids were not detected in any of the groundwater monitoring wells monitored.
- Groundwater flow direction could not be determined at the Site at this time. However, it is most likely following the site topography, which is downgradient towards the southeast (based on AECOM 2009 and site observations).
- There is a decreasing trend in concentrations of toluene for monitoring well MW1 and MW2. The remaining monitoring wells have stable concentrations of toluene that are below detection limits. The detections of toluene correlate with MW1 and MW2 locations (within and downgradient of the Waste Midden 1, respectively). F2 detection was observed at MW12, which is located downgradient of the Waste Midden 2.
- MW1, MW8 and MW9 show a decreasing trend in concentrations for dissolved sodium, dissolved sulphate and TDS. The monitoring wells are located within the Waste Midden 1. MW3, MW6 and MW7 show an increasing trend in concentrations for dissolved sodium, dissolved sulphate and TDS. The monitoring wells are located at various locations on-site. Additional data are required in order to confirm the

increase of concentrations, especially regarding the monitoring well located upgradient of the Waste Midden.

- MW2 and MW4 show an increasing trend in concentrations for dissolved iron and dissolved manganese. The monitoring wells are located downgradient of Waste Midden 1 and within Waste Midden 2, respectively. MW8 and MW12 show an increasing trend in concentration for dissolved manganese. The monitoring wells are located within Waste Midden 1 and downgradient of Waste Midden 2, respectively. Copper, selenium and uranium results are considered representative of background values as MW7 is located upgradient of the Waste Midden 1.
- The frequency of PAHs overall across the site have a stable concentration where majority of the parameters are below detection limit. MW6 located within the Waste Midden 2 showed the most detection and/or exceedances (anthracene, chrysene, fluoranthene, phenanthrene and pyrene). The PAHs detections are likely from the midden content (potentially waste oil and fuel containers, and creosote treated lumber)
- Overall the frequency of PAH across the site have stable concentrations with a majority of the parameters below detection limit.
- All monitoring wells had concentrations below the applicable guidelines and detection limits for organochlorinated pesticides.
- Based on the quality assurance/quality control review, the data presented in this report are considered to be reliable.
- The site has a NCSCS letter grade of "C". The percentage of questions answered with certainty was 81%, and 5% of the questions were answered with "do not know". The total NCSCS Score for the site is 58.8; therefore, the site is classified as Class 2, medium priority for action.
- The Site Closure Tool (SCT) provides guidance for federal government departments, agencies and custodians for Steps 6 to 10 of the 10-step approach to contaminated sites process. The SCT helps track progress of the remediation of contaminated sites and standardizes the remediation/risk and closure process as well as documenting the activities that were conducted on the site. Because of the presence of contaminants in excess of applicable federal guidelines, the site cannot be closed in its current state. To achieve site closure, the following is required: a Health and Ecological Risk Assessment is completed and confirms that the existing levels of contamination do not pose a risk, or the parameters are below the applicable guidelines. Risk management may also include the development of site specific guidelines, derived from site-specific data, current and future land use considerations and potential exposure pathways to contaminants of concern on the site.

9.0 RECOMMENDATIONS

The purpose of the groundwater monitoring and sampling was to determine the effectiveness of capping the Waste Middens to reduce water infiltration from precipitation. We expect that the capping of the middens will result in a reduction in surface water infiltration through the waste materials and into the shallow groundwater at the base of the middens. This reduction in infiltration should result in a gradual decrease in the concentrations of chemicals of concern over time in the shallow groundwater downgradient of the middens. However, there is insufficient data at this time to conclude on the trends in concentrations of chemicals of concern, as only one sampling event (2014) has been conducted since installation of the midden caps.

Therefore, we recommend the following:

1. Complete additional groundwater sampling twice annually, one in the spring when there is high recharge and one in the fall during low recharge.
2. Attempt to find the remaining monitoring wells during the spring when there is no snow cover or tall grass. The monitoring wells should be flagged to allow for easy identification.
3. The long-term objective is to achieve closure for this site. Therefore, we recommend assessing additional information needs and potential data gaps using the Site Closure Tool for Federal Contaminated Sites. This assessment will help direct any additional works required. Additionally, since the removal of contamination is not practical at the site, a risk assessment update will be undertaken to determine whether the contamination levels on the site are posing a risk to human and ecological receptors.

10.0 REFERENCES

- AECOM., *Monitoring Well Installation/Sampling and Capping of Waste Disposal Middens, Bar U Ranch National Historic Site, Longview, AB*, April 8, 2009.
- CCME (Canadian Council of Ministers of the Environment). 1999. *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. Winnipeg, MB. 1999.
- CCME (Canadian Council of Ministers of the Environment). 1999. *Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses*. Winnipeg, MB. 1999.
- Federal Contaminated Sites Action Plan. *Guidance Document on Federal Interim Groundwater Quality Guidelines for federal Contaminated Sites*. March 2014.
- HC (Health Canada). 2014 *Guidelines for Canadian Drinking Water Quality – Summary Table*. October 2014.
- Meridian Environmental Inc., *Human Health Ecological Risk Assessment Former Water Disposal Middens, Bar U Ranch National Historic Site*, March 14, 2007.

11.0 STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by Golder Associates Ltd. for Parks Canada Agency. It is intended for the sole and exclusive use of Parks Canada Agency, its affiliated companies and partners and their respective insurers, agents, employees and advisors (collectively, "Parks Canada Agency"). Any use, reliance on or decision made by any person other than Parks Canada Agency based on this report is the sole responsibility of such other person. Parks Canada Agency and Golder Associates Ltd. make no representation or warranty to any other person with regard to this report and the work referred to in this report, and they accept no duty of care to any other person or any liability or responsibility whatsoever for any losses, expenses, damages, fines, penalties or other harm that may be suffered or incurred by any other person as a result of the use of, or reliance on, any decision made or any action taken based on this report or the work referred to in this report.

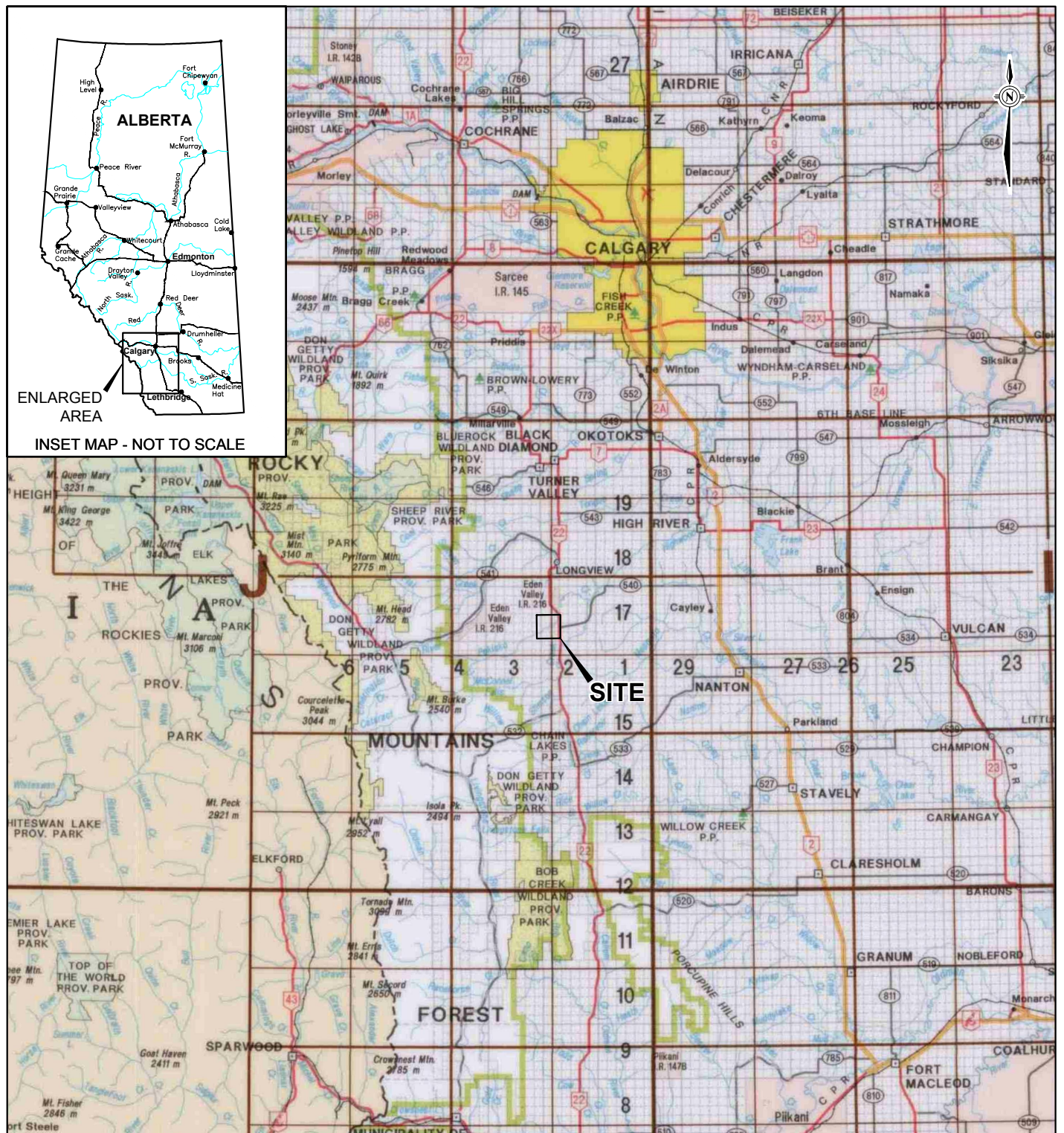
The investigation undertaken by Golder Associates Ltd. with respect to this report and any conclusions or recommendations made in this report reflect Golder Associates Ltd.'s judgment based on the site conditions observed at the time of the site inspection on the date(s) set out in this report, and on information available at the time of preparation of this report. This report has been prepared for specific application to this site and it is based, in part, upon visual observation of the site, subsurface investigation at discrete locations and depths, and specific analysis of specific chemical parameters and materials during a

specific time interval, all as described in this report. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, portions of the site which were unavailable for direct investigation, subsurface locations which were not investigated directly, or chemical parameters, materials or analysis which were not addressed. Substances other than those addressed by the investigation described in this report may exist within the site, substances addressed by the investigation may exist in areas of the site not investigated and concentrations of substances addressed which are different than those reported may exist in areas other than the locations from which samples were taken.

If site conditions or applicable standards change or if any additional information becomes available at a future date, modifications to the findings, conclusions and recommendations in this report may be necessary.

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FIGURES



REFERENCE

BASE MAP OBTAINED FROM ALBERTA SUSTAINABLE RESOURCE DEVELOPMENT
 © 2008 HER MAJESTY THE QUEEN IN RIGHT OF CANADA. DEPARTMENT OF
 SUSTAINABLE RESOURCES. ALL RIGHTS RESERVED. PROJECTION: TRANSVERSE
 MERCATOR DATUM: NAD83 COORDINATE SYSTEM: UTM ZONE 12
 REPRODUCED WITH THE PERMISSION OF ALBERTA SUSTAINABLE RESOURCE
 DEVELOPMENT.

CLIENT

PARKS CANADA AGENCY
 BAR U RANCH NATIONAL HISTORIC SITE
 LONGVIEW, ALBERTA

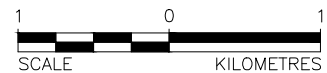
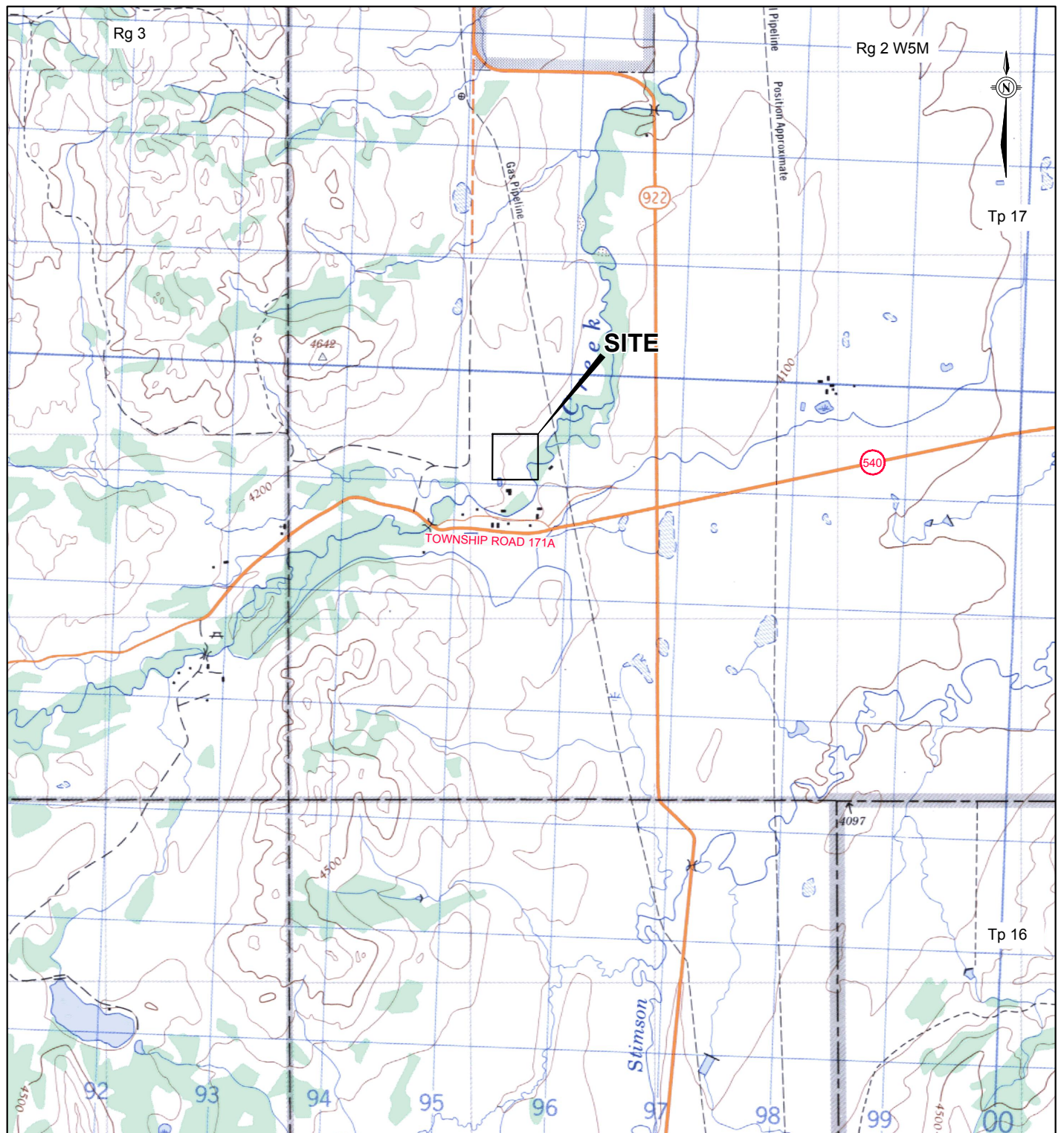
TITLE


SITE LOCATION



PROJECT	1418041.1000	FILE No.	1418041-1000-HS-0001
DESIGN	AC	29/01/15	SCALE AS SHOWN
CADD	KA	06/02/15	REV. 0
CHECK	AB	02/04/15	FIGURE: 1
REVIEW	DP	02/04/15	

L:\PARKS_CANADA\LONGVIEW_AB_BAR_U_RANCH\99_PROJECTS\1418041\02_PRODUCTION\1000-2016\DWG\1418041-1000-HS-0002.dwg Apr 01, 2015 - 8:31am



CLIENT		PARKS CANADA AGENCY BAR U RANCH NATIONAL HISTORIC SITE LONGVIEW, ALBERTA			
TITLE		TOPOGRAPHIC MAP			
		PROJECT	1418041.1000	FILE No. 1418041-1000-HS-0002	
		DESIGN	AC	29/01/15	SCALE AS SHOWN
		CADD	KA	06/02/15	REV. 0
		CHECK	AB	02/04/15	FIGURE: 2
		REVIEW	DP	02/04/15	

REFERENCE

TOPOGRAPHIC MAP 82J/08 OBTAINED FROM Canmatrix. ©1979 HER MAJESTY THE QUEEN IN RIGHT OF CANADA. DEPARTMENT OF NATURAL RESOURCES.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD83 COORDINATE SYSTEM:
UTM ZONE 12.

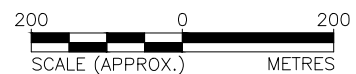


LEGEND

- WASTE MIDDENS BOUNDARY (APPROXIMATE)
- WATER BODY
- WATER COURSE
- WATER WELL

REFERENCE

IMAGE OBTAINED FROM GOOGLE EARTH, USED UNDER LICENSE
IMAGERY DATE UNKNOWN. GOOGLE EARTH IMAGE IS NOT TO SCALE.
ORIGINAL DRAWING OBTAINED FROM MERIDIAN ENVIRONMENTAL INC.;
JOB No.: 11005; SCALE: 1:1,250 (APPROXIMATE); DATE: MARCH 3, 2006.



CLIENT

PARKS CANADA AGENCY
BAR U RANCH NATIONAL HISTORIC SITE
LONGVIEW, ALBERTA

TITLE

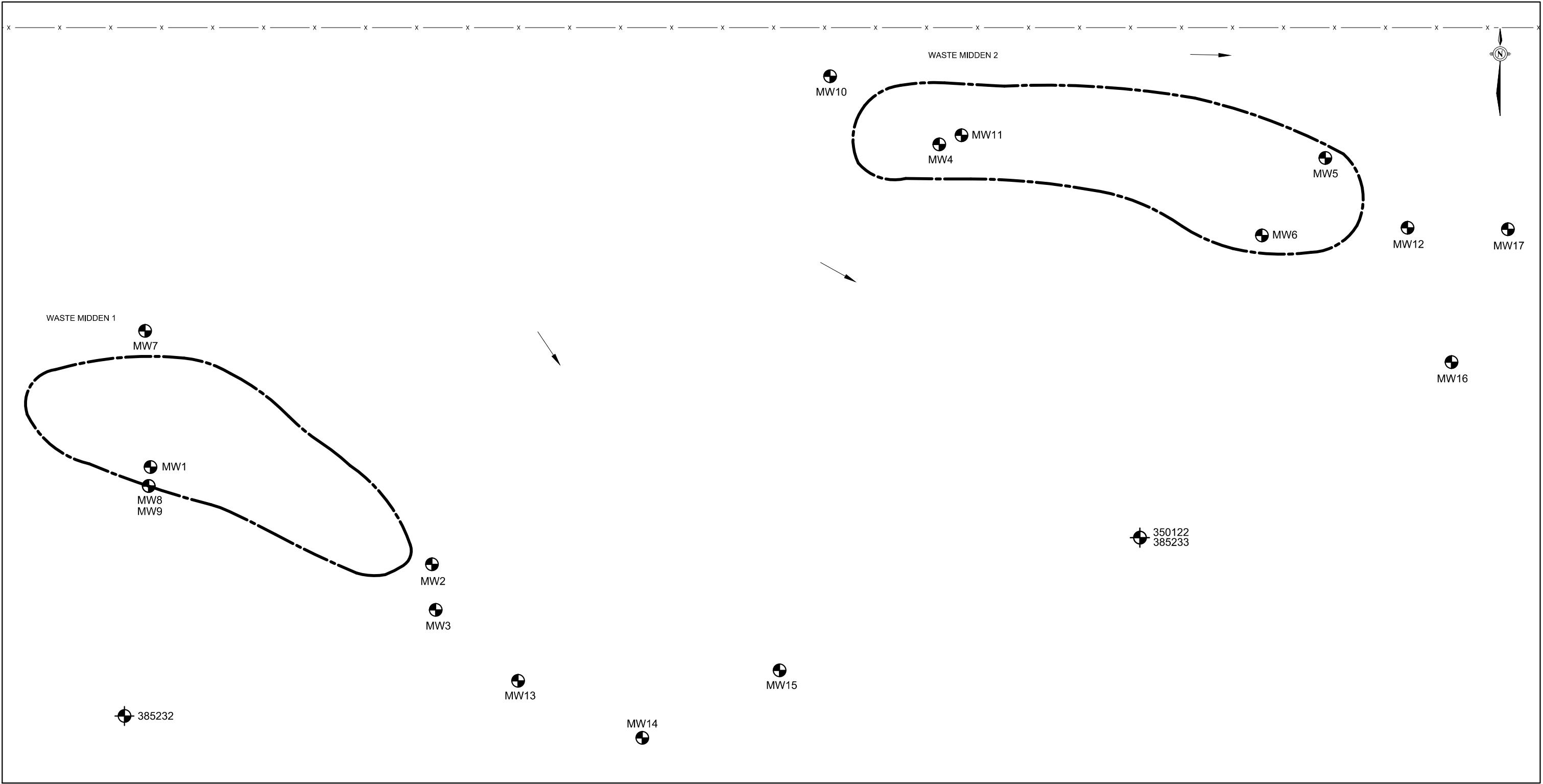
SITE LOCALITY MAP



PROJECT	1418041.1000	FILE No.1418041-1000-HS-0003
DESIGN	AC	29/01/15
CADD	KA	06/02/15
CHECK	AB	02/04/15
REVIEW	DP	02/04/15
SCALE	AS SHOWN	REV. 0

FIGURE: 3

L:\PARKS_CANADA\LONGVIEW_AB_BAR_U_RANCH\99_PROJECTS\1418041\02_PRODUCTION\1000-2016\DWG\1418041-1000-HS-0004.dwg Apr 01, 2015 - 8:31am

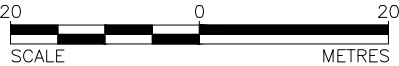


LEGEND

- WASTE MIDDENS BOUNDARY (APPROXIMATE)
- FENCELINE
- MONITORING WELL LOCATION
- WATER WELL
- DIRECTION OF SLOPE

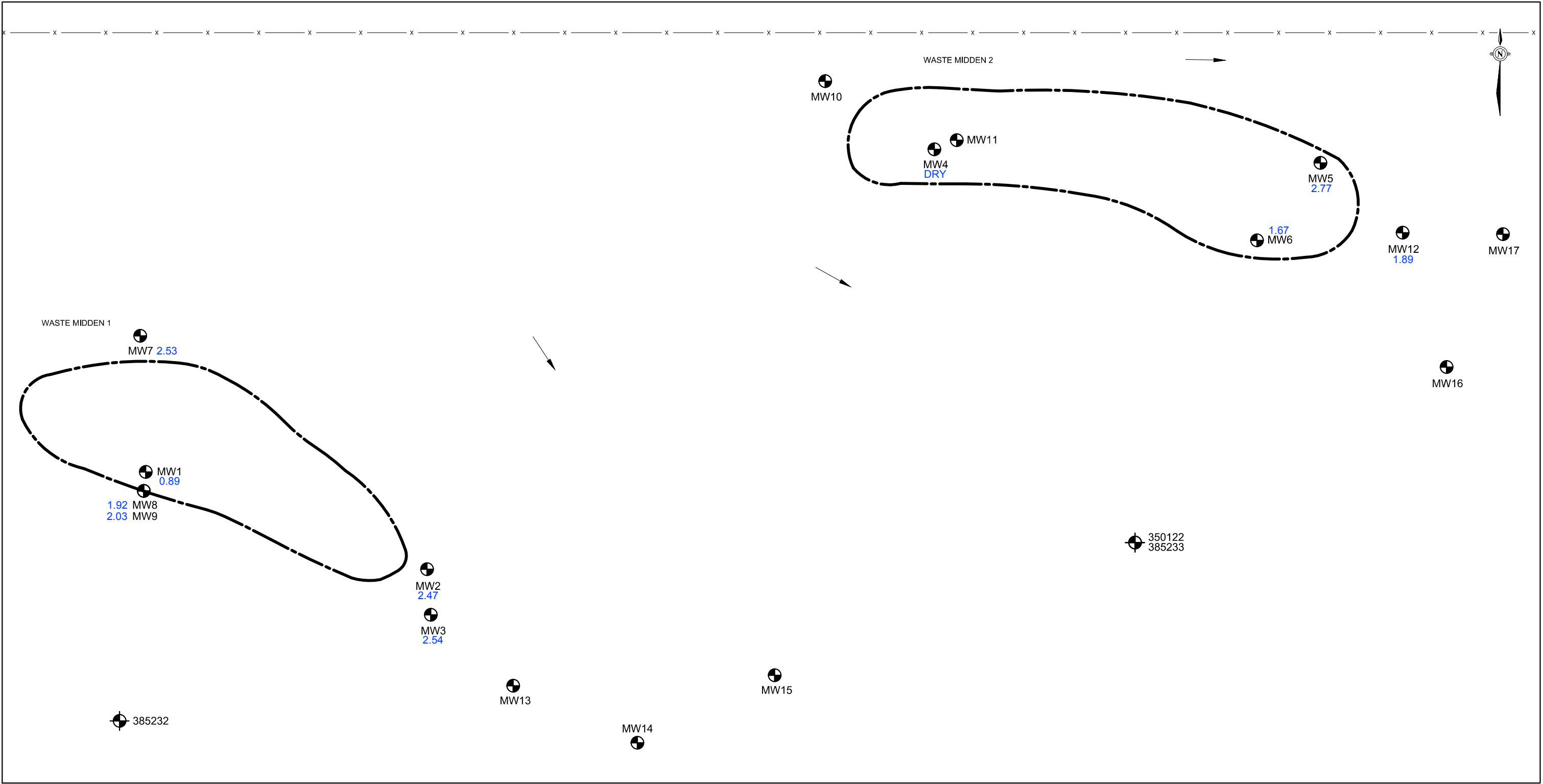
REFERENCE

ORIGINAL DRAWING OBTAINED FROM MERIDIAN ENVIRONMENTAL INC.; JOB No.: 11005; SCALE: 1:1,250 (APPROXIMATE);
DATE: MARCH 3, 2006.



CLIENT		PARKS CANADA AGENCY BAR U RANCH NATIONAL HISTORIC SITE LONGVIEW, ALBERTA			
TITLE		SITE PLAN WITH MONITORING WELL LOCATIONS			
	PROJECT	1418041.1000	FILE No. 1418041-1000-HS-0004		
	DESIGN	AC	29/01/15	SCALE	AS SHOWN
	CADD	KA	06/02/15	REV.	0
	CHECK	AB	02/04/15	FIGURE: 4	
	REVIEW	DP	02/04/15		

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LEGEND

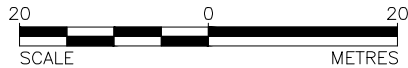
- WASTE MIDDENS BOUNDARY (APPROXIMATE)
- FENCELINE
- MONITORING WELL LOCATION
- WATER WELL
- DIRECTION OF SLOPE
- DEPTH TO GROUNDWATER (mbtoc)

LIST OF APPLICABLE ABBREVIATIONS

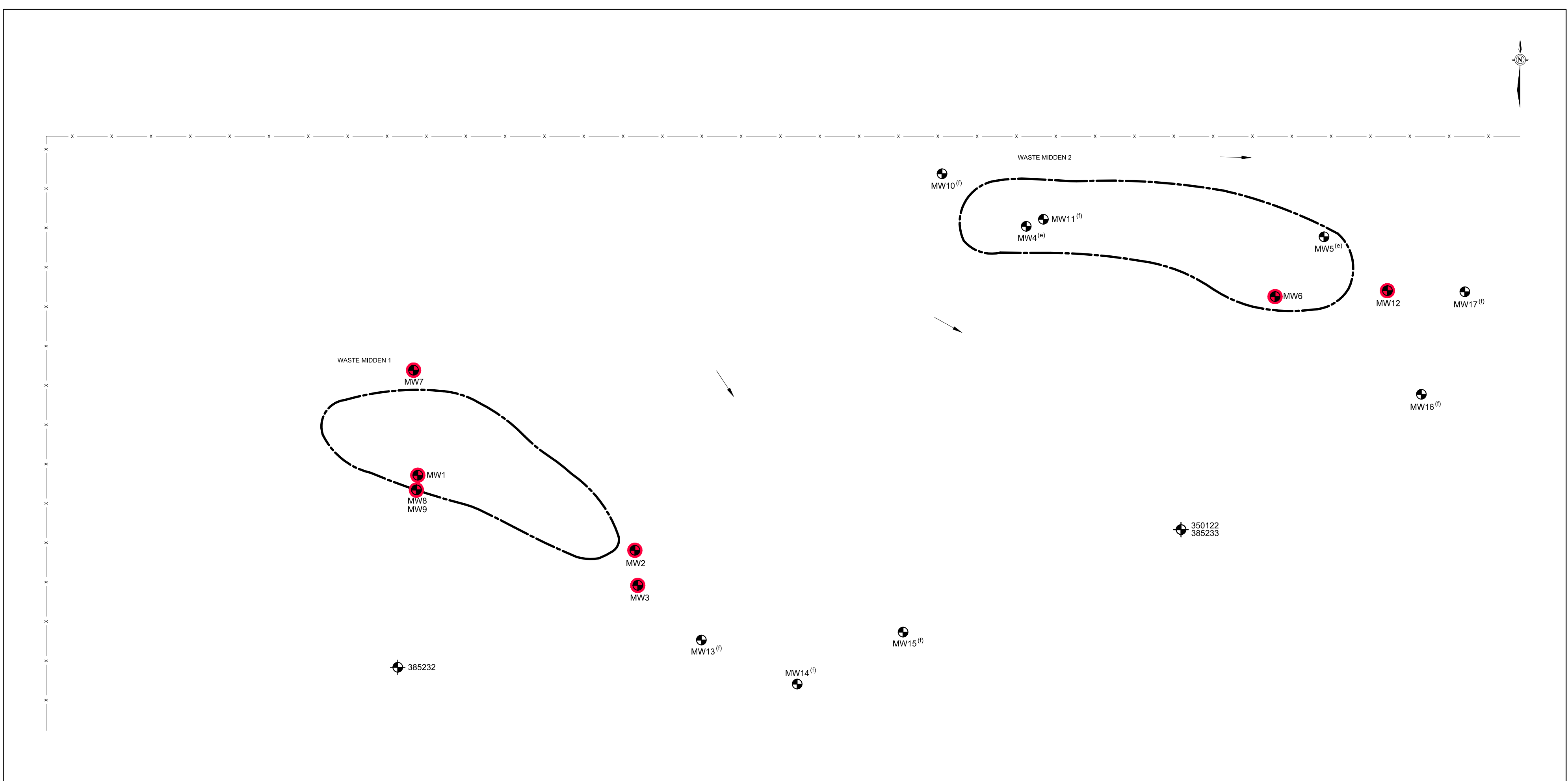
mbtoc METRE BELOW TOP OF CASING

REFERENCE

ORIGINAL DRAWING OBTAINED FROM MERIDIAN ENVIRONMENTAL INC.; JOB No.: 11005; SCALE: 1:1,250 (APPROXIMATE);
DATE: MARCH 3, 2006.



CLIENT		PARKS CANADA AGENCY BAR U RANCH NATIONAL HISTORIC SITE LONGVIEW, ALBERTA			
TITLE		GROUNDWATER DEPTHS December 16 and 18, 2015			
	PROJECT	1418041.1000	FILE No. 1418041-1000-HS-0005		
	DESIGN	AC	29/01/15	SCALE	AS SHOWN
	CADD	KA	06/02/15	REV.	0
	CHECK	AB	02/04/15	FIGURE: 5	
REVIEW		DP	02/04/15		



MW1										
Date	pH	Ca	Cl	Mg	NO ₃ (N)	NO ₂ (N)	K	Na	SO ₄	TDS
31-Oct-06	7.8	449	8	662	<0.05	<0.05	9.3	702	4,670	6,880
16-Dec-14	7.47	350	13	290	0.017	<0.010	9.8	370	2,800	4,100

MW2										
Date	pH	Ca	Cl	Mg	NO ₃ (N)	NO ₂ (N)	K	Na	SO ₄	TDS
16-Dec-14	7.84	140	11	130	<0.010	<0.010	4.5	180	790	1,600

MW3										
Date	pH	Ca	Cl	Mg	NO ₃ (N)	NO ₂ (N)	K	Na	SO ₄	TDS
15-Sep-06	7.9	275	21.8	205	0.18	<0.05	18.9	148	1,510	2,430
03-Nov-06	7.6	364	34.3	285	0.21	<0.05	23.1	187	2,140	3,310
18-Dec-14	7.54	300	21	330	1.5	0.012	17	250	2,100	3,400

MW6										
Date	pH	Ca	Cl	Mg	NO ₃ (N)	NO ₂ (N)	K	Na	SO ₄	TDS
15-Sep-06	8	239	50.6	190	<0.05	<0.05	10.3	186	1,030	2,100
18-Dec-14	7.59	270	44	240	0.012	<0.010	18	210	1,200	2,600

MW7										
Date	pH	Ca	Cl	Mg	NO ₃ (N)	NO ₂ (N)	K	Na	SO ₄	TDS
31-Oct-06	7.9	488	7.2	383	0.28	<0.05	12	434	3,330	4,950
16-Dec-14	7.73	440	120	1,300	7.6	<0.010	12	850	6,600	9,700

MW8										
Date	pH	Ca	Cl	Mg	NO ₃ (N)	NO ₂ (N)	K	Na	SO ₄	TDS
31-Oct-06	7.8	620	3.1	1,480	0.08	<0.05	13.8	1,130	8,390	12,000
16-Dec-14	7.58	290	9.6	1,100	<0.020	<0.020	12	760	6,600	9,100

MW9										
Date	pH	Ca	Cl	Mg	NO ₃ (N)	NO ₂ (N)	K	Na	SO ₄	TDS
03-Nov-06	7.9	165	18.4	347	0.26	<0.05	5	298	2,150	3,350
16-Dec-14	7.89	100	23	250	0.035	<0.010	2.9	140	840	1,700

MW12										
Date	pH	Ca	Cl	Mg	NO ₃ (N)	NO ₂ (N)	K	Na	SO ₄	TDS
31-Oct-06	8	166	16.4	95.1	<0.05	<0.05	10.2	61	656	1,260
18-Dec-14	7.7	260	13	150	0.035	<0.010	10	82	870	1,700

CCME GUIDELINES

PARAMETERS	pH	Ca	Cl	Mg	NO ₃ (N)	NO ₂ (N)	K	Na	SO ₄	TDS
CRITERIA ^(a)	6.5 - 8.5 ^(a)	n/g	250 ^(a)	n/g	10	1	n/g	200 ^(a)	500 ^(a)	500 ^(a)
CRITERIA ^(a)	6.5 - 9.0	n/g	120	n/g	13	0.06	n/g	n/g	n/g	n/g
CRITERIA ^(a)	n/g	1000	n/g	n/g	n/g	10	n/g	n/g	1000	3000
RDL	n/a	0.3	1	0.2	0.01	0.01	0.3	0.5	5	10
UNITS	pH units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L

LIST OF APPLICABLE ABBREVIATIONS

(a)	CCME DRINKING WATER GUIDELINES (2014), BASED ON HEALTH CANADA'S GUIDELINES FOR CANADIAN DRINKING WATER QUALITY.	n/g	NO GUIDELINE
(b)	BASED ON AESTHETIC OBJECTIVES.	NA	NOT AVAILABLE
(c)	CCME WATER QUALITY GUIDELINES FOR THE PROTECTION OF AQUATIC LIFE (CCME 1999).	Na	SODIUM
(d)	CCME WATER QUALITY GUIDELINES FOR THE PROTECTION OF AGRICULTURAL WATER USES (CCME 1999).	NO ₃ (N)	NITRITE AS NITROGEN
(e)	INSUFFICIENT VOLUME OF WATER DURING DECEMBER 2014 EVENT.	NO ₃ (N)	NITRATE AS NITROGEN
(f)	WELL COULD NOT BE LOCATED DURING DECEMBER 2014 EVENT.	pH	CCI (2-1) WET pH
<	LESS THAN	RDL	REPORTABLE DETECTION LIMIT
Ca	CALCIUM	SO ₄	SULPHATE
CCME	CANADIAN COUNCILS OF MINISTERS OF THE ENVIRONMENT	TDS	TOTAL DISSOLVED SOLIDS
Cl	CHLORIDE		
K	POTASSIUM		
mbgs	METRES BELOW GROUND SURFACE		
Mg	MAGNESIUM		
mg/L	MILLIGRAMS PER LITRE		
n/a	NOT APPLICABLE		

LEGEND

---	WASTE MIDDENS BOUNDARY (APPROXIMATE)
x	FENCELINE
⊙	MONITORING WELL LOCATION
⊕	WATER WELL
→	DIRECTION OF SLOPE

NOTES

- LOCATIONS WHERE MOST RECENT GROUNDWATER SAMPLE MEETS APPLICABLE GUIDELINES FOR ALL PARAMETERS ANALYZED SHOWN IN **GREEN**.
- LOCATIONS WHERE MOST RECENT GROUNDWATER SAMPLE EXCEEDS APPLICABLE GUIDELINES FOR AT LEAST ONE OF THE PARAMETERS ANALYZED SHOWN IN **RED**.
- EXCEEDANCES OF APPLICABLE GUIDELINES IN TEXT ARE SHOWN IN **RED**.
- LOCATION WHERE NO SAMPLES WERE TAKEN IN THE MOST RECENT SAMPLING EVENT SHOWN IN **BLACK**.

REFERENCE

ORIGINAL DRAWING OBTAINED FROM MERIDIAN ENVIRONMENTAL INC.; JOB No.: 11005; SCALE: 1:1,250 (APPROXIMATE); DATE: MARCH 3, 2006.
2006 DATA FROM HUMAN HEALTH ECOLOGICAL RISK ASSESSMENT FORMER WATER DISPOSAL MIDDENS, BAR U RANCH NATIONAL HISTORIC SITE (MARCH 2007). 2008 DATA FROM MONITORING WELL INSTALLATION/SAMPLING AND CAPPING OF WASTE DISPOSAL MIDDENS, BAR U RANCH NATIONAL HISTORIC SITE, LONGVIEW, AB (APRIL 2009).

CLIENT

PARKS CANADA AGENCY
BAR U RANCH NATIONAL HISTORIC SITE
LONGVIEW, ALBERTA

TITLE

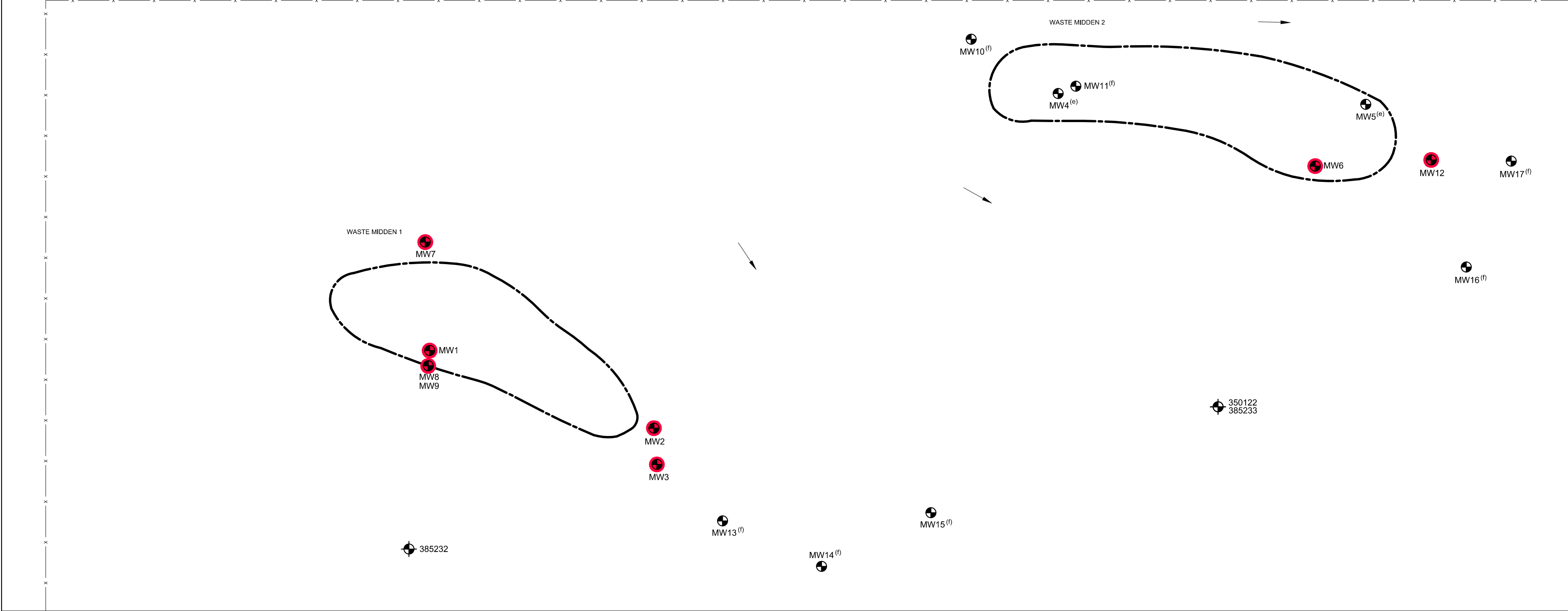
SOIL ANALYTICAL RESULTS
SALINITY

PROJECT	1418041-1000	FILE	1418041-1000-HS-0006
DESIGN	AC	29/01/15	SCALE AS SHOWN
CADD	KA	06/02/15	REV. 0
CHECK	AB	02/04/15	
REVIEW	DP	02/04/15	

SCALE

20 0 20
METRES

FIGURE: 6



MW1															Screen Interval: NA			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn		
20-Oct-04	<0.005	0.0011	<0.002	0.081	0.083	<0.0001	<0.005	0.0008	<0.03	<0.0005	<0.005	<0.01	0.005	<0.0001	0.0201	<0.05		
28-Nov-08	0.05	NA	NA	0.026	0.12	<0.001	<0.005	0.007	0.117	<0.005	2.74	0.028	NA	<0.005	N/A	0.004		
16-Dec-14	0.005	<0.00060	0.00076	0.03	0.093	<0.000020	<0.0010	0.0005	0.21	<0.00020	1.8	0.011	0.0066	<0.00010	0.02	<0.0030		

MW2															Screen Interval: NA			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn		
04-Nov-04	<0.005	<0.0005	<0.002	0.07	0.117	<0.0001	<0.005	0.0017	<0.03	<0.0005	<0.005	<0.001	0.021	<0.0001	0.0243	<0.005		
16-Dec-14	0.0037	<0.00060	0.00076	0.025	0.066	<0.000020	<0.0010	0.0024	1.5	<0.00020	0.62	0.0054	0.0007	<0.00010	0.029	<0.0030		

MW3															Screen Interval: NA			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn		
15-Sep-06	<0.01	NA	NA	0.086	0.15	<0.001	<0.005	0.005	0.016	<0.005	0.671	0.015	0.0027	<0.005	<0.05	0.026		
31-Oct-06	<0.01	0.0007	0.0012	0.085	0.19	0.0002	<0.005	0.004	0.089	<0.0001	1.46	0.018	0.0017	0.0002	0.0130	0.052		
28-Nov-08	<0.01	NA	NA	0.043	0.06	<0.001	<0.005	0.002	0.006	<0.005	0.162	0.005	NA	<0.005	N/A	0.003		
18-Dec-14	0.0044	<0.00060	0.00077	0.036	0.12	0.000032	<0.0010	0.0021	0.1	<0.00020	0.13	0.0053	0.0006	<0.00010	0.016	0.0052		

MW6															Screen Interval: NA			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn		
20-Oct-04	<0.005	0.0006	<0.002	0.256	0.049	<0.0001	<0.005	0.0017	0.07	<0.0005	0.934	0.013	NA	<0.0001	0.0076	<0.005		
28-Nov-08	0.01	NA	NA	0.053	0.08	<0.001	<0.005	0.002	1.17	<0.005	0.282	0.005	NA	<0.005	N/A	0.002		
18-Dec-14	0.0055	<0.00060	0.0057	0.042	0.088	<0.000020	<0.0010	<0.00020	3	<0.00020	0.19	0.0038	0.0066	<0.00010	0.0092	<0.0030		

MW7															Screen Interval: 0.5 - 6.0 mbgs			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn		
31-Oct-06	<0.01	0.0004	0.0010	0.076	0.12	<0.0001	<0.005	0.005	<0.005	<0.00001	<0.001	0.013	0.0040	<0.0001	0.0474	0.024		
16-Dec-14	<0.0030	<0.00060	0.0014	0.023	0.076	0.000053	<0.0010	0.0077	<0.060	<0.00020	<0.0040	0.0048	0.019	<0.00010	0.1	<0.0030		

MW8															Screen Interval: 4.5 - 6.0 mbgs			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn		
31-Oct-06	<0.01	0.0004	0.0010	0.068	0.07	0.0001	<0.005	0.012	<0.005	<0.00001	0.193	0.021	0.0019	<0.0001	0.0474	0.023		
16-Dec-14	0.0041	<0.00060	0.0013	0.05	0.043	0.000027	<0.0010	0.0013	0.085	<0.00020	2.4	0.026	0.0009	<0.00010	0.947	0.0063		

MW12															Screen Interval: 1.0 - 3.0 mbgs			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn		
31-Oct-06	<0.001	0.0004	0.0007	0.181	0.08	<0.0001	<0.005	0.003	0.008	<0.0001	0.123	0.007	0.0021	<0.0001	0.0385	0.024		
18-Dec-14	0.0039	<0.00060	0.00041	0.085	0.055	0.00003	<0.0010	0.0021	0.077	<0.00020	0.38	0.0027	0.0003	<0.00010	0.019	<0.0030		

CCME GUIDELINES

PARAMETERS ^(a)	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn
CRITERIA ^(a)	0.1 ^(b)	0.006	0.01	1	5	0.005	0.05	1.0 ^(b)	0.3 ^(b)	0.01	0.05 ^(b)	n/g	0.05	n/g	0.02	5.0 ^(b)
CRITERIA ^(a)	n/g	n/g	0.005	n/g	1.5	0.00037	0.0089	0.004	0.3	0.007	n/g	0.15	0.001	0.0001	0.015	0.03
CRITERIA ^(a)	5	n/g	0.1	n/g	5	0.080	0.05	1	5	0.2	0.2	1	0.05	n/g	0.2	50
RDL	0.003	0.0006	0.0002	0.01	0.02	0.00002	0.001	0.0002	0.06	0.0002	0.004	0.0005	0.0002	0.0001	0.0001	0.003

LEGEND

- WASTE MIDDENS BOUNDARY (APPROXIMATE)
- FENCELINE
- MONITORING WELL LOCATION
- WATER WELL
- DIRECTION OF SLOPE

LIST OF APPLICABLE ABBREVIATIONS

- (a) CCME DRINKING WATER GUIDELINES (2014), BASED ON HEALTH CANADA'S GUIDELINES FOR CANADIAN DRINKING WATER QUALITY.
- (b) BASED ON AESTHETIC OBJECTIVES.
- (c) CCME WATER QUALITY GUIDELINES FOR THE PROTECTION OF AQUATIC LIFE (CCME 1999).
- (d) CCME WATER QUALITY GUIDELINES FOR THE PROTECTION OF AGRICULTURAL WATER USES (CCME 1999).
- (e) INSUFFICIENT VOLUME OF WATER DURING DECEMBER 2014 EVENT.
- (f) WELL COULD NOT BE LOCATED DURING DECEMBER 2014 EVENT.
- < LESS THAN
- Ag SILVER
- Al ALUMINUM
- As ARSENIC
- B BORON
- Ba BARIUM
- CCME CANADIAN COUNCILS OF MINISTERS OF THE ENVIRONMENT
- Cr CADMIUM
- Cd CHROMIUM
- Cu COPPER
- Fe IRON
- mbgs METRES BELOW GROUND SURFACE
- mg/L MILLIGRAMS PER LITRE
- Mn MANGANESE
- n/g NO GUIDELINE
- NA NOT AVAILABLE
- Ni NICKEL
- Pb LEAD
- RDL REPORTABLE DETECTION LIMIT
- Sb ANTIMONY
- Se SELENIUM
- U URANIUM
- Zn ZINC

NOTES

- LOCATIONS WHERE MOST RECENT GROUNDWATER SAMPLE MEETS APPLICABLE GUIDELINES FOR ALL PARAMETERS ANALYZED SHOWN IN GREEN.
- LOCATIONS WHERE MOST RECENT GROUNDWATER SAMPLE EXCEEDS APPLICABLE GUIDELINES FOR AT LEAST ONE OF THE PARAMETERS ANALYZED SHOWN IN RED.
- EXCEEDANCES OF APPLICABLE GUIDELINES IN TEXT ARE SHOWN IN RED.
- LOCATION WHERE NO SAMPLES WERE TAKEN IN THE MOST RECENT SAMPLING EVENT SHOWN IN BLACK.
- ALL RESULTS IN mg/L.

REFERENCE

ORIGINAL DRAWING OBTAINED FROM MERIDIAN ENVIRONMENTAL INC.; JOB No.: 11005; SCALE: 1:1,250 (APPROXIMATE); DATE: MARCH 3, 2006.
2006 DATA FROM HUMAN HEALTH ECOLOGICAL RISK ASSESSMENT FORMER WATER DISPOSAL MIDDENS, BAR U RANCH NATIONAL HISTORIC SITE (MARCH 2007). 2008 DATA FROM MONITORING WELL INSTALLATION/SAMPLING AND CAPPING OF WASTE DISPOSAL MIDDENS, BAR U RANCH NATIONAL HISTORIC SITE, LONGVIEW, AB (APRIL 2009).

CLIENT

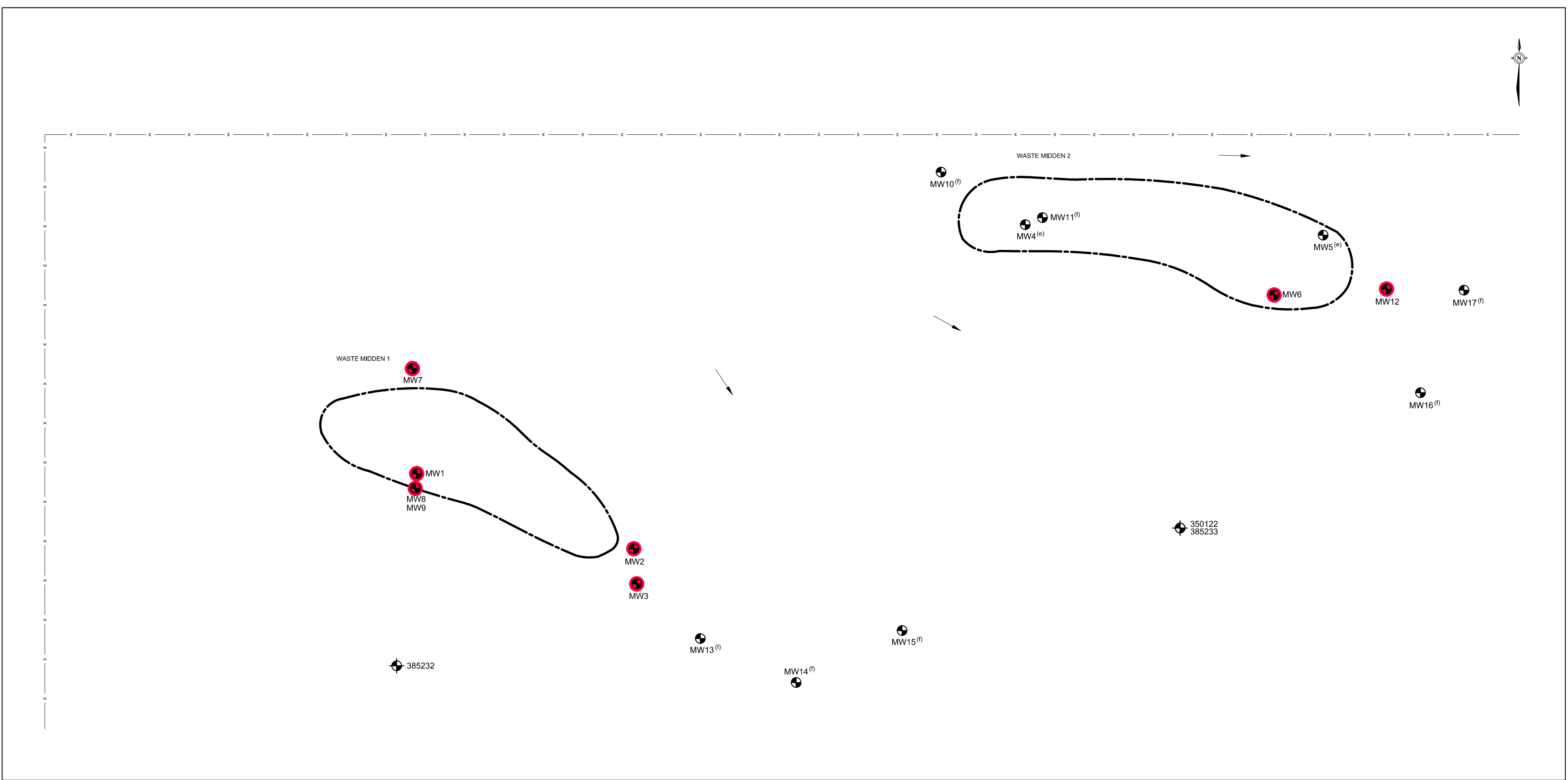
PARKS CANADA AGENCY
BAR U RANCH NATIONAL HISTORIC SITE
LONGVIEW, ALBERTA

TITLE

GROUNDWATER ANALYTICAL RESULTS
DISSOLVED METALS

PROJECT	1418041-1000	FILE	1418041-1000-HS-0007
DESIGN	AC	29/01/15	SCALE AS SHOWN
CADD	KA	06/02/15	REV. 0
CHECK	AB	02/04/15	
REVIEW	DP	02/04/15	

FIGURE: 7



MW1																Screen Interval: NA			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn			
16-Dec-14	0.53	<0.00060	0.0014	0.073	0.11	0.00028	0.0012	0.0051	1.5	0.001	2.5	0.014	0.0003	<0.00010	0.018	0.026			

MW2																Screen Interval: NA			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn			
16-Dec-14	84	<0.00060	0.12	0.68	<0.20	0.0083	0.14	0.19	37	0.25	1.1	0.26	0.014	0.0016	0.087	1			

MW3																Screen Interval: NA			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn			
18-Dec-14	41	0.0013	0.048	2.5	0.15	0.0052	0.07	0.12	110	0.069	2.3	0.14	0.0024	0.0011	0.024	0.6			

MW6																Screen Interval: NA			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn			
18-Dec-14	29	0.0018	0.11	0.98	0.13	0.0041	0.059	0.14	200	0.053	3.2	0.18	0.035	0.00073	0.0087	0.42			

MW7																Screen Interval: 0.5 - 6.0 mbgs			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn			
16-Dec-14	13	0.0013	0.032	1.9	0.076	0.0013	0.036	0.048	62	0.027	2.9	0.081	0.018	0.00023	0.087	0.14			

MW8																Screen Interval: 4.5 - 6.0 mbgs			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn			
16-Dec-14	15	0.00093	0.019	1.4	0.061	0.0045	0.018	0.11	33	0.055	3.1	0.067	0.0089	0.0004	0.047	0.32			

MW12																Screen Interval: 1.0 - 3.0 mbgs			
Date	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn			
18-Dec-14	28	0.0012	0.053	1.3	0.076	0.0027	0.064	0.002	130	0.047	3.4	0.13	0.0035	0.00076	0.018	0.41			

CCME GUIDELINES																			
PARAMETERS	Al	Sb	As	Ba	B	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Se	Ag	U	Zn			
CRITERIA ^(a)	0.1 ^(a)	0.006	0.01	1	5	0.005	0.05	1.0 ^(a)	0.3 ^(a)	0.01	0.05 ^(a)	n/g	0.05	n/g	0.02	5.0 ^(a)			
CRITERIA ^(c)	n/g	n/g	0.005	n/g	1.5	0.00037	0.0089	0.004	0.3	0.007	n/g	0.15	0.001	0.0001	0.015	0.03			
CRITERIA ^(e)	5	n/g	0.1	n/g	5	0.080	0.05	1	5	0.2	0.2	1	0.05	n/g	0.2	50			
RDL	0.003	0.0006	0.0002	0.01	0.02	0.00002	0.001	0.0002	0.06	0.0002	0.004	0.0005	0.0002	0.0001	0.0001	0.003			

LEGEND

x

WASTE MIDDENS BOUNDARY (APPROXIMATE)

FENCELINE

MONITORING WELL LOCATION

WATER WELL

DIRECTION OF SLOPE

- NOTES
1. LOCATIONS WHERE MOST RECENT GROUNDWATER SAMPLE MEETS APPLICABLE GUIDELINES FOR ALL PARAMETERS ANALYZED SHOWN IN GREEN.

2. LOCATIONS WHERE MOST RECENT GROUNDWATER SAMPLE EXCEEDS APPLICABLE GUIDELINES FOR AT LEAST ONE OF THE PARAMETERS ANALYZED SHOWN IN RED.

3. EXCEEDANCES OF APPLICABLE GUIDELINES IN TEXT ARE SHOWN IN RED.

4. LOCATION WHERE NO SAMPLES WERE TAKEN IN THE MOST RECENT SAMPLING EVENT SHOWN IN BLACK.

- LIST OF APPLICABLE ABBREVIATIONS
- (a) CCME DRINKING WATER GUIDELINES (2014), BASED ON HEALTH CANADA'S GUIDELINES FOR CANADIAN DRINKING WATER QUALITY.

(b) BASED ON AESTHETIC OBJECTIVES.

(c) CCME WATER QUALITY GUIDELINES FOR THE PROTECTION OF AQUATIC LIFE (CCME 1999).

(d) CCME WATER QUALITY GUIDELINES FOR THE PROTECTION OF AGRICULTURAL WATER USES (CCME 1999).

(e) INSUFFICIENT VOLUME OF WATER DURING DECEMBER 2014 EVENT.

(f) WELL COULD NOT BE LOCATED DURING DECEMBER 2014 EVENT.

< LESS THAN

Ag SILVER

Al ALUMINUM

As ARSENIC

B BORON

Ba BARIUM

CCME CANADIAN COUNCILS OF MINISTERS OF THE ENVIRONMENT

Cd CADMIUM

Cr CHROMIUM

Cu COPPER

Fe IRON

mbgs METRES BELOW GROUND SURFACE

mg/L MILLIGRAMS PER LITRE

Mn MANGANESE

NA NOT AVAILABLE

Ni NICKEL

Pb LEAD

RDL REPORTABLE DETECTION LIMIT

Sb ANTIMONY

Se SELENIUM

U URANIUM

Zn ZINC

REFERENCE

ORIGINAL DRAWING OBTAINED FROM MERIDIAN ENVIRONMENTAL INC.; JOB No.: 11005; SCALE: 1:1,250 (APPROXIMATE); DATE: MARCH 3, 2006.

20020

SCALEMETRES

CLIENT

PARKS CANADA AGENCY
BAR U RANCH NATIONAL HISTORIC SITE
LONGVIEW, ALBERTA

TITLE

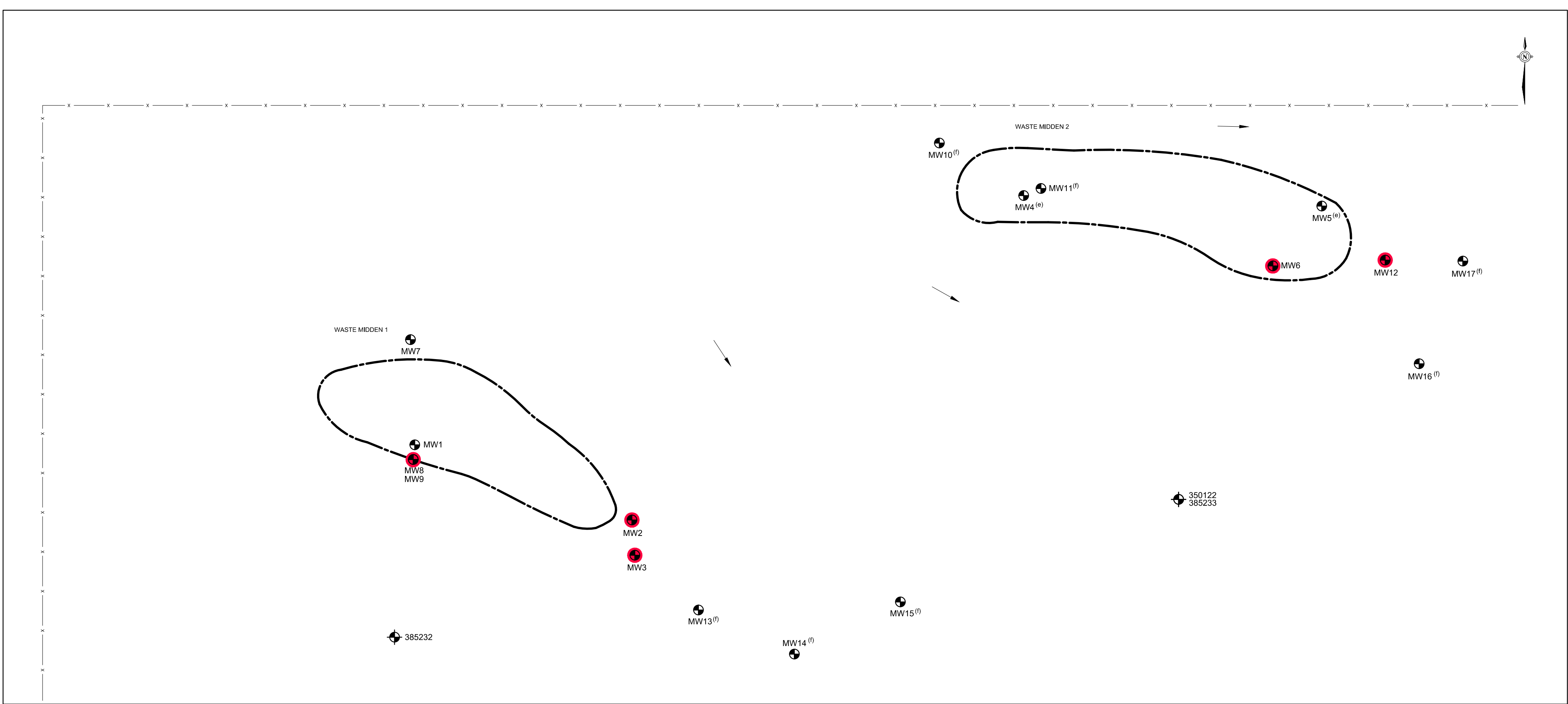
GROUNDWATER ANALYTICAL RESULTS
TOTAL METALS

Golder Associates

PROJECT	1418041-1000	FILE	1418041-1000-HS-0008
DESIGN	AC	29/01/15	SCALE AS SHOWN
CADD	KA	06/02/15	REV. 0
CHECK	AB	02/04/15	
REVIEW	DP	02/04/15	

FIGURE: 8

L:\PARKS CANADA\LONGVIEW_AB_BAR_U_RANCH\99_PROJECTS\1418041_02_PRODUCTION\1000-2016\DWG\1418041-1000-HS-0009.dwg Apr 01, 2015 - 8:32am



MW2																	Screen Interval: NA					
	Athe	Athy	Ac	An	B(a)A	B(b)+JF	B(k)F	B(g,h,i)P	B(c)Ph	B(a)P	B(e)P	CRYH	D(a,h)A	Fla	File	I(1,2,3-cd)P	N	PYLH	Ph	P	Q	B(a)PE
03-Nov-06	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	NA	<0.00003
16-Dec-14	<0.00025	<0.00025	<0.00050	<0.000025 ^(a)	<0.0000021 ^(a)	<0.000021	<0.000021	<0.000021	<0.00013	<0.000019 ^(a)	<0.00013	<0.000021	<0.000019	0.000037	<0.00013	<0.000021	<0.00025	<0.00013	<0.00013	0.000054	<0.00050	0.000023

MW3																Screen Interval: NA						
Date	Athe	Athy	Ac	An	B(a)A	B(b)+JF	B(k)F	B(g,h,i)P	B(c)Ph	B(a)P	B(e)P	CRYH	D(a,h)A	Fla	File	I(1,2,3-cd)P	N	PYLH	Ph	P	Q	B(a)PE
28-Nov-08	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	NA	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	NA	NA
18-Dec-14	<0.00010	<0.00010	<0.00020	<0.000010	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000050	<0.0000075	<0.000050	<0.0000085	<0.0000075	0.000043	<0.000050	<0.0000085	<0.00010	<0.000050	<0.000050	0.000042	<0.00020	<0.00010

MW6																	Screen Interval: NA					
Date	Athe	Athy	Ac	An	B(a)A	B(b)+JF	B(k)F	B(g,h,i)P	B(c)Ph	B(a)P	B(e)P	CRYH	D(a,h)A	Fla	File	I(1,2,3-cd)P	N	PYLH	Ph	P	Q	B(a)PE
20-Oct-04	<0.00005	<0.00005	NA	0.000012	0.00002	0.000051	0.000013	0.000038	NA	0.000024	NA	0.000078	0.000012	0.000053	0.000099	0.000015	0.000178	NA	0.000346	0.000116	NA	NA
28-Nov-08	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	NA	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00003	NA	0.00003	<0.00001	<0.00001	NA
18-Dec-14	<0.00010	<0.00010	<0.00020	0.000014	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.000050	<0.000075	<0.000050	0.000011	<0.000075	0.000062	0.000071	<0.0000085	<0.00010	<0.000050	0.00019	0.000088	<0.00020	<0.00010

MW8		Screen Interval: 4.5 - 6.0 mbgs																				
Date	Athe	Athy	Ac	An	B(a)A	B(b)+JF	B(k)F	B(g,h,i)P	B(c)Ph	B(a)P	B(e)P	CRYH	D(a,h)A	Fla	File	I(1,2,3-cd)P	N	PYLH	Ph	P	Q	B(a)PE
31-Oct-06	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	NA	<0.00003
16-Dec-14	<0.00010	<0.00010	<0.00020	<0.000010	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000050	<0.0000075	<0.000050	<0.0000085	<0.0000075	0.000021	<0.000050	<0.0000085	<0.00010	<0.000050	<0.000050	0.000041	<0.00020	<0.000010

MW9																	Screen Interval: 1.0 - 3.0 mbgs					
	Athe	Athy	Ac	An	B(a)A	B(b)+JF	B(k)F	B(g,h,i)P	B(c)Ph	B(a)P	B(e)P	CRYH	D(a,h)A	Fla	File	I(1,2,3-cd)P	N	PYLH	Ph	P	Q	B(a)PE
31-Oct-06	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	NA	<0.00003
16-Dec-14	<0.00010	<0.00010	<0.00020	<0.000010	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000050	<0.0000075	<0.000050	<0.0000085	<0.0000075	<0.000010	<0.000050	<0.0000085	<0.00010	<0.000050	<0.000050	0.000032	<0.00020	<0.000010

MW12																	Screen Interval: 1.0 - 3.0 mbgs					
Date	Athe	Athy	Ac	An	B(a)A	B(b)+JF	B(k)F	B(g,h,i)P	B(c)Ph	B(a)P	B(e)P	CRYH	D(a,h)A	Fla	File	I(1,2,3-cd)P	N	PYLH	Ph	P	Q	B(a)PE
31-Oct-06	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	NA	<0.00003
18-Dec-14	<0.00025	<0.00025	<0.00050	<0.000025 ^(a)	<0.000021 ^(a)	<0.000021	<0.000021	<0.000021	<0.00013	<0.000019 ^(a)	<0.00013	<0.000021	<0.000019	<0.000025	<0.00013	<0.000021	<0.00025	<0.00013	0.00015	0.000064	<0.00050	0.000023

CCME GUIDELINES

PARAMETERS	Athe	Athy	Ac	An	B(a)A	B(b+)JF	B(k)F	B(g,h,i)P	B(c)Ph	B(a)P	B(e)P	CRYH	D(a,h)A	Fla	File	I(1,2,3-cd)P	N	PYLH	Ph	P	Q	B(a)PE
CRITERIA ^(a)	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	0.00001	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g
CRITERIA ^(a)	0.0058	n/g	0.0044	0.000012	0.000018	n/g	n/g	n/g	n/g	0.000015	n/g	n/g	n/g	0.00004	0.003	n/g	0.0011	n/g	0.0004	0.000025	0.00034	n/g
CRITERIA ^(a)	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g
RDL	0.0001	0.0001	0.0002	0.00001	0.0000085	0.0000085	0.0000085	0.0000085	0.00005	0.0000075	0.00005	0.0000085	0.0000075	0.00001	0.00005	0.0000085	0.0001	0.00005	0.00005	0.00002	0.0002	0.00001

LEGEND

- WASTE MIDDENS BOUNDARY (APPROXIMATE)
- FENCELINE
- MONITORING WELL LOCATION
- WATER WELL
- DIRECTION OF SLOPE

NOTES

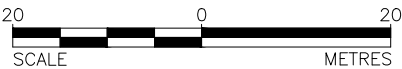
- LOCATIONS WHERE MOST RECENT GROUNDWATER SAMPLE MEETS APPLICABLE GUIDELINES FOR ALL PARAMETERS ANALYZED SHOWN IN **GREEN**.
- LOCATIONS WHERE MOST RECENT GROUNDWATER SAMPLE EXCEEDS APPLICABLE GUIDELINES FOR AT LEAST ONE OF THE PARAMETERS ANALYZED SHOWN IN **RED**.
- EXCEEDANCES OF APPLICABLE GUIDELINES IN TEXT ARE SHOWN IN **RED**.
- LOCATION WHERE NO SAMPLES WERE TAKEN IN THE MOST RECENT SAMPLING EVENT SHOWN IN **BLACK**.
- ALL RESULTS IN mg/L.

LIST OF APPLICABLE ABBREVIATIONS

- (a) CCME DRINKING WATER GUIDELINES (2014), BASED ON HEALTH CANADA'S GUIDELINES FOR CANADIAN DRINKING WATER QUALITY.
- (b) RDL GREATER THAN CRITERIA.
- (c) CCME WATER QUALITY GUIDELINES FOR THE PROTECTION OF AQUATIC LIFE (CCME 1999).
- (d) CCME WATER QUALITY GUIDELINES FOR THE PROTECTION OF AGRICULTURAL WATER USES (CCME 1999).
- (e) INSUFFICIENT VOLUME OF WATER DURING DECEMBER 2014 EVENT.
- (f) WELL COULD NOT BE LOCATED DURING DECEMBER 2014 EVENT.
- < LESS THAN
- Athe ACENAPHTHENE
- Athy ACRIDINE
- Ac ACENAPHTYLENE
- An ANTHRACENE
- B(a)A BENZO(a)ANTHRACENE
- B(a)P BENZO(a)PYRENE
- B(a)PE B(a)P EQUIVALENCY
- B(b+)JF BENZO(b+)JFLUORANTHRENE
- B(c)Ph BENZO(c)PHENANTHRENE
- B(e)P BENZO(e)PYRENE
- B(g,h,i)P BENZO(g,h,i)PERYLENE
- B(k)F BENZO(k)FLUORANTHRENE
- CRYH CHRYSENE
- CCME CANADIAN COUNCILS OF MINISTERS OF THE ENVIRONMENT
- D(a,h)A DIBENZ(a,h)ANTHRACENE
- Fla FLUORANTHRENE
- File FLUORENE
- I(1,2,3-cd)P INDENO(1,2,3-cd)PYRENE
- mbgs METRES BELOW GROUND SURFACE
- N NAPHTHALENE
- n/g NO GUIDELINE
- NA NOT AVAILABLE
- P PYRENE
- Ph PHENANTHRENE
- PYLH PERYLENE
- Q QUINOLINE
- RDL REPORTABLE DETECTION LIMIT

REFERENCE

ORIGINAL DRAWING OBTAINED FROM MERIDIAN ENVIRONMENTAL INC.; JOB No.: 11005; SCALE: 1:1,250 (APPROXIMATE); DATE: MARCH 3, 2006.
2004 AND 2006 DATA FROM HUMAN HEALTH ECOLOGICAL RISK ASSESSMENT FORMER WATER DISPOSAL MIDDENS, BAR U RANCH NATIONAL HISTORIC SITE (MARCH 2007); 2008 DATA FROM MONITORING WELL INSTALLATION/SAMPLING AND CAPPING OF WASTE DISPOSAL MIDDENS, BAR U RANCH NATIONAL HISTORIC SITE, LONGVIEW, AB (APRIL 2009).



CLIENT

PARKS CANADA AGENCY
BAR U RANCH NATIONAL HISTORIC SITE
LONGVIEW, ALBERTA

TITLE

GROUNDWATER ANALYTICAL RESULTS
POLYCYCLIC AROMATIC HYDROCARBONS

PROJECT	1418041.1000	FILE	1418041-1000-HS-0009
DESIGN	AC 29/01/15	SCALE	AS SHOWN
CADD	KA 06/02/15	REV.	0
CHECK	AB 02/04/15		
REVIEW	DP 02/04/15		

FIGURE: 9

TABLES

Table 1
Summary of Groundwater Field Monitoring Results
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Well ID	Date	Depth to Groundwater (mbtoc)	Product Thickness (m)	Headspace Vapours (ppmv)	Electrical Conductivity (µS/m)	pH	Temperature (°C)	GPS Coordinates
MW1	16-Dec-14	0.89	n/d	n/d	1,003	7.05	6.3	11 U 0695242, 5589552
MW2	16-Dec-14	2.47	n/d	5	1,879	7.09	6	11 U 0695299, 5589534
MW3	18-Dec-14	2.54	n/d	65	1,142	7.18	6	11 U 0695301, 5589525
MW4	18-Dec-14	DRY	n/d	n/m	n/m	n/m	n/m	11 U 0695405, 5589620
MW5 ^(b)	18-Dec-14	2.77	n/d	20	n/m	n/m	n/m	11 U 0695484, 5589617
MW6	18-Dec-14	1.67	n/d	n/d	3,365	7.09	6	11 U 0695473, 5589601
MW7	16-Dec-14	2.53	n/d	5	2,004	6.67	6	11 U 0695250, 5589574
MW8	16-Dec-14	1.92	n/d	n/d	1,218	6.98	6.3	11 U 0695243, 5589552
MW9	16-Dec-14	2.03	n/d	55	1,516	6.6	7	11 U 0695243, 5589552
MW10 ^(a)	18-Dec-14	n/m	n/m	n/m	n/m	n/m	n/m	NA
MW11 ^(a)	18-Dec-14	n/m	n/m	n/m	n/m	n/m	n/m	NA
MW12	18-Dec-14	1.89	n/d	n/d	2,342	7.15	6.2	11 U 0695491, 5589600
MW13 ^(a)	18-Dec-14	n/m	n/m	n/m	n/m	n/m	n/m	NA
MW14 ^(a)	18-Dec-14	n/m	n/m	n/m	n/m	n/m	n/m	NA
MW15 ^(a)	18-Dec-14	n/m	n/m	n/m	n/m	n/m	n/m	NA
MW16 ^(a)	18-Dec-14	n/m	n/m	n/m	n/m	n/m	n/m	NA
MW17 ^(a)	18-Dec-14	n/m	n/m	n/m	n/m	n/m	n/m	NA

Notes:^(a) well could not be located^(b) insufficient amount of water

°C - degrees Celsius

m - metres

mbtoc - metres below top of casing

NA - not available

n/d - not detected

n/m - not measured

ppmv - parts per million volume

µS/m - microSiemens per metre

Table 2
Summary of Current and Historical Groundwater Analytical Results - Petroleum Hydrocarbons
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Monitoring Well	Sample Collection Date	Maxxam Sample ID	Benzene	Toluene	Ethylbenzene	Xylenes	F1 (C ₆ -C ₁₀) - BTEX	F2 (C ₁₀ -C ₁₆)
MW1	20-Oct-04	NA	<0.0002	0.00073	<0.0002	<0.0004	<0.1	<0.1
	16-Dec-14	LJ9563	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10
MW2	04-Nov-04	NA	<0.01	0.0003	<0.0005	<0.0001	<0.1	<0.1
	16-Dec-14	LJ9567	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10
MW3	15-Sep-06	NA	<0.0005	<0.0005	<0.0005	<0.0005	<0.1	<0.05
	31-Oct-06	NA	<0.0005	<0.0005	<0.0005	<0.0005	<0.1	0.13
	18-Dec-14	LK1840	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10
MW4	20-Oct-04	NA	<0.0002	<0.0002	<0.0002	<0.0004	<0.1	<0.1
MW6	20-Oct-04	NA	<0.0002	<0.0002	<0.0002	<0.0004	<0.1	<0.1
	18-Dec-14	LK1839	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10
MW7	16-Dec-14	LJ9566	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10
MW8	16-Dec-14	LJ9564	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10
MW9	31-Oct-06	NA	<0.0005	<0.0005	<0.0005	<0.0005	<0.1	<0.05
	16-Dec-14	LJ9565	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10
MW12	18-Dec-14	LK1838	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	0.19
RDL			0.0004	0.0004	0.0004	0.0008	0.1	0.1
Criteria^(a)			0.005	0.06	0.14	0.09	n/g	n/g
Criteria^(b)			0.37	0.002	0.09	n/g	n/g	n/g
Criteria^(c)			n/g	0.024	0.0024	n/g	n/g	n/g
Criteria^(d)			0.088	4.9	3.2	13	6.5	1.8

Notes:

^(a) CCME Drinking Water Guidelines (2014), based on Health Canada's Guidelines for Canadian Drinking Water Quality

^(b) CCME Water Quality Guidelines for the Protection of Aquatic Life (1999)

^(c) CCME Water Quality Guidelines for the Protection of Agricultural Water Uses (1999)

^(d) Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites (2014)

Bold/Underlined - value exceeds criteria for the lowest of all guidelines

BTEX - benzene, toluene, ethylbenzene, xylenes

F1, F2 - petroleum hydrocarbon fractions 1 and 2

NA - not available

RDL - reportable detection limit

< - less than

All values reported in milligrams per litre (mg/L)

2004 and 2006 data from Human Health Ecological Risk Assessment Former Water Disposal Middens, Bar U Ranch National Historic Site (March 2007)

Table 3
Summary of current and Historical Groundwater Analytical Results - Salinity
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Monitoring Well	Sample Collection Date	Maxxam Sample ID	pH	Dissolved Calcium	Dissolved Chloride	Dissolved Magnesium	Dissolved Nitrate as Nitrogen	Dissolved Nitrite as Nitrogen	Dissolved Potassium	Dissolved Sodium	Dissolved Sulphate	Total Dissolved Solids
MW1	31-Oct-06	NA	7.8	449	8	662	<0.05	<0.05	9.3	<u>702</u>	<u>4,670</u>	<u>6,880</u>
	16-Dec-14	LJ9563	7.47	350	13	290	0.017	<0.010	9.8	<u>370</u>	<u>2,800</u>	<u>4,100</u>
MW2	16-Dec-14	LJ9567	7.84	140	11	130	<0.010	<0.010	4.5	180	<u>790</u>	<u>1,600</u>
MW3	15-Sep-06	NA	7.9	275	21.8	205	0.18	<0.05	18.9	148	<u>1,510</u>	<u>2,430</u>
	03-Nov-06	NA	7.6	364	34.3	285	0.21	<0.05	23.1	187	<u>2,140</u>	<u>3,310</u>
	18-Dec-14	LK1840	7.54	300	21	330	1.5	0.012	17	<u>250</u>	<u>2,100</u>	<u>3,400</u>
MW4	31-Oct-06	NA	7.8	403	1.7	406	<0.05	<0.05	14.9	<u>1,080</u>	<u>4,220</u>	<u>6,670</u>
MW6	15-Sep-06	NA	8	239	50.6	190	<0.05	<0.05	10.3	186	<u>1,030</u>	<u>2,100</u>
	18-Dec-14	LK1839	7.59	270	44	240	0.012	<0.010	18	<u>210</u>	<u>1,200</u>	<u>2,600</u>
MW7	31-Oct-06	NA	7.9	488	7.2	383	0.28	<0.05	12	<u>434</u>	<u>3,330</u>	<u>4,950</u>
	16-Dec-14	LJ9566	7.73	440	120	1,300	7.6	<0.010	12	<u>850</u>	<u>6,600</u>	<u>9,700</u>
MW8	31-Oct-06	NA	7.8	620	3.1	1,480	0.08	<0.05	13.8	<u>1,130</u>	<u>8,390</u>	<u>12,000</u>
	16-Dec-14	LJ9564	7.58	290	9.6	1,100	<0.020	<0.020	12	<u>760</u>	<u>6,600</u>	<u>9,100</u>
MW9	03-Nov-06	NA	7.9	165	18.4	347	0.26	<0.05	5	<u>298</u>	<u>2,150</u>	<u>3,350</u>
	16-Dec-14	LJ9565	7.89	100	23	250	0.035	<0.010	2.9	140	<u>840</u>	<u>1,700</u>
MW10	31-Oct-06	NA	7.9	556	3.6	1,040	0.89	<0.05	17.9	<u>933</u>	<u>7,120</u>	<u>9,940</u>
MW12	31-Oct-06	NA	8	166	16.4	95.1	<0.05	<0.05	10.2	61	<u>656</u>	<u>1,260</u>
	18-Dec-14	LK1838	7.7	260	13	150	0.035	<0.010	10	82	<u>870</u>	<u>1,700</u>
MW13	31-Oct-06	NA	8	161	14.9	114	1	<0.05	6.6	78	<u>647</u>	<u>1,300</u>
MW14	28-Nov-08	NA	8	NA	NA	NA	6.36	<0.05	NA	NA	184	<u>606</u>
MW16	28-Nov-08	NA	8.09	NA	NA	NA	0.21	<0.05	NA	NA	47	294
RDL			n/a	0.3	1	0.2	0.01	0.01	0.3	0.5	5	10
Criteria ^(a)			6.5 - 8.5 ^(b)	n/g	250 ^(b)	n/g	10	1	n/g	200 ^(b)	500 ^(b)	500 ^(b)
Criteria ^(c)			6.5 - 9.0	n/g	120	n/g	13	0.06	n/g	n/g	n/g	n/g
Criteria ^(d)			n/g	1000	n/g	n/g	n/g	10	n/g	n/g	1000	3000

Notes:^(a) CCME Drinking Water Guidelines (2014), based on Health Canada's Guidelines for Canadian Drinking Water Quality^(b) based on aesthetic objectives^(c) CCME Water Quality Guidelines for the Protection of Aquatic Life (1999)^(d) CCME Water Quality Guidelines for the Protection of Agricultural Water Uses (1999)**Bold/Underlined** - value exceeds criteria for the lowest of all guidelines

NA - not available

n/g - no guideline

RDL - reportable detection limit

< - less than

All values reported in milligrams per litre (mg/L)

2006 data from Human Health Ecological Risk Assessment Former Water Disposal Middens, Bar U Ranch National Historic Site (March 2007). 2008 data from Monitoring Well Installation/Sampling and Capping of Waste Disposal Middens, Bar U Ranch National Historic Site, Longview, AB (April 2009).

Table 4
Summary of Current and Historical Groundwater Analytical Results - Dissolved Metals
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Monitoring Well	Sample Collection Date	Maxxam Sample ID	Aluminum	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Uranium	Zinc
MW1	20-Oct-04	NA	<0.005	0.0011	<0.002	0.081	0.083	<0.0001	<0.005	0.0008	<0.03	<0.0005	<0.005	<0.01	<u>0.005</u>	<0.0001	<u>0.0201</u>	<0.05
	28-Nov-08	NA	0.05	NA	NA	0.026	0.12	<0.001	<0.005	<u>0.007</u>	0.117	<0.005	<u>2.74</u>	0.028	NA	<0.005	N/A	0.004
	16-Dec-14	LJ9563	0.005	<0.00060	0.0008	0.03	0.093	<0.000020	<0.0010	0.00049	0.21	<0.00020	<u>1.8</u>	0.011	<u>0.0066</u>	<0.00010	<u>0.02</u>	<0.0030
MW2	04-Nov-04	NA	<0.005	<0.0005	<0.002	0.07	0.117	<0.0001	<0.005	0.0017	<0.03	<0.0005	<0.005	<0.001	<u>0.021</u>	<0.0001	<u>0.0243</u>	<0.005
	16-Dec-14	LJ9567	0.0037	<0.00060	0.0008	0.025	0.066	<0.000020	<0.0010	0.0024	<u>1.5</u>	<0.00020	<u>0.52</u>	0.0054	0.00068	<0.00010	<u>0.029</u>	<0.0030
MW3	15-Sep-06	NA	<0.01	NA	NA	0.086	0.15	<0.001	<0.005	<u>0.005</u>	0.016	<0.005	<u>0.671</u>	0.015	<u>0.0027</u>	<0.005	<0.05	0.026
	31-Oct-06	NA	<0.01	0.0007	0.0012	0.085	0.19	0.0002	<0.005	0.004	0.089	<0.0001	<u>1.46</u>	0.018	<u>0.0017</u>	0.0002	0.0130	<u>0.052</u>
	28-Nov-08	NA	<0.01	NA	NA	0.043	0.06	<0.001	<0.005	0.002	0.006	<0.005	<u>0.152</u>	0.005	NA	<0.005	N/A	0.003
	18-Dec-14	LK1840	0.0044	<0.00060	0.0008	0.036	0.12	0.000032	<0.0010	0.0021	0.1	<0.00020	<u>0.13</u>	0.0053	0.00082	<0.00010	<u>0.016</u>	0.0052
MW4	20-Oct-04	NA	<0.005	0.0014	<0.002	0.055	0.168	<0.0001	<0.005	<0.005	0.03	<0.0005	0.008	0.015	<u>0.008</u>	<0.0001	<u>0.0253</u>	<0.05
	28-Nov-08	NA	0.1	NA	NA	0.035	0.17	<0.001	<0.005	<u>0.008</u>	<u>2.88</u>	<0.005	<u>2.63</u>	0.057	NA	<0.005	N/A	0.007
MW6	20-Oct-04	NA	<0.005	0.0006	<0.002	0.256	0.049	<0.0001	<0.005	0.0017	0.07	<0.0005	<u>0.934</u>	0.013	NA	<0.0001	0.0076	<0.005
	28-Nov-08	NA	0.01	NA	NA	0.053	0.08	<0.001	<0.005	0.002	<u>1.17</u>	<0.005	<u>0.282</u>	0.005	NA	<0.005	N/A	0.002
	18-Dec-14	LK1839	0.0055	<0.00060	<u>0.0057</u>	0.042	0.088	<0.000020	<0.0010	<0.00020	<u>3</u>	<0.00020	<u>0.19</u>	0.0038	<u>0.0066</u>	<0.00010	0.0092	<0.0030
MW7	31-Oct-06	NA	<0.01	0.0004	0.0010	0.076	0.12	<0.0001	<0.005	<u>0.005</u>	<0.005	<0.00001	<0.001	0.013	<u>0.0040</u>	<0.0001	<u>0.0385</u>	0.024
	16-Dec-14	LJ9566	<0.0030	<0.00060	0.0014	0.023	0.076	0.000053	<0.0010	<u>0.0077</u>	<0.060	<0.00020	<0.0040	0.0048	<u>0.019</u>	<0.00010	<u>0.1</u>	<0.0030
MW8	31-Oct-06	NA	<0.01	0.0004	0.0020	0.068	0.07	0.0001	<0.005	0.012	<0.005	<0.0001	<u>0.183</u>	0.021	<u>0.0019</u>	<0.0001	<u>0.0474</u>	0.023
	16-Dec-14	LJ9564	0.0041	<0.00060	0.0013	0.05	0.043	0.000027	<0.0010	0.0013	0.085	<0.00020	<u>2.4</u>	0.026	0.00086	<0.00010	<u>0.047</u>	0.0063
MW9	31-Oct-06	NA	<0.01	0.0013	0.0013	0.132	0.13	<0.0001	<0.005	<u>0.006</u>	<0.005	<0.0001	0.022	0.009	<u>0.0088</u>	<0.0001	<u>0.0361</u>	0.023
MW10	31-Oct-06	NA	<0.01	<0.0004	0.0014	0.072	0.11	<0.0001	0.007	<u>0.012</u>	<0.005	<0.001	<0.001	0.017	<u>0.0502</u>	<0.0001	<u>0.0503</u>	0.016
MW12	31-Oct-06	NA	<0.001	0.0004	0.0007	0.181	0.08	<0.0001	<0.005	0.003	0.008	<0.0001	<u>0.123</u>	0.007	<u>0.0021</u>	<0.0001	0.0095	0.024
	18-Dec-14	LK1838	0.0039	<0.00060	0.0004	0.085	0.055	0.00003	<0.0010	0.0021	0.077	<0.00020	<u>0.38</u>	0.0027	0.00027	<0.00010	<u>0.019</u>	<0.0030
MW13	31-Oct-06	NA	<0.01	0.0007	0.0007	0.047	0.10	<0.0001	<0.005	0.003	<0.005	<0.0001	<u>0.093</u>	0.005	<u>0.0107</u>	<0.0001	<u>0.0179</u>	0.015
MW14	28-Nov-08	NA	<0.01	NA	NA	0.093	0.05	<0.001	<0.005	0.002	0.006	<0.005	<u>0.113</u>	0.003	NA	<0.005	NA	<0.002
MW16	28-Nov-08	NA	<0.01	NA	NA	0.11	<0.05	<0.001	<0.005	<0.001	<0.005	<0.005	0.008	0.003	NA	<0.005	NA	<0.002
RDL			0.003	0.0006	0.0002	0.01	0.02	0.00002	0.001	0.0002	0.06	0.0002	0.004	0.0005	0.0002	0.0001	0.0001	0.003
Criteria ^(a)			0.1 ^(b)	0.006	0.01	1	5	0.005	0.05	1.0 ^(b)	0.3 ^(b)	0.01	0.05 ^(b)	n/g	0.05	n/g	0.02	5.0 ^(b)
Criteria ^(c)			n/g	n/g	0.005	n/g	1.5	0.00037	0.0089	0.004	0.3	0.007	n/g	0.15	0.001	0.0001	0.015	0.03
Criteria ^(d)			5	n/g	0.1	n/g	5	0.080	0.05	1	5	0.2	0.2	1	0.05	n/g	0.2	50

Notes:^(a) CCME Drinking Water Guidelines (2014), based on Health Canada's Guidelines for Canadian Drinking Water Quality^(b) based on aesthetic objectives^(c) CCME Water Quality Guidelines for the Protection of Aquatic Life (1999)^(d) CCME Water Quality Guidelines for the Protection of Agricultural Water Uses (1999)**Bold/Underlined** - value exceeds criteria for the lowest of all guidelines

NA - not available

n/g - no guideline

RDL - reportable detection limit

< - less than

All values reported in milligrams per litre (mg/L)

2004 and 2006 data from Human Health Ecological Risk Assessment Former Water Disposal Middens, Bar U Ranch National Historic Site (March 2007). 2008 data from Monitoring Well Installation/Sampling and Capping of Waste Disposal Middens, Bar U Ranch National Historic Site, Longview, AB (April 2009).

Table 5
Summary of Current Groundwater Analytical Results - Total Metals
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Monitoring Well	Sample Collection Date	Maxxam Sample ID	Aluminum	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Nickel	Selenium	Silver	Uranium	Zinc
MW1	16-Dec-14	LJ9563	<u>0.53</u>	<0.00060	0.0014	0.073	0.11	0.00028	0.0012	<u>0.0051</u>	<u>1.5</u>	0.001	<u>2.5</u>	0.014	0.00034	<0.00010	<u>0.018</u>	0.026
MW2	16-Dec-14	LJ9567	<u>84</u>	<0.00060	<u>0.12</u>	0.68	<0.20	<u>0.0083</u>	<u>0.14</u>	<u>0.19</u>	<u>37</u>	<u>0.25</u>	<u>1.1</u>	<u>0.26</u>	<u>0.014</u>	<u>0.0016</u>	<u>0.087</u>	<u>1</u>
MW3	18-Dec-14	LK1840	<u>41</u>	0.0013	<u>0.048</u>	<u>2.5</u>	0.15	<u>0.0052</u>	<u>0.07</u>	<u>0.12</u>	<u>110</u>	<u>0.069</u>	<u>2.3</u>	0.14	<u>0.0024</u>	<u>0.0011</u>	<u>0.024</u>	<u>0.6</u>
MW6	18-Dec-14	LK1839	<u>29</u>	0.0018	<u>0.11</u>	0.98	0.13	<u>0.0041</u>	<u>0.059</u>	<u>0.14</u>	<u>200</u>	<u>0.053</u>	<u>3.2</u>	<u>0.18</u>	<u>0.035</u>	<u>0.00073</u>	0.0087	<u>0.42</u>
MW7	16-Dec-14	LJ9566	<u>13</u>	0.0013	<u>0.032</u>	<u>1.9</u>	0.076	<u>0.0013</u>	<u>0.036</u>	<u>0.048</u>	<u>62</u>	<u>0.027</u>	<u>2.9</u>	0.081	<u>0.018</u>	<u>0.00023</u>	<u>0.087</u>	<u>0.14</u>
MW8	16-Dec-14	LJ9564	<u>15</u>	0.00093	<u>0.019</u>	<u>1.4</u>	0.061	<u>0.0045</u>	<u>0.018</u>	<u>0.11</u>	<u>33</u>	<u>0.055</u>	<u>3.1</u>	0.067	<u>0.0089</u>	<u>0.0004</u>	<u>0.047</u>	<u>0.32</u>
MW12	18-Dec-14	LK1838	<u>28</u>	0.0012	<u>0.053</u>	<u>1.3</u>	0.076	<u>0.0027</u>	<u>0.064</u>	0.002	<u>130</u>	<u>0.047</u>	<u>3.4</u>	0.13	<u>0.0035</u>	<u>0.00076</u>	<u>0.018</u>	<u>0.41</u>
RDL			0.003	0.0006	0.0002	0.01	0.02	0.00002	0.001	0.0002	0.06	0.0002	0.004	0.0005	0.0002	0.0001	0.0001	0.003
Criteria ^(a)			0.1 ^(b)	0.006	0.01	1	5	0.005	0.05	1.0 ^(b)	0.3 ^(b)	0.01	0.05 ^(b)	n/g	0.05	n/g	0.02	5.0 ^(b)
Criteria ^(c)			n/g	n/g	0.005	n/g	1.5	0.00037	0.0089	0.004	0.3	0.007	n/g	0.15	0.001	0.0001	0.015	0.03
Criteria ^(d)			5	n/g	0.1	n/g	5	0.080	0.05	1	5	0.2	0.2	1	0.05	n/g	0.2	50

Notes:^(a) CCME Drinking Water Guidelines (2014), based on Health Canada's Guidelines for Canadian Drinking Water Quality^(b) based on aesthetic objectives^(c) CCME Water Quality Guidelines for the Protection of Aquatic Life (1999)^(d) CCME Water Quality Guidelines for the Protection of Agricultural Water Uses (1999)**Bold/Underlined** - value exceeds criteria for the lowest of all guidelines

n/g - no guideline

RDL - reportable detection limit

< - less than

All values reported in milligrams per litre (mg/L)

Table 6
Summary of Current and Historical Groundwater Analytical Results - Polycyclic Aromatic Hydrocarbon
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Monitoring Well	Sample Collection Date	Maxxam Sample ID	Acenaphthene	Acenaphthylene	Acridine	Anthracene	Benzo[a]anthracene	Benzo[b,j]fluoranthene	Benzo[k]fluoranthene	Benzo[g,h,i]perylene	Benzo[c]phenanthrene	Benzo[e]pyrene	Benzo[a]pyrene	Chrysene	Dibenzo[a,h]anthracene	Fluoranthene	Fluorene	Indeno[1,2,3-cd]pyrene	Naphthalene	Perylene	Phenanthrene	Pyrene	Quinoline	B(a)P Equivalency
MW1	20-Oct-04	NA	<0.00005	<0.00005	NA	0.00002	<0.00001	0.000015	<0.00001	0.000013	N/A	0.00001	NA	0.000017	<0.00001	0.000015	<0.00005	<0.00001	0.000051	NA	0.000064	0.000036	NA	0.000012
	28-Nov-08	NA	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	NA	NA	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	0.00003	<0.00001	<0.00001	NA
	16-Dec-14	LJ9563	<0.00010	<0.00010	<0.00020	<0.000010	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.000050	<0.0000075	<0.000050	<0.0000085	<0.0000075	<0.000010	<0.000050	<0.000085	<0.00010	<0.000050	<0.000050	<0.000020	<0.00020	<0.000010
MW2	03-Nov-06	NA	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	NA	<0.00003
	16-Dec-14	LJ9567	<0.00025	<0.00025	<0.00050	<0.000025 ^(b)	<0.000021 ^(b)	<0.000021	<0.000021	<0.000021	<0.00013	<0.000019 ^(b)	<0.00013	<0.000021	<0.000019	0.000037	<0.00013	<0.000021	<0.00025	<0.00013	<0.00013	0.000054	<0.00050	0.000023
MW3	28-Nov-08	NA	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	NA	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	NA
	18-Dec-14	LK1840	<0.00010	<0.00010	<0.00020	<0.000010	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.000050	<0.0000075	<0.000050	<0.0000085	<0.0000075	0.000043	<0.000050	<0.000085	<0.00010	<0.000050	<0.000050	0.000042	<0.00020	<0.000010
MW4	20-Oct-04	NA	<0.0002	<0.0002	NA	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	NA	0.000007	NA	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	NA	<0.0002	<0.0002	NA	NA
	28-Nov-08	NA	<0.00001	N/A	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	NA	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	NA
MW6	20-Oct-04	NA	<0.00005	<0.00005	NA	0.000012	0.00002	0.000051	0.000013	0.000038	NA	0.000024	NA	0.000078	0.000012	0.000053	0.000099	0.000015	0.000178	NA	0.000346	0.000116	NA	NA
	28-Nov-08	NA	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	NA	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00003	NA	0.00003	<0.00001	<0.00001	NA
	18-Dec-14	LK1839	<0.00010	<0.00010	<0.00020	0.000014	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.000050	<0.0000075	<0.000050	0.000011	<0.0000075	0.000062	0.000071	<0.0000085	<0.00010	<0.000050	0.00019	0.000088	<0.00020	<0.000010
MW7	16-Dec-14	LJ9566	<0.00010	<0.00010	<0.00020	<0.000010	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.000050	<0.0000075	<0.000050	<0.0000085	<0.0000075	<0.000010	<0.000050	<0.0000085	<0.00010	<0.000050	<0.000050	<0.000020	<0.00020	<0.000010
	31-Oct-06	NA	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	NA	<0.00003
MW8	16-Dec-14	LJ9564	<0.00010	<0.00010	<0.00020	<0.000010	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.000050	<0.0000075	<0.000050	<0.0000085	<0.0000075	0.000021	<0.000050	<0.0000085	<0.00010	<0.000050	<0.000050	0.000041	<0.00020	<0.000010
	31-Oct-06	NA	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	NA	<0.00003
MW9	16-Dec-14	LJ9565	<0.00010	<0.00010	<0.00020	<0.000010	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.000050	<0.0000075	<0.000050	<0.0000085	<0.0000075	<0.000010	<0.000050	<0.0000085	<0.00010	<0.000050	<0.000050	0.000032	<0.00020	<0.000010
	31-Oct-06	N/A	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	0.00002	<0.00001	NA	<0.00003
MW12	18-Dec-14	LK1838	<0.00025	<0.00025	<0.00050	<0.000025 ^(b)	<0.000021 ^(b)	<0.000021	<0.000021	<0.000021	<0.00013	<0.000019 ^(b)	<0.00013	<0.000021	<0.000019	<0.000025	<0.00013	<0.000021	<0.00025	<0.00013	0.00015	0.000064	<0.00050	0.000023
	31-Oct-06	NA	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	<0.00001	<0.00001	N/A	<0.00003
MW14	28-Nov-08	NA	0.00002	NA	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	NA	NA	0.00002	NA	0.00002	<0.00001	0.00003	0.00004	<0.00001	0.00003	NA	0.00012	0.00007	<0.00001	NA
MW16	28-Nov-08	NA	<0.01	NA	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	NA	NA	<0.00001	NA	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	0.00002	NA	0.00003	0.00003	<0.00001	NA
RDL			0.0001	0.0001	0.0002	0.00001	0.0000085	0.0000085	0.0000085	0.0000085	0.00005	0.0000075	0.00005	0.0000085	0.0000075	0.00001	0.00005	0.0000085	0.0001	0.00005	0.00005	0.00002	0.0002	0.00001
Criteria^(a)			n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	0.00001	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g
Criteria^(c)			0.0058	n/g	0.0044	0.000012	0.000018	n/g	n/g	n/g	n/g	0.000015	n/g	n/g	n/g	0.00004	0.003	n/g	0.0011	n/g	0.0004	0.000025	0.0034	n/g
Criteria^(d)			n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g

Notes:^(a) CCME Drinking Water Guidelines (2014), based on Health Canada's Guidelines for Canadian Drinking Water Quality^(b) RDL greater than criteria^(c) CCME Water Quality Guidelines for the Protection of Aquatic Life (1999)^(d) CCME Water Quality Guidelines for the Protection of Agricultural Water Uses (1999)**Bold/Underlined** - value exceeds criteria for the lowest of all guidelines

NA - not available

n/g - no guideline

RDL - reportable detection limit

< - less than

All values reported in milligrams per litre (mg/L)

2004 and 2006 data from Human Health Ecological Risk Assessment Former Water Disposal Middens, Bar U Ranch National Historic Site (March 2007). 2008 data from Monitoring Well Installation/Sampling and Capping of Waste Disposal Middens, Bar U Ranch National Historic Site, Longview, AB (April 2009).

Table 7
Summary of Current and Historical Groundwater Analytical Results - Organochlorinated Pesticide
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Monitoring Well	Sample Collection Date	Maxxam Sample ID	Aldrin	alpha-BHC	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1262	Aroclor 1268	beta-BHC	a-Chlordane	g-Chlordane	delta-BHC	Dieldrin	Endosulfan I (alpha)	Endosulfan II	Endosulfan Sulfate	Endrin	Endrin Aldehyde	Endrin Ketone	Heptachlor	Heptachlor Epoxide	Hexachlorobenzene	Hexachlorobutadiene	Hexachlorocyclopentadiene	Hexachlorocyclohexane	Lindane	Methoxychlor	Mirex	o,p'-DDD	o,p'-DDE	o,p'-DDT	Octachlorostyrene	Oxychlorane	p,p'-DDD	p,p'-DDE	p,p'-DDT	Toxaphene		
MW1	20-Oct-04	NA	<0.002	<0.002	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.004	<0.004	<0.004	<0.004	<0.01	<0.004	<0.002	<0.002	NA	NA	NA	NA	<0.002	<0.04	<0.004	NA	NA	NA	NA	NA	<0.1	<0.1	<0.1	<0.1	NA	
	28-Nov-08	NA	<0.01	<0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	<0.1	<0.1	NA	<0.1	<0.1	<0.1	NA	<0.1	NA	NA	<0.1	NA	NA	NA	NA	NA	<0.1	<0.2	<0.01	NA	NA	NA	NA	<0.1	<0.1	<0.1	<0.1	NA		
	16-Dec-14	YY0272	<0.005	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.009	<0.02	<0.01	<0.003	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.2		
MW2	16-Dec-14	YY0276	<0.005	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.009	<0.02	<0.01	<0.003	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.2	
MW3	28-Nov-08	NA	<0.1	<0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	<0.1	<0.1	NA	<0.1	<0.1	<0.1	NA	<0.1	NA	NA	<0.1	NA	NA	NA	NA	NA	<0.1	<0.2	<0.01	NA	NA	NA	NA	<0.1	<0.1	<0.1	<0.1	NA		
MW4	04-Nov-04	NA	<0.002	<0.002	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.004	<0.004	<0.004	<0.004	<0.01	<0.004	<0.002	<0.002	NA	NA	NA	NA	<0.002	<0.04	<0.004	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.3	
MW6	20-Oct-04	NA	<0.002	<0.002	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.004	<0.004	<0.004	<0.004	<0.01	<0.004	<0.002	<0.002	NA	NA	NA	NA	<0.002	<0.04	<0.004	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.3	
	18-Dec-14	YY3472	<0.005	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	NA	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.009	<0.02	<0.01	<0.003	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.2	
MW7	16-Dec-14	YY0275	<0.005	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.009	<0.02	<0.01	<0.003	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.2	
MW8	16-Dec-14	YY0273	<0.005	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.009	<0.02	<0.01	<0.003	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.2	
MW9	16-Dec-14	YY0274	<0.005	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.009	<0.02	<0.01	<0.003	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.2	
MW12	18-Dec-14	YY3471	<0.005	<0.005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	NA	NA	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.009	<0.02	<0.01	<0.003	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.2	
MW14	28-Nov-08	NA	<0.1	<0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.1	<0.1	<0.1	NA	<0.1	<0.1	<0.1	NA	<0.1	NA	NA	<0.1	NA	NA	NA	NA	NA	<0.1	<0.2	<0.1	NA	NA	NA	NA	<0.1	<0.1	<0.1	<0.1	NA		
RDL			0.005	0.005	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.009	0.02	0.01	0.003	0.01	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.2	
Criteria ^(a)			n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g
Criteria ^(b)			n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	0.003	0.003	n/g	n/g	n/g	n/g	n/g	n/g	n/g	1.3	n/g	n/g	0.01	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g
Criteria ^(c)			n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	0.52	n/g	n/g	n/g	4	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g	n/g

Notes:^(a) CCME Drinking Water Guidelines (2014), based on Health Canada's Guidelines for Canadian Drinking Water Quality^(b) based on aesthetic objectives^(c) CCME Water Quality Guidelines for the Protection of Aquatic Life (1999)^(d) CCME Water Quality Guidelines for the Protection of Agricultural Water Uses (1999)**Below Underlined** - value exceeds criteria for the lowest of all guidelines

NA - not available

n/g - no guideline

RDL - reportable detection limit

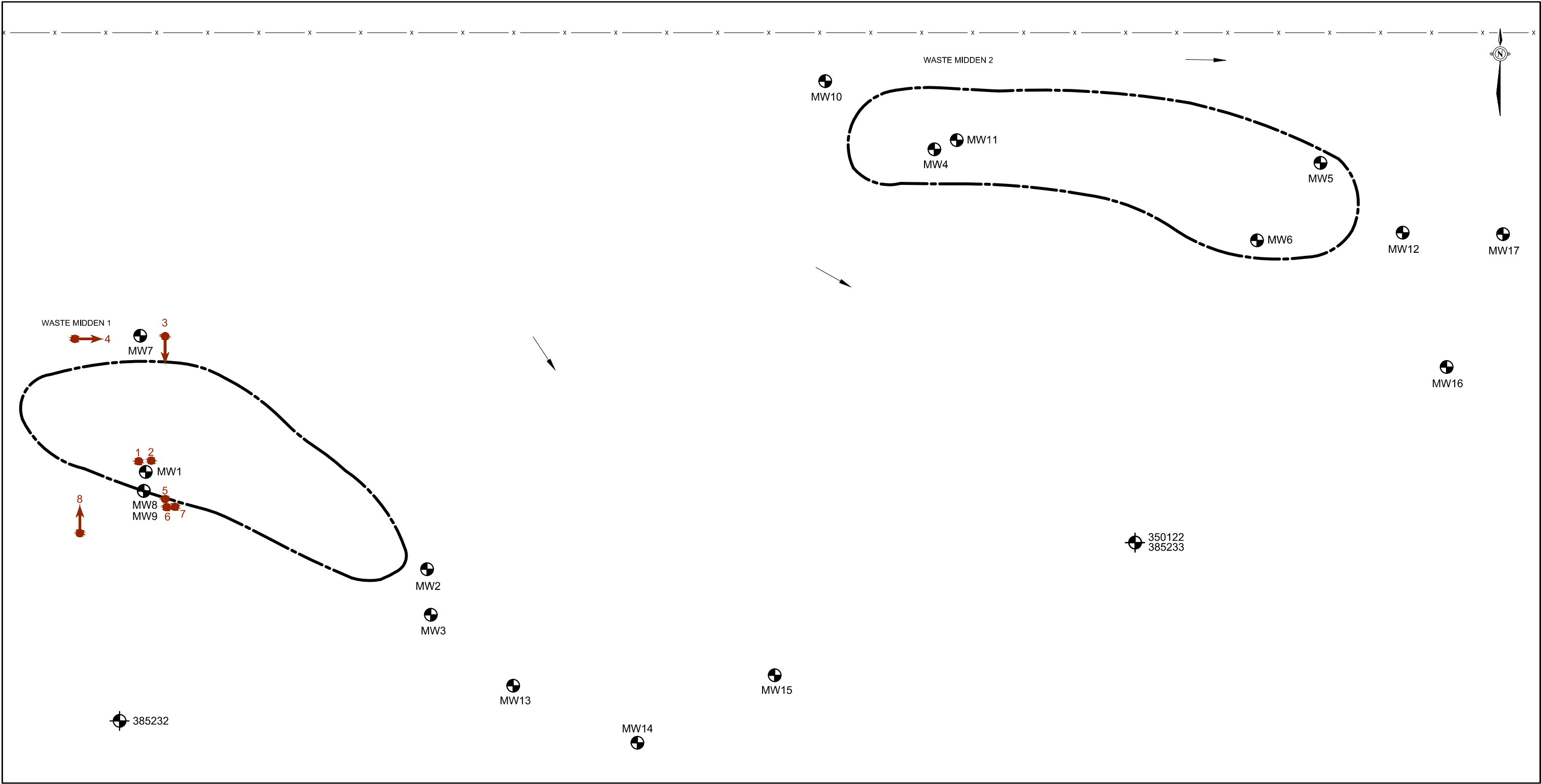
< - less than

All values reported in micrograms per litre (ug/L)

2004 data from Human Health Ecological Risk Assessment Former Water Disposal Middens, Bar U Ranch National Historic Site (March 2007). 2008 data from Monitoring Well Installation/Sampling and Capping of Waste Disposal Middens, Bar U Ranch National Historic Site, Longview, AB (April 2009).

APPENDIX A SITE PHOTOGRAPHS

L:\PARKS_CANADA\LONGVIEW_AB_BAR_U_RANCH\99_PROJECTS\1418041\02_PRODUCTION\1000-2016\DWG\1418041-1000-HS-0010.dwg Apr 01, 2015 - 8:32am

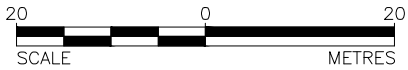


LEGEND

- WASTE MIDDENS BOUNDARY (APPROXIMATE)
- FENCELINE
- MONITORING WELL LOCATION
- WATER WELL
- DIRECTION OF SLOPE
- PHOTOGRAPH LOCATION AND DIRECTION

REFERENCE

ORIGINAL DRAWING OBTAINED FROM MERIDIAN ENVIRONMENTAL INC.; JOB No.: 11005; SCALE: 1:1,250 (APPROXIMATE);
DATE: MARCH 3, 2006.



CLIENT		PARKS CANADA AGENCY BAR U RANCH NATIONAL HISTORIC SITE LONGVIEW, ALBERTA			
TITLE		PHOTOGRAPH LOCATIONS			
	PROJECT	1418041.1000	FILE No. 1418041-1000-HS-0010		
	DESIGN	AC	29/01/15	SCALE	AS SHOWN
	CADD	KA	06/02/15	REV.	0
	CHECK	AB	02/04/15	FIGURE: A.1	
	REVIEW	DP	02/04/15		



Photo 1 Monitoring well MW1 work area (December 16, 2014).



Photo 2 Monitoring well MW1, MW8 and MW9 work area. (December 16, 2014).



Photo 3 Monitoring well MW7 at the flag and MW1, MW8 and MW9 at the truck tailgate, facing south (December 16, 2014).



Photo 4 Monitoring well MW7, facing east (December 16, 2014).

Photographs



Photo 5 Monitoring well MW8 (December 16, 2014).



Photo 6 Monitoring well MW9 buried (December 16, 2014).

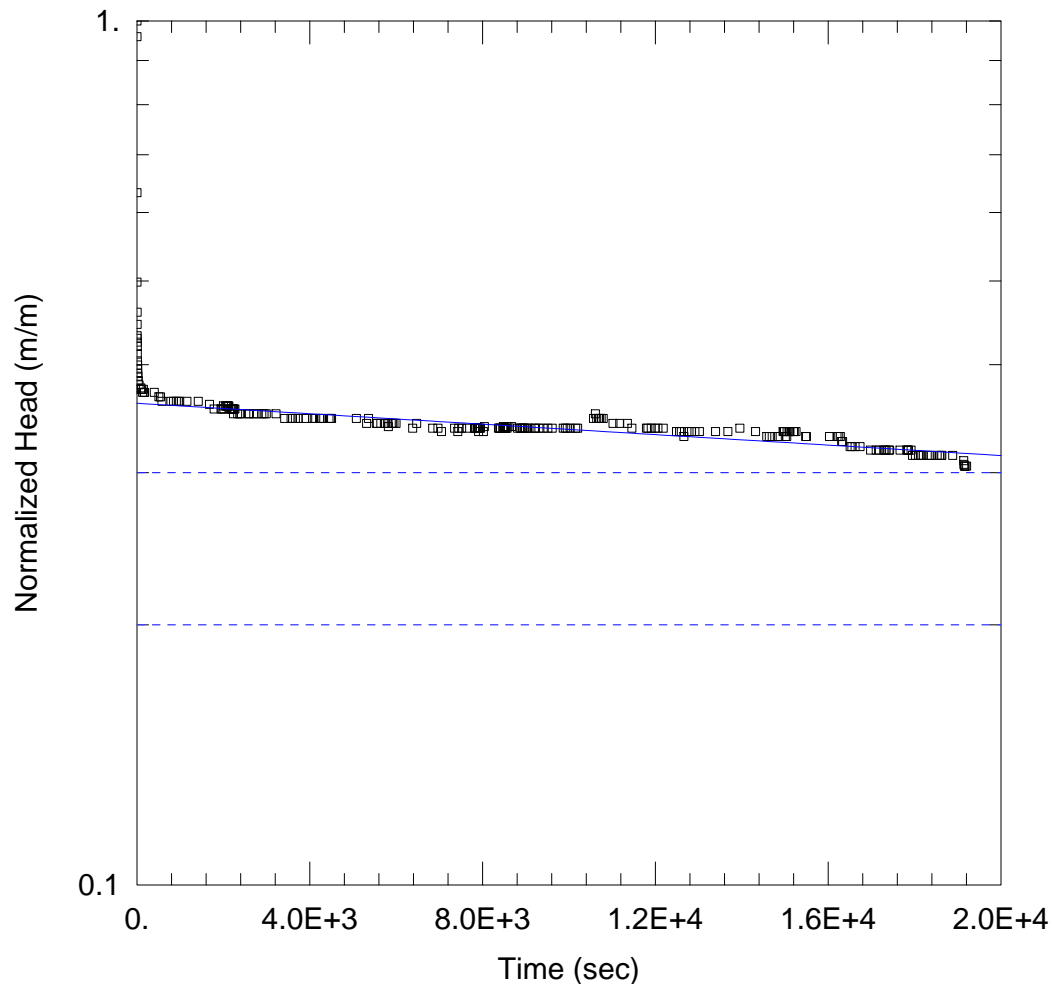


Photo 7 Monitoring well MW9 (December 16, 2014).



Photo 8 From southwest corner of site, facing north (December 18, 2014).

APPENDIX B HYDRAULIC CONDUCTIVITY



WELL TEST ANALYSIS

Data Set: \...\MW7 revised.aqt

Date: 01/08/15

Time: 09:43:00

PROJECT INFORMATION

Company: Golder Associates Ltd.

Client: Parks Canada

Project: 1418041-1000

Location: Bar-U Ranch National Historic

Test Well: MW7

Analyzed by: A. Newberry

Reviewed by: G. Padusenko

Chandra Nauling
by PLU

AQUIFER DATA

Saturated Thickness: 1.966 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (New Well)

Initial Displacement: 0.3955 m

Total Well Penetration Depth: 1.966 m

Casing Radius: 0.0254 m

Static Water Column Height: 1.966 m

Screen Length: 1.966 m

Well Radius: 0.0762 m

Gravel Pack Porosity: 0.36

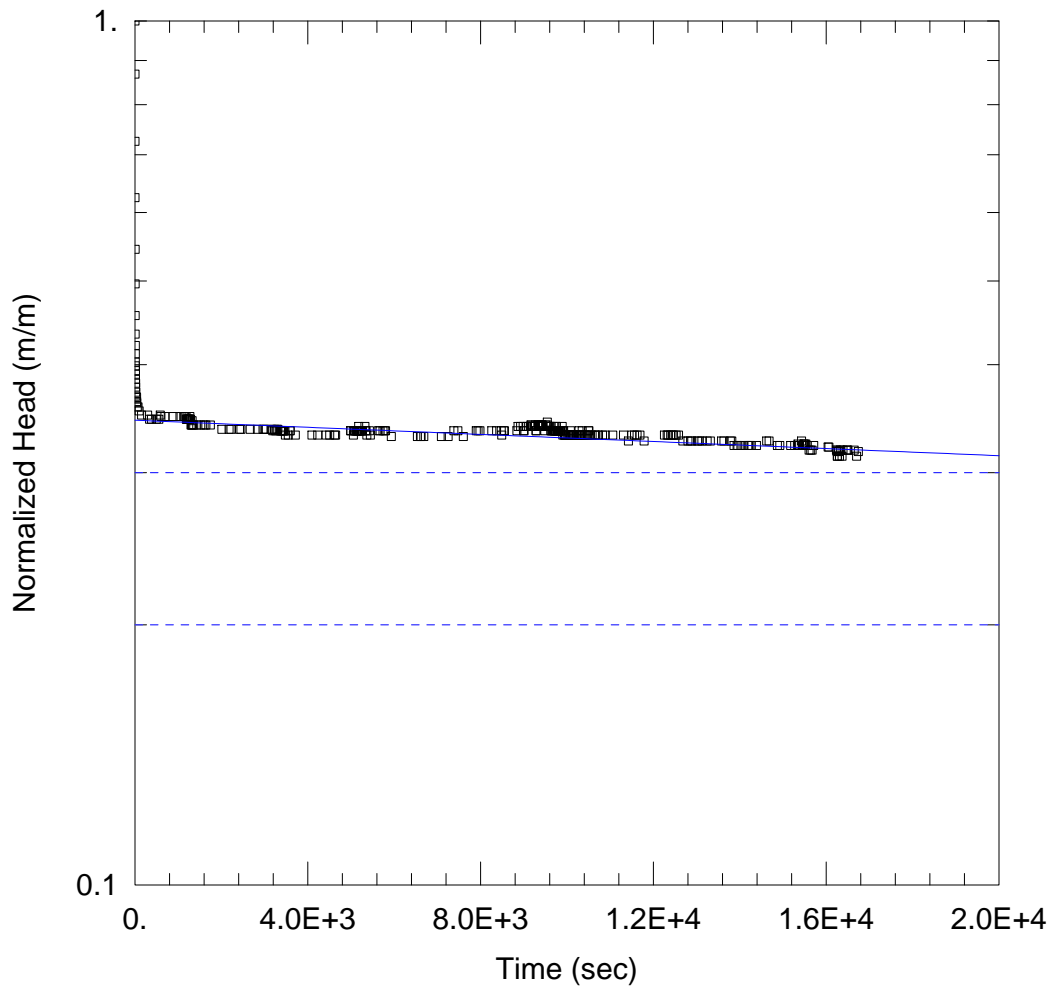
SOLUTION

Aquifer Model: Unconfined

$K = 1.082E-8$ m/sec

Solution Method: Bouwer-Rice

$y_0 = 0.1428$ m



WELL TEST ANALYSIS

Data Set: \...\MW8 revised.aqt

Date: 01/08/15

Time: 09:44:22

PROJECT INFORMATION

Company: Golder Associates Ltd.

Client: Parks Canada

Project: 1418041-1000

Location: Bar-U Ranch National Historic

Test Well: MW8

Analyzed by: A. Newberry

Reviewed by: G. Padusenko

Chandra Nauling
by PLU

AQUIFER DATA

Saturated Thickness: 1.764 m

Anisotropy Ratio (K_z/K_r): 1.

WELL DATA (New Well)

Initial Displacement: 0.4503 m

Total Well Penetration Depth: 1.764 m

Casing Radius: 0.0254 m

Static Water Column Height: 1.764 m

Screen Length: 1.764 m

Well Radius: 0.0762 m

Gravel Pack Porosity: 0.36

SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

$K = 7.871E-9$ m/sec

$y_0 = 0.1554$ m

APPENDIX C LABORATORY CERTIFICATES OF ANALYSIS AND DATA QUALITY REVIEW CHECKLISTS

Your Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Your C.O.C. #: A096867

Attention: AURELIE BELLAVANCE

GOLDER ASSOCIATES LTD.
CALGARY - NATIONAL CONTRACT
102, 2535 - 3rd Avenue SE
CALGARY, AB
CANADA T2A 7W5

Report Date: 2015/01/02
Report #: R1771481
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4B4360

Received: 2014/12/17, 15:07

Sample Matrix: Water
Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	6	N/A	2014/12/19	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	8	N/A	2014/12/19	AB SOP-00039	CCME CWS/EPA 8260C m
Cadmium - low level CCME - Dissolved	6	N/A	2014/12/22	AB SOP-00043	EPA 200.8 R5.4 m
Cadmium - low level CCME (Total)	3	2014/12/18	2014/12/19	AB SOP-00014 / AB SOP-00043	EPA 200.8 R5.4 m
Cadmium - low level CCME (Total)	3	2014/12/18	2014/12/20	AB SOP-00014 / AB SOP-00043	EPA 200.8 R5.4 m
Chloride by Automated Colourimetry	6	N/A	2014/12/29	AB SOP-00020	SM 22-4500-Cl G m
Conductivity @25C	6	N/A	2014/12/19	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16)	7	2014/12/22	2014/12/22	AB SOP-00040 AB SOP-00037	CCME PHC-CWS
CCME Hydrocarbons in Water (F2; C10-C16)	1	2014/12/22	2014/12/23	AB SOP-00040 AB SOP-00037	CCME PHC-CWS
Hardness	6	N/A	2014/12/22	AB WI-00065	Auto Calc
Elements by ICP - Dissolved	6	N/A	2014/12/19	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICP - Total	6	2014/12/18	2014/12/19	AB SOP-00014 / AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved	4	N/A	2014/12/19	AB SOP-00043	EPA 200.8 R5.4 m
Elements by ICPMS - Dissolved	2	N/A	2014/12/20	AB SOP-00043	EPA 200.8 R5.4 m
Elements by ICPMS - Total	6	2014/12/18	2014/12/19	AB SOP-00014 / AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	6	N/A	2014/12/19	AB WI-00065	SM 1030E
Sum of cations, anions	6	N/A	2014/12/22	AB WI-00065	SM 1030E
Nitrate and Nitrite	5	N/A	2014/12/22	AB SOP-00023	Auto Calc
Nitrate and Nitrite	1	N/A	2014/12/23	AB SOP-00023	Auto Calc
Nitrate + Nitrite-N (calculated)	5	N/A	2014/12/22	AB SOP-00023	Auto Calc
Nitrate + Nitrite-N (calculated)	1	N/A	2014/12/23	AB SOP-00023	Auto Calc
Nitrogen, (Nitrite, Nitrate) by IC	5	N/A	2014/12/19	AB SOP-00023	SM 22 4110 B m
Nitrogen, (Nitrite, Nitrate) by IC	1	N/A	2014/12/22	AB SOP-00023	SM 22 4110 B m
Benzo[a]pyrene Equivalency (1)	6	N/A	2014/12/24	AB SOP-00003	Auto Calc

Your Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Your C.O.C. #: A096867

Attention:AURELIE BELLAVANCE

GOLDER ASSOCIATES LTD.
CALGARY - NATIONAL CONTRACT
102, 2535 - 3rd Avenue SE
CALGARY, AB
CANADA T2A 7W5

Report Date: 2015/01/02
Report #: R1771481
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4B4360

Received: 2014/12/17, 15:07

Sample Matrix: Water
Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
PAH in Water by GC/MS	6	2014/12/20	2014/12/23	AB SOP-00037 / AB SOP-00003	EPA 8270D m
pH @25°C (Alkalinity titrator)	6	N/A	2014/12/19	AB SOP-00005	SM 22 4500-H+B m
Sulphate by Automated Colourimetry	6	N/A	2014/12/29	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Calculated)	6	N/A	2014/12/29	AB WI-00065	SM 1030E

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) B[a]P TPE is calculated using 1/2 of the RDL for non detect results as per Alberta Environment instructions. This protocol may not apply in other jurisdictions.

Encryption Key  Wendy Sears
02 Jan 2015 15:04:44 -07:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Wendy Sears, Project manager
Email: WSears@maxxam.ca
Phone# (403)735-2277

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

AT1 BTEX AND F1-F2 (WATER)

Maxxam ID		LJ9563	LJ9564	LJ9565	LJ9565	LJ9566	LJ9567		
Sampling Date		2014/12/16 12:00	2014/12/16 11:30	2014/12/16 11:00	2014/12/16 11:00	2014/12/16 13:15	2014/12/16 14:50		
COC Number		A096867	A096867	A096867	A096867	A096867	A096867		
	Units	MW1	MW8	MW9	MW9 Lab-Dup	MW7	MW2	RDL	QC Batch

Hydrocarbons									
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	7761700
Volatiles									
Benzene	mg/L	<0.00040	<0.00040	<0.00040	N/A	<0.00040	<0.00040	0.00040	7759807
Toluene	mg/L	<0.00040	<0.00040	<0.00040	N/A	<0.00040	<0.00040	0.00040	7759807
Ethylbenzene	mg/L	<0.00040	<0.00040	<0.00040	N/A	<0.00040	<0.00040	0.00040	7759807
m & p-Xylene	mg/L	<0.00080	<0.00080	<0.00080	N/A	<0.00080	<0.00080	0.00080	7759807
o-Xylene	mg/L	<0.00040	<0.00040	<0.00040	N/A	<0.00040	<0.00040	0.00040	7759807
Xylenes (Total)	mg/L	<0.00080	<0.00080	<0.00080	N/A	<0.00080	<0.00080	0.00080	7759807
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	<0.10	N/A	<0.10	<0.10	0.10	7759807
(C6-C10)	mg/L	<0.10	<0.10	<0.10	N/A	<0.10	<0.10	0.10	7759807
Surrogate Recovery (%)									
1,4-Difluorobenzene (sur.)	%	109	107	108	N/A	108	108	N/A	7759807
4-Bromofluorobenzene (sur.)	%	111	111	110	N/A	111	110	N/A	7759807
D4-1,2-Dichloroethane (sur.)	%	110	109	109	N/A	110	110	N/A	7759807
O-TERPHENYL (sur.)	%	101	80	94	96	88	90	N/A	7761700
RDL = Reportable Detection Limit									
Lab-Dup = Laboratory Initiated Duplicate									
N/A = Not Applicable									

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

AT1 BTEX AND F1-F2 (WATER)

Maxxam ID		LJ9568	LJ9569	LJ9570		
Sampling Date		2014/12/16 12:00	2014/12/16 12:15	2014/12/16 12:20		
COC Number		A096867	A096867	A096867		
	Units	DUP A	TRIP BLANK	FIELD BLANK	RDL	QC Batch
Hydrocarbons						
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	<0.10	0.10	7761700
Volatiles						
Benzene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	7759807
Toluene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	7759807
Ethylbenzene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	7759807
m & p-Xylene	mg/L	<0.00080	<0.00080	<0.00080	0.00080	7759807
o-Xylene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	7759807
Xylenes (Total)	mg/L	<0.00080	<0.00080	<0.00080	0.00080	7759807
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	<0.10	0.10	7759807
(C6-C10)	mg/L	<0.10	<0.10	<0.10	0.10	7759807
Surrogate Recovery (%)						
1,4-Difluorobenzene (sur.)	%	108	107	107	N/A	7759807
4-Bromofluorobenzene (sur.)	%	110	111	111	N/A	7759807
D4-1,2-Dichloroethane (sur.)	%	110	109	108	N/A	7759807
O-TERPHENYL (sur.)	%	86	109	97	N/A	7761700
RDL = Reportable Detection Limit						
N/A = Not Applicable						

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

ROUTINE WATER & DISS. REGULATED METALS (WATER)

Maxxam ID		LJ9563	LJ9563			LJ9564		
Sampling Date		2014/12/16 12:00	2014/12/16 12:00			2014/12/16 11:30		
COC Number		A096867	A096867			A096867		
	Units	MW1	MW1 Lab-Dup	RDL	QC Batch	MW8	RDL	QC Batch
Calculated Parameters								
Anion Sum	meq/L	69	N/A	N/A	7758415	150	N/A	7758415
Cation Sum	meq/L	57	N/A	N/A	7758415	140	N/A	7758415
Hardness (CaCO ₃)	mg/L	2100	N/A	0.50	7758413	5100	0.50	7758413
Ion Balance	N/A	0.83	N/A	0.010	7758414	0.91	0.010	7758414
Dissolved Nitrate (NO ₃)	mg/L	0.073	N/A	0.044	7758416	<0.089	0.089	7758416
Nitrate plus Nitrite (N)	mg/L	0.017	N/A	0.010	7758417	<0.020	0.020	7758417
Dissolved Nitrite (NO ₂)	mg/L	<0.033	N/A	0.033	7758416	<0.066	0.066	7758416
Total Dissolved Solids	mg/L	4100	N/A	10	7758418	9100	10	7758418
Misc. Inorganics								
Conductivity	uS/cm	4700	N/A	1.0	7760273	9200	1.0	7760273
pH	pH	7.47	N/A	N/A	7760274	7.58	N/A	7760274
Low Level Elements								
Dissolved Cadmium (Cd)	mg/L	<0.000020	N/A	0.000020	7758540	0.000027	0.000020	7758540
Anions								
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	N/A	0.50	7760272	<0.50	0.50	7760272
Alkalinity (Total as CaCO ₃)	mg/L	500	N/A	0.50	7760272	560	0.50	7760272
Bicarbonate (HCO ₃)	mg/L	620	N/A	0.50	7760272	680	0.50	7760272
Carbonate (CO ₃)	mg/L	<0.50	N/A	0.50	7760272	<0.50	0.50	7760272
Hydroxide (OH)	mg/L	<0.50	N/A	0.50	7760272	<0.50	0.50	7760272
Dissolved Sulphate (SO ₄)	mg/L	2800 (1)	2700	20	7765821	6600 (1)	50	7765821
Dissolved Chloride (Cl)	mg/L	13	13	1.0	7765819	9.6	1.0	7765819
Nutrients								
Dissolved Nitrite (N)	mg/L	<0.010	N/A	0.010	7760867	<0.020 (2)	0.020	7762431
Dissolved Nitrate (N)	mg/L	0.017	N/A	0.010	7760867	<0.020 (2)	0.020	7762431
Elements								
Dissolved Aluminum (Al)	mg/L	0.0050	N/A	0.0030	7759178	0.0041	0.0030	7759178
Dissolved Antimony (Sb)	mg/L	<0.00060	N/A	0.00060	7759178	<0.00060	0.00060	7759178
Dissolved Arsenic (As)	mg/L	0.00076	N/A	0.00020	7759178	0.0013	0.00020	7759178
Dissolved Barium (Ba)	mg/L	0.030	N/A	0.010	7760011	0.050	0.010	7760011
Dissolved Beryllium (Be)	mg/L	<0.0010	N/A	0.0010	7759178	<0.0010	0.0010	7759178
Dissolved Boron (B)	mg/L	0.093	N/A	0.020	7760011	0.043	0.020	7760011
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable (1) Detection limits raised due to dilution to bring analyte within the calibrated range. (2) Detection limits raised due to matrix interference.								

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

ROUTINE WATER & DISS. REGULATED METALS (WATER)

Maxxam ID		LJ9563	LJ9563			LJ9564		
Sampling Date		2014/12/16 12:00	2014/12/16 12:00			2014/12/16 11:30		
COC Number		A096867	A096867			A096867		
	Units	MW1	MW1 Lab-Dup	RDL	QC Batch	MW8	RDL	QC Batch
Dissolved Calcium (Ca)	mg/L	350	N/A	0.30	7766136	290	0.30	7760011
Dissolved Chromium (Cr)	mg/L	<0.0010	N/A	0.0010	7759178	<0.0010	0.0010	7759178
Dissolved Cobalt (Co)	mg/L	0.0028	N/A	0.00030	7759178	0.0065	0.00030	7759178
Dissolved Copper (Cu)	mg/L	0.00049	N/A	0.00020	7759178	0.0013	0.00020	7759178
Dissolved Iron (Fe)	mg/L	0.21	N/A	0.060	7760011	0.085	0.060	7760011
Dissolved Lead (Pb)	mg/L	<0.00020	N/A	0.00020	7759178	<0.00020	0.00020	7759178
Dissolved Lithium (Li)	mg/L	0.067	N/A	0.020	7760011	0.068	0.020	7760011
Dissolved Magnesium (Mg)	mg/L	290	N/A	0.20	7766136	1100 (1)	2.0	7760011
Dissolved Manganese (Mn)	mg/L	1.8	N/A	0.0040	7760011	2.4	0.0040	7760011
Dissolved Molybdenum (Mo)	mg/L	0.0012	N/A	0.00020	7759178	0.0019	0.00020	7759178
Dissolved Nickel (Ni)	mg/L	0.011	N/A	0.00050	7759178	0.026	0.00050	7759178
Dissolved Phosphorus (P)	mg/L	0.10 (2)	N/A	0.10	7760011	0.18	0.10	7760011
Dissolved Potassium (K)	mg/L	9.8 (3)	N/A	0.30	7760011	12 (3)	0.30	7760011
Dissolved Selenium (Se)	mg/L	0.0066 (4)	N/A	0.00020	7759178	0.00086	0.00020	7759178
Dissolved Silicon (Si)	mg/L	5.2	N/A	0.10	7760011	5.3	0.10	7760011
Dissolved Silver (Ag)	mg/L	<0.00010	N/A	0.00010	7759178	<0.00010	0.00010	7759178
Dissolved Sodium (Na)	mg/L	370	N/A	0.50	7766136	760 (1)	5.0	7760011
Dissolved Strontium (Sr)	mg/L	4.3	N/A	0.020	7760011	4.6	0.020	7760011
Dissolved Sulphur (S)	mg/L	770 (1)	N/A	1.0	7760011	2000 (1)	2.0	7760011
Dissolved Thallium (Tl)	mg/L	<0.00020	N/A	0.00020	7759178	<0.00020	0.00020	7759178
Dissolved Tin (Sn)	mg/L	<0.0010	N/A	0.0010	7759178	<0.0010	0.0010	7759178
Dissolved Titanium (Ti)	mg/L	<0.0010	N/A	0.0010	7759178	<0.0010	0.0010	7759178
Dissolved Uranium (U)	mg/L	0.020 (3)	N/A	0.00010	7759178	0.047	0.00010	7759178
Dissolved Vanadium (V)	mg/L	<0.0010	N/A	0.0010	7759178	<0.0010	0.0010	7759178
Dissolved Zinc (Zn)	mg/L	<0.0030	N/A	0.0030	7759178	0.0063	0.0030	7759178

RDL = Reportable Detection Limit

Lab-Dup = Laboratory Initiated Duplicate

N/A = Not Applicable

(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

(2) Dissolved greater than total. Results are within limits of uncertainty(MU).

(3) Dissolved greater than total. Results within acceptable limits of precision.

(4) Dissolved greater than total. Reanalysis yields similar results.

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

ROUTINE WATER & DISS. REGULATED METALS (WATER)

Maxxam ID		LJ9565		LJ9566		LJ9567		
Sampling Date		2014/12/16 11:00		2014/12/16 13:15		2014/12/16 14:50		
COC Number		A096867		A096867		A096867		
	Units	MW9	RDL	MW7	RDL	MW2	RDL	QC Batch
Calculated Parameters								
Anion Sum	meq/L	30	N/A	150	N/A	27	N/A	7758415
Cation Sum	meq/L	32	N/A	170	N/A	26	N/A	7758415
Hardness (CaCO ₃)	mg/L	1300	0.50	6400	0.50	880	0.50	7758413
Ion Balance	N/A	1.1	0.010	1.1	0.010	0.94	0.010	7758414
Dissolved Nitrate (NO ₃)	mg/L	0.16	0.044	34	0.044	<0.044	0.044	7758416
Nitrate plus Nitrite (N)	mg/L	0.035	0.010	7.6	0.010	<0.010	0.010	7758417
Dissolved Nitrite (NO ₂)	mg/L	<0.033	0.033	<0.033	0.033	<0.033	0.033	7758416
Total Dissolved Solids	mg/L	1700	10	9700	10	1600	10	7758418
Misc. Inorganics								
Conductivity	uS/cm	2500	1.0	9600	1.0	2400	1.0	7760273
pH	pH	7.89	N/A	7.73	N/A	7.84	N/A	7760274
Low Level Elements								
Dissolved Cadmium (Cd)	mg/L	0.000021	0.000020	0.000053	0.000020	<0.000020	0.000020	7758540
Anions								
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	0.50	<0.50	0.50	<0.50	0.50	7760272
Alkalinity (Total as CaCO ₃)	mg/L	580	0.50	550	0.50	540	0.50	7760272
Bicarbonate (HCO ₃)	mg/L	710	0.50	670	0.50	660	0.50	7760272
Carbonate (CO ₃)	mg/L	<0.50	0.50	<0.50	0.50	<0.50	0.50	7760272
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50	0.50	<0.50	0.50	7760272
Dissolved Sulphate (SO ₄)	mg/L	840 (1)	10	6600 (1)	50	790 (1)	5.0	7765821
Dissolved Chloride (Cl)	mg/L	23	1.0	120	1.0	11	1.0	7765819
Nutrients								
Dissolved Nitrite (N)	mg/L	<0.010	0.010	<0.010	0.010	<0.010	0.010	7760867
Dissolved Nitrate (N)	mg/L	0.035	0.010	7.6	0.010	<0.010	0.010	7760867
Elements								
Dissolved Aluminum (Al)	mg/L	0.022	0.0030	<0.0030	0.0030	0.0037	0.0030	7759178
Dissolved Antimony (Sb)	mg/L	<0.00060	0.00060	<0.00060	0.00060	<0.00060	0.00060	7759178
Dissolved Arsenic (As)	mg/L	0.0018	0.00020	0.0014	0.00020	0.00076	0.00020	7759178
Dissolved Barium (Ba)	mg/L	0.096	0.010	0.023	0.010	0.025	0.010	7760011
Dissolved Beryllium (Be)	mg/L	<0.0010	0.0010	<0.0010	0.0010	<0.0010	0.0010	7759178
Dissolved Boron (B)	mg/L	0.12	0.020	0.076	0.020	0.066	0.020	7760011
Dissolved Calcium (Ca)	mg/L	100	0.30	440	0.30	140	0.30	7760011
RDL = Reportable Detection Limit								
N/A = Not Applicable								
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.								

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

ROUTINE WATER & DISS. REGULATED METALS (WATER)

Maxxam ID		LJ9565		LJ9566		LJ9567		
Sampling Date		2014/12/16 11:00		2014/12/16 13:15		2014/12/16 14:50		
COC Number		A096867		A096867		A096867		
	Units	MW9	RDL	MW7	RDL	MW2	RDL	QC Batch
Dissolved Chromium (Cr)	mg/L	<0.0010	0.0010	<0.0010	0.0010	<0.0010	0.0010	7759178
Dissolved Cobalt (Co)	mg/L	0.0063	0.00030	0.00082	0.00030	0.0019	0.00030	7759178
Dissolved Copper (Cu)	mg/L	0.0011	0.00020	0.0077	0.00020	0.0024	0.00020	7759178
Dissolved Iron (Fe)	mg/L	0.23	0.060	<0.060	0.060	1.5	0.060	7760011
Dissolved Lead (Pb)	mg/L	<0.00020	0.00020	<0.00020	0.00020	<0.00020	0.00020	7759178
Dissolved Lithium (Li)	mg/L	0.044	0.020	0.15	0.020	0.063	0.020	7760011
Dissolved Magnesium (Mg)	mg/L	250	0.20	1300 (1)	2.0	130	0.20	7760011
Dissolved Manganese (Mn)	mg/L	2.1	0.0040	<0.0040	0.0040	0.52	0.0040	7760011
Dissolved Molybdenum (Mo)	mg/L	0.0029	0.00020	0.0015	0.00020	0.0029	0.00020	7759178
Dissolved Nickel (Ni)	mg/L	0.020	0.00050	0.0048	0.00050	0.0054	0.00050	7759178
Dissolved Phosphorus (P)	mg/L	<0.10	0.10	<0.10	0.10	<0.10	0.10	7760011
Dissolved Potassium (K)	mg/L	2.9	0.30	12	0.30	4.5	0.30	7760011
Dissolved Selenium (Se)	mg/L	0.00042	0.00020	0.019 (2)	0.00020	0.00068	0.00020	7759178
Dissolved Silicon (Si)	mg/L	5.2	0.10	4.3	0.10	4.9	0.10	7760011
Dissolved Silver (Ag)	mg/L	<0.00010	0.00010	<0.00010	0.00010	<0.00010	0.00010	7759178
Dissolved Sodium (Na)	mg/L	140 (2)	0.50	850 (1)	5.0	180	0.50	7760011
Dissolved Strontium (Sr)	mg/L	1.8	0.020	9.1 (1)	0.20	2.0	0.020	7760011
Dissolved Sulphur (S)	mg/L	300 (2)	0.20	2400 (3)	2.0	210	0.20	7760011
Dissolved Thallium (Tl)	mg/L	<0.00020	0.00020	<0.00020	0.00020	<0.00020	0.00020	7759178
Dissolved Tin (Sn)	mg/L	<0.0010	0.0010	<0.0010	0.0010	<0.0010	0.0010	7759178
Dissolved Titanium (Ti)	mg/L	<0.0010	0.0010	<0.0010	0.0010	<0.0010	0.0010	7759178
Dissolved Uranium (U)	mg/L	0.019	0.00010	0.10 (2)	0.00010	0.029	0.00010	7759178
Dissolved Vanadium (V)	mg/L	0.0023	0.0010	<0.0010	0.0010	<0.0010	0.0010	7759178
Dissolved Zinc (Zn)	mg/L	0.18	0.0030	<0.0030	0.0030	<0.0030	0.0030	7759178

RDL = Reportable Detection Limit

- (1) Detection limits raised due to dilution to bring analyte within the calibrated range.
(2) Dissolved greater than total. Results within acceptable limits of precision.
(3) Detection limits raised due to dilution to bring analyte within the calibrated range.
Dissolved greater than total. Results within acceptable limits of precision.

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

ROUTINE WATER & DISS. REGULATED METALS (WATER)

Maxxam ID		LJ9568		
Sampling Date		2014/12/16 12:00		
COC Number		A096867		
	Units	DUP A	RDL	QC Batch
Calculated Parameters				
Anion Sum	meq/L	65	N/A	7758415
Cation Sum	meq/L	59	N/A	7758415
Hardness (CaCO ₃)	mg/L	2100	0.50	7758413
Ion Balance	N/A	0.90	0.010	7758414
Dissolved Nitrate (NO ₃)	mg/L	<0.044	0.044	7758416
Nitrate plus Nitrite (N)	mg/L	<0.010	0.010	7758417
Dissolved Nitrite (NO ₂)	mg/L	<0.033	0.033	7758416
Total Dissolved Solids	mg/L	4000	10	7758418
Misc. Inorganics				
Conductivity	uS/cm	4700	1.0	7760273
pH	pH	7.56	N/A	7760274
Low Level Elements				
Dissolved Cadmium (Cd)	mg/L	<0.000020	0.000020	7758540
Anions				
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	0.50	7760272
Alkalinity (Total as CaCO ₃)	mg/L	500	0.50	7760272
Bicarbonate (HCO ₃)	mg/L	610	0.50	7760272
Carbonate (CO ₃)	mg/L	<0.50	0.50	7760272
Hydroxide (OH)	mg/L	<0.50	0.50	7760272
Dissolved Sulphate (SO ₄)	mg/L	2600 (1)	20	7765821
Dissolved Chloride (Cl)	mg/L	13	1.0	7765819
Nutrients				
Dissolved Nitrite (N)	mg/L	<0.010	0.010	7760867
Dissolved Nitrate (N)	mg/L	<0.010	0.010	7760867
Elements				
Dissolved Aluminum (Al)	mg/L	0.0064	0.0030	7759178
Dissolved Antimony (Sb)	mg/L	<0.00060	0.00060	7759178
Dissolved Arsenic (As)	mg/L	0.00067	0.00020	7759178
Dissolved Barium (Ba)	mg/L	0.029	0.010	7760011
Dissolved Beryllium (Be)	mg/L	<0.0010	0.0010	7759178
Dissolved Boron (B)	mg/L	0.097	0.020	7760011
Dissolved Calcium (Ca)	mg/L	360	0.30	7760011
RDL = Reportable Detection Limit N/A = Not Applicable (1) Detection limits raised due to dilution to bring analyte within the calibrated range.				

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

ROUTINE WATER & DISS. REGULATED METALS (WATER)

Maxxam ID		LJ9568		
Sampling Date		2014/12/16 12:00		
COC Number		A096867		
	Units	DUP A	RDL	QC Batch
Dissolved Chromium (Cr)	mg/L	<0.0010	0.0010	7759178
Dissolved Cobalt (Co)	mg/L	0.0029	0.00030	7759178
Dissolved Copper (Cu)	mg/L	0.00038	0.00020	7759178
Dissolved Iron (Fe)	mg/L	0.22	0.060	7760011
Dissolved Lead (Pb)	mg/L	<0.00020	0.00020	7759178
Dissolved Lithium (Li)	mg/L	0.072 (1)	0.020	7760011
Dissolved Magnesium (Mg)	mg/L	280	0.20	7760011
Dissolved Manganese (Mn)	mg/L	1.9	0.0040	7760011
Dissolved Molybdenum (Mo)	mg/L	0.0012	0.00020	7759178
Dissolved Nickel (Ni)	mg/L	0.011	0.00050	7759178
Dissolved Phosphorus (P)	mg/L	<0.10	0.10	7760011
Dissolved Potassium (K)	mg/L	9.9 (2)	0.30	7760011
Dissolved Selenium (Se)	mg/L	0.0056 (3)	0.00020	7759178
Dissolved Silicon (Si)	mg/L	5.2	0.10	7760011
Dissolved Silver (Ag)	mg/L	<0.00010	0.00010	7759178
Dissolved Sodium (Na)	mg/L	390	0.50	7760011
Dissolved Strontium (Sr)	mg/L	4.8	0.020	7760011
Dissolved Sulphur (S)	mg/L	800 (4)	1.0	7760011
Dissolved Thallium (Tl)	mg/L	<0.00020	0.00020	7759178
Dissolved Tin (Sn)	mg/L	<0.0010	0.0010	7759178
Dissolved Titanium (Ti)	mg/L	<0.0010	0.0010	7759178
Dissolved Uranium (U)	mg/L	0.020 (2)	0.00010	7759178
Dissolved Vanadium (V)	mg/L	<0.0010	0.0010	7759178
Dissolved Zinc (Zn)	mg/L	<0.0030	0.0030	7759178
RDL = Reportable Detection Limit				
(1) Dissolved greater than total. Results are within limits of uncertainty(MU).				
(2) Dissolved greater than total. Results within acceptable limits of precision.				
(3) Dissolved greater than total. Reanalysis yields similar results.				
(4) Detection limits raised due to dilution to bring analyte within the calibrated range.				

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

REGULATED METALS (CCME/AT1) - TOTAL

Maxxam ID		LJ9563		LJ9564		LJ9565		LJ9566		
Sampling Date		2014/12/16 12:00		2014/12/16 11:30		2014/12/16 11:00		2014/12/16 13:15		
COC Number		A096867		A096867		A096867		A096867		
	Units	MW1	RDL	MW8	RDL	MW9	RDL	MW7	RDL	QC Batch

Low Level Elements										
Total Cadmium (Cd)	mg/L	0.00028	0.000020	0.0045	0.000020	0.0080	0.000020	0.0013	0.000020	7758410
Elements										
Total Aluminum (Al)	mg/L	0.53	0.0030	15	0.0030	42	0.0030	13	0.0030	7758992
Total Antimony (Sb)	mg/L	<0.00060	0.00060	0.00093	0.00060	0.0013	0.00060	0.0013	0.00060	7758992
Total Arsenic (As)	mg/L	0.0014	0.00020	0.019	0.00020	0.036	0.00020	0.032	0.00020	7758992
Total Barium (Ba)	mg/L	0.073	0.010	1.4	0.010	2.1	0.010	1.9	0.010	7758994
Total Beryllium (Be)	mg/L	<0.0010	0.0010	0.0026	0.0010	0.0059	0.0010	0.0016	0.0010	7758992
Total Boron (B)	mg/L	0.11	0.020	0.061	0.020	0.15	0.020	0.076	0.020	7758994
Total Calcium (Ca)	mg/L	440	0.30	340	0.30	350	0.30	620 (1)	3.0	7758994
Total Chromium (Cr)	mg/L	0.0012	0.0010	0.018	0.0010	0.082	0.0010	0.036	0.0010	7758992
Total Cobalt (Co)	mg/L	0.0044	0.00030	0.017	0.00030	0.063	0.00030	0.049	0.00030	7758992
Total Copper (Cu)	mg/L	0.0051	0.00020	0.11	0.00020	0.17	0.00020	0.048	0.00020	7758992
Total Iron (Fe)	mg/L	1.5	0.060	33	0.060	100	0.060	62	0.060	7758994
Total Lead (Pb)	mg/L	0.0010	0.00020	0.055	0.00020	0.13	0.00020	0.027	0.00020	7758992
Total Lithium (Li)	mg/L	0.071	0.020	0.081	0.020	0.11	0.020	0.15	0.020	7758994
Total Magnesium (Mg)	mg/L	290	0.20	1300 (1)	2.0	320	0.20	1300 (1)	2.0	7758994
Total Manganese (Mn)	mg/L	2.5	0.0040	3.1	0.0040	4.5	0.0040	2.9	0.0040	7758994
Total Molybdenum (Mo)	mg/L	0.0013	0.00020	0.0045	0.00020	0.0062	0.00020	0.0053	0.00020	7758992
Total Nickel (Ni)	mg/L	0.014	0.00050	0.067	0.00050	0.18	0.00050	0.081	0.00050	7758992
Total Phosphorus (P)	mg/L	<0.10	0.10	1.3	0.10	4.3	0.10	2.2	0.10	7758994
Total Potassium (K)	mg/L	8.5	0.30	11	0.30	11	0.30	14	0.30	7758994
Total Selenium (Se)	mg/L	0.00034	0.00020	0.0089	0.00020	0.0064	0.00020	0.018	0.00020	7758992
Total Silicon (Si)	mg/L	5.7	0.10	33	0.10	90	0.10	30	0.10	7758994
Total Silver (Ag)	mg/L	<0.00010	0.00010	0.00040	0.00010	0.00092	0.00010	0.00023	0.00010	7758992
Total Sodium (Na)	mg/L	390	0.50	880 (1)	5.0	130	0.50	850 (1)	5.0	7758994
Total Strontium (Sr)	mg/L	6.1 (1)	0.10	6.3 (1)	0.20	2.3	0.020	9.5 (1)	0.20	7758994
Total Sulphur (S)	mg/L	960 (1)	1.0	2400 (1)	2.0	290	0.20	2300 (1)	2.0	7758994
Total Thallium (Tl)	mg/L	<0.00020	0.00020	0.00087	0.00020	0.0021	0.00020	0.00093	0.00020	7758992
Total Tin (Sn)	mg/L	<0.0010	0.0010	0.0026	0.0010	0.0057	0.0010	0.0024	0.0010	7758992
Total Titanium (Ti)	mg/L	0.032	0.0010	0.24	0.0010	0.44	0.0010	0.71	0.0010	7758992
Total Uranium (U)	mg/L	0.018	0.00010	0.047	0.00010	0.020	0.00010	0.087	0.00010	7758992
Total Vanadium (V)	mg/L	0.0024	0.0010	0.038	0.0010	0.15	0.0010	0.065	0.0010	7758992
Total Zinc (Zn)	mg/L	0.026	0.0030	0.32	0.0030	9.2 (1)	0.030	0.14	0.0030	7758992

RDL = Reportable Detection Limit

(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

REGULATED METALS (CCME/AT1) - TOTAL

Maxxam ID		LJ9567		LJ9568		
Sampling Date		2014/12/16 14:50		2014/12/16 12:00		
COC Number		A096867		A096867		
	Units	MW2	RDL	DUP A	RDL	QC Batch
Low Level Elements						
Total Cadmium (Cd)	mg/L	0.0083	0.000020	0.00028	0.000020	7758410
Elements						
Total Aluminum (Al)	mg/L	84	0.0030	0.50	0.0030	7758992
Total Antimony (Sb)	mg/L	<0.00060	0.00060	<0.00060	0.00060	7758992
Total Arsenic (As)	mg/L	0.12	0.00020	0.0013	0.00020	7758992
Total Barium (Ba)	mg/L	0.68	0.10	0.073	0.010	7758994
Total Beryllium (Be)	mg/L	0.027	0.0010	<0.0010	0.0010	7758992
Total Boron (B)	mg/L	<0.20	0.20	0.10	0.020	7758994
Total Calcium (Ca)	mg/L	110	3.0	430	0.30	7758994
Total Chromium (Cr)	mg/L	0.14	0.0010	0.0013	0.0010	7758992
Total Cobalt (Co)	mg/L	0.11	0.00030	0.0045	0.00030	7758992
Total Copper (Cu)	mg/L	0.19	0.00020	0.0048	0.00020	7758992
Total Iron (Fe)	mg/L	37	0.60	1.5	0.060	7758994
Total Lead (Pb)	mg/L	0.25	0.00020	0.00099	0.00020	7758992
Total Lithium (Li)	mg/L	<0.20	0.20	0.071	0.020	7758994
Total Magnesium (Mg)	mg/L	39	2.0	290	0.20	7758994
Total Manganese (Mn)	mg/L	1.1	0.040	2.4	0.0040	7758994
Total Molybdenum (Mo)	mg/L	0.0060	0.00020	0.0013	0.00020	7758992
Total Nickel (Ni)	mg/L	0.26	0.00050	0.014	0.00050	7758992
Total Phosphorus (P)	mg/L	1.3	1.0	0.14	0.10	7758994
Total Potassium (K)	mg/L	<3.0	3.0	8.6	0.30	7758994
Total Selenium (Se)	mg/L	0.014	0.00020	0.00031	0.00020	7758992
Total Silicon (Si)	mg/L	18	1.0	6.4	0.10	7758994
Total Silver (Ag)	mg/L	0.0016	0.00010	<0.00010	0.00010	7758992
Total Sodium (Na)	mg/L	21	5.0	400	0.50	7758994
Total Strontium (Sr)	mg/L	0.51	0.20	6.0 (1)	0.10	7758994
Total Sulphur (S)	mg/L	25	2.0	930 (1)	1.0	7758994
Total Thallium (Tl)	mg/L	0.0029	0.00020	<0.00020	0.00020	7758992
Total Tin (Sn)	mg/L	0.0056	0.0010	<0.0010	0.0010	7758992
Total Titanium (Ti)	mg/L	0.38	0.0010	0.029	0.0010	7758992
Total Uranium (U)	mg/L	0.087	0.00010	0.018	0.00010	7758992
Total Vanadium (V)	mg/L	0.25	0.0010	0.0017	0.0010	7758992
Total Zinc (Zn)	mg/L	1.0	0.0030	0.026	0.0030	7758992
RDL = Reportable Detection Limit						
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.						

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

SEMIVOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		LJ9563	LJ9564	LJ9565	LJ9565	LJ9566		
Sampling Date		2014/12/16 12:00	2014/12/16 11:30	2014/12/16 11:00	2014/12/16 11:00	2014/12/16 13:15		
COC Number		A096867	A096867	A096867	A096867	A096867		
	Units	MW1	MW8	MW9	MW9 Lab-Dup	MW7	RDL	QC Batch

Polycyclic Aromatics								
Benzo[a]pyrene equivalency	ug/L	<0.010	<0.010	<0.010	N/A	<0.010	0.010	7758609
Acenaphthene	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	7761697
Acenaphthylene	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	7761697
Acridine	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00020	7761697
Anthracene	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000010	7761697
Benzo(a)anthracene	mg/L	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	0.0000085	7761697
Benzo(b&j)fluoranthene	mg/L	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	0.0000085	7761697
Benzo(k)fluoranthene	mg/L	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	0.0000085	7761697
Benzo(g,h,i)perylene	mg/L	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	0.0000085	7761697
Benzo(c)phenanthrene	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000050	7761697
Benzo(a)pyrene	mg/L	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	0.0000075	7761697
Benzo[e]pyrene	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000050	7761697
Chrysene	mg/L	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	0.0000085	7761697
Dibenz(a,h)anthracene	mg/L	<0.0000075	<0.0000075	<0.0000075	<0.0000075	<0.0000075	0.0000075	7761697
Fluoranthene	mg/L	<0.000010	0.000021	<0.000010	0.000014	<0.000010	0.000010	7761697
Fluorene	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000050	7761697
Indeno(1,2,3-cd)pyrene	mg/L	<0.0000085	<0.0000085	<0.0000085	<0.0000085	<0.0000085	0.0000085	7761697
2-Methylnaphthalene	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	7761697
Naphthalene	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	7761697
Phenanthrene	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000050	7761697
Perylene	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000050	7761697
Pyrene	mg/L	<0.000020	0.000041	0.000032	0.000026	<0.000020	0.000020	7761697
Quinoline	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00020	7761697

Surrogate Recovery (%)								
D10-ANTHRACENE (sur.)	%	93	91	73	77	102	N/A	7761697
D12-BENZO(A)PYRENE (sur.)	%	54	59	34 (1)	41 (1)	50	N/A	7761697
D8-ACENAPHTHYLENE (sur.)	%	75	73	85	70	83	N/A	7761697
TERPHENYL-D14 (sur.)	%	69	69	38 (1)	46 (1)	68	N/A	7761697

RDL = Reportable Detection Limit

Lab-Dup = Laboratory Initiated Duplicate

N/A = Not Applicable

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

SEMIVOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		LJ9567		LJ9568		
Sampling Date		2014/12/16 14:50		2014/12/16 12:00		
COC Number		A096867		A096867		
	Units	MW2	RDL	DUP A	RDL	QC Batch
Polycyclic Aromatics						
Benzo[a]pyrene equivalency	ug/L	0.023	0.010	<0.010	0.010	7758609
Acenaphthene	mg/L	<0.00025	0.00025	<0.00010	0.00010	7761697
Acenaphthylene	mg/L	<0.00025	0.00025	<0.00010	0.00010	7761697
Acridine	mg/L	<0.00050	0.00050	<0.00020	0.00020	7761697
Anthracene	mg/L	<0.000025	0.000025	<0.000010	0.000010	7761697
Benzo(a)anthracene	mg/L	<0.000021	0.000021	<0.0000085	0.0000085	7761697
Benzo(b&j)fluoranthene	mg/L	<0.000021	0.000021	<0.0000085	0.0000085	7761697
Benzo(k)fluoranthene	mg/L	<0.000021	0.000021	<0.0000085	0.0000085	7761697
Benzo(g,h,i)perylene	mg/L	<0.000021	0.000021	<0.0000085	0.0000085	7761697
Benzo(c)phenanthrene	mg/L	<0.00013	0.00013	<0.000050	0.000050	7761697
Benzo(a)pyrene	mg/L	<0.000019	0.000019	<0.0000075	0.0000075	7761697
Benzo[e]pyrene	mg/L	<0.00013	0.00013	<0.000050	0.000050	7761697
Chrysene	mg/L	<0.000021	0.000021	<0.0000085	0.0000085	7761697
Dibenz(a,h)anthracene	mg/L	<0.000019	0.000019	<0.0000075	0.0000075	7761697
Fluoranthene	mg/L	0.000037	0.000025	<0.000010	0.000010	7761697
Fluorene	mg/L	<0.00013	0.00013	<0.000050	0.000050	7761697
Indeno(1,2,3-cd)pyrene	mg/L	<0.000021	0.000021	<0.0000085	0.0000085	7761697
2-Methylnaphthalene	mg/L	<0.00025	0.00025	<0.00010	0.00010	7761697
Naphthalene	mg/L	<0.00025	0.00025	<0.00010	0.00010	7761697
Phenanthrene	mg/L	<0.00013	0.00013	<0.000050	0.000050	7761697
Perylene	mg/L	<0.00013	0.00013	<0.000050	0.000050	7761697
Pyrene	mg/L	0.000054	0.000050	<0.000020	0.000020	7761697
Quinoline	mg/L	<0.00050	0.00050	<0.00020	0.00020	7761697
Surrogate Recovery (%)						
D10-ANTHRACENE (sur.)	%	108	N/A	105	N/A	7761697
D12-BENZO(A)PYRENE (sur.)	%	53	N/A	59	N/A	7761697
D8-ACENAPHTHYLENE (sur.)	%	90	N/A	81	N/A	7761697
TERPHENYL-D14 (sur.)	%	55	N/A	74	N/A	7761697
RDL = Reportable Detection Limit N/A = Not Applicable						

Maxxam Job #: B4B4360
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GOLDER ASSOCIATES LTD.
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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	1.0°C
Package 2	0.0°C

OC Pesticides results are attached to this report. The reference number for these results from Maxxam Campobello is B4O0942.

Sample LJ9563-01 : Cation - Anion balance exceeds normal acceptance limits, major ions reanalyzed, possible matrix interference.

REGULATED METALS (CCME/AT1) - TOTAL Comments

Sample LJ9567-03 Elements by ICP - Total: Due to the sample matrix, sample required dilution. Detection limit was adjusted accordingly

SEMIVOLATILE ORGANICS BY GC-MS (WATER) Comments

Sample LJ9567-05 PAH in Water by GC/MS: Detection limits raised due to matrix interference.

Sample LJ9563, Elements by ICP - Dissolved: Test repeated.

Results relate only to the items tested.

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QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7758992	HC7	Matrix Spike	Total Aluminum (Al)	2014/12/19		89	%	80 - 120
			Total Antimony (Sb)	2014/12/19		105	%	80 - 120
			Total Arsenic (As)	2014/12/19		104	%	80 - 120
			Total Beryllium (Be)	2014/12/19		103	%	80 - 120
			Total Chromium (Cr)	2014/12/19		103	%	80 - 120
			Total Cobalt (Co)	2014/12/19		103	%	80 - 120
			Total Copper (Cu)	2014/12/19		99	%	80 - 120
			Total Lead (Pb)	2014/12/19		106	%	80 - 120
			Total Molybdenum (Mo)	2014/12/19		111	%	80 - 120
			Total Nickel (Ni)	2014/12/19		99	%	80 - 120
			Total Selenium (Se)	2014/12/19		102	%	80 - 120
			Total Silver (Ag)	2014/12/19		106	%	80 - 120
			Total Thallium (Tl)	2014/12/19		103	%	80 - 120
			Total Tin (Sn)	2014/12/19		111	%	80 - 120
			Total Titanium (Ti)	2014/12/19		104	%	80 - 120
			Total Uranium (U)	2014/12/19		103	%	80 - 120
			Total Vanadium (V)	2014/12/19		106	%	80 - 120
			Total Zinc (Zn)	2014/12/19		94	%	80 - 120
7758992	HC7	Spiked Blank	Total Aluminum (Al)	2014/12/19		108	%	80 - 120
			Total Antimony (Sb)	2014/12/19		116	%	80 - 120
			Total Arsenic (As)	2014/12/19		105	%	80 - 120
			Total Beryllium (Be)	2014/12/19		103	%	80 - 120
			Total Chromium (Cr)	2014/12/19		105	%	80 - 120
			Total Cobalt (Co)	2014/12/19		104	%	80 - 120
			Total Copper (Cu)	2014/12/19		102	%	80 - 120
			Total Lead (Pb)	2014/12/19		109	%	80 - 120
			Total Molybdenum (Mo)	2014/12/19		107	%	80 - 120
			Total Nickel (Ni)	2014/12/19		101	%	80 - 120
			Total Selenium (Se)	2014/12/19		103	%	80 - 120
			Total Silver (Ag)	2014/12/19		108	%	80 - 120
			Total Thallium (Tl)	2014/12/19		105	%	80 - 120
			Total Tin (Sn)	2014/12/19		113	%	80 - 120
			Total Titanium (Ti)	2014/12/19		104	%	80 - 120
			Total Uranium (U)	2014/12/19		108	%	80 - 120
			Total Vanadium (V)	2014/12/19		109	%	80 - 120
			Total Zinc (Zn)	2014/12/19		107	%	80 - 120
7758992	HC7	Method Blank	Total Aluminum (Al)	2014/12/19	0.0051, RDL=0.0030		mg/L	
			Total Antimony (Sb)	2014/12/19	<0.00060		mg/L	
			Total Arsenic (As)	2014/12/19	<0.00020		mg/L	
			Total Beryllium (Be)	2014/12/19	<0.0010		mg/L	
			Total Chromium (Cr)	2014/12/19	<0.0010		mg/L	
			Total Cobalt (Co)	2014/12/19	<0.00030		mg/L	
			Total Copper (Cu)	2014/12/19	0.00035, RDL=0.00020		mg/L	
			Total Lead (Pb)	2014/12/19	<0.00020		mg/L	
			Total Molybdenum (Mo)	2014/12/19	<0.00020		mg/L	
			Total Nickel (Ni)	2014/12/19	<0.00050		mg/L	
			Total Selenium (Se)	2014/12/19	<0.00020		mg/L	
			Total Silver (Ag)	2014/12/19	<0.00010		mg/L	
			Total Thallium (Tl)	2014/12/19	<0.00020		mg/L	
			Total Tin (Sn)	2014/12/19	<0.0010		mg/L	

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GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
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Sampler Initials: AMV

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7758992	HC7	RPD	Total Titanium (Ti)	2014/12/19	<0.0010		mg/L	
			Total Uranium (U)	2014/12/19	<0.00010		mg/L	
			Total Vanadium (V)	2014/12/19	<0.0010		mg/L	
			Total Zinc (Zn)	2014/12/19	<0.0030		mg/L	
			Total Aluminum (Al)	2014/12/19	NC		%	20
			Total Antimony (Sb)	2014/12/19	NC		%	20
			Total Arsenic (As)	2014/12/19	NC		%	20
			Total Beryllium (Be)	2014/12/19	NC		%	20
			Total Chromium (Cr)	2014/12/19	NC		%	20
			Total Cobalt (Co)	2014/12/19	NC		%	20
			Total Copper (Cu)	2014/12/19	5.7		%	20
			Total Lead (Pb)	2014/12/19	7.1		%	20
			Total Molybdenum (Mo)	2014/12/19	NC		%	20
			Total Nickel (Ni)	2014/12/19	NC		%	20
			Total Selenium (Se)	2014/12/19	NC		%	20
			Total Silver (Ag)	2014/12/19	NC		%	20
			Total Thallium (Tl)	2014/12/19	NC		%	20
			Total Tin (Sn)	2014/12/19	NC		%	20
			Total Titanium (Ti)	2014/12/19	NC		%	20
			Total Uranium (U)	2014/12/19	2.5		%	20
			Total Vanadium (V)	2014/12/19	NC		%	20
			Total Zinc (Zn)	2014/12/19	NC		%	20
7758994	SRT	Matrix Spike	Total Barium (Ba)	2014/12/19		90	%	80 - 120
			Total Boron (B)	2014/12/19		94	%	80 - 120
			Total Calcium (Ca)	2014/12/19		NC	%	80 - 120
			Total Iron (Fe)	2014/12/19		NC	%	80 - 120
			Total Lithium (Li)	2014/12/19		88	%	80 - 120
			Total Magnesium (Mg)	2014/12/19		NC	%	80 - 120
			Total Manganese (Mn)	2014/12/19		91	%	80 - 120
			Total Phosphorus (P)	2014/12/19		86	%	80 - 120
			Total Potassium (K)	2014/12/19		85	%	80 - 120
			Total Silicon (Si)	2014/12/19		NC	%	80 - 120
			Total Sodium (Na)	2014/12/19		93	%	80 - 120
			Total Strontium (Sr)	2014/12/19		93	%	80 - 120
			Total Barium (Ba)	2014/12/19		92	%	80 - 120
			Total Boron (B)	2014/12/19		97	%	80 - 120
			Total Calcium (Ca)	2014/12/19		92	%	80 - 120
			Total Iron (Fe)	2014/12/19		92	%	80 - 120
7758994	SRT	Spiked Blank	Total Lithium (Li)	2014/12/19		90	%	80 - 120
			Total Magnesium (Mg)	2014/12/19		92	%	80 - 120
			Total Manganese (Mn)	2014/12/19		94	%	80 - 120
			Total Phosphorus (P)	2014/12/19		87	%	80 - 120
			Total Potassium (K)	2014/12/19		86	%	80 - 120
			Total Silicon (Si)	2014/12/19		89	%	80 - 120
			Total Sodium (Na)	2014/12/19		94	%	80 - 120
			Total Strontium (Sr)	2014/12/19		96	%	80 - 120
			Total Barium (Ba)	2014/12/19	<0.010		mg/L	
			Total Boron (B)	2014/12/19	0.027, RDL=0.020		mg/L	
			Total Calcium (Ca)	2014/12/19	<0.30		mg/L	
			Total Iron (Fe)	2014/12/19	<0.060		mg/L	
			Total Lithium (Li)	2014/12/19	<0.020		mg/L	

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GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
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Sampler Initials: AMV

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7758994	SRT	RPD	Total Magnesium (Mg)	2014/12/19	<0.20		mg/L	
			Total Manganese (Mn)	2014/12/19	<0.0040		mg/L	
			Total Phosphorus (P)	2014/12/19	<0.10		mg/L	
			Total Potassium (K)	2014/12/19	<0.30		mg/L	
			Total Silicon (Si)	2014/12/19	<0.10		mg/L	
			Total Sodium (Na)	2014/12/19	<0.50		mg/L	
			Total Strontium (Sr)	2014/12/19	<0.020		mg/L	
			Total Sulphur (S)	2014/12/19	<0.20		mg/L	
			Total Barium (Ba)	2014/12/19	0.88		%	20
			Total Boron (B)	2014/12/19	NC		%	20
			Total Calcium (Ca)	2014/12/19	1.2		%	20
			Total Iron (Fe)	2014/12/19	1.5		%	20
			Total Lithium (Li)	2014/12/19	NC		%	20
			Total Magnesium (Mg)	2014/12/19	0.82		%	20
			Total Manganese (Mn)	2014/12/19	2.7		%	20
			Total Phosphorus (P)	2014/12/19	NC		%	20
			Total Potassium (K)	2014/12/19	NC		%	20
			Total Silicon (Si)	2014/12/19	0.92		%	20
			Total Sodium (Na)	2014/12/19	0.96		%	20
			Total Strontium (Sr)	2014/12/19	NC		%	20
			Total Sulphur (S)	2014/12/19	0.97		%	20
7759178	HC7	Matrix Spike	Dissolved Aluminum (Al)	2014/12/20		111	%	80 - 120
			Dissolved Antimony (Sb)	2014/12/20		97	%	80 - 120
			Dissolved Arsenic (As)	2014/12/20		97	%	80 - 120
			Dissolved Beryllium (Be)	2014/12/20		107	%	80 - 120
			Dissolved Chromium (Cr)	2014/12/20		94	%	80 - 120
			Dissolved Cobalt (Co)	2014/12/20		92	%	80 - 120
			Dissolved Copper (Cu)	2014/12/20		93	%	80 - 120
			Dissolved Lead (Pb)	2014/12/20		95	%	80 - 120
			Dissolved Molybdenum (Mo)	2014/12/20		102	%	80 - 120
			Dissolved Nickel (Ni)	2014/12/20		92	%	80 - 120
			Dissolved Selenium (Se)	2014/12/20		97	%	80 - 120
			Dissolved Silver (Ag)	2014/12/20		83	%	80 - 120
			Dissolved Thallium (Tl)	2014/12/20		97	%	80 - 120
			Dissolved Tin (Sn)	2014/12/20		97	%	80 - 120
			Dissolved Titanium (Ti)	2014/12/20		93	%	80 - 120
			Dissolved Uranium (U)	2014/12/20		101	%	80 - 120
			Dissolved Vanadium (V)	2014/12/20		98	%	80 - 120
			Dissolved Zinc (Zn)	2014/12/20		99	%	80 - 120
			Dissolved Aluminum (Al)	2014/12/19		107	%	80 - 120
			Dissolved Antimony (Sb)	2014/12/19		105	%	80 - 120
7759178	HC7	Spiked Blank	Dissolved Arsenic (As)	2014/12/19		102	%	80 - 120
			Dissolved Beryllium (Be)	2014/12/19		100	%	80 - 120
			Dissolved Chromium (Cr)	2014/12/19		98	%	80 - 120
			Dissolved Cobalt (Co)	2014/12/19		101	%	80 - 120
			Dissolved Copper (Cu)	2014/12/19		100	%	80 - 120
			Dissolved Lead (Pb)	2014/12/19		103	%	80 - 120
			Dissolved Molybdenum (Mo)	2014/12/19		99	%	80 - 120
			Dissolved Nickel (Ni)	2014/12/19		101	%	80 - 120
			Dissolved Selenium (Se)	2014/12/19		104	%	80 - 120
			Dissolved Silver (Ag)	2014/12/19		101	%	80 - 120
			Dissolved Thallium (Tl)	2014/12/19		106	%	80 - 120

Maxxam Job #: B4B4360
Report Date: 2015/01/02

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
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Sampler Initials: AMV

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC	Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7759178	HC7	Method Blank		Dissolved Tin (Sn)	2014/12/19		99	%	80 - 120
				Dissolved Titanium (Ti)	2014/12/19		103	%	80 - 120
				Dissolved Uranium (U)	2014/12/19		101	%	80 - 120
				Dissolved Vanadium (V)	2014/12/19		102	%	80 - 120
				Dissolved Zinc (Zn)	2014/12/19		99	%	80 - 120
				Dissolved Aluminum (Al)	2014/12/19	<0.0030		mg/L	
				Dissolved Antimony (Sb)	2014/12/19	<0.00060		mg/L	
				Dissolved Arsenic (As)	2014/12/19	<0.00020		mg/L	
				Dissolved Beryllium (Be)	2014/12/19	<0.0010		mg/L	
				Dissolved Chromium (Cr)	2014/12/19	<0.0010		mg/L	
				Dissolved Cobalt (Co)	2014/12/19	<0.00030		mg/L	
				Dissolved Copper (Cu)	2014/12/19	<0.00020		mg/L	
				Dissolved Lead (Pb)	2014/12/19	<0.00020		mg/L	
				Dissolved Molybdenum (Mo)	2014/12/19	<0.00020		mg/L	
				Dissolved Nickel (Ni)	2014/12/19	<0.00050		mg/L	
				Dissolved Selenium (Se)	2014/12/19	<0.00020		mg/L	
				Dissolved Silver (Ag)	2014/12/19	<0.00010		mg/L	
				Dissolved Thallium (Tl)	2014/12/19	<0.00020		mg/L	
				Dissolved Tin (Sn)	2014/12/19	<0.0010		mg/L	
				Dissolved Titanium (Ti)	2014/12/19	<0.0010		mg/L	
7759178	HC7	RPD		Dissolved Uranium (U)	2014/12/19	<0.00010		mg/L	
				Dissolved Vanadium (V)	2014/12/19	<0.0010		mg/L	
				Dissolved Zinc (Zn)	2014/12/19	<0.0030		mg/L	
				Dissolved Aluminum (Al)	2014/12/20	NC		%	20
				Dissolved Antimony (Sb)	2014/12/20	NC		%	20
				Dissolved Arsenic (As)	2014/12/20	NC		%	20
				Dissolved Beryllium (Be)	2014/12/20	NC		%	20
				Dissolved Chromium (Cr)	2014/12/20	NC		%	20
				Dissolved Cobalt (Co)	2014/12/20	NC		%	20
				Dissolved Copper (Cu)	2014/12/20	NC		%	20
				Dissolved Lead (Pb)	2014/12/20	NC		%	20
				Dissolved Molybdenum (Mo)	2014/12/20	NC		%	20
				Dissolved Nickel (Ni)	2014/12/20	NC		%	20
				Dissolved Selenium (Se)	2014/12/20	NC		%	20
				Dissolved Silver (Ag)	2014/12/20	NC		%	20
				Dissolved Thallium (Tl)	2014/12/20	NC		%	20
				Dissolved Tin (Sn)	2014/12/20	NC		%	20
				Dissolved Titanium (Ti)	2014/12/20	NC		%	20
				Dissolved Uranium (U)	2014/12/20	3.3		%	20
				Dissolved Vanadium (V)	2014/12/20	NC		%	20
7759807	RSU	Matrix Spike		Dissolved Zinc (Zn)	2014/12/20	NC		%	20
				1,4-Difluorobenzene (sur.)	2014/12/19		107	%	70 - 130
				4-Bromofluorobenzene (sur.)	2014/12/19		112	%	70 - 130
				D4-1,2-Dichloroethane (sur.)	2014/12/19		110	%	70 - 130
				Benzene	2014/12/19		92	%	70 - 130
				Toluene	2014/12/19		85	%	70 - 130
				Ethylbenzene	2014/12/19		90	%	70 - 130
				m & p-Xylene	2014/12/19		90	%	70 - 130
				o-Xylene	2014/12/19		84	%	70 - 130
				(C6-C10)	2014/12/19		74	%	70 - 130
7759807	RSU	Spiked Blank		1,4-Difluorobenzene (sur.)	2014/12/19		108	%	70 - 130
				4-Bromofluorobenzene (sur.)	2014/12/19		118	%	70 - 130

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Sampler Initials: AMV

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7759807	RSU	Method Blank	D4-1,2-Dichloroethane (sur.)	2014/12/19		111	%	70 - 130
			Benzene	2014/12/19		83	%	70 - 130
			Toluene	2014/12/19		77	%	70 - 130
			Ethylbenzene	2014/12/19		82	%	70 - 130
			m & p-Xylene	2014/12/19		82	%	70 - 130
			o-Xylene	2014/12/19		78	%	70 - 130
			(C6-C10)	2014/12/19		92	%	70 - 130
			1,4-Difluorobenzene (sur.)	2014/12/19		108	%	70 - 130
			4-Bromofluorobenzene (sur.)	2014/12/19		113	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2014/12/19		106	%	70 - 130
			Benzene	2014/12/19	<0.00040		mg/L	
			Toluene	2014/12/19	<0.00040		mg/L	
			Ethylbenzene	2014/12/19	<0.00040		mg/L	
			m & p-Xylene	2014/12/19	<0.00080		mg/L	
			o-Xylene	2014/12/19	<0.00040		mg/L	
			Xylenes (Total)	2014/12/19	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2014/12/19	<0.10		mg/L	
			(C6-C10)	2014/12/19	<0.10		mg/L	
7759807	RSU	RPD	Benzene	2014/12/19	NC		%	40
			Toluene	2014/12/19	NC		%	40
			Ethylbenzene	2014/12/19	NC		%	40
			m & p-Xylene	2014/12/19	NC		%	40
			o-Xylene	2014/12/19	NC		%	40
			Xylenes (Total)	2014/12/19	NC		%	40
			F1 (C6-C10) - BTEX	2014/12/19	NC		%	40
			(C6-C10)	2014/12/19	NC		%	40
7760011	SRT	Matrix Spike	Dissolved Barium (Ba)	2014/12/19		94	%	80 - 120
			Dissolved Boron (B)	2014/12/19		96	%	80 - 120
			Dissolved Calcium (Ca)	2014/12/19		NC	%	80 - 120
			Dissolved Iron (Fe)	2014/12/19		88	%	80 - 120
			Dissolved Lithium (Li)	2014/12/19		96	%	80 - 120
			Dissolved Magnesium (Mg)	2014/12/19		89	%	80 - 120
			Dissolved Manganese (Mn)	2014/12/19		93	%	80 - 120
			Dissolved Phosphorus (P)	2014/12/19		95	%	80 - 120
			Dissolved Potassium (K)	2014/12/19		90	%	80 - 120
			Dissolved Silicon (Si)	2014/12/19		NC	%	80 - 120
			Dissolved Sodium (Na)	2014/12/19		96	%	80 - 120
			Dissolved Strontium (Sr)	2014/12/19		96	%	80 - 120
			Dissolved Barium (Ba)	2014/12/19		89	%	80 - 120
			Dissolved Boron (B)	2014/12/19		92	%	80 - 120
			Dissolved Calcium (Ca)	2014/12/19		90	%	80 - 120
			Dissolved Iron (Fe)	2014/12/19		86	%	80 - 120
			Dissolved Lithium (Li)	2014/12/19		91	%	80 - 120
			Dissolved Magnesium (Mg)	2014/12/19		91	%	80 - 120
			Dissolved Manganese (Mn)	2014/12/19		90	%	80 - 120
7760011	SRT	Spiked Blank	Dissolved Phosphorus (P)	2014/12/19		88	%	80 - 120
			Dissolved Potassium (K)	2014/12/19		86	%	80 - 120
			Dissolved Silicon (Si)	2014/12/19		88	%	80 - 120
			Dissolved Sodium (Na)	2014/12/19		91	%	80 - 120
			Dissolved Strontium (Sr)	2014/12/19		91	%	80 - 120
7760011	SRT	Method Blank	Dissolved Barium (Ba)	2014/12/19	<0.010		mg/L	
			Dissolved Boron (B)	2014/12/19	<0.020		mg/L	

Maxxam Job #: B4B4360
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GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7760011	SRT	RPD	Dissolved Calcium (Ca)	2014/12/19	<0.30		mg/L	
			Dissolved Iron (Fe)	2014/12/19	<0.060		mg/L	
			Dissolved Lithium (Li)	2014/12/19	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2014/12/19	<0.20		mg/L	
			Dissolved Manganese (Mn)	2014/12/19	<0.0040		mg/L	
			Dissolved Phosphorus (P)	2014/12/19	<0.10		mg/L	
			Dissolved Potassium (K)	2014/12/19	<0.30		mg/L	
			Dissolved Silicon (Si)	2014/12/19	<0.10		mg/L	
			Dissolved Sodium (Na)	2014/12/19	<0.50		mg/L	
			Dissolved Strontium (Sr)	2014/12/19	<0.020		mg/L	
			Dissolved Sulphur (S)	2014/12/19	<0.20		mg/L	
			Dissolved Barium (Ba)	2014/12/19	0.32		%	20
			Dissolved Boron (B)	2014/12/19	NC		%	20
			Dissolved Calcium (Ca)	2014/12/19	0.079		%	20
			Dissolved Iron (Fe)	2014/12/19	0.29		%	20
			Dissolved Lithium (Li)	2014/12/19	NC		%	20
			Dissolved Magnesium (Mg)	2014/12/19	0.41		%	20
			Dissolved Manganese (Mn)	2014/12/19	0.13		%	20
			Dissolved Phosphorus (P)	2014/12/19	NC		%	20
			Dissolved Potassium (K)	2014/12/19	NC		%	20
			Dissolved Silicon (Si)	2014/12/19	0.20		%	20
			Dissolved Sodium (Na)	2014/12/19	0.27		%	20
			Dissolved Strontium (Sr)	2014/12/19	NC		%	20
			Dissolved Sulphur (S)	2014/12/19	0.26		%	20
7760272	JLD	Spiked Blank	Alkalinity (Total as CaCO ₃)	2014/12/19		93	%	80 - 120
7760272	JLD	Method Blank	Alkalinity (PP as CaCO ₃)	2014/12/19	<0.50		mg/L	
			Alkalinity (Total as CaCO ₃)	2014/12/19	0.53, RDL=0.50		mg/L	
			Bicarbonate (HCO ₃)	2014/12/19	0.64, RDL=0.50		mg/L	
7760272	JLD	RPD	Carbonate (CO ₃)	2014/12/19	<0.50		mg/L	
			Hydroxide (OH)	2014/12/19	<0.50		mg/L	
			Alkalinity (PP as CaCO ₃)	2014/12/19	NC		%	20
			Alkalinity (Total as CaCO ₃)	2014/12/19	5.1		%	20
			Bicarbonate (HCO ₃)	2014/12/19	5.1		%	20
			Carbonate (CO ₃)	2014/12/19	NC		%	20
			Hydroxide (OH)	2014/12/19	NC		%	20
7760273	JLD	Spiked Blank	Conductivity	2014/12/19		100	%	90 - 110
7760273	JLD	Method Blank	Conductivity	2014/12/19	<1.0		uS/cm	
7760273	JLD	RPD	Conductivity	2014/12/19	0.18		%	20
7760274	JLD	Spiked Blank	pH	2014/12/19		100	%	97 - 103
7760274	JLD	RPD	pH	2014/12/19	0.51		%	N/A
7760867	NW4	Matrix Spike	Dissolved Nitrite (N)	2014/12/19		101	%	80 - 120
			Dissolved Nitrate (N)	2014/12/19		101	%	80 - 120
7760867	NW4	Spiked Blank	Dissolved Nitrite (N)	2014/12/19		100	%	80 - 120
			Dissolved Nitrate (N)	2014/12/19		100	%	80 - 120
7760867	NW4	Method Blank	Dissolved Nitrite (N)	2014/12/19	<0.010		mg/L	
			Dissolved Nitrate (N)	2014/12/19	<0.010		mg/L	
7760867	NW4	RPD	Dissolved Nitrite (N)	2014/12/19	NC		%	20
			Dissolved Nitrate (N)	2014/12/19	5.0		%	20
7761697	SJ1	Matrix Spike [LJ9563-05]	D10-ANTHRACENE (sur.)	2014/12/24		104	%	50 - 130
			D12-BENZO(A)PYRENE (sur.)	2014/12/24		41 (1)	%	50 - 130

Maxxam Job #: B4B4360
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GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			D8-ACENAPHTHYLENE (sur.)	2014/12/24		113	%	50 - 130
			TERPHENYL-D14 (sur.)	2014/12/24		51	%	50 - 130
			Acenaphthene	2014/12/24		95	%	50 - 130
			Acenaphthylene	2014/12/24		101	%	50 - 130
			Acridine	2014/12/24		84	%	50 - 130
			Anthracene	2014/12/24		90	%	50 - 130
			Benzo(a)anthracene	2014/12/24		94	%	50 - 130
			Benzo(b&j)fluoranthene	2014/12/24		85	%	50 - 130
			Benzo(k)fluoranthene	2014/12/24		85	%	50 - 130
			Benzo(g,h,i)perylene	2014/12/24		82	%	50 - 130
			Benzo(c)phenanthrene	2014/12/24		90	%	50 - 130
			Benzo(a)pyrene	2014/12/24		90	%	50 - 130
			Benzo[e]pyrene	2014/12/24		87	%	50 - 130
			Chrysene	2014/12/24		86	%	50 - 130
			Dibenz(a,h)anthracene	2014/12/24		86	%	50 - 130
			Fluoranthene	2014/12/24		100	%	50 - 130
			Fluorene	2014/12/24		103	%	50 - 130
			Indeno(1,2,3-cd)pyrene	2014/12/24		99	%	50 - 130
			2-Methylnaphthalene	2014/12/24		95	%	50 - 130
			Naphthalene	2014/12/24		97	%	50 - 130
			Phenanthrene	2014/12/24		95	%	50 - 130
			Perylene	2014/12/24		86	%	50 - 130
			Pyrene	2014/12/24		102	%	50 - 130
			Quinoline	2014/12/24		86	%	50 - 130
7761697	SJ1	Spiked Blank	D10-ANTHRACENE (sur.)	2014/12/23		96	%	50 - 130
			D12-BENZO(A)PYRENE (sur.)	2014/12/23		98	%	50 - 130
			D8-ACENAPHTHYLENE (sur.)	2014/12/23		91	%	50 - 130
			TERPHENYL-D14 (sur.)	2014/12/23		103	%	50 - 130
			Acenaphthene	2014/12/23		82	%	50 - 130
			Acenaphthylene	2014/12/23		87	%	50 - 130
			Acridine	2014/12/23		91	%	50 - 130
			Anthracene	2014/12/23		81	%	50 - 130
			Benzo(a)anthracene	2014/12/23		93	%	50 - 130
			Benzo(b&j)fluoranthene	2014/12/23		87	%	50 - 130
			Benzo(k)fluoranthene	2014/12/23		84	%	50 - 130
			Benzo(g,h,i)perylene	2014/12/23		88	%	50 - 130
			Benzo(c)phenanthrene	2014/12/23		82	%	50 - 130
			Benzo(a)pyrene	2014/12/23		90	%	50 - 130
			Benzo[e]pyrene	2014/12/23		89	%	50 - 130
			Chrysene	2014/12/23		85	%	50 - 130
			Dibenz(a,h)anthracene	2014/12/23		93	%	50 - 130
			Fluoranthene	2014/12/23		93	%	50 - 130
			Fluorene	2014/12/23		90	%	50 - 130
			Indeno(1,2,3-cd)pyrene	2014/12/23		105	%	50 - 130
			2-Methylnaphthalene	2014/12/23		76	%	50 - 130
			Naphthalene	2014/12/23		78	%	50 - 130
			Phenanthrene	2014/12/23		83	%	50 - 130
			Perylene	2014/12/23		87	%	50 - 130
			Pyrene	2014/12/23		96	%	50 - 130
			Quinoline	2014/12/23		90	%	50 - 130
7761697	SJ1	Method Blank	D10-ANTHRACENE (sur.)	2014/12/23		106	%	50 - 130
			D12-BENZO(A)PYRENE (sur.)	2014/12/23		110	%	50 - 130

Maxxam Job #: B4B4360
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GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			D8-ACENAPHTHYLENE (sur.)	2014/12/23		88	%	50 - 130
			TERPHENYL-D14 (sur.)	2014/12/23		114	%	50 - 130
			Acenaphthene	2014/12/23	<0.00010		mg/L	
			Acenaphthylene	2014/12/23	<0.00010		mg/L	
			Acridine	2014/12/23	<0.00020		mg/L	
			Anthracene	2014/12/23	<0.000010		mg/L	
			Benzo(a)anthracene	2014/12/23	<0.0000085		mg/L	
			Benzo(b&j)fluoranthene	2014/12/23	<0.0000085		mg/L	
			Benzo(k)fluoranthene	2014/12/23	<0.0000085		mg/L	
			Benzo(g,h,i)perylene	2014/12/23	<0.0000085		mg/L	
			Benzo(c)phenanthrene	2014/12/23	<0.000050		mg/L	
			Benzo(a)pyrene	2014/12/23	<0.0000075		mg/L	
			Benzo[e]pyrene	2014/12/23	<0.000050		mg/L	
			Chrysene	2014/12/23	<0.0000085		mg/L	
			Dibenz(a,h)anthracene	2014/12/23	<0.0000075		mg/L	
			Fluoranthene	2014/12/23	<0.000010		mg/L	
			Fluorene	2014/12/23	<0.000050		mg/L	
			Indeno(1,2,3-cd)pyrene	2014/12/23	<0.0000085		mg/L	
			2-Methylnaphthalene	2014/12/23	<0.00010		mg/L	
			Naphthalene	2014/12/23	<0.00010		mg/L	
			Phenanthrene	2014/12/23	<0.000050		mg/L	
			Perylene	2014/12/23	<0.000050		mg/L	
			Pyrene	2014/12/23	<0.000020		mg/L	
			Quinoline	2014/12/23	<0.00020		mg/L	
7761697	SJ1	RPD [LJ9565-05]	Acenaphthene	2014/12/23	NC		%	40
			Acenaphthylene	2014/12/23	NC		%	40
			Acridine	2014/12/23	NC		%	40
			Anthracene	2014/12/23	NC		%	40
			Benzo(a)anthracene	2014/12/23	NC		%	40
			Benzo(b&j)fluoranthene	2014/12/23	NC		%	40
			Benzo(k)fluoranthene	2014/12/23	NC		%	40
			Benzo(g,h,i)perylene	2014/12/23	NC		%	40
			Benzo(c)phenanthrene	2014/12/23	NC		%	40
			Benzo(a)pyrene	2014/12/23	NC		%	40
			Benzo[e]pyrene	2014/12/23	NC		%	40
			Chrysene	2014/12/23	NC		%	40
			Dibenz(a,h)anthracene	2014/12/23	NC		%	40
			Fluoranthene	2014/12/23	NC		%	40
			Fluorene	2014/12/23	NC		%	40
			Indeno(1,2,3-cd)pyrene	2014/12/23	NC		%	40
			2-Methylnaphthalene	2014/12/23	NC		%	40
			Naphthalene	2014/12/23	NC		%	40
			Phenanthrene	2014/12/23	NC		%	40
			Perylene	2014/12/23	NC		%	40
			Pyrene	2014/12/23	NC		%	40
			Quinoline	2014/12/23	NC		%	40
7761700	MWB	Matrix Spike [LJ9564-05]	O-TERPHENYL (sur.)	2014/12/22		107	%	50 - 130
			F2 (C10-C16 Hydrocarbons)	2014/12/22		108	%	50 - 130
7761700	MWB	Spiked Blank	O-TERPHENYL (sur.)	2014/12/22		94	%	50 - 130
			F2 (C10-C16 Hydrocarbons)	2014/12/22		94	%	70 - 130
7761700	MWB	Method Blank	O-TERPHENYL (sur.)	2014/12/22		94	%	50 - 130
			F2 (C10-C16 Hydrocarbons)	2014/12/22	<0.10		mg/L	

Maxxam Job #: B4B4360
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GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
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Sampler Initials: AMV

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7761700	MWB	RPD [LJ9565-05]	F2 (C10-C16 Hydrocarbons)	2014/12/22	NC		%	40
7762431	JLD	Matrix Spike	Dissolved Nitrite (N)	2014/12/22		95	%	80 - 120
			Dissolved Nitrate (N)	2014/12/22		106	%	80 - 120
7762431	JLD	Spiked Blank	Dissolved Nitrite (N)	2014/12/22		96	%	80 - 120
			Dissolved Nitrate (N)	2014/12/22		98	%	80 - 120
7762431	JLD	Method Blank	Dissolved Nitrite (N)	2014/12/22	<0.010		mg/L	
			Dissolved Nitrate (N)	2014/12/22	<0.010		mg/L	
7762431	JLD	RPD	Dissolved Nitrite (N)	2014/12/22	NC		%	20
			Dissolved Nitrate (N)	2014/12/22	5.3		%	20
7765819	ZI	Matrix Spike [LJ9563-02]	Dissolved Chloride (Cl)	2014/12/29		NC	%	80 - 120
7765819	ZI	Spiked Blank	Dissolved Chloride (Cl)	2014/12/29		103	%	80 - 120
7765819	ZI	Method Blank	Dissolved Chloride (Cl)	2014/12/29	<1.0		mg/L	
7765819	ZI	RPD [LJ9563-02]	Dissolved Chloride (Cl)	2014/12/29	2.1		%	20
7765821	ZI	Matrix Spike [LJ9563-02]	Dissolved Sulphate (SO4)	2014/12/29		NC	%	80 - 120
7765821	ZI	Spiked Blank	Dissolved Sulphate (SO4)	2014/12/29		102	%	80 - 120
7765821	ZI	Method Blank	Dissolved Sulphate (SO4)	2014/12/29	<1.0		mg/L	
7765821	ZI	RPD [LJ9563-02]	Dissolved Sulphate (SO4)	2014/12/29	3.5		%	20
7766136	MAP	Matrix Spike	Dissolved Calcium (Ca)	2014/12/29		NC	%	80 - 120
			Dissolved Magnesium (Mg)	2014/12/29		97	%	80 - 120
			Dissolved Sodium (Na)	2014/12/29		NC	%	80 - 120
7766136	MAP	Spiked Blank	Dissolved Calcium (Ca)	2014/12/29		103	%	80 - 120
			Dissolved Magnesium (Mg)	2014/12/29		103	%	80 - 120
			Dissolved Sodium (Na)	2014/12/29		95	%	80 - 120
7766136	MAP	Method Blank	Dissolved Calcium (Ca)	2014/12/29	<0.30		mg/L	
			Dissolved Magnesium (Mg)	2014/12/29	<0.20		mg/L	
			Dissolved Sodium (Na)	2014/12/29	<0.50		mg/L	
7766136	MAP	RPD	Dissolved Calcium (Ca)	2014/12/29	0.25		%	20
			Dissolved Magnesium (Mg)	2014/12/29	0.46		%	20
			Dissolved Sodium (Na)	2014/12/29	0.43		%	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

Maxxam Job #: B4B4360
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GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE, AB
Sampler Initials: AMV

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Ghayasuddin Khan, M.Sc., B.Ed., P.Chem, Scientific Specialist



Michael Sheppard, Senior Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

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Chain of Custody

A096867

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Page: 1 of 1

Company:	Invoice To:	Report To:	Same as Invoice
Avellie Bellavance-Golder Associates	Avellie Bellavance	abellavane@golder.com	<input checked="" type="checkbox"/>
Contact:	Address:	abaman@golder.com	
102, 2535 3rd Ave SE, Calgary	PO: Alberta		
Contact #s:	PO: 403-267-3164		
	Cell: 403-816-0245		

PO #:	1418041-1000-2007
Project # / Name:	Bay U Ranch National Historic Site, AB
Site Location:	Quote #:
N/A	Sampled By: Anna-Maria Viad
SERVICE REQUESTED:	<input type="checkbox"/> RUSH (Contact lab to reserve)
<input checked="" type="checkbox"/> REGULAR (5 to 7 Days)	

Sample ID	Depth (unit)	Matrix GW / SW Soil	Date/Time Sampled YYMMDD 24:00	BTEX F1-F4	Sieve (75 micron)	Regulated Metals (CCME / AT1)	Salinity 4	Assessment ICP Metals	Basic Class II Landfill
1	N/A	GW	14/12/16 12:00						
2	N/A	GW	14/12/16 11:30						
3	N/A	GW	14/12/16 11:00						
4	N/A	GW	14/12/16 13:15						
5	N/A	GW	14/12/16 14:50						
6	N/A	GW	14/12/16 12:00						
7	N/A	other	14/12/16 12:15						
8	N/A	other	14/12/16 12:20						
9									
10									
11									
12									

Please indicate Filtered, Preserved or Both (F, P, F/P)

Relinquished By (Signature/Print):	Date (YYMMDD):	Time (24:00):
F. M. P. P. Anna-Maria Viad	14/12/16	14:00
Relinquished By (Signature/Print):	Date (YYMMDD):	Time (24:00):
Special Instructions:	# of Jars Used & Not Submitted	N/A

AB ECD-00331 Rev3 2010/05

Maxxam Analytics International Corporation c/o Maxxam Analytics

Report Distribution (E-Mail):
abellavane@golder.com
abaman@golder.com

REGULATORY GUIDELINES:
<input checked="" type="checkbox"/> AT1
<input type="checkbox"/> CCME
<input type="checkbox"/> Regulated Drinking Water
<input type="checkbox"/> Other:

WATER	SOIL	Other Analysis	# of Containers Submitted
<input checked="" type="checkbox"/> BTEX F1-F4	<input type="checkbox"/> BTEX F1-F4		
<input type="checkbox"/> VOCs			
<input type="checkbox"/> TOC			
<input type="checkbox"/> DOC			
<input type="checkbox"/> Routine Water			
<input type="checkbox"/> Turb			
<input type="checkbox"/> F			
<input type="checkbox"/> Regulated Metals			
<input type="checkbox"/> Total			
<input type="checkbox"/> Dissolved			
<input type="checkbox"/> CCME / AT1			
<input type="checkbox"/> Mercury			
<input type="checkbox"/> Total			
<input type="checkbox"/> Dissolved			
<input type="checkbox"/> CCME / AT1			
<input type="checkbox"/> PAH			
<input type="checkbox"/> Organochlorine Pesticides (CCME)			

17-Dec-14 15:07

Wendy Sears

B4B4360

NC

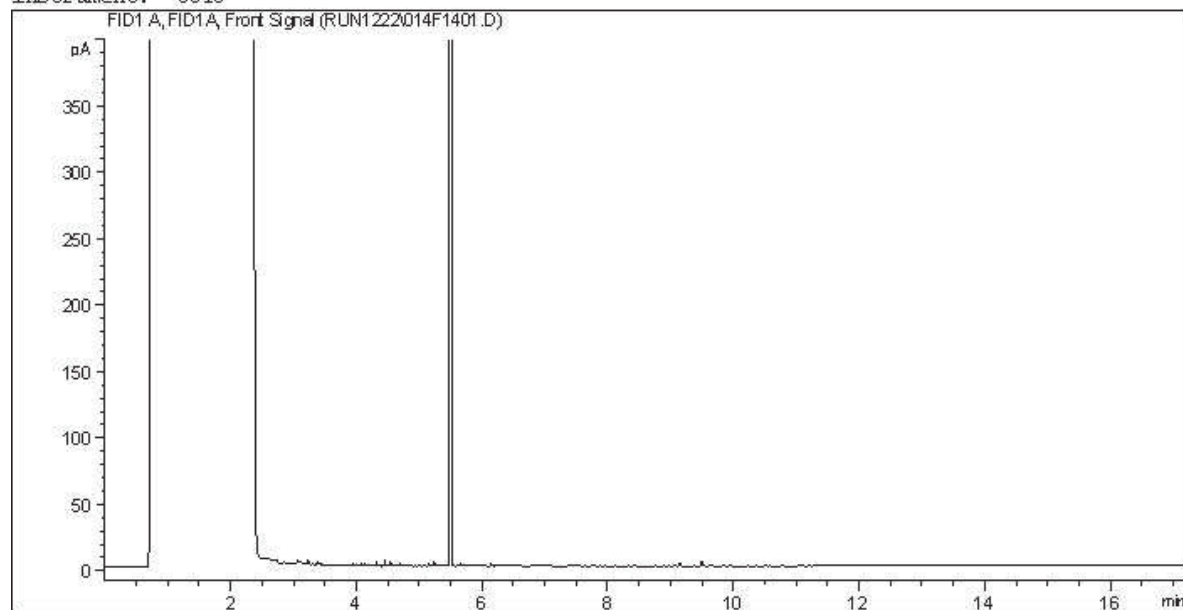
BRU INS-0038

Relinquished By (Signature/Print):	Date (YYMMDD):	Time (24:00):
Jesse Luong	14/12/17	15:07
Relinquished By (Signature/Print):	Date (YYMMDD):	Time (24:00):
Special Instructions:	# of Jars Used & Not Submitted	N/A

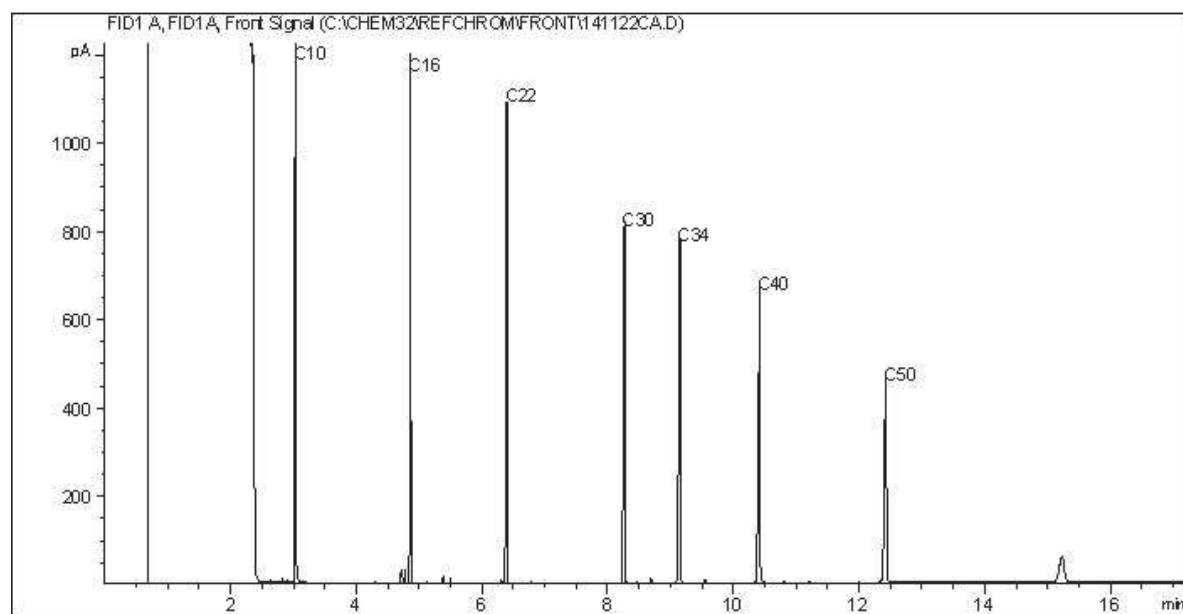
0, 0, 0

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

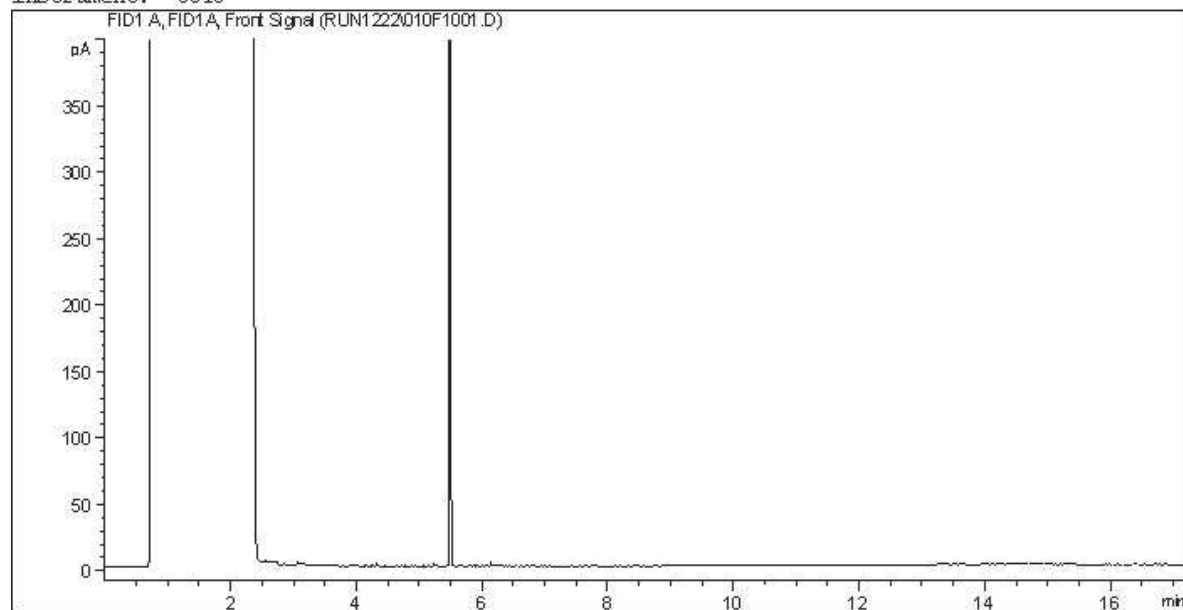
Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

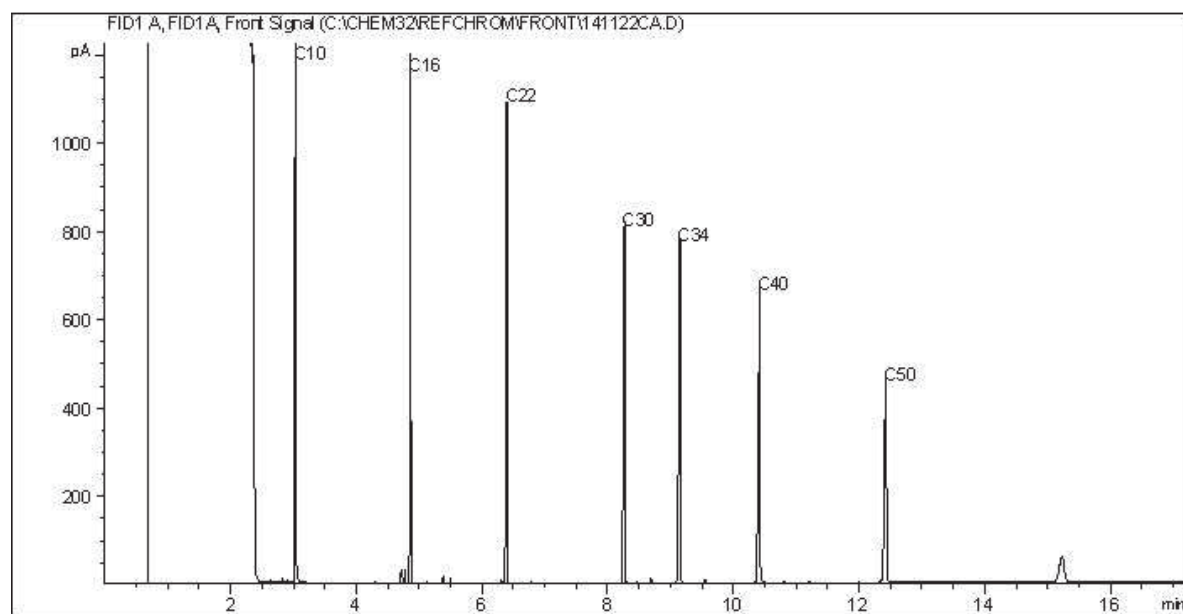
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

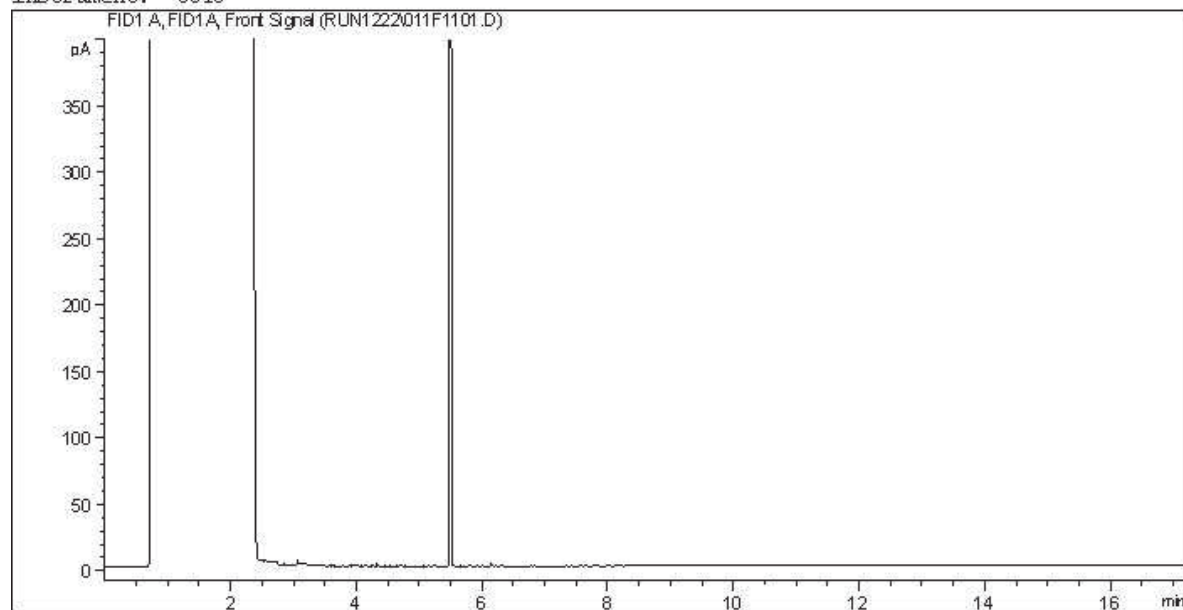
Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

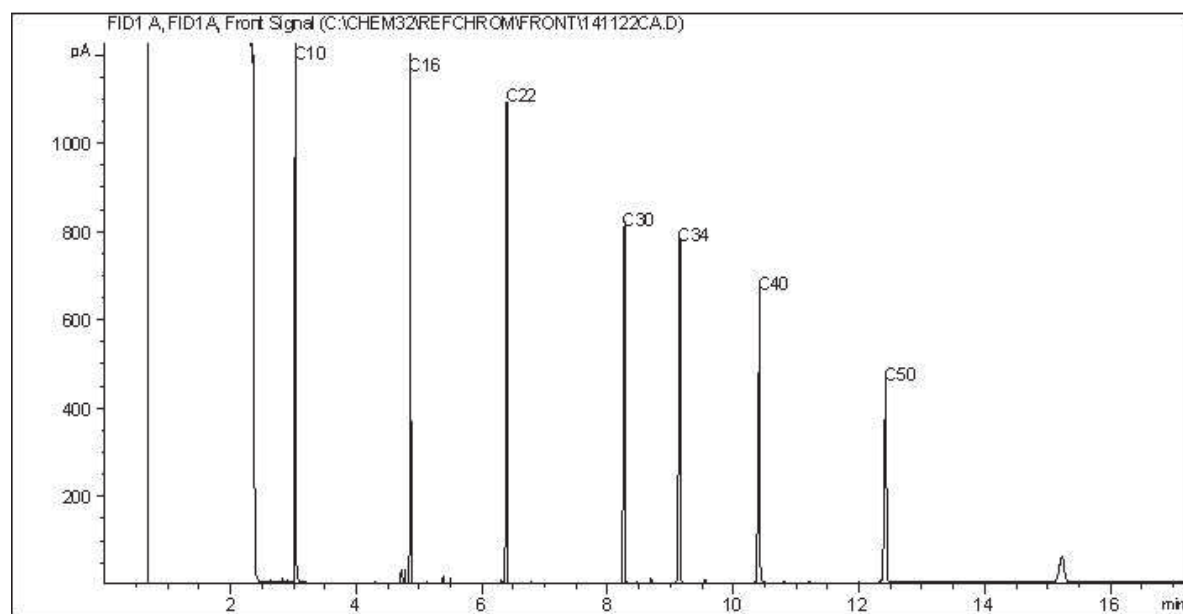
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

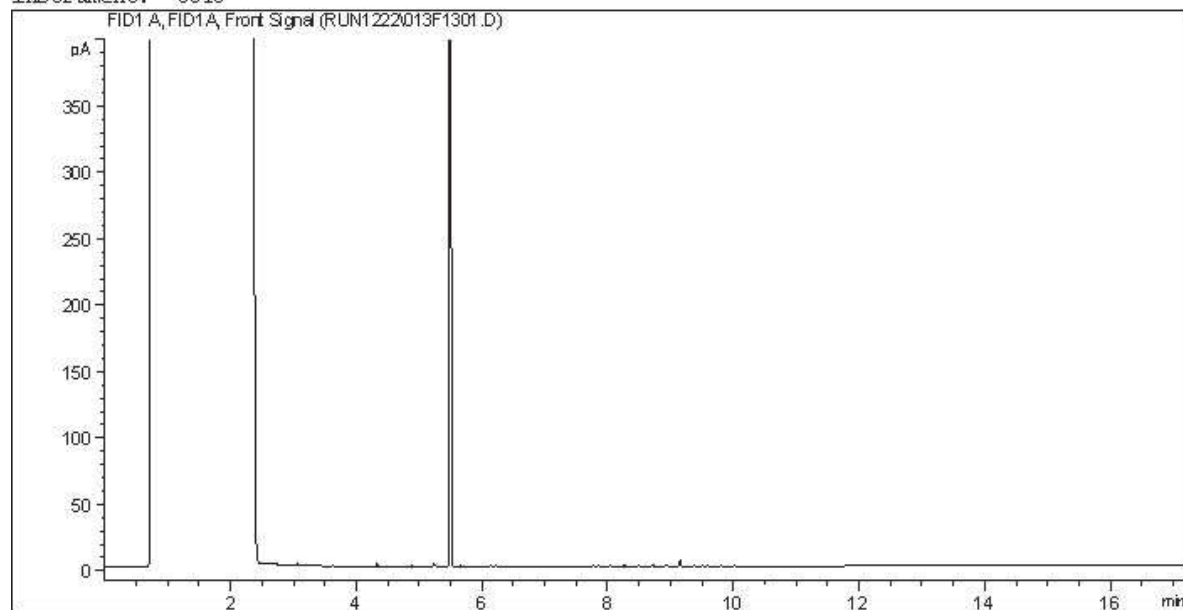
Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

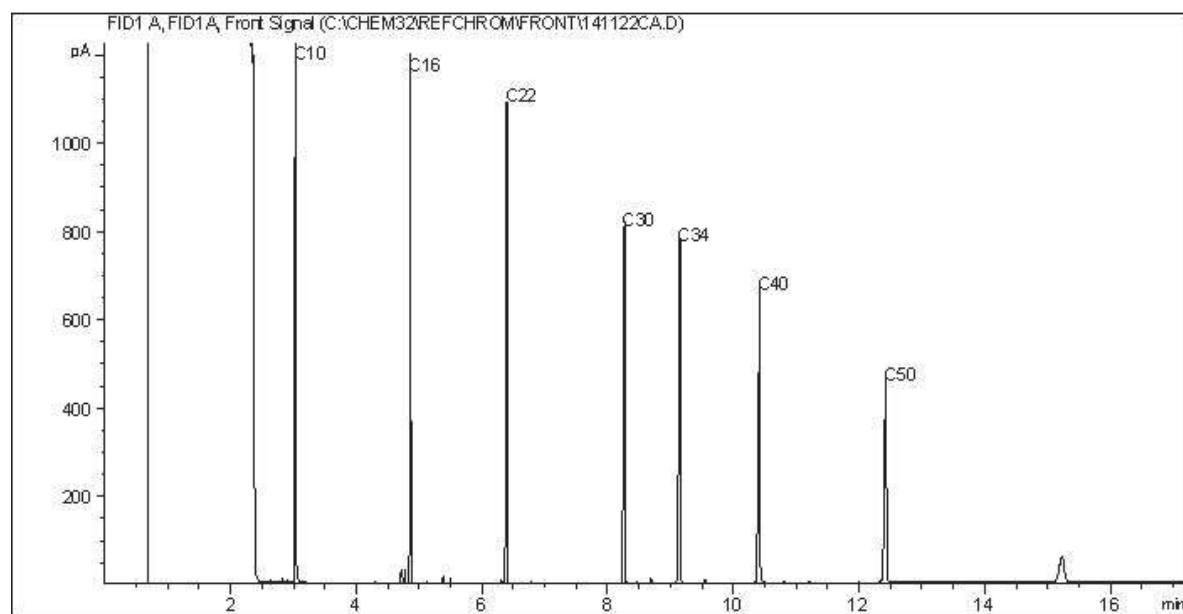
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

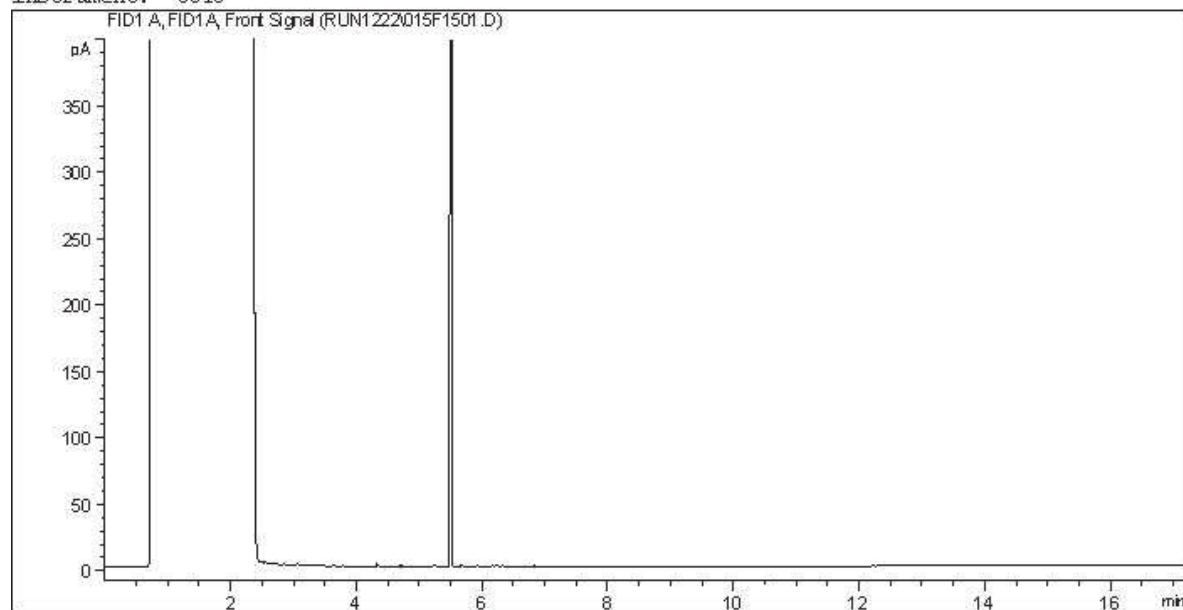
Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

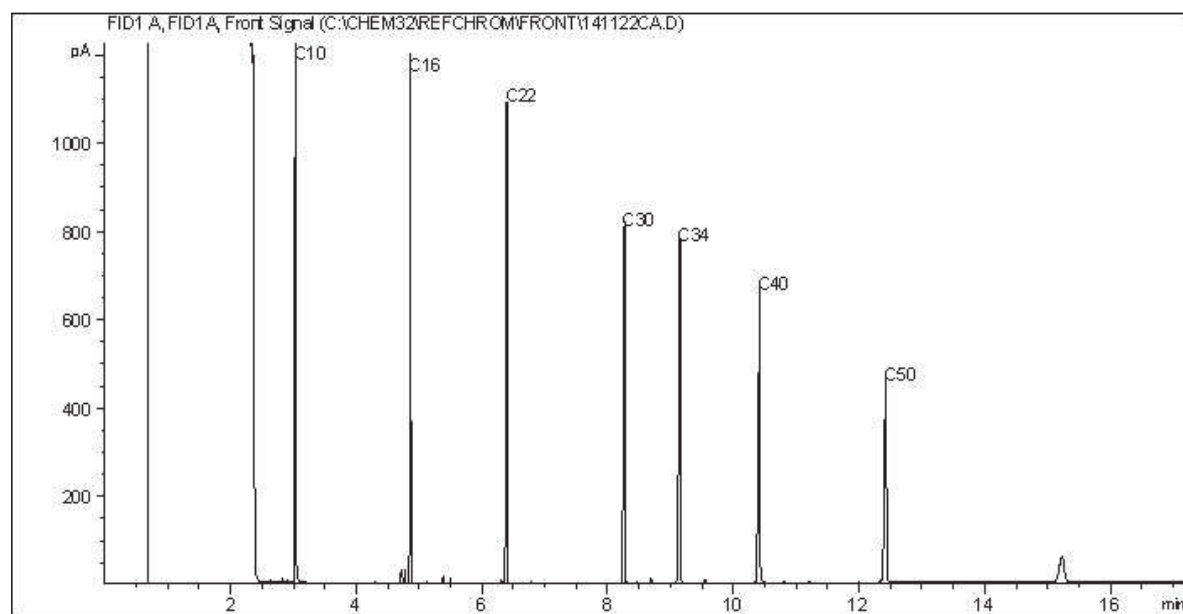
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

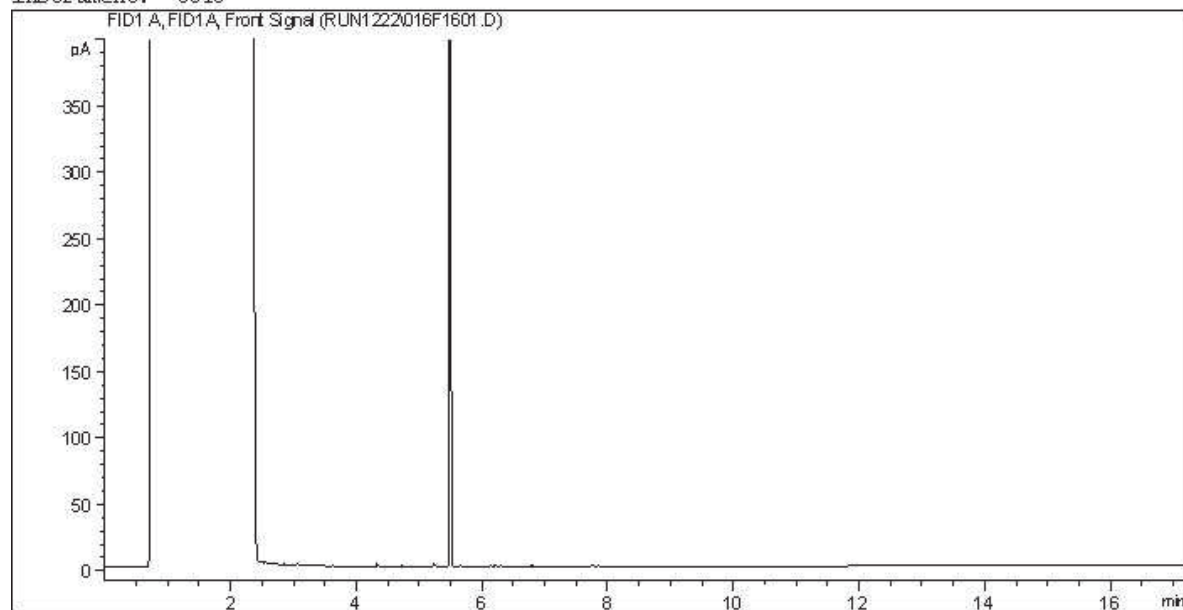
Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

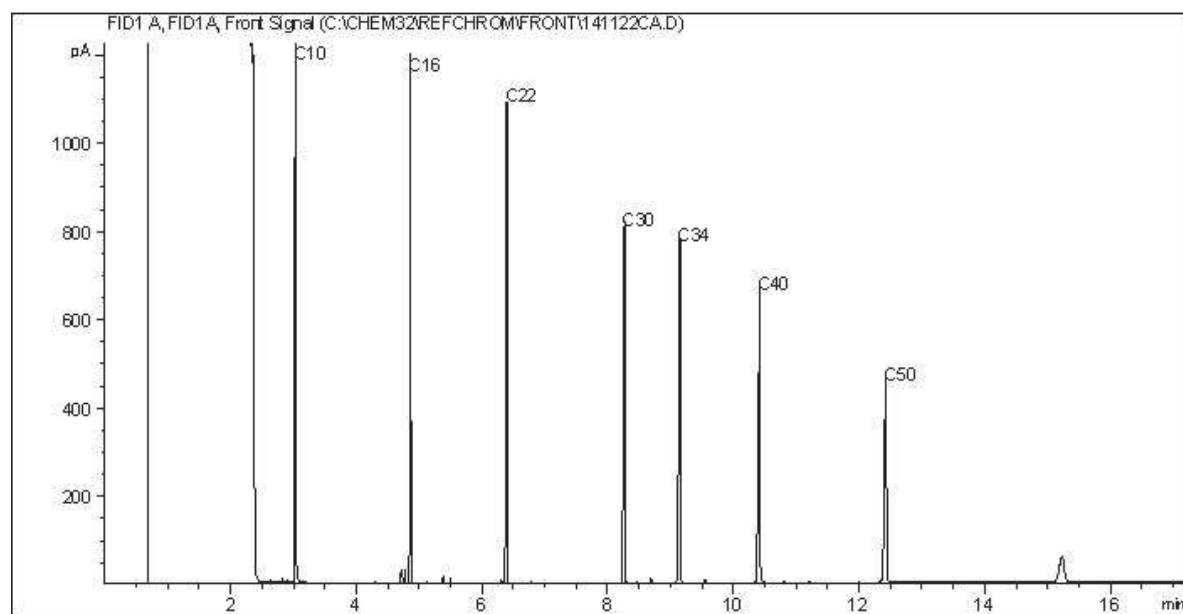
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CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

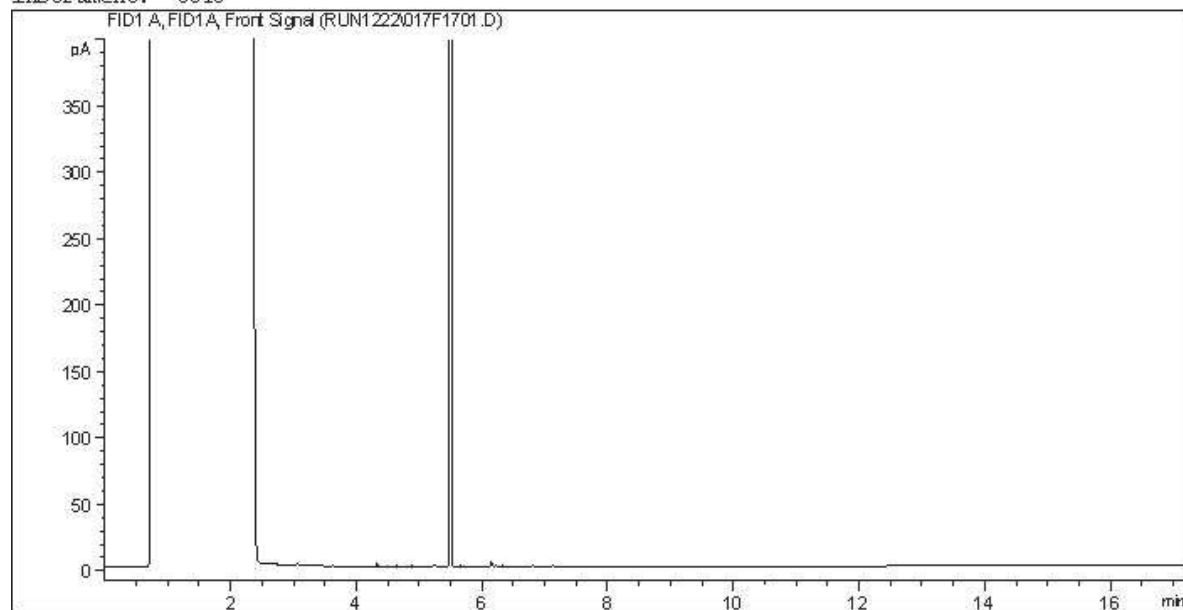
Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

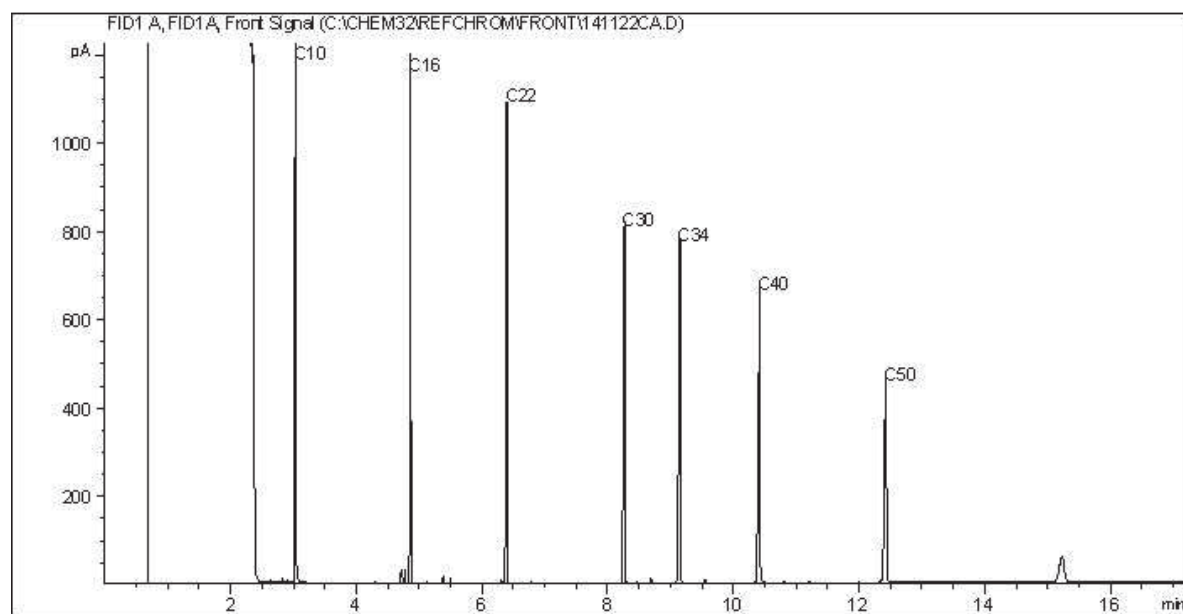
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

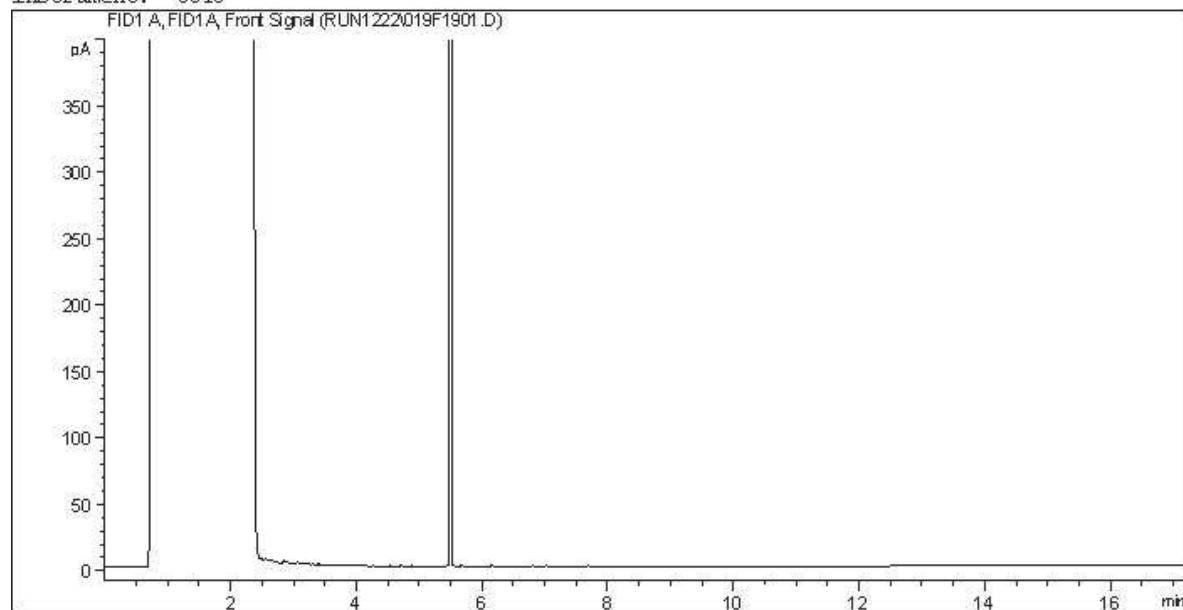
Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

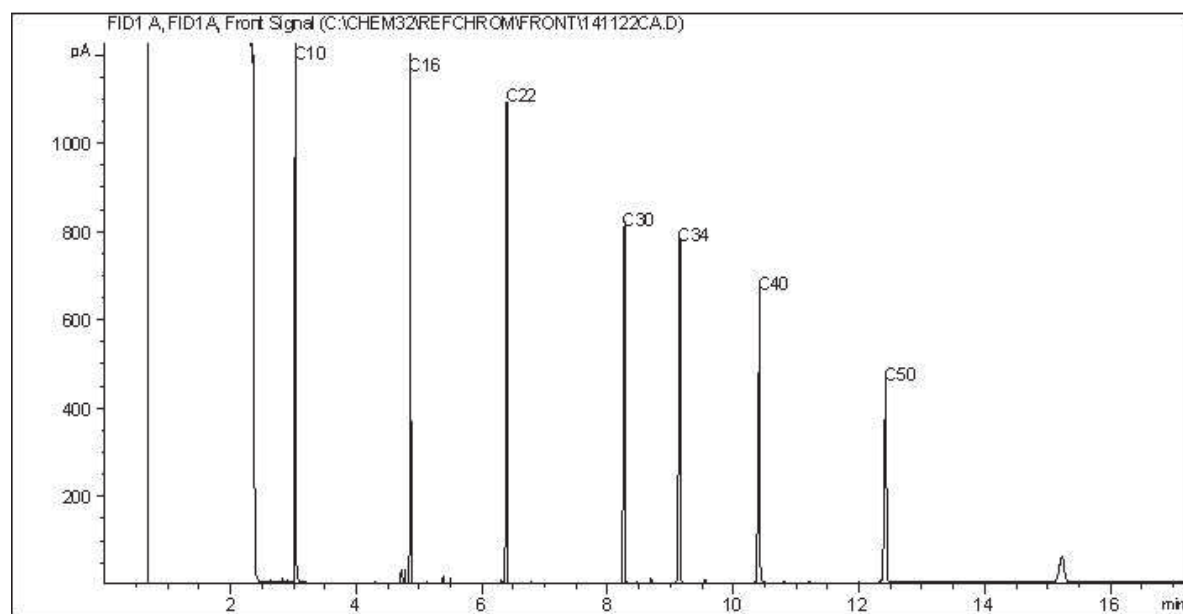
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

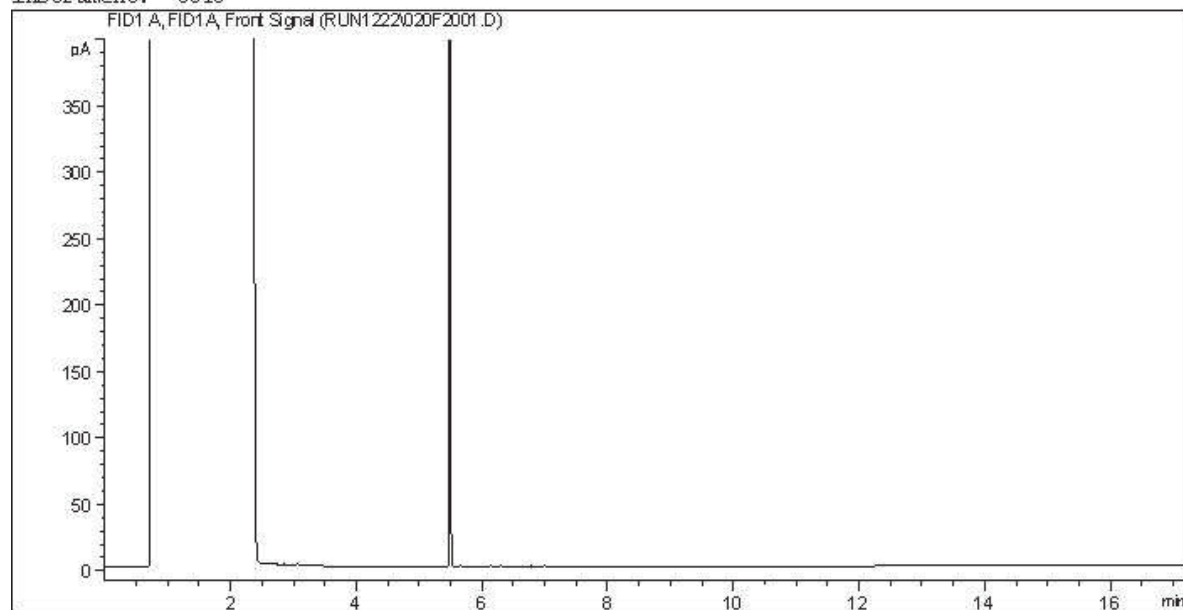
Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

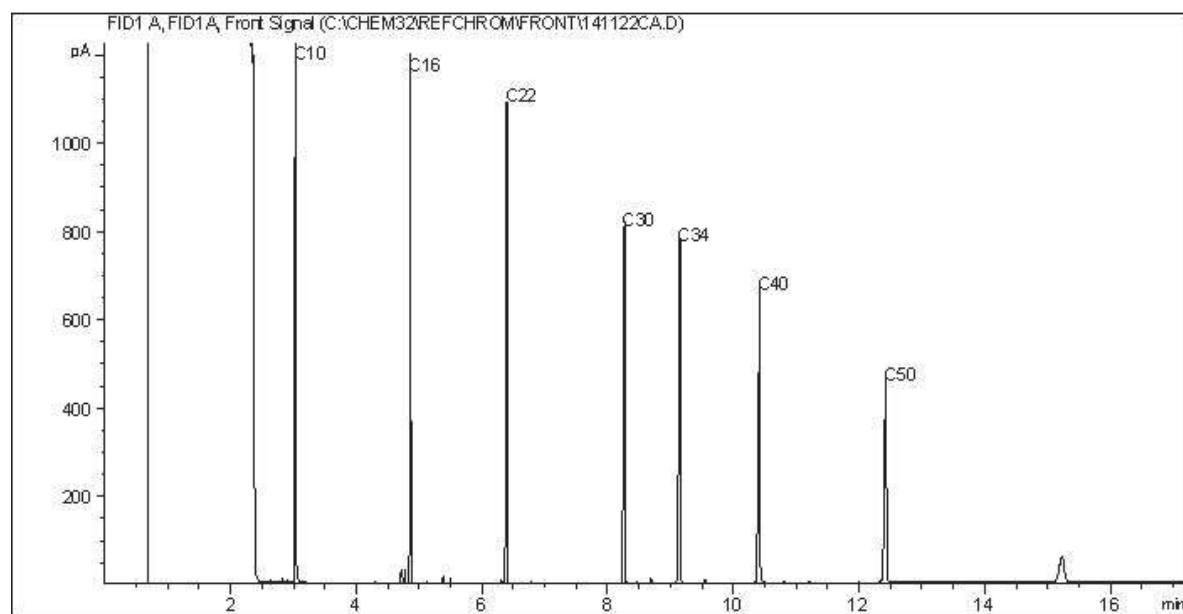
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Your Project #: B4B4360
Your C.O.C. #: na

Attention: Wendy Sears

Maxxam Analytics
Calgary (Golder)
2021 41st Ave. NE
Calgary, AB
Canada

Report Date: 2015/01/02
Report #: R3276414
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4O0942

Received: 2014/12/19, 10:00


Sample Matrix: Water
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
OC Pesticides (Selected) & PCB (1)	4	2014/12/22	2014/12/24	CAM SOP-00307	EPA 8081/8082 m
OC Pesticides (Selected) & PCB (1)	2	2014/12/22	2014/12/25	CAM SOP-00307	EPA 8081/8082 m
OC Pesticides Summed Parameters	6	N/A	2015/01/02	CAM SOP-00307	EPA 8081/8082 m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Chlordane (Total) = Alpha Chlordane + Gamma Chlordane

Encryption Key



Hina Siddiqui

02 Jan 2015 15:29:31 -05:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Antonella Brasil, Senior Project Manager

Email: ABrasil@maxxam.ca

Phone# (905)817-5817

=====

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B4O0942
Report Date: 2015/01/02

Maxxam Analytics
Client Project #: B4B4360

ORGANOCHLORINATED PESTICIDES BY GC-ECD (WATER)

Maxxam ID		YY0272	YY0273	YY0274	YY0275		
Sampling Date		2014/12/16 12:00	2014/12/16 11:30	2014/12/16 11:00	2014/12/16 13:15		
COC Number		na	na	na	na		
	Units	LJ9563-07R\MW1	LJ9564-07R\MW8	LJ9565-07R\MW9	LJ9566-07R\MW7	RDL	QC Batch
Calculated Parameters							
Aldrin + Dieldrin	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3866210
Chlordane (Total)	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3866210
DDT+ Metabolites	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3866210
Heptachlor + Heptachlor epoxide	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3866210
o,p-DDD + p,p-DDD	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3866210
o,p-DDE + p,p-DDE	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3866210
o,p-DDT + p,p-DDT	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3866210
Total Endosulfan	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3866210
Total PCB	ug/L	<0.05	<0.05	<0.05	<0.05	0.05	3866210
Pesticides & Herbicides							
Aldrin	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Dieldrin	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
a-Chlordane	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
g-Chlordane	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
o,p-DDD	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
p,p-DDD	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
o,p-DDE	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
p,p-DDE	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
o,p-DDT	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
p,p-DDT	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Lindane	ug/L	<0.003	<0.003	<0.003	<0.003	0.003	3869936
Endosulfan I (alpha)	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Endosulfan II	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Endrin	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Heptachlor	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Heptachlor epoxide	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Hexachlorobenzene	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Hexachlorobutadiene	ug/L	<0.009	<0.009	<0.009	<0.009	0.009	3869936
Hexachloroethane	ug/L	<0.01	<0.01	<0.01	<0.01	0.01	3869936
Methoxychlor	ug/L	<0.01	<0.01	<0.01	<0.01	0.01	3869936
Aroclor 1016	ug/L	<0.05	<0.05	<0.05	<0.05	0.05	3869936
Aroclor 1221	ug/L	<0.05	<0.05	<0.05	<0.05	0.05	3869936
Aroclor 1232	ug/L	<0.05	<0.05	<0.05	<0.05	0.05	3869936
Aroclor 1242	ug/L	<0.05	<0.05	<0.05	<0.05	0.05	3869936
Aroclor 1248	ug/L	<0.05	<0.05	<0.05	<0.05	0.05	3869936
RDL = Reportable Detection Limit							
QC Batch = Quality Control Batch							

Maxxam Job #: B4O0942
Report Date: 2015/01/02

Maxxam Analytics
Client Project #: B4B4360

ORGANOCHLORINATED PESTICIDES BY GC-ECD (WATER)

Maxxam ID		YY0272	YY0273	YY0274	YY0275		
Sampling Date		2014/12/16 12:00	2014/12/16 11:30	2014/12/16 11:00	2014/12/16 13:15		
COC Number		na	na	na	na		
	Units	LJ9563-07R\MW1	LJ9564-07R\MW8	LJ9565-07R\MW9	LJ9566-07R\MW7	RDL	QC Batch
Aroclor 1254	ug/L	<0.05	<0.05	<0.05	<0.05	0.05	3869936
Aroclor 1260	ug/L	<0.05	<0.05	<0.05	<0.05	0.05	3869936
Aroclor 1262	ug/L	<0.05	<0.05	<0.05	<0.05	0.05	3869936
Aroclor 1268	ug/L	<0.05	<0.05	<0.05	<0.05	0.05	3869936
alpha-BHC	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
beta-BHC	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
delta-BHC	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Hexachlorocyclopentadiene	ug/L	<0.02	<0.02	<0.02	<0.02	0.02	3869936
Endosulfan sulfate	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Endrin aldehyde	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Endrin ketone	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Mirex	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Octachlorostyrene	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Oxychlorodane	ug/L	<0.005	<0.005	<0.005	<0.005	0.005	3869936
Toxaphene	ug/L	<0.2	<0.2	<0.2	<0.2	0.2	3869936
Surrogate Recovery (%)							
2,4,5,6-Tetrachloro-m-xylene	%	63	67	65	65		3869936
Decachlorobiphenyl	%	101	97	110	108		3869936
RDL = Reportable Detection Limit							
QC Batch = Quality Control Batch							

Maxxam Job #: B400942
Report Date: 2015/01/02

Maxxam Analytics
Client Project #: B4B4360

ORGANOCHLORINATED PESTICIDES BY GC-ECD (WATER)

Maxxam ID		YY0276	YY0277		
Sampling Date		2014/12/16 14:50	2014/12/16 12:00		
COC Number		na	na		
	Units	LJ9567-07R\MW2	LJ9568-07R\DUP A	RDL	QC Batch
Calculated Parameters					
Aldrin + Dieldrin	ug/L	<0.005	<0.005	0.005	3866210
Chlordane (Total)	ug/L	<0.005	<0.005	0.005	3866210
DDT+ Metabolites	ug/L	<0.005	<0.005	0.005	3866210
Heptachlor + Heptachlor epoxide	ug/L	<0.005	<0.005	0.005	3866210
o,p-DDD + p,p-DDD	ug/L	<0.005	<0.005	0.005	3866210
o,p-DDE + p,p-DDE	ug/L	<0.005	<0.005	0.005	3866210
o,p-DDT + p,p-DDT	ug/L	<0.005	<0.005	0.005	3866210
Total Endosulfan	ug/L	<0.005	<0.005	0.005	3866210
Total PCB	ug/L	<0.05	<0.05	0.05	3866210
Pesticides & Herbicides					
Aldrin	ug/L	<0.005	<0.005	0.005	3869936
Dieldrin	ug/L	<0.005	<0.005	0.005	3869936
a-Chlordane	ug/L	<0.005	<0.005	0.005	3869936
g-Chlordane	ug/L	<0.005	<0.005	0.005	3869936
o,p-DDD	ug/L	<0.005	<0.005	0.005	3869936
p,p-DDD	ug/L	<0.005	<0.005	0.005	3869936
o,p-DDE	ug/L	<0.005	<0.005	0.005	3869936
p,p-DDE	ug/L	<0.005	<0.005	0.005	3869936
o,p-DDT	ug/L	<0.005	<0.005	0.005	3869936
p,p-DDT	ug/L	<0.005	<0.005	0.005	3869936
Lindane	ug/L	<0.003	<0.003	0.003	3869936
Endosulfan I (alpha)	ug/L	<0.005	<0.005	0.005	3869936
Endosulfan II	ug/L	<0.005	<0.005	0.005	3869936
Endrin	ug/L	<0.005	<0.005	0.005	3869936
Heptachlor	ug/L	<0.005	<0.005	0.005	3869936
Heptachlor epoxide	ug/L	<0.005	<0.005	0.005	3869936
Hexachlorobenzene	ug/L	<0.005	<0.005	0.005	3869936
Hexachlorobutadiene	ug/L	<0.009	<0.009	0.009	3869936
Hexachloroethane	ug/L	<0.01	<0.01	0.01	3869936
Methoxychlor	ug/L	<0.01	<0.01	0.01	3869936
Aroclor 1016	ug/L	<0.05	<0.05	0.05	3869936
Aroclor 1221	ug/L	<0.05	<0.05	0.05	3869936
Aroclor 1232	ug/L	<0.05	<0.05	0.05	3869936
Aroclor 1242	ug/L	<0.05	<0.05	0.05	3869936
Aroclor 1248	ug/L	<0.05	<0.05	0.05	3869936
RDL = Reportable Detection Limit					
QC Batch = Quality Control Batch					

Maxxam Job #: B4O0942
Report Date: 2015/01/02

Maxxam Analytics
Client Project #: B4B4360

ORGANOCHLORINATED PESTICIDES BY GC-ECD (WATER)

Maxxam ID		YY0276	YY0277		
Sampling Date		2014/12/16 14:50	2014/12/16 12:00		
COC Number		na	na		
	Units	LJ9567-07R\MW2	LJ9568-07R\DUP A	RDL	QC Batch
Aroclor 1254	ug/L	<0.05	<0.05	0.05	3869936
Aroclor 1260	ug/L	<0.05	<0.05	0.05	3869936
Aroclor 1262	ug/L	<0.05	<0.05	0.05	3869936
Aroclor 1268	ug/L	<0.05	<0.05	0.05	3869936
alpha-BHC	ug/L	<0.005	<0.005	0.005	3869936
beta-BHC	ug/L	<0.005	<0.005	0.005	3869936
delta-BHC	ug/L	<0.005	<0.005	0.005	3869936
Hexachlorocyclopentadiene	ug/L	<0.02	<0.02	0.02	3869936
Endosulfan sulfate	ug/L	<0.005	<0.005	0.005	3869936
Endrin aldehyde	ug/L	<0.005	<0.005	0.005	3869936
Endrin ketone	ug/L	<0.005	<0.005	0.005	3869936
Mirex	ug/L	<0.005	<0.005	0.005	3869936
Octachlorostyrene	ug/L	<0.005	<0.005	0.005	3869936
Oxychlordane	ug/L	<0.005	<0.005	0.005	3869936
Toxaphene	ug/L	<0.2	<0.2	0.2	3869936
Surrogate Recovery (%)					
2,4,5,6-Tetrachloro-m-xylene	%	67	61		3869936
Decachlorobiphenyl	%	110	99		3869936
RDL = Reportable Detection Limit QC Batch = Quality Control Batch					

Maxxam Job #: B4O0942
Report Date: 2015/01/02

Maxxam Analytics
Client Project #: B4B4360

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.3°C
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Samples decanted for OC Pesticide as per client request.

Results relate only to the items tested.

Maxxam Job #: B4O0942
Report Date: 2015/01/02

QUALITY ASSURANCE REPORT

Maxxam Analytics
Client Project #: B4B4360

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
3869936	2,4,5,6-Tetrachloro-m-xylene	2014/12/24	62	50 - 130	63	50 - 130	67	%		
3869936	Decachlorobiphenyl	2014/12/24	108	50 - 130	105	50 - 130	116	%		
3869936	a-Chlordane	2014/12/25	96	50 - 130	98	50 - 130	<0.005	ug/L	NC	30
3869936	Aldrin	2014/12/25	86	50 - 130	77	50 - 130	<0.005	ug/L	NC	30
3869936	alpha-BHC	2014/12/25	89	30 - 130	86	30 - 130	<0.005	ug/L	NC	40
3869936	Aroclor 1016	2014/12/25					<0.05	ug/L	NC	30
3869936	Aroclor 1221	2014/12/25					<0.05	ug/L	NC	30
3869936	Aroclor 1232	2014/12/25					<0.05	ug/L	NC	30
3869936	Aroclor 1242	2014/12/25					<0.05	ug/L	NC	30
3869936	Aroclor 1248	2014/12/25					<0.05	ug/L	NC	30
3869936	Aroclor 1254	2014/12/25					<0.05	ug/L	NC	30
3869936	Aroclor 1260	2014/12/25					<0.05	ug/L	NC	30
3869936	Aroclor 1262	2014/12/24					<0.05	ug/L		
3869936	Aroclor 1268	2014/12/24					<0.05	ug/L		
3869936	beta-BHC	2014/12/25	80	30 - 130	86	30 - 130	<0.005	ug/L	NC	40
3869936	Chlordane (Total)	2014/12/25							NC	30
3869936	DDT+ Metabolites	2014/12/25							NC	30
3869936	delta-BHC	2014/12/25	83	30 - 130	87	30 - 130	<0.005	ug/L	NC	40
3869936	Dieldrin	2014/12/25	94	50 - 130	97	50 - 130	<0.005	ug/L	NC	30
3869936	Endosulfan I (alpha)	2014/12/25	82	50 - 130	103	50 - 130	<0.005	ug/L	NC	30
3869936	Endosulfan II	2014/12/25	93	50 - 130	96	50 - 130	<0.005	ug/L	NC	30
3869936	Endosulfan sulfate	2014/12/25	92	30 - 130	92	30 - 130	<0.005	ug/L	NC	40
3869936	Endrin aldehyde	2014/12/25	90	30 - 130	95	30 - 130	<0.005	ug/L	NC	40
3869936	Endrin ketone	2014/12/25	105	30 - 130	101	30 - 130	<0.005	ug/L	NC	40
3869936	Endrin	2014/12/25	106	50 - 130	103	50 - 130	<0.005	ug/L	NC	30
3869936	g-Chlordane	2014/12/25	99	50 - 130	99	50 - 130	<0.005	ug/L	NC	30
3869936	Heptachlor epoxide	2014/12/25	92	50 - 130	96	50 - 130	<0.005	ug/L	NC	30
3869936	Heptachlor	2014/12/25	86	50 - 130	107	50 - 130	<0.005	ug/L	NC	30
3869936	Hexachlorobenzene	2014/12/25	69	50 - 130	78	50 - 130	<0.005	ug/L	NC	30
3869936	Hexachlorobutadiene	2014/12/24	55	50 - 130	53	50 - 130	<0.009	ug/L		
3869936	Hexachlorocyclopentadiene	2014/12/24	46	30 - 130	50	30 - 130	<0.02	ug/L		
3869936	Hexachloroethane	2014/12/24	62	50 - 130	63	50 - 130	<0.01	ug/L		

Maxxam Job #: B4O0942
Report Date: 2015/01/02

QUALITY ASSURANCE REPORT(CONT'D)

Maxxam Analytics
Client Project #: B4B4360

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
3869936	Lindane	2014/12/25	80	50 - 130	93	50 - 130	<0.003	ug/L	NC	30
3869936	Methoxychlor	2014/12/25	128	50 - 130	127	50 - 130	<0.01	ug/L	NC	30
3869936	Mirex	2014/12/25	100	30 - 130	94	30 - 130	<0.005	ug/L	NC	40
3869936	o,p-DDD + p,p-DDD	2014/12/25							NC	30
3869936	o,p-DDD	2014/12/25	98	50 - 130	99	50 - 130	<0.005	ug/L	NC	30
3869936	o,p-DDE + p,p-DDE	2014/12/25							NC	30
3869936	o,p-DDE	2014/12/25	79	50 - 130	89	50 - 130	<0.005	ug/L	NC	30
3869936	o,p-DDT + p,p-DDT	2014/12/25							NC	30
3869936	o,p-DDT	2014/12/25	108	50 - 130	108	50 - 130	<0.005	ug/L	NC	30
3869936	Octachlorostyrene	2014/12/25	90	30 - 130	88	30 - 130	<0.005	ug/L	NC	40
3869936	Oxychlorodane	2014/12/25	88	30 - 130	91	30 - 130	<0.005	ug/L	NC	30
3869936	p,p-DDD	2014/12/25	103	50 - 130	100	50 - 130	<0.005	ug/L	NC	30
3869936	p,p-DDE	2014/12/25	83	50 - 130	98	50 - 130	<0.005	ug/L	NC	30
3869936	p,p-DDT	2014/12/25	124	50 - 130	120	50 - 130	<0.005	ug/L	NC	30
3869936	Total Endosulfan	2014/12/25							NC	30
3869936	Total PCB	2014/12/25							NC	30
3869936	Toxaphene	2014/12/25					<0.2	ug/L	NC	40

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B4O0942
Report Date: 2015/01/02

Maxxam Analytics
Client Project #: B4B4360

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Cristina Carriere

Cristina Carriere, Scientific Services

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

MAXXAM ANALYTICS
4000 19st N.E
Calgary, Alberta, T2E 6P8
Phone: (403) 291-3077
Fax: (403) 291-9468

IMMEDIATE TEST

Ma

SUBCONTRA

19-Dec-14 10:00

Shaun Nowickyj



B400942

FW

ENV-815

Page #: 1

GOLDER ASSOCIATES LTD. -
CALGARY - NATIONAL
CONTRACT
Maxxam PM Wendy Sears

To: Maxxam Ontario (From Calgary)

Job# B4B4360

☐ Yes ☒ No International Sample/BioHazard (if yes, add copy of Movement Cert., heat treat is required prior to disposal)
☐ Yes ☒ No Special Protocol (if yes, Protocol _____)

Sample ID	Matrix	Test(s) Required	Container	Date Sampled	Date Required
LJ9563-07R \ MW1	GRWTR	OC Pesticides and PCB -Subcontract	1(ILAG)	2014/12/16 12:00	2015/01/05
LJ9564-07R \ MW8	GRWTR	OC Pesticides and PCB -Subcontract	1(ILAG)	2014/12/16 11:30	2015/01/05
LJ9565-07R \ MW9	GRWTR	OC Pesticides and PCB -Subcontract	1(ILAG)	2014/12/16 11:00	2015/01/05
LJ9566-07R \ MW7	GRWTR	OC Pesticides and PCB -Subcontract	1(ILAG)	2014/12/16 13:15	2015/01/05
LJ9567-07R \ MW2	GRWTR	OC Pesticides and PCB -Subcontract	1(ILAG)	2014/12/16 14:50	2015/01/05
LJ9568-07R \ DUP A	GRWTR	OC Pesticides and PCB -Subcontract	1(ILAG)	2014/12/16 12:00	2015/01/05

	Temp. 1	Temp. 2	Temp. 3			
Cooler #1	5	2	3	Custody Seal Present	YES <input checked="" type="checkbox"/>	NO
				Custody Seal Intact	YES <input checked="" type="checkbox"/>	NO
				Ice Present Upon Receipt	YES <input checked="" type="checkbox"/>	NO
Cooler #2				Custody Seal Present	YES	NO
				Custody Seal Intact	YES	NO
				Ice Present Upon Receipt	YES	NO
Cooler #3				Custody Seal Present	YES	NO
				Custody Seal Intact	YES	NO
				Ice Present Upon Receipt	YES	NO

Receiving Maxxam Location: Maxxam Ontario (From Calgary)

JOB #

Relinquished by (Sign)

(Print)

Albert Tanyi

Date and Time 2014/12/18 12:00

Received by (Sign)

(Print)

Maxxam Ontario

Date and Time 2014/12/19 10:00

Subcontract Comments

ORGANOCHLORINE PESTICIDES (CCME)

NOTES:

- 1) Please call us if due date cannot be met. Please reference Sample ID on your report.
- 2) Include copy of this completed form, Client COC & signed final report to calgarycustomerservice@maxxamanalytics.com

Reporting Requirements:

National:

Regional:

MAXXAM ANALYTICS
4000 19st N.E
Calgary, Alberta, T2E 6P8
Phone: (403) 291-3077
Fax: (403) 291-9468



Page #: 2

GOLDER ASSOCIATES LTD. -
CALGARY - NATIONAL
CONTRACT
Maxxam PM Wendy Sears

SHIPPING INSTRUCTIONS

- | | |
|---|---|
| <input type="checkbox"/> Ship Immediately (highlight Yellow) | <input checked="" type="checkbox"/> Ship Cold |
| <input type="checkbox"/> Requires 9am | <input type="checkbox"/> Ship Room Temp |
| <input type="checkbox"/> Requires Sat. Delivery | <input type="checkbox"/> Ship Frozen |
| <input checked="" type="checkbox"/> Regular Ship next available day | <input type="checkbox"/> COC Must be Attached |
- Sender (Print) Adalberto Initial AT

SHIPPING DEPARTMENT CHECKLIST

- | | |
|--|-------------------------|
| <input type="checkbox"/> Correct Shipping location | |
| <input type="checkbox"/> Correct Sample Ids (Paperwork vs Bottles) | |
| <input type="checkbox"/> Yes <input type="checkbox"/> No Special-Cooler, Ice, Tape-custody seal, Date&Sign | |
| Date Shipped _____ | Number of coolers _____ |
| Shipper (Print) _____ | Initial _____ |

Maxam Analytics International Corporation or Maxam Analytics

GOLDER DATA QUALITY REVIEW CHECKLIST

Site Location: Bar U Ranch National Historic Site, AB Sampling Date: December 16, 2014

Golder Project Number: 1418041-1000

Laboratory: Maxxam - Calgary

Lab Submission Number: B4B4360(B4O0942-SC)

Was the Cooler Received at the lab under a sealed and intact custody seal?	<u>n/a</u>
Was proper chain of custody of the samples documented and kept?	<u>Yes</u>
Were sample temperatures acceptable when they reached lab?:	<u>Yes</u>
Were all samples analyzed and extracted within hold times?:	<u>Yes</u>
Has lab warranted all tests were in statistical control in CoA?:	<u>Yes</u>
Was sufficient sample provided for the requested analysis?	<u>Yes</u>
Has lab warranted all samples were analyzed with limited headspace present?:	<u>Yes</u>

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Surrogate Recovery	X			All laboratory QC results are within acceptance criteria, please see QA/QC appendix.
Method Blank Concentration	X			
Laboratory Duplicate RPD	X			
Matrix Spike Recovery	X			
Blank Spike Recovery	X			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration	X			All field QC samples are within alert limits.
Trip Blank Concentration	X			
Field Duplicate RPD	X			

Is data considered reliable (Yes/No/Suspect)?: Suspect

If answer is "No" or "Suspect", describe and provide rationale:

Please see QA/QC appendix.

Data Reviewed by (Print): Anita Colbert

Data Reviewed by (Signature): Anita Colbert

Date: January 27, 2015

Your Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Your C.O.C. #: A096866

Attention: AURELIE BELLAVANCE

GOLDER ASSOCIATES LTD.
CALGARY - NATIONAL CONTRACT
102, 2535 - 3rd Avenue SE
CALGARY, AB
CANADA T2A 7W5

Report Date: 2015/01/06
Report #: R1774276
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4B4887

Received: 2014/12/18, 17:16

Sample Matrix: GROUND WATER
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	3	N/A	2014/12/20	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	3	N/A	2014/12/23	AB SOP-00039	CCME CWS/EPA 8260C m
Cadmium - low level CCME - Dissolved	3	N/A	2014/12/24	AB SOP-00043	EPA 200.8 R5.4 m
Cadmium - low level CCME (Total)	1	2014/12/19	2014/12/24	AB SOP-00014 / AB SOP-00043	EPA 200.8 R5.4 m
Cadmium - low level CCME (Total)	2	2014/12/19	2014/12/29	AB SOP-00014 / AB SOP-00043	EPA 200.8 R5.4 m
Chloride by Automated Colourimetry	3	N/A	2014/12/24	AB SOP-00020	SM 22-4500-Cl G m
Conductivity @25C	3	N/A	2014/12/20	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16)	3	2014/12/22	2014/12/23	AB SOP-00040 AB SOP-00037	CCME PHC-CWS
Hardness	3	N/A	2014/12/22	AB WI-00065	Auto Calc
Elements by ICP - Dissolved	3	N/A	2014/12/20	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICP - Total	3	2014/12/20	2014/12/20	AB SOP-00014 / AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved	3	N/A	2014/12/23	AB SOP-00043	EPA 200.8 R5.4 m
Elements by ICPMS - Total	3	2014/12/20	2014/12/23	AB SOP-00014 / AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	3	N/A	2014/12/22	AB WI-00065	SM 1030E
Sum of cations, anions	3	N/A	2014/12/22	AB WI-00065	SM 1030E
Nitrate and Nitrite	3	N/A	2014/12/23	AB SOP-00023	Auto Calc
Nitrate + Nitrite-N (calculated)	3	N/A	2014/12/23	AB SOP-00023	Auto Calc
Nitrogen, (Nitrite, Nitrate) by IC	3	N/A	2014/12/22	AB SOP-00023	SM 22 4110 B m
Benzo[a]pyrene Equivalency (1)	3	N/A	2014/12/24	AB SOP-00003	Auto Calc
PAH in Water by GC/MS	3	2014/12/22	2014/12/23	AB SOP-00037 / AB SOP-00003	EPA 8270D m
pH @25°C (Alkalinity titrator)	3	N/A	2014/12/20	AB SOP-00005	SM 22 4500-H+B m
Sulphate by Automated Colourimetry	3	N/A	2014/12/24	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Calculated)	3	N/A	2014/12/24	AB WI-00065	SM 1030E

Your Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Your C.O.C. #: A096866

Attention:AURELIE BELLAVANCE

GOLDER ASSOCIATES LTD.
CALGARY - NATIONAL CONTRACT
102, 2535 - 3rd Avenue SE
CALGARY, AB
CANADA T2A 7W5

Report Date: 2015/01/06
Report #: R1774276
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4B4887

Received: 2014/12/18, 17:16

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Cadmium - low level CCME (Total)	1	2014/12/19	2014/12/29	AB SOP-00014 / AB SOP-00043	EPA 200.8 R5.4 m
Elements by ICP - Total	1	2014/12/20	2014/12/20	AB SOP-00014 / AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Total	1	2014/12/20	2014/12/23	AB SOP-00014 / AB SOP-00043	EPA 200.8 R5.4 m
Benzo[a]pyrene Equivalency (1)	1	N/A	2014/12/24	AB SOP-00003	Auto Calc
PAH in Water by GC/MS	1	2014/12/22	2014/12/23	AB SOP-00037 / AB SOP-00003	EPA 8270D m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) B[a]P TPE is calculated using 1/2 of the RDL for non detect results as per Alberta Environment instructions. This protocol may not apply in other jurisdictions.

Encryption Key  Wendy Sears
07 Jan 2015 11:37:42 -07:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Wendy Sears, Project manager

Email: WSears@maxxam.ca

Phone# (403)735-2277

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

AT1 BTEX AND F1-F2 (GROUND WATER)

Maxxam ID		LK1838	LK1838	LK1839	LK1840		
Sampling Date		2014/12/18 12:30	2014/12/18 12:30	2014/12/18 13:00	2014/12/18 14:00		
COC Number		A096866	A096866	A096866	A096866		
	Units	MW12	MW12 Lab-Dup	MW6	MW3	RDL	QC Batch
Hydrocarbons							
F2 (C10-C16 Hydrocarbons)	mg/L	0.19	N/A	<0.10	<0.10	0.10	7761700
Volatiles							
Benzene	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	0.00040	7763440
Toluene	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	0.00040	7763440
Ethylbenzene	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	0.00040	7763440
m & p-Xylene	mg/L	<0.00080	<0.00080	<0.00080	<0.00080	0.00080	7763440
o-Xylene	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	0.00040	7763440
Xylenes (Total)	mg/L	<0.00080	<0.00080	<0.00080	<0.00080	0.00080	7763440
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	<0.10	<0.10	0.10	7763440
(C6-C10)	mg/L	<0.10	<0.10	<0.10	<0.10	0.10	7763440
Surrogate Recovery (%)							
1,4-Difluorobenzene (sur.)	%	103	103	104	102	N/A	7763440
4-Bromofluorobenzene (sur.)	%	91	90	90	91	N/A	7763440
D4-1,2-Dichloroethane (sur.)	%	96	95	95	96	N/A	7763440
O-TERPHENYL (sur.)	%	110	N/A	91	88	N/A	7761700
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable							

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

ROUTINE WATER & DISS. REGULATED METALS (GROUND WATER)

Maxxam ID		LK1838	LK1838		LK1839		
Sampling Date		2014/12/18 12:30	2014/12/18 12:30		2014/12/18 13:00		
COC Number		A096866	A096866		A096866		
	Units	MW12	MW12 Lab-Dup	QC Batch	MW6	RDL	QC Batch
Calculated Parameters							
Anion Sum	meq/L	28	N/A	7760107	45	N/A	7760107
Cation Sum	meq/L	29	N/A	7760107	43	N/A	7760107
Hardness (CaCO ₃)	mg/L	1200	N/A	7760093	1700	0.50	7760093
Ion Balance	N/A	1.0	N/A	7760106	0.97	0.010	7760106
Dissolved Nitrate (NO ₃)	mg/L	0.16	N/A	7760073	0.052	0.044	7760073
Nitrate plus Nitrite (N)	mg/L	0.035	N/A	7760074	0.012	0.010	7760074
Dissolved Nitrite (NO ₂)	mg/L	<0.033	N/A	7760073	<0.033	0.033	7760073
Total Dissolved Solids	mg/L	1700	N/A	7760108	2600	10	7760108
Misc. Inorganics							
Conductivity	uS/cm	2300	N/A	7761364	3500	1.0	7761364
pH	pH	7.70	N/A	7761363	7.59	N/A	7761363
Low Level Elements							
Dissolved Cadmium (Cd)	mg/L	0.000030	N/A	7760199	<0.000020	0.000020	7760199
Anions							
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	N/A	7761359	<0.50	0.50	7761359
Alkalinity (Total as CaCO ₃)	mg/L	480	N/A	7761359	880	0.50	7761359
Bicarbonate (HCO ₃)	mg/L	590	N/A	7761359	1100	0.50	7761359
Carbonate (CO ₃)	mg/L	<0.50	N/A	7761359	<0.50	0.50	7761359
Hydroxide (OH)	mg/L	<0.50	N/A	7761359	<0.50	0.50	7761359
Dissolved Sulphate (SO ₄)	mg/L	870 (1)	N/A	7764871	1200 (1)	10	7764871
Dissolved Chloride (Cl)	mg/L	13	N/A	7764860	44	1.0	7764860
Nutrients							
Dissolved Nitrite (N)	mg/L	<0.010	<0.010	7761965	<0.010	0.010	7761959
Dissolved Nitrate (N)	mg/L	0.035	0.035	7761965	0.012	0.010	7761959
Elements							
Dissolved Aluminum (Al)	mg/L	0.0039	N/A	7762456	0.0055	0.0030	7762456
Dissolved Antimony (Sb)	mg/L	<0.00060	N/A	7762456	<0.00060	0.00060	7762456
Dissolved Arsenic (As)	mg/L	0.00041	N/A	7762456	0.0057	0.00020	7762456
Dissolved Barium (Ba)	mg/L	0.085	N/A	7761369	0.042	0.010	7761369
Dissolved Beryllium (Be)	mg/L	<0.0010	N/A	7762456	<0.0010	0.0010	7762456
Dissolved Boron (B)	mg/L	0.055	N/A	7761369	0.088	0.020	7761369
Dissolved Calcium (Ca)	mg/L	260	N/A	7761369	270	0.30	7761369
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable (1) Detection limits raised due to dilution to bring analyte within the calibrated range.							

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

ROUTINE WATER & DISS. REGULATED METALS (GROUND WATER)

Maxxam ID		LK1838	LK1838		LK1839		
Sampling Date		2014/12/18 12:30	2014/12/18 12:30		2014/12/18 13:00		
COC Number		A096866	A096866		A096866		
	Units	MW12	MW12 Lab-Dup	QC Batch	MW6	RDL	QC Batch
Dissolved Chromium (Cr)	mg/L	<0.0010	N/A	7762456	<0.0010	0.0010	7762456
Dissolved Cobalt (Co)	mg/L	0.00058	N/A	7762456	0.00042	0.00030	7762456
Dissolved Copper (Cu)	mg/L	0.0021	N/A	7762456	<0.00020	0.00020	7762456
Dissolved Iron (Fe)	mg/L	0.077	N/A	7761369	3.0	0.060	7761369
Dissolved Lead (Pb)	mg/L	<0.00020	N/A	7762456	<0.00020	0.00020	7762456
Dissolved Lithium (Li)	mg/L	<0.020	N/A	7761369	0.079	0.020	7761369
Dissolved Magnesium (Mg)	mg/L	150	N/A	7761369	240	0.20	7761369
Dissolved Manganese (Mn)	mg/L	0.38	N/A	7761369	0.19	0.0040	7761369
Dissolved Molybdenum (Mo)	mg/L	0.0016	N/A	7762456	0.0057	0.00020	7762456
Dissolved Nickel (Ni)	mg/L	0.0027	N/A	7762456	0.0038	0.00050	7762456
Dissolved Phosphorus (P)	mg/L	<0.10	N/A	7761369	<0.10	0.10	7761369
Dissolved Potassium (K)	mg/L	10	N/A	7761369	18	0.30	7761369
Dissolved Selenium (Se)	mg/L	0.00027	N/A	7762456	0.0066	0.00020	7762456
Dissolved Silicon (Si)	mg/L	3.2	N/A	7761369	3.5	0.10	7761369
Dissolved Silver (Ag)	mg/L	<0.00010	N/A	7762456	<0.00010	0.00010	7762456
Dissolved Sodium (Na)	mg/L	82	N/A	7761369	210	0.50	7761369
Dissolved Strontium (Sr)	mg/L	1.4	N/A	7761369	2.8	0.020	7761369
Dissolved Sulphur (S)	mg/L	280	N/A	7761369	480	0.20	7761369
Dissolved Thallium (Tl)	mg/L	<0.00020	N/A	7762456	<0.00020	0.00020	7762456
Dissolved Tin (Sn)	mg/L	<0.0010	N/A	7762456	<0.0010	0.0010	7762456
Dissolved Titanium (Ti)	mg/L	<0.0010	N/A	7762456	0.0010	0.0010	7762456
Dissolved Uranium (U)	mg/L	0.019	N/A	7762456	0.0092	0.00010	7762456
Dissolved Vanadium (V)	mg/L	<0.0010	N/A	7762456	0.0011	0.0010	7762456
Dissolved Zinc (Zn)	mg/L	<0.0030	N/A	7762456	<0.0030	0.0030	7762456
RDL = Reportable Detection Limit							
Lab-Dup = Laboratory Initiated Duplicate							
N/A = Not Applicable							

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

ROUTINE WATER & DISS. REGULATED METALS (GROUND WATER)

Maxxam ID		LK1840		
Sampling Date		2014/12/18 14:00		
COC Number		A096866		
	Units	MW3	RDL	QC Batch
Calculated Parameters				
Anion Sum	meq/L	56	N/A	7760107
Cation Sum	meq/L	53	N/A	7760107
Hardness (CaCO ₃)	mg/L	2100	0.50	7760093
Ion Balance	N/A	0.95	0.010	7760106
Dissolved Nitrate (NO ₃)	mg/L	6.7	0.044	7760073
Nitrate plus Nitrite (N)	mg/L	1.5	0.010	7760074
Dissolved Nitrite (NO ₂)	mg/L	0.039	0.033	7760073
Total Dissolved Solids	mg/L	3400	10	7760108
Misc. Inorganics				
Conductivity	uS/cm	4100	1.0	7761364
pH	pH	7.54	N/A	7761363
Low Level Elements				
Dissolved Cadmium (Cd)	mg/L	0.000032	0.000020	7760199
Anions				
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	0.50	7761359
Alkalinity (Total as CaCO ₃)	mg/L	530	0.50	7761359
Bicarbonate (HCO ₃)	mg/L	650	0.50	7761359
Carbonate (CO ₃)	mg/L	<0.50	0.50	7761359
Hydroxide (OH)	mg/L	<0.50	0.50	7761359
Dissolved Sulphate (SO ₄)	mg/L	2100 (1)	20	7764871
Dissolved Chloride (Cl)	mg/L	21	1.0	7764860
Nutrients				
Dissolved Nitrite (N)	mg/L	0.012	0.010	7761954
Dissolved Nitrate (N)	mg/L	1.5	0.010	7761954
Elements				
Dissolved Aluminum (Al)	mg/L	0.0044	0.0030	7762456
Dissolved Antimony (Sb)	mg/L	<0.00060	0.00060	7762456
Dissolved Arsenic (As)	mg/L	0.00077	0.00020	7762456
Dissolved Barium (Ba)	mg/L	0.036	0.010	7761369
Dissolved Beryllium (Be)	mg/L	<0.0010	0.0010	7762456
Dissolved Boron (B)	mg/L	0.12	0.020	7761369
Dissolved Calcium (Ca)	mg/L	300	0.30	7761369
RDL = Reportable Detection Limit N/A = Not Applicable (1) Detection limits raised due to dilution to bring analyte within the calibrated range.				

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

ROUTINE WATER & DISS. REGULATED METALS (GROUND WATER)

Maxxam ID		LK1840		
Sampling Date		2014/12/18 14:00		
COC Number		A096866		
	Units	MW3	RDL	QC Batch
Dissolved Chromium (Cr)	mg/L	<0.0010	0.0010	7762456
Dissolved Cobalt (Co)	mg/L	0.00057	0.00030	7762456
Dissolved Copper (Cu)	mg/L	0.0021	0.00020	7762456
Dissolved Iron (Fe)	mg/L	0.10	0.060	7761369
Dissolved Lead (Pb)	mg/L	<0.00020	0.00020	7762456
Dissolved Lithium (Li)	mg/L	0.030	0.020	7761369
Dissolved Magnesium (Mg)	mg/L	330	0.20	7761369
Dissolved Manganese (Mn)	mg/L	0.13	0.0040	7761369
Dissolved Molybdenum (Mo)	mg/L	0.0013	0.00020	7762456
Dissolved Nickel (Ni)	mg/L	0.0053	0.00050	7762456
Dissolved Phosphorus (P)	mg/L	<0.10	0.10	7761369
Dissolved Potassium (K)	mg/L	17	0.30	7761369
Dissolved Selenium (Se)	mg/L	0.00082	0.00020	7762456
Dissolved Silicon (Si)	mg/L	5.4	0.10	7761369
Dissolved Silver (Ag)	mg/L	<0.00010	0.00010	7762456
Dissolved Sodium (Na)	mg/L	250	0.50	7761369
Dissolved Strontium (Sr)	mg/L	2.0	0.020	7761369
Dissolved Sulphur (S)	mg/L	700 (1)	1.0	7761369
Dissolved Thallium (Tl)	mg/L	<0.00020	0.00020	7762456
Dissolved Tin (Sn)	mg/L	<0.0010	0.0010	7762456
Dissolved Titanium (Ti)	mg/L	<0.0010	0.0010	7762456
Dissolved Uranium (U)	mg/L	0.016	0.00010	7762456
Dissolved Vanadium (V)	mg/L	<0.0010	0.0010	7762456
Dissolved Zinc (Zn)	mg/L	0.0052	0.0030	7762456
RDL = Reportable Detection Limit				
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.				

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

REGULATED METALS (CCME/AT1) - TOTAL

Maxxam ID		LK1838		LK1839	LK1840		
Sampling Date		2014/12/18 12:30		2014/12/18 13:00	2014/12/18 14:00		
COC Number		A096866		A096866	A096866		
	Units	MW12	RDL	MW6	MW3	RDL	QC Batch
Low Level Elements							
Total Cadmium (Cd)	mg/L	0.0027	0.000020	0.0041	0.0052	0.000020	7760141
Elements							
Total Aluminum (Al)	mg/L	28	0.0030	29	41	0.0030	7761143
Total Antimony (Sb)	mg/L	0.0012	0.00060	0.0018	0.0013	0.00060	7761143
Total Arsenic (As)	mg/L	0.053	0.00020	0.11	0.048	0.00020	7761143
Total Barium (Ba)	mg/L	1.3	0.010	0.98	2.5	0.010	7761144
Total Beryllium (Be)	mg/L	0.0033	0.0010	0.0051	0.0045	0.0010	7761143
Total Boron (B)	mg/L	0.076	0.020	0.13	0.15	0.020	7761144
Total Calcium (Ca)	mg/L	440	0.30	530 (1)	590 (1)	1.5	7761144
Total Chromium (Cr)	mg/L	0.064	0.0010	0.059	0.070	0.0010	7761143
Total Cobalt (Co)	mg/L	0.044	0.00030	0.064	0.040	0.00030	7761143
Total Copper (Cu)	mg/L	0.0020	0.00020	0.14	0.12	0.00020	7761143
Total Iron (Fe)	mg/L	130	0.060	200	110	0.060	7761144
Total Lead (Pb)	mg/L	0.047	0.00020	0.053	0.069	0.00020	7761143
Total Lithium (Li)	mg/L	0.065	0.020	0.16	0.095	0.020	7761144
Total Magnesium (Mg)	mg/L	200	0.20	320	430	0.20	7761144
Total Manganese (Mn)	mg/L	3.4	0.0040	3.2	2.3	0.0040	7761144
Total Molybdenum (Mo)	mg/L	0.014	0.00020	0.021	0.0057	0.00020	7761143
Total Nickel (Ni)	mg/L	0.13	0.00050	0.18	0.14	0.00050	7761143
Total Phosphorus (P)	mg/L	3.6	0.10	5.2	5.8	0.10	7761144
Total Potassium (K)	mg/L	14	0.30	24	26	0.30	7761144
Total Selenium (Se)	mg/L	0.0035	0.00020	0.035	0.0024	0.00020	7761143
Total Silicon (Si)	mg/L	35	0.10	42	59	0.10	7761144
Total Silver (Ag)	mg/L	0.00076	0.00010	0.00073	0.0011	0.00010	7761143
Total Sodium (Na)	mg/L	83	0.50	240	270	0.50	7761144
Total Strontium (Sr)	mg/L	1.7	0.020	3.4	2.5	0.020	7761144
Total Sulphur (S)	mg/L	290	0.20	560 (1)	700 (1)	1.0	7761144
Total Thallium (Tl)	mg/L	0.00052	0.00020	0.0013	0.0012	0.00020	7761143
Total Tin (Sn)	mg/L	0.0021	0.0010	0.0019	0.0034	0.0010	7761143
Total Titanium (Ti)	mg/L	0.13	0.0010	0.22	0.26	0.0010	7761143
Total Uranium (U)	mg/L	0.018	0.00010	0.0087	0.024	0.00010	7761143
Total Vanadium (V)	mg/L	0.11	0.0010	0.14	0.12	0.0010	7761143
Total Zinc (Zn)	mg/L	0.41	0.0030	0.42	0.60	0.0030	7761143
RDL = Reportable Detection Limit							
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.							

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

REGULATED METALS (CCME/AT1) - TOTAL

Maxxam ID		LK1841		
Sampling Date		2014/12/18 13:30		
COC Number		A096866		
	Units	FIELD BLANK	RDL	QC Batch
Low Level Elements				
Total Cadmium (Cd)	mg/L	0.000058	0.000020	7760141
Elements				
Total Aluminum (Al)	mg/L	0.0031	0.0030	7761143
Total Antimony (Sb)	mg/L	<0.00060	0.00060	7761143
Total Arsenic (As)	mg/L	<0.00020	0.00020	7761143
Total Barium (Ba)	mg/L	<0.010	0.010	7761144
Total Beryllium (Be)	mg/L	<0.0010	0.0010	7761143
Total Boron (B)	mg/L	<0.020	0.020	7761144
Total Calcium (Ca)	mg/L	<0.30	0.30	7761144
Total Chromium (Cr)	mg/L	<0.0010	0.0010	7761143
Total Cobalt (Co)	mg/L	<0.00030	0.00030	7761143
Total Copper (Cu)	mg/L	<0.00020	0.00020	7761143
Total Iron (Fe)	mg/L	<0.060	0.060	7761144
Total Lead (Pb)	mg/L	<0.00020	0.00020	7761143
Total Lithium (Li)	mg/L	<0.020	0.020	7761144
Total Magnesium (Mg)	mg/L	<0.20	0.20	7761144
Total Manganese (Mn)	mg/L	<0.0040	0.0040	7761144
Total Molybdenum (Mo)	mg/L	<0.00020	0.00020	7761143
Total Nickel (Ni)	mg/L	<0.00050	0.00050	7761143
Total Phosphorus (P)	mg/L	<0.10	0.10	7761144
Total Potassium (K)	mg/L	<0.30	0.30	7761144
Total Selenium (Se)	mg/L	<0.00020	0.00020	7761143
Total Silicon (Si)	mg/L	<0.10	0.10	7761144
Total Silver (Ag)	mg/L	<0.00010	0.00010	7761143
Total Sodium (Na)	mg/L	<0.50	0.50	7761144
Total Strontium (Sr)	mg/L	<0.020	0.020	7761144
Total Sulphur (S)	mg/L	<0.20	0.20	7761144
Total Thallium (Tl)	mg/L	<0.00020	0.00020	7761143
Total Tin (Sn)	mg/L	<0.0010	0.0010	7761143
Total Titanium (Ti)	mg/L	<0.0010	0.0010	7761143
Total Uranium (U)	mg/L	<0.00010	0.00010	7761143
Total Vanadium (V)	mg/L	<0.0010	0.0010	7761143
Total Zinc (Zn)	mg/L	<0.0030	0.0030	7761143
RDL = Reportable Detection Limit				

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

SEMIVOLATILE ORGANICS BY GC-MS (GROUND WATER)

Maxxam ID		LK1838		LK1839	LK1840		
Sampling Date		2014/12/18 12:30		2014/12/18 13:00	2014/12/18 14:00		
COC Number		A096866		A096866	A096866		
	Units	MW12	RDL	MW6	MW3	RDL	QC Batch
Polycyclic Aromatics							
Benzo[a]pyrene equivalency	ug/L	0.023	0.010	<0.010	<0.010	0.010	7760200
Acenaphthene	mg/L	<0.00025	0.00025	<0.00010	<0.00010	0.00010	7761697
Acenaphthylene	mg/L	<0.00025	0.00025	<0.00010	<0.00010	0.00010	7761697
Acridine	mg/L	<0.00050	0.00050	<0.00020	<0.00020	0.00020	7761697
Anthracene	mg/L	<0.000025	0.000025	0.000014	<0.000010	0.000010	7761697
Benzo(a)anthracene	mg/L	<0.000021	0.000021	<0.0000085	<0.0000085	0.0000085	7761697
Benzo(b&j)fluoranthene	mg/L	<0.000021	0.000021	<0.0000085	<0.0000085	0.0000085	7761697
Benzo(k)fluoranthene	mg/L	<0.000021	0.000021	<0.0000085	<0.0000085	0.0000085	7761697
Benzo(g,h,i)perylene	mg/L	<0.000021	0.000021	<0.0000085	<0.0000085	0.0000085	7761697
Benzo(c)phenanthrene	mg/L	<0.00013	0.00013	<0.000050	<0.000050	0.000050	7761697
Benzo(a)pyrene	mg/L	<0.000019	0.000019	<0.0000075	<0.0000075	0.0000075	7761697
Benzo[e]pyrene	mg/L	<0.00013	0.00013	<0.000050	<0.000050	0.000050	7761697
Chrysene	mg/L	<0.000021	0.000021	0.000011	<0.0000085	0.0000085	7761697
Dibenz(a,h)anthracene	mg/L	<0.000019	0.000019	<0.0000075	<0.0000075	0.0000075	7761697
Fluoranthene	mg/L	<0.000025	0.000025	0.000062	0.000043	0.000010	7761697
Fluorene	mg/L	<0.00013	0.00013	0.000071	<0.000050	0.000050	7761697
Indeno(1,2,3-cd)pyrene	mg/L	<0.000021	0.000021	<0.0000085	<0.0000085	0.0000085	7761697
2-Methylnaphthalene	mg/L	<0.00025	0.00025	0.00013	<0.00010	0.00010	7761697
Naphthalene	mg/L	<0.00025	0.00025	<0.00010	<0.00010	0.00010	7761697
Phenanthrene	mg/L	0.00015	0.00013	0.00019	<0.000050	0.000050	7761697
Perylene	mg/L	<0.00013	0.00013	<0.000050	<0.000050	0.000050	7761697
Pyrene	mg/L	0.000064	0.000050	0.000088	0.000042	0.000020	7761697
Quinoline	mg/L	<0.00050	0.00050	<0.00020	<0.00020	0.00020	7761697
Surrogate Recovery (%)							
D10-ANTHRACENE (sur.)	%	115	N/A	86	92	N/A	7761697
D12-BENZO(A)PYRENE (sur.)	%	65	N/A	42 (1)	43 (1)	N/A	7761697
D8-ACENAPHTHYLENE (sur.)	%	103	N/A	78	85	N/A	7761697
TERPHENYL-D14 (sur.)	%	73	N/A	50	55	N/A	7761697
RDL = Reportable Detection Limit							
N/A = Not Applicable							
(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.							

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

SEMIVOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		LK1841		
Sampling Date		2014/12/18 13:30		
COC Number		A096866		
	Units	FIELD BLANK	RDL	QC Batch
Polycyclic Aromatics				
Benzo[a]pyrene equivalency	ug/L	<0.010	0.010	7760200
Acenaphthene	mg/L	<0.00010	0.00010	7761697
Acenaphthylene	mg/L	<0.00010	0.00010	7761697
Acridine	mg/L	<0.00020	0.00020	7761697
Anthracene	mg/L	<0.000010	0.000010	7761697
Benzo(a)anthracene	mg/L	<0.0000085	0.0000085	7761697
Benzo(b&j)fluoranthene	mg/L	<0.0000085	0.0000085	7761697
Benzo(k)fluoranthene	mg/L	<0.0000085	0.0000085	7761697
Benzo(g,h,i)perylene	mg/L	<0.0000085	0.0000085	7761697
Benzo(c)phenanthrene	mg/L	<0.000050	0.000050	7761697
Benzo(a)pyrene	mg/L	<0.0000075	0.0000075	7761697
Benzo[e]pyrene	mg/L	<0.000050	0.000050	7761697
Chrysene	mg/L	<0.0000085	0.0000085	7761697
Dibenz(a,h)anthracene	mg/L	<0.0000075	0.0000075	7761697
Fluoranthene	mg/L	<0.000010	0.000010	7761697
Fluorene	mg/L	<0.000050	0.000050	7761697
Indeno(1,2,3-cd)pyrene	mg/L	<0.0000085	0.0000085	7761697
2-Methylnaphthalene	mg/L	<0.00010	0.00010	7761697
Naphthalene	mg/L	<0.00010	0.00010	7761697
Phenanthrene	mg/L	<0.000050	0.000050	7761697
Perylene	mg/L	<0.000050	0.000050	7761697
Pyrene	mg/L	<0.000020	0.000020	7761697
Quinoline	mg/L	<0.00020	0.00020	7761697
Surrogate Recovery (%)				
D10-ANTHRACENE (sur.)	%	103	N/A	7761697
D12-BENZO(A)PYRENE (sur.)	%	84	N/A	7761697
D8-ACENAPHTHYLENE (sur.)	%	92	N/A	7761697
TERPHENYL-D14 (sur.)	%	93	N/A	7761697
RDL = Reportable Detection Limit N/A = Not Applicable				

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	5.0°C
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OC Pesticides results are attached to this report. The reference number for these results from Maxxam Campobello is B4O1588.

SEMIVOLATILE ORGANICS BY GC-MS (GROUND WATER) Comments

Sample LK1838-05 PAH in Water by GC/MS: Detection limits raised due to matrix interference.

Results relate only to the items tested.

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

QUALITY ASSURANCE REPORT

QA/QC				Date							
Batch	Init	QC Type	Parameter	Analyzed	Value	Recovery	Units	QC Limits			
7761143	MB5	Matrix Spike	Total Aluminum (Al)	2014/12/23		NC	%	80 - 120			
			Total Antimony (Sb)	2014/12/23		93	%	80 - 120			
			Total Arsenic (As)	2014/12/23		99	%	80 - 120			
			Total Beryllium (Be)	2014/12/23		91	%	80 - 120			
			Total Chromium (Cr)	2014/12/23		101	%	80 - 120			
			Total Cobalt (Co)	2014/12/23		100	%	80 - 120			
			Total Copper (Cu)	2014/12/23		NC	%	80 - 120			
			Total Lead (Pb)	2014/12/23		89	%	80 - 120			
			Total Molybdenum (Mo)	2014/12/23		102	%	80 - 120			
			Total Nickel (Ni)	2014/12/23		96	%	80 - 120			
			Total Selenium (Se)	2014/12/23		95	%	80 - 120			
			Total Silver (Ag)	2014/12/23		92	%	80 - 120			
			Total Thallium (Tl)	2014/12/23		85	%	80 - 120			
			Total Tin (Sn)	2014/12/23		NC	%	80 - 120			
			Total Titanium (Ti)	2014/12/23		NC	%	80 - 120			
			Total Uranium (U)	2014/12/23		93	%	80 - 120			
			Total Vanadium (V)	2014/12/23		107	%	80 - 120			
			Total Zinc (Zn)	2014/12/23		NC	%	80 - 120			
			7761143	MB5	Spiked Blank	Total Aluminum (Al)	2014/12/23		76 (1)	%	80 - 120
						Total Antimony (Sb)	2014/12/23		103	%	80 - 120
Total Arsenic (As)	2014/12/23					99	%	80 - 120			
Total Beryllium (Be)	2014/12/23					86	%	80 - 120			
Total Chromium (Cr)	2014/12/23					104	%	80 - 120			
Total Cobalt (Co)	2014/12/23					104	%	80 - 120			
Total Copper (Cu)	2014/12/23					103	%	80 - 120			
Total Lead (Pb)	2014/12/23					94	%	80 - 120			
Total Molybdenum (Mo)	2014/12/23					98	%	80 - 120			
Total Nickel (Ni)	2014/12/23					96	%	80 - 120			
Total Selenium (Se)	2014/12/23					101	%	80 - 120			
Total Silver (Ag)	2014/12/23					95	%	80 - 120			
Total Thallium (Tl)	2014/12/23					90	%	80 - 120			
Total Tin (Sn)	2014/12/23					99	%	80 - 120			
Total Titanium (Ti)	2014/12/23					105	%	80 - 120			
Total Uranium (U)	2014/12/23					93	%	80 - 120			
Total Vanadium (V)	2014/12/23					106	%	80 - 120			
Total Zinc (Zn)	2014/12/23					100	%	80 - 120			
7761143	MB5	Method Blank				Total Aluminum (Al)	2014/12/23	<0.0030		mg/L	
						Total Antimony (Sb)	2014/12/23	<0.00060		mg/L	
			Total Arsenic (As)	2014/12/23	<0.00020		mg/L				
			Total Beryllium (Be)	2014/12/23	<0.0010		mg/L				
			Total Chromium (Cr)	2014/12/23	<0.0010		mg/L				
			Total Cobalt (Co)	2014/12/23	<0.00030		mg/L				
			Total Copper (Cu)	2014/12/23	<0.00020		mg/L				
			Total Lead (Pb)	2014/12/23	<0.00020		mg/L				
			Total Molybdenum (Mo)	2014/12/23	<0.00020		mg/L				
			Total Nickel (Ni)	2014/12/23	<0.00050		mg/L				
			Total Selenium (Se)	2014/12/23	<0.00020		mg/L				
			Total Silver (Ag)	2014/12/23	<0.00010		mg/L				
			Total Thallium (Tl)	2014/12/23	<0.00020		mg/L				
			Total Tin (Sn)	2014/12/23	<0.0010		mg/L				
			Total Titanium (Ti)	2014/12/23	<0.0010		mg/L				
			Total Uranium (U)	2014/12/23	<0.00010		mg/L				

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7761143	MB5	RPD	Total Vanadium (V)	2014/12/23	<0.0010		mg/L	
			Total Zinc (Zn)	2014/12/23	<0.0030		mg/L	
			Total Antimony (Sb)	2014/12/23	NC		%	20
			Total Arsenic (As)	2014/12/23	1.8		%	20
			Total Beryllium (Be)	2014/12/23	NC		%	20
			Total Chromium (Cr)	2014/12/23	1.2		%	20
			Total Cobalt (Co)	2014/12/23	4.9		%	20
			Total Copper (Cu)	2014/12/23	0.44		%	20
			Total Lead (Pb)	2014/12/23	4.4		%	20
			Total Molybdenum (Mo)	2014/12/23	9.7		%	20
			Total Nickel (Ni)	2014/12/23	9.3		%	20
			Total Selenium (Se)	2014/12/23	3.2		%	20
			Total Silver (Ag)	2014/12/23	NC		%	20
			Total Thallium (Tl)	2014/12/23	NC		%	20
			Total Tin (Sn)	2014/12/23	4.6		%	20
			Total Titanium (Ti)	2014/12/23	7.4		%	20
			Total Vanadium (V)	2014/12/23	2.8		%	20
7761144	STI	Matrix Spike	Total Zinc (Zn)	2014/12/23	5.0		%	20
			Total Barium (Ba)	2014/12/20		94	%	80 - 120
			Total Boron (B)	2014/12/20		95	%	80 - 120
			Total Calcium (Ca)	2014/12/20		NC	%	80 - 120
			Total Iron (Fe)	2014/12/20		NC	%	80 - 120
			Total Lithium (Li)	2014/12/20		99	%	80 - 120
			Total Magnesium (Mg)	2014/12/20		NC	%	80 - 120
			Total Manganese (Mn)	2014/12/20		91	%	80 - 120
			Total Phosphorus (P)	2014/12/20		94	%	80 - 120
			Total Potassium (K)	2014/12/20		NC	%	80 - 120
			Total Silicon (Si)	2014/12/20		116	%	80 - 120
			Total Sodium (Na)	2014/12/20		NC	%	80 - 120
			Total Strontium (Sr)	2014/12/20		92	%	80 - 120
	STI	Spiked Blank	Total Barium (Ba)	2014/12/20		99	%	80 - 120
			Total Boron (B)	2014/12/20		99	%	80 - 120
			Total Calcium (Ca)	2014/12/20		96	%	80 - 120
			Total Iron (Fe)	2014/12/20		99	%	80 - 120
			Total Lithium (Li)	2014/12/20		104	%	80 - 120
			Total Magnesium (Mg)	2014/12/20		100	%	80 - 120
			Total Manganese (Mn)	2014/12/20		94	%	80 - 120
			Total Phosphorus (P)	2014/12/20		96	%	80 - 120
			Total Potassium (K)	2014/12/20		100	%	80 - 120
			Total Silicon (Si)	2014/12/20		90	%	80 - 120
	STI	Method Blank	Total Sodium (Na)	2014/12/20		98	%	80 - 120
			Total Strontium (Sr)	2014/12/20		97	%	80 - 120
			Total Barium (Ba)	2014/12/20	<0.010		mg/L	
			Total Boron (B)	2014/12/20	<0.020		mg/L	
			Total Calcium (Ca)	2014/12/20	<0.30		mg/L	
			Total Iron (Fe)	2014/12/20	<0.060		mg/L	
			Total Lithium (Li)	2014/12/20	<0.020		mg/L	
7761144	STI	Method Blank	Total Magnesium (Mg)	2014/12/20	<0.20		mg/L	
			Total Manganese (Mn)	2014/12/20	<0.0040		mg/L	
			Total Phosphorus (P)	2014/12/20	<0.10		mg/L	
			Total Potassium (K)	2014/12/20	<0.30		mg/L	
			Total Silicon (Si)	2014/12/20	<0.10		mg/L	

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7761144	STI	RPD	Total Sodium (Na)	2014/12/20	<0.50		mg/L	
			Total Strontium (Sr)	2014/12/20	<0.020		mg/L	
			Total Sulphur (S)	2014/12/20	<0.20		mg/L	
			Total Boron (B)	2014/12/20	NC		%	20
			Total Iron (Fe)	2014/12/20	0.41		%	20
			Total Manganese (Mn)	2014/12/20	0.073		%	20
7761359	KBF	Spiked Blank	Alkalinity (Total as CaCO3)	2014/12/20		91	%	80 - 120
7761359	KBF	Method Blank	Alkalinity (PP as CaCO3)	2014/12/20	<0.50		mg/L	
			Alkalinity (Total as CaCO3)	2014/12/20	<0.50		mg/L	
			Bicarbonate (HCO3)	2014/12/20	<0.50		mg/L	
			Carbonate (CO3)	2014/12/20	<0.50		mg/L	
			Hydroxide (OH)	2014/12/20	<0.50		mg/L	
7761359	KBF	RPD	Alkalinity (PP as CaCO3)	2014/12/20	NC		%	20
			Alkalinity (Total as CaCO3)	2014/12/20	6.0		%	20
			Bicarbonate (HCO3)	2014/12/20	6.0		%	20
			Carbonate (CO3)	2014/12/20	NC		%	20
			Hydroxide (OH)	2014/12/20	NC		%	20
7761363	KBF	Spiked Blank	pH	2014/12/20		100	%	97 - 103
7761363	KBF	RPD	pH	2014/12/20	0.47		%	N/A
7761364	KBF	Spiked Blank	Conductivity	2014/12/20		101	%	90 - 110
7761364	KBF	Method Blank	Conductivity	2014/12/20	<1.0		uS/cm	
7761364	KBF	RPD	Conductivity	2014/12/20	0.18		%	20
7761369	STI	Matrix Spike	Dissolved Barium (Ba)	2014/12/20		97	%	80 - 120
			Dissolved Boron (B)	2014/12/20		99	%	80 - 120
			Dissolved Calcium (Ca)	2014/12/20		95	%	80 - 120
			Dissolved Iron (Fe)	2014/12/20		96	%	80 - 120
			Dissolved Lithium (Li)	2014/12/20		101	%	80 - 120
			Dissolved Magnesium (Mg)	2014/12/20		101	%	80 - 120
			Dissolved Manganese (Mn)	2014/12/20		94	%	80 - 120
			Dissolved Phosphorus (P)	2014/12/20		101	%	80 - 120
			Dissolved Potassium (K)	2014/12/20		101	%	80 - 120
			Dissolved Silicon (Si)	2014/12/20		92	%	80 - 120
			Dissolved Sodium (Na)	2014/12/20		NC	%	80 - 120
			Dissolved Strontium (Sr)	2014/12/20		96	%	80 - 120
			Dissolved Barium (Ba)	2014/12/20		94	%	80 - 120
			Dissolved Boron (B)	2014/12/20		96	%	80 - 120
			Dissolved Calcium (Ca)	2014/12/20		93	%	80 - 120
			Dissolved Iron (Fe)	2014/12/20		93	%	80 - 120
			Dissolved Lithium (Li)	2014/12/20		99	%	80 - 120
			Dissolved Magnesium (Mg)	2014/12/20		99	%	80 - 120
			Dissolved Manganese (Mn)	2014/12/20		91	%	80 - 120
			Dissolved Phosphorus (P)	2014/12/20		98	%	80 - 120
			Dissolved Potassium (K)	2014/12/20		99	%	80 - 120
			Dissolved Silicon (Si)	2014/12/20		90	%	80 - 120
			Dissolved Sodium (Na)	2014/12/20		93	%	80 - 120
			Dissolved Strontium (Sr)	2014/12/20		93	%	80 - 120
7761369	STI	Method Blank	Dissolved Barium (Ba)	2014/12/20	<0.010		mg/L	
			Dissolved Boron (B)	2014/12/20	0.026,		mg/L	
					RDL=0.020			
			Dissolved Calcium (Ca)	2014/12/20	<0.30		mg/L	
			Dissolved Iron (Fe)	2014/12/20	<0.060		mg/L	
			Dissolved Lithium (Li)	2014/12/20	<0.020		mg/L	

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7761369	STI	RPD	Dissolved Magnesium (Mg)	2014/12/20	<0.20		mg/L	
			Dissolved Manganese (Mn)	2014/12/20	<0.0040		mg/L	
			Dissolved Phosphorus (P)	2014/12/20	<0.10		mg/L	
			Dissolved Potassium (K)	2014/12/20	<0.30		mg/L	
			Dissolved Silicon (Si)	2014/12/20	<0.10		mg/L	
			Dissolved Sodium (Na)	2014/12/20	<0.50		mg/L	
			Dissolved Strontium (Sr)	2014/12/20	<0.020		mg/L	
			Dissolved Sulphur (S)	2014/12/20	<0.20		mg/L	
			Dissolved Barium (Ba)	2014/12/20	NC		%	20
			Dissolved Boron (B)	2014/12/20	NC		%	20
			Dissolved Calcium (Ca)	2014/12/20	0.26		%	20
			Dissolved Iron (Fe)	2014/12/20	NC		%	20
			Dissolved Lithium (Li)	2014/12/20	NC		%	20
			Dissolved Magnesium (Mg)	2014/12/20	0.29		%	20
			Dissolved Manganese (Mn)	2014/12/20	NC		%	20
			Dissolved Phosphorus (P)	2014/12/20	NC		%	20
			Dissolved Potassium (K)	2014/12/20	0.40		%	20
			Dissolved Silicon (Si)	2014/12/20	0.16		%	20
			Dissolved Sodium (Na)	2014/12/20	0.74		%	20
			Dissolved Strontium (Sr)	2014/12/20	NC		%	20
			Dissolved Sulphur (S)	2014/12/20	1.9		%	20
7761697	SJ1	Matrix Spike	D10-ANTHRACENE (sur.)	2014/12/24		104	%	50 - 130
			D12-BENZO(A)PYRENE (sur.)	2014/12/24		41 (1)	%	50 - 130
			D8-ACENAPHTHYLENE (sur.)	2014/12/24		113	%	50 - 130
			TERPHENYL-D14 (sur.)	2014/12/24		51	%	50 - 130
			Acenaphthene	2014/12/24		95	%	50 - 130
			Acenaphthylene	2014/12/24		101	%	50 - 130
			Acridine	2014/12/24		84	%	50 - 130
			Anthracene	2014/12/24		90	%	50 - 130
			Benzo(a)anthracene	2014/12/24		94	%	50 - 130
			Benzo(b&j)fluoranthene	2014/12/24		85	%	50 - 130
			Benzo(k)fluoranthene	2014/12/24		85	%	50 - 130
			Benzo(g,h,i)perylene	2014/12/24		82	%	50 - 130
			Benzo(c)phenanthrene	2014/12/24		90	%	50 - 130
			Benzo(a)pyrene	2014/12/24		90	%	50 - 130
			Benzo[e]pyrene	2014/12/24		87	%	50 - 130
			Chrysene	2014/12/24		86	%	50 - 130
			Dibenz(a,h)anthracene	2014/12/24		86	%	50 - 130
			Fluoranthene	2014/12/24		100	%	50 - 130
			Fluorene	2014/12/24		103	%	50 - 130
			Indeno(1,2,3-cd)pyrene	2014/12/24		99	%	50 - 130
			2-Methylnaphthalene	2014/12/24		95	%	50 - 130
			Naphthalene	2014/12/24		97	%	50 - 130
			Phenanthrene	2014/12/24		95	%	50 - 130
			Perylene	2014/12/24		86	%	50 - 130
			Pyrene	2014/12/24		102	%	50 - 130
			Quinoline	2014/12/24		86	%	50 - 130
			D10-ANTHRACENE (sur.)	2014/12/23		96	%	50 - 130
			D12-BENZO(A)PYRENE (sur.)	2014/12/23		98	%	50 - 130
			D8-ACENAPHTHYLENE (sur.)	2014/12/23		91	%	50 - 130
			TERPHENYL-D14 (sur.)	2014/12/23		103	%	50 - 130
			Acenaphthene	2014/12/23		82	%	50 - 130
7761697	SJ1	Spiked Blank						

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				Acenaphthylene	2014/12/23		87	%	50 - 130
				Acridine	2014/12/23		91	%	50 - 130
				Anthracene	2014/12/23		81	%	50 - 130
				Benzo(a)anthracene	2014/12/23		93	%	50 - 130
				Benzo(b&j)fluoranthene	2014/12/23		87	%	50 - 130
				Benzo(k)fluoranthene	2014/12/23		84	%	50 - 130
				Benzo(g,h,i)perylene	2014/12/23		88	%	50 - 130
				Benzo(c)phenanthrene	2014/12/23		82	%	50 - 130
				Benzo(a)pyrene	2014/12/23		90	%	50 - 130
				Benzo[e]pyrene	2014/12/23		89	%	50 - 130
				Chrysene	2014/12/23		85	%	50 - 130
				Dibenz(a,h)anthracene	2014/12/23		93	%	50 - 130
				Fluoranthene	2014/12/23		93	%	50 - 130
				Fluorene	2014/12/23		90	%	50 - 130
				Indeno(1,2,3-cd)pyrene	2014/12/23		105	%	50 - 130
				2-Methylnaphthalene	2014/12/23		76	%	50 - 130
				Naphthalene	2014/12/23		78	%	50 - 130
				Phenanthrene	2014/12/23		83	%	50 - 130
				Perylene	2014/12/23		87	%	50 - 130
				Pyrene	2014/12/23		96	%	50 - 130
				Quinoline	2014/12/23		90	%	50 - 130
7761697	SJ1		Method Blank	D10-ANTHRACENE (sur.)	2014/12/23		106	%	50 - 130
				D12-BENZO(A)PYRENE (sur.)	2014/12/23		110	%	50 - 130
				D8-ACENAPHTHYLENE (sur.)	2014/12/23		88	%	50 - 130
				TERPHENYL-D14 (sur.)	2014/12/23		114	%	50 - 130
				Acenaphthene	2014/12/23	<0.00010		mg/L	
				Acenaphthylene	2014/12/23	<0.00010		mg/L	
				Acridine	2014/12/23	<0.00020		mg/L	
				Anthracene	2014/12/23	<0.000010		mg/L	
				Benzo(a)anthracene	2014/12/23	<0.0000085		mg/L	
				Benzo(b&j)fluoranthene	2014/12/23	<0.0000085		mg/L	
				Benzo(k)fluoranthene	2014/12/23	<0.0000085		mg/L	
				Benzo(g,h,i)perylene	2014/12/23	<0.0000085		mg/L	
				Benzo(c)phenanthrene	2014/12/23	<0.000050		mg/L	
				Benzo(a)pyrene	2014/12/23	<0.0000075		mg/L	
				Benzo[e]pyrene	2014/12/23	<0.000050		mg/L	
				Chrysene	2014/12/23	<0.0000085		mg/L	
				Dibenz(a,h)anthracene	2014/12/23	<0.0000075		mg/L	
				Fluoranthene	2014/12/23	<0.000010		mg/L	
				Fluorene	2014/12/23	<0.000050		mg/L	
				Indeno(1,2,3-cd)pyrene	2014/12/23	<0.0000085		mg/L	
				2-Methylnaphthalene	2014/12/23	<0.00010		mg/L	
				Naphthalene	2014/12/23	<0.00010		mg/L	
				Phenanthrene	2014/12/23	<0.000050		mg/L	
				Perylene	2014/12/23	<0.000050		mg/L	
				Pyrene	2014/12/23	<0.000020		mg/L	
				Quinoline	2014/12/23	<0.00020		mg/L	
7761697	SJ1		RPD	Acenaphthene	2014/12/23	NC		%	40
				Acenaphthylene	2014/12/23	NC		%	40
				Acridine	2014/12/23	NC		%	40
				Anthracene	2014/12/23	NC		%	40
				Benzo(a)anthracene	2014/12/23	NC		%	40

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			Benzo(b&j)fluoranthene	2014/12/23	NC		%	40
			Benzo(k)fluoranthene	2014/12/23	NC		%	40
			Benzo(g,h,i)perylene	2014/12/23	NC		%	40
			Benzo(c)phenanthrene	2014/12/23	NC		%	40
			Benzo(a)pyrene	2014/12/23	NC		%	40
			Benzo[e]pyrene	2014/12/23	NC		%	40
			Chrysene	2014/12/23	NC		%	40
			Dibenz(a,h)anthracene	2014/12/23	NC		%	40
			Fluoranthene	2014/12/23	NC		%	40
			Fluorene	2014/12/23	NC		%	40
			Indeno(1,2,3-cd)pyrene	2014/12/23	NC		%	40
			2-Methylnaphthalene	2014/12/23	NC		%	40
			Naphthalene	2014/12/23	NC		%	40
			Phenanthrene	2014/12/23	NC		%	40
			Perylene	2014/12/23	NC		%	40
			Pyrene	2014/12/23	NC		%	40
			Quinoline	2014/12/23	NC		%	40
7761700	MWB	Matrix Spike	O-TERPHENYL (sur.)	2014/12/22		107	%	50 - 130
			F2 (C10-C16 Hydrocarbons)	2014/12/22		108	%	50 - 130
7761700	MWB	Spiked Blank	O-TERPHENYL (sur.)	2014/12/22		94	%	50 - 130
			F2 (C10-C16 Hydrocarbons)	2014/12/22		94	%	70 - 130
7761700	MWB	Method Blank	O-TERPHENYL (sur.)	2014/12/22		94	%	50 - 130
			F2 (C10-C16 Hydrocarbons)	2014/12/22	<0.10		mg/L	
7761700	MWB	RPD	F2 (C10-C16 Hydrocarbons)	2014/12/22	NC		%	40
7761954	JLD	Matrix Spike	Dissolved Nitrite (N)	2014/12/22		100	%	80 - 120
			Dissolved Nitrate (N)	2014/12/22		100	%	80 - 120
7761954	JLD	Spiked Blank	Dissolved Nitrite (N)	2014/12/22		102	%	80 - 120
			Dissolved Nitrate (N)	2014/12/22		103	%	80 - 120
7761954	JLD	Method Blank	Dissolved Nitrite (N)	2014/12/22	<0.010		mg/L	
			Dissolved Nitrate (N)	2014/12/22	<0.010		mg/L	
7761954	JLD	RPD	Dissolved Nitrite (N)	2014/12/22	NC		%	20
			Dissolved Nitrate (N)	2014/12/22	NC		%	20
7761959	JLD	Matrix Spike	Dissolved Nitrite (N)	2014/12/22		95	%	80 - 120
			Dissolved Nitrate (N)	2014/12/22		97	%	80 - 120
7761959	JLD	Spiked Blank	Dissolved Nitrite (N)	2014/12/22		101	%	80 - 120
			Dissolved Nitrate (N)	2014/12/22		102	%	80 - 120
7761959	JLD	Method Blank	Dissolved Nitrite (N)	2014/12/22	<0.010		mg/L	
			Dissolved Nitrate (N)	2014/12/22	<0.010		mg/L	
7761959	JLD	RPD	Dissolved Nitrite (N)	2014/12/22	NC		%	20
			Dissolved Nitrate (N)	2014/12/22	4.0		%	20
7761965	JLD	Matrix Spike [LK1838-01]	Dissolved Nitrite (N)	2014/12/22		101	%	80 - 120
			Dissolved Nitrate (N)	2014/12/22		101	%	80 - 120
7761965	JLD	Spiked Blank	Dissolved Nitrite (N)	2014/12/22		101	%	80 - 120
			Dissolved Nitrate (N)	2014/12/22		102	%	80 - 120
7761965	JLD	Method Blank	Dissolved Nitrite (N)	2014/12/22	<0.010		mg/L	
			Dissolved Nitrate (N)	2014/12/22	<0.010		mg/L	
7761965	JLD	RPD [LK1838-01]	Dissolved Nitrite (N)	2014/12/22	NC		%	20
			Dissolved Nitrate (N)	2014/12/22	NC		%	20
7762456	MB5	Matrix Spike	Dissolved Aluminum (Al)	2014/12/23		106	%	80 - 120
			Dissolved Antimony (Sb)	2014/12/23		54 (1)	%	80 - 120
			Dissolved Arsenic (As)	2014/12/23		95	%	80 - 120
			Dissolved Beryllium (Be)	2014/12/23		96	%	80 - 120

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC				Date		Recovery	Units	QC Limits			
Batch	Init	QC Type	Parameter	Analyzed	Value						
7762456	MB5	Spiked Blank	Dissolved Chromium (Cr)	2014/12/23		92	%	80 - 120			
			Dissolved Cobalt (Co)	2014/12/23		92	%	80 - 120			
			Dissolved Copper (Cu)	2014/12/23		92	%	80 - 120			
			Dissolved Lead (Pb)	2014/12/23		91	%	80 - 120			
			Dissolved Molybdenum (Mo)	2014/12/23		96	%	80 - 120			
			Dissolved Nickel (Ni)	2014/12/23		91	%	80 - 120			
			Dissolved Selenium (Se)	2014/12/23		91	%	80 - 120			
			Dissolved Silver (Ag)	2014/12/23		91	%	80 - 120			
			Dissolved Thallium (Tl)	2014/12/23		90	%	80 - 120			
			Dissolved Tin (Sn)	2014/12/23		92	%	80 - 120			
			Dissolved Titanium (Ti)	2014/12/23		93	%	80 - 120			
			Dissolved Uranium (U)	2014/12/23		90	%	80 - 120			
			Dissolved Vanadium (V)	2014/12/23		97	%	80 - 120			
			Dissolved Zinc (Zn)	2014/12/23		101	%	80 - 120			
			Dissolved Aluminum (Al)	2014/12/23		76 (1)	%	80 - 120			
			Dissolved Antimony (Sb)	2014/12/23		101	%	80 - 120			
			Dissolved Arsenic (As)	2014/12/23		98	%	80 - 120			
			Dissolved Beryllium (Be)	2014/12/23		88	%	80 - 120			
			Dissolved Chromium (Cr)	2014/12/23		95	%	80 - 120			
			Dissolved Cobalt (Co)	2014/12/23		103	%	80 - 120			
			Dissolved Copper (Cu)	2014/12/23		102	%	80 - 120			
			Dissolved Lead (Pb)	2014/12/23		94	%	80 - 120			
			Dissolved Molybdenum (Mo)	2014/12/23		98	%	80 - 120			
			Dissolved Nickel (Ni)	2014/12/23		97	%	80 - 120			
			Dissolved Selenium (Se)	2014/12/23		99	%	80 - 120			
			Dissolved Silver (Ag)	2014/12/23		95	%	80 - 120			
			Dissolved Thallium (Tl)	2014/12/23		90	%	80 - 120			
			Dissolved Tin (Sn)	2014/12/23		98	%	80 - 120			
			Dissolved Titanium (Ti)	2014/12/23		100	%	80 - 120			
			Dissolved Uranium (U)	2014/12/23		94	%	80 - 120			
			Dissolved Vanadium (V)	2014/12/23		104	%	80 - 120			
			Dissolved Zinc (Zn)	2014/12/23		98	%	80 - 120			
7762456	MB5	Method Blank	Dissolved Aluminum (Al)	2014/12/23	<0.0030		mg/L				
			Dissolved Antimony (Sb)	2014/12/23	0.00061, RDL=0.00060		mg/L				
			Dissolved Arsenic (As)	2014/12/23	<0.00020		mg/L				
			Dissolved Beryllium (Be)	2014/12/23	<0.0010		mg/L				
			Dissolved Chromium (Cr)	2014/12/23	<0.0010		mg/L				
			Dissolved Cobalt (Co)	2014/12/23	<0.00030		mg/L				
			Dissolved Copper (Cu)	2014/12/23	<0.00020		mg/L				
			Dissolved Lead (Pb)	2014/12/23	<0.00020		mg/L				
			Dissolved Molybdenum (Mo)	2014/12/23	<0.00020		mg/L				
			Dissolved Nickel (Ni)	2014/12/23	<0.00050		mg/L				
			Dissolved Selenium (Se)	2014/12/23	<0.00020		mg/L				
			Dissolved Silver (Ag)	2014/12/23	<0.00010		mg/L				
			Dissolved Thallium (Tl)	2014/12/23	<0.00020		mg/L				
			Dissolved Tin (Sn)	2014/12/23	<0.0010		mg/L				
			Dissolved Titanium (Ti)	2014/12/23	<0.0010		mg/L				
			Dissolved Uranium (U)	2014/12/23	<0.00010		mg/L				
			Dissolved Vanadium (V)	2014/12/23	<0.0010		mg/L				
			Dissolved Zinc (Zn)	2014/12/23	<0.0030		mg/L				
			7762456	MB5	RPD	Dissolved Aluminum (Al)	2014/12/23	NC		%	20

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Dissolved Antimony (Sb)	2014/12/23	NC		%	20
			Dissolved Arsenic (As)	2014/12/23	NC		%	20
			Dissolved Beryllium (Be)	2014/12/23	NC		%	20
			Dissolved Chromium (Cr)	2014/12/23	NC		%	20
			Dissolved Cobalt (Co)	2014/12/23	NC		%	20
			Dissolved Copper (Cu)	2014/12/23	4.3		%	20
			Dissolved Lead (Pb)	2014/12/23	NC		%	20
			Dissolved Molybdenum (Mo)	2014/12/23	NC		%	20
			Dissolved Nickel (Ni)	2014/12/23	NC		%	20
			Dissolved Selenium (Se)	2014/12/23	NC		%	20
			Dissolved Silver (Ag)	2014/12/23	NC		%	20
			Dissolved Thallium (Tl)	2014/12/23	NC		%	20
			Dissolved Tin (Sn)	2014/12/23	NC		%	20
			Dissolved Titanium (Ti)	2014/12/23	NC		%	20
			Dissolved Uranium (U)	2014/12/23	NC		%	20
			Dissolved Vanadium (V)	2014/12/23	NC		%	20
			Dissolved Zinc (Zn)	2014/12/23	NC		%	20
7763440	RSU	Matrix Spike [LK1839-06]	1,4-Difluorobenzene (sur.)	2014/12/23		102	%	70 - 130
			4-Bromofluorobenzene (sur.)	2014/12/23		93	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2014/12/23		98	%	70 - 130
			Benzene	2014/12/23		91	%	70 - 130
			Toluene	2014/12/23		90	%	70 - 130
			Ethylbenzene	2014/12/23		90	%	70 - 130
			m & p-Xylene	2014/12/23		91	%	70 - 130
			o-Xylene	2014/12/23		94	%	70 - 130
			(C6-C10)	2014/12/23		71	%	70 - 130
7763440	RSU	Spiked Blank	1,4-Difluorobenzene (sur.)	2014/12/23		102	%	70 - 130
			4-Bromofluorobenzene (sur.)	2014/12/23		93	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2014/12/23		93	%	70 - 130
			Benzene	2014/12/23		90	%	70 - 130
			Toluene	2014/12/23		89	%	70 - 130
			Ethylbenzene	2014/12/23		91	%	70 - 130
			m & p-Xylene	2014/12/23		92	%	70 - 130
			o-Xylene	2014/12/23		94	%	70 - 130
			(C6-C10)	2014/12/23		102	%	70 - 130
7763440	RSU	Method Blank	1,4-Difluorobenzene (sur.)	2014/12/23		103	%	70 - 130
			4-Bromofluorobenzene (sur.)	2014/12/23		91	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2014/12/23		95	%	70 - 130
			Benzene	2014/12/23	<0.00040		mg/L	
			Toluene	2014/12/23	<0.00040		mg/L	
			Ethylbenzene	2014/12/23	<0.00040		mg/L	
			m & p-Xylene	2014/12/23	<0.00080		mg/L	
			o-Xylene	2014/12/23	<0.00040		mg/L	
			Xylenes (Total)	2014/12/23	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2014/12/23	<0.10		mg/L	
			(C6-C10)	2014/12/23	<0.10		mg/L	
7763440	RSU	RPD [LK1838-06]	Benzene	2014/12/23	NC		%	40
			Toluene	2014/12/23	NC		%	40
			Ethylbenzene	2014/12/23	NC		%	40
			m & p-Xylene	2014/12/23	NC		%	40
			o-Xylene	2014/12/23	NC		%	40
			Xylenes (Total)	2014/12/23	NC		%	40

Maxxam Job #: B4B4887
Report Date: 2015/01/06

GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			F1 (C6-C10) - BTEX	2014/12/23	NC		%	40
			(C6-C10)	2014/12/23	NC		%	40
7764860	ZI	Matrix Spike	Dissolved Chloride (Cl)	2014/12/24		109	%	80 - 120
7764860	ZI	Spiked Blank	Dissolved Chloride (Cl)	2014/12/24		103	%	80 - 120
7764860	ZI	Method Blank	Dissolved Chloride (Cl)	2014/12/24	<1.0		mg/L	
7764860	ZI	RPD	Dissolved Chloride (Cl)	2014/12/24	3.5		%	20
7764871	ZI	Matrix Spike	Dissolved Sulphate (SO4)	2014/12/24		NC	%	80 - 120
7764871	ZI	Spiked Blank	Dissolved Sulphate (SO4)	2014/12/24		105	%	80 - 120
7764871	ZI	Method Blank	Dissolved Sulphate (SO4)	2014/12/24	<1.0		mg/L	
7764871	ZI	RPD	Dissolved Sulphate (SO4)	2014/12/24	3.3		%	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

Maxxam Job #: B4B4887
Report Date: 2015/01/06


GOLDER ASSOCIATES LTD.
Client Project #: 1418041-1000-2007
Site Location: BAR U RANCH NATIONAL HISTORIC SITE
Sampler Initials: EN

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Ghayasuddin Khan, M.Sc., B.Ed., P.Chem, Scientific Specialist



Michael Sheppard, Senior Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Company:	Invoice To:	C/O Report Address	<input type="checkbox"/>
Contact:	Golder Associates		
Address:	Audette Bellavance 102-12535 3 rd Ave SE, Calgary PC Alberta T2A 7W5		
Contact #s:	Ph: 403-247-3164 Cell: 403-816-0245	Pro: PC Gld: Gld.	
Report To:	Same as Invoice	<input checked="" type="checkbox"/>	
Report Distribution (E-Mail):			
	abellavance@golder.com		
	cbaumann@golder.com		
	(3) (3)		
REGULATORY GUIDELINES:	<input checked="" type="checkbox"/> AT1 <input type="checkbox"/> CCME <input type="checkbox"/> Regulated Drinking Water <input type="checkbox"/> Other:		

[illegible]

SERVICE REQUESTED:

☐ RUSH (Contact lab to reserve)

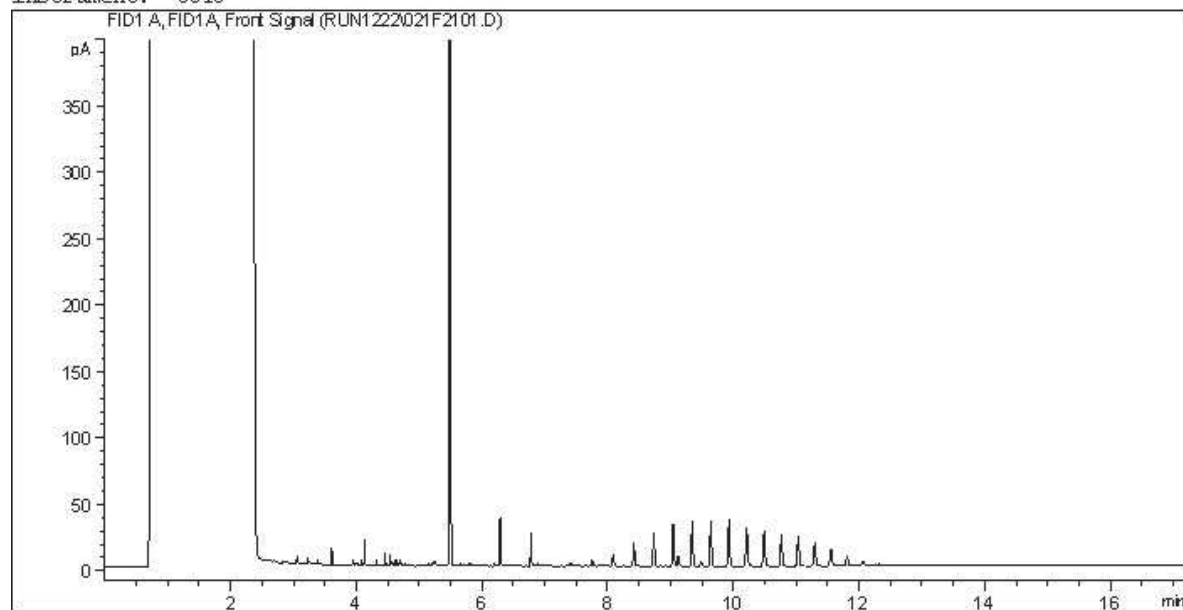
Date Required:

☒ REGULAR (5 to 7 Days)

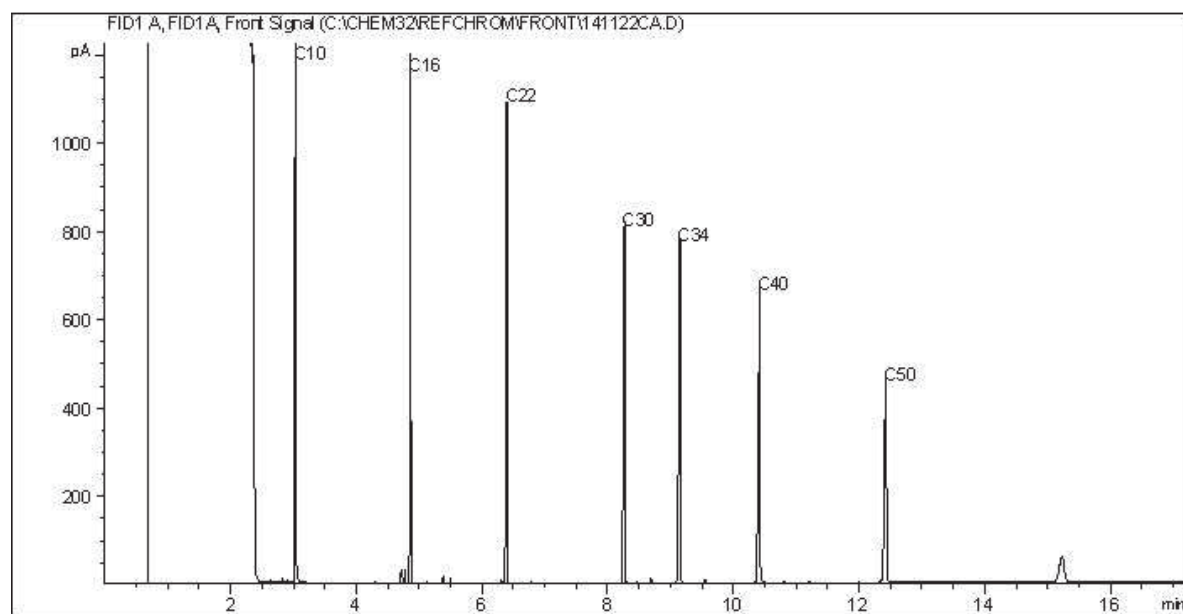
[illegible]

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

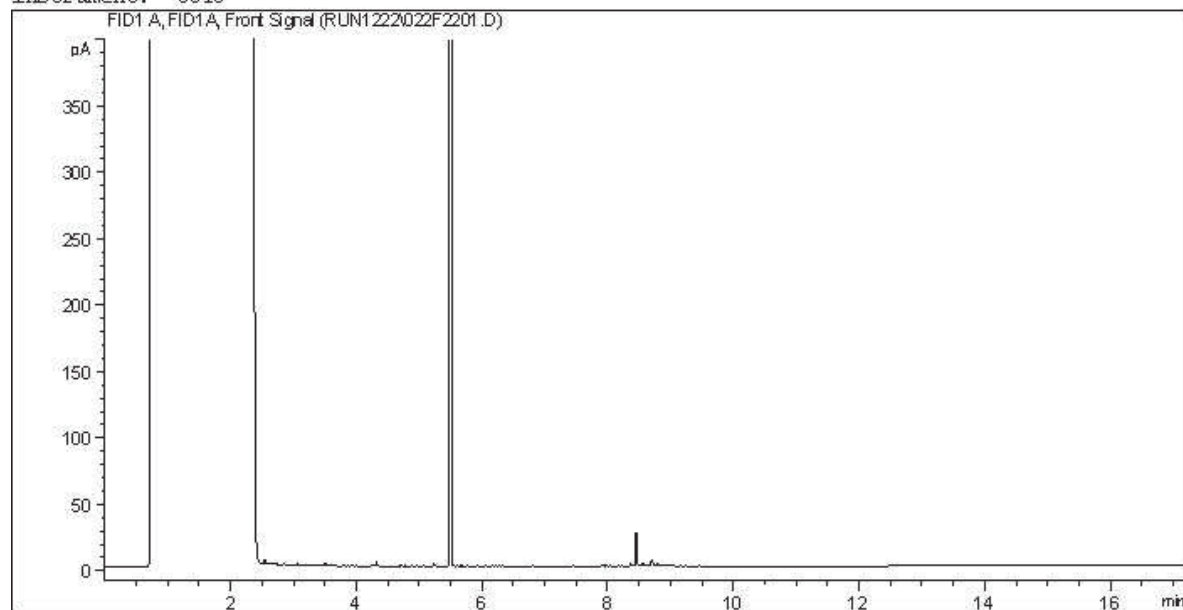
Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

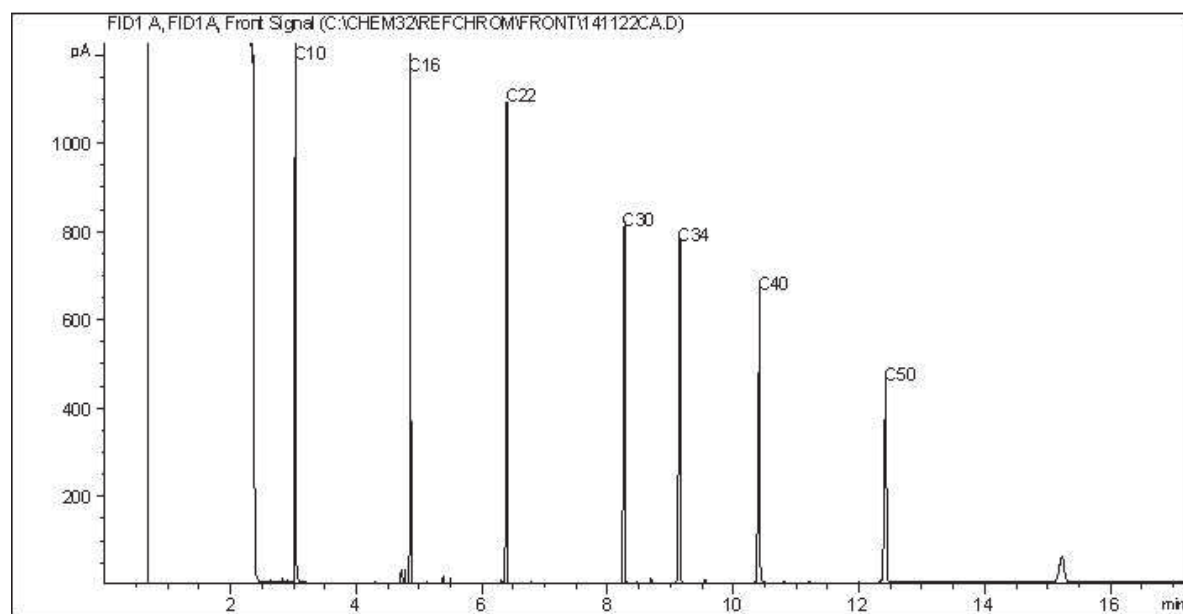
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

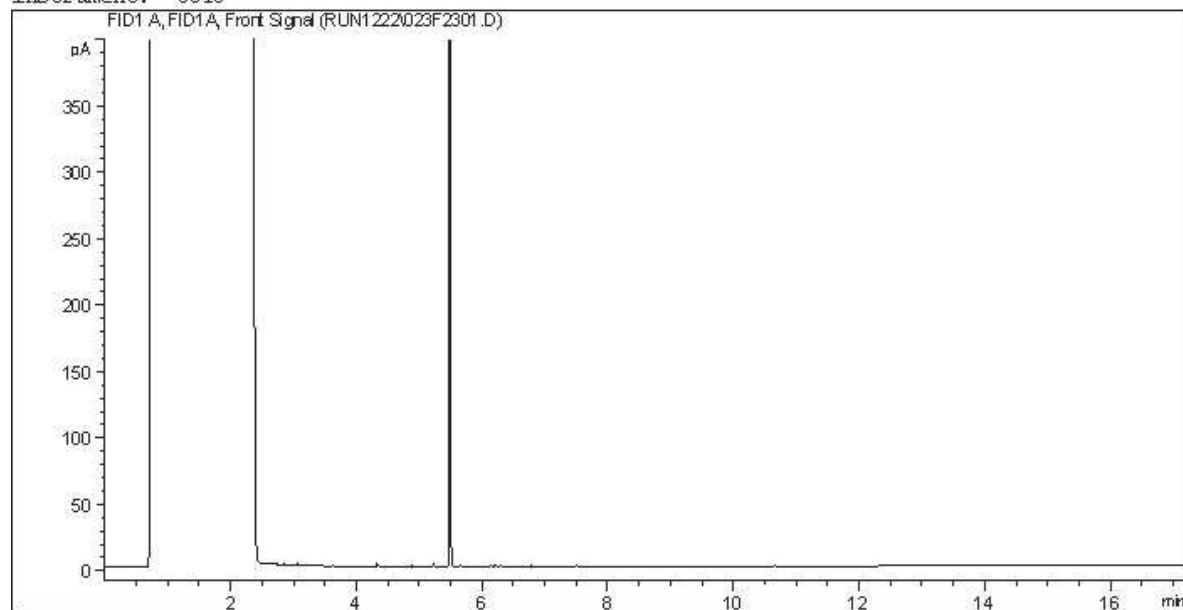
Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

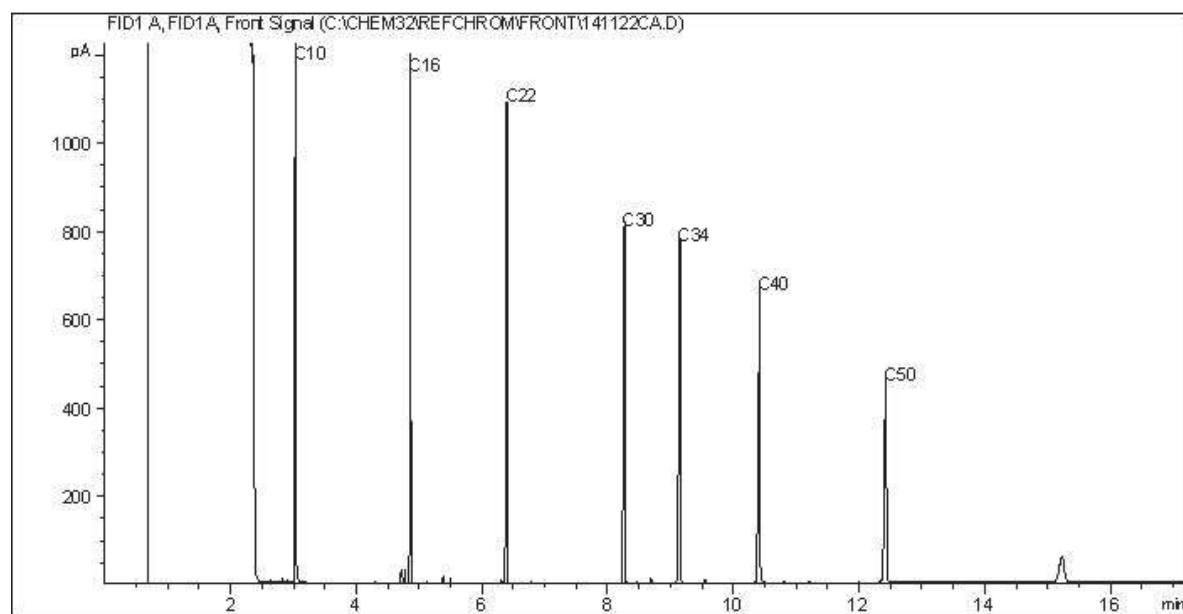
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: GC13



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Page 1 of 1

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Your Project #: 14180417000-2007
Site#: 14180417000-2007
Site Location: B4B4887
Your C.O.C. #: na

Attention: Wendy Sears

Maxxam Analytics
Calgary (Golder)
2021 41st Ave. NE
Calgary, AB
Canada

Report Date: 2015/01/05
Report #: R3277705
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4O1588

Received: 2014/12/20, 10:10

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
OC Pesticides (Selected) & PCB (1)	2	2014/12/22	2014/12/24	CAM SOP-00307	EPA 8081/8082 m
OC Pesticides Summed Parameters	2	N/A	2015/01/02	CAM SOP-00307	EPA 8081/8082 m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Chlordane (Total) = Alpha Chlordane + Gamma Chlordane

Encryption Key

Antonella Brasil

Antonella Brasil

05 Jan 2015 16:09:43 -05:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Antonella Brasil, Senior Project Manager

Email: ABrasil@maxxam.ca

Phone# (905)817-5817

=====

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B4O1588
Report Date: 2015/01/05

Maxxam Analytics
Client Project #: 14180417000-2007
Site Location: B4B4887
Sampler Initials: NV

ORGANOCHLORINATED PESTICIDES BY GC-ECD (WATER)

Maxxam ID		YY3471	YY3472		
Sampling Date		2014/12/18 12:30	2014/12/18 13:00		
COC Number		na	na		
	Units	LK1838-07R\MW12	LK1839-07R\MW6	RDL	QC Batch
Calculated Parameters					
Aldrin + Dieldrin	ug/L	<0.005	<0.005	0.005	3867389
Chlordane (Total)	ug/L	<0.005	<0.005	0.005	3867389
DDT+ Metabolites	ug/L	<0.005	<0.005	0.005	3867389
Heptachlor + Heptachlor epoxide	ug/L	<0.005	<0.005	0.005	3867389
o,p-DDD + p,p-DDD	ug/L	<0.005	<0.005	0.005	3867389
o,p-DDE + p,p-DDE	ug/L	<0.005	<0.005	0.005	3867389
o,p-DDT + p,p-DDT	ug/L	<0.005	<0.005	0.005	3867389
Total Endosulfan	ug/L	<0.005	<0.005	0.005	3867389
Total PCB	ug/L	<0.05	<0.05	0.05	3867389
Pesticides & Herbicides					
Aldrin	ug/L	<0.005	<0.005	0.005	3868612
Dieldrin	ug/L	<0.005	<0.005	0.005	3868612
a-Chlordane	ug/L	<0.005	<0.005	0.005	3868612
g-Chlordane	ug/L	<0.005	<0.005	0.005	3868612
o,p-DDD	ug/L	<0.005	<0.005	0.005	3868612
p,p-DDD	ug/L	<0.005	<0.005	0.005	3868612
o,p-DDE	ug/L	<0.005	<0.005	0.005	3868612
p,p-DDE	ug/L	<0.005	<0.005	0.005	3868612
o,p-DDT	ug/L	<0.005	<0.005	0.005	3868612
p,p-DDT	ug/L	<0.005	<0.005	0.005	3868612
Lindane	ug/L	<0.003	<0.003	0.003	3868612
Endosulfan I (alpha)	ug/L	<0.005	<0.005	0.005	3868612
Endosulfan II	ug/L	<0.005	<0.005	0.005	3868612
Endrin	ug/L	<0.005	<0.005	0.005	3868612
Heptachlor	ug/L	<0.005	<0.005	0.005	3868612
Heptachlor epoxide	ug/L	<0.005	<0.005	0.005	3868612
Hexachlorobenzene	ug/L	<0.005	<0.005	0.005	3868612
Methoxychlor	ug/L	<0.01	<0.01	0.01	3868612
Aroclor 1016	ug/L	<0.05	<0.05	0.05	3868612
Aroclor 1221	ug/L	<0.05	<0.05	0.05	3868612
Aroclor 1232	ug/L	<0.05	<0.05	0.05	3868612
Aroclor 1242	ug/L	<0.05	<0.05	0.05	3868612
Aroclor 1248	ug/L	<0.05	<0.05	0.05	3868612
RDL = Reportable Detection Limit					
QC Batch = Quality Control Batch					

Maxxam Job #: B4O1588
Report Date: 2015/01/05

Maxxam Analytics
Client Project #: 14180417000-2007
Site Location: B4B4887
Sampler Initials: NV

ORGANOCHLORINATED PESTICIDES BY GC-ECD (WATER)

Maxxam ID		YY3471	YY3472		
Sampling Date		2014/12/18 12:30	2014/12/18 13:00		
COC Number		na	na		
	Units	LK1838-07R\MW12	LK1839-07R\MW6	RDL	QC Batch
Aroclor 1254	ug/L	<0.05	<0.05	0.05	3868612
Aroclor 1260	ug/L	<0.05	<0.05	0.05	3868612
alpha-BHC	ug/L	<0.005	<0.005	0.005	3868612
beta-BHC	ug/L	<0.005	<0.005	0.005	3868612
delta-BHC	ug/L	<0.005	<0.005	0.005	3868612
Endosulfan sulfate	ug/L	<0.005	<0.005	0.005	3868612
Endrin aldehyde	ug/L	<0.005	<0.005	0.005	3868612
Endrin ketone	ug/L	<0.005	<0.005	0.005	3868612
Mirex	ug/L	<0.005	<0.005	0.005	3868612
Octachlorostyrene	ug/L	<0.005	<0.005	0.005	3868612
Oxychlordane	ug/L	<0.005	<0.005	0.005	3868612
Toxaphene	ug/L	<0.2	<0.2	0.2	3868612
Surrogate Recovery (%)					
2,4,5,6-Tetrachloro-m-xylene	%	60	54		3868612
Decachlorobiphenyl	%	76	81		3868612
RDL = Reportable Detection Limit					
QC Batch = Quality Control Batch					

Maxxam Job #: B4O1588
Report Date: 2015/01/05

Maxxam Analytics
Client Project #: 14180417000-2007
Site Location: B4B4887
Sampler Initials: NV

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	0.7°C
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Results relate only to the items tested.

Maxxam Job #: B4O1588
Report Date: 2015/01/05

QUALITY ASSURANCE REPORT

Maxxam Analytics
Client Project #: 14180417000-2007
Site Location: B4B4887
Sampler Initials: NV

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
3868612	2,4,5,6-Tetrachloro-m-xylene	2014/12/24	130	50 - 130	73	50 - 130	63	%		
3868612	Decachlorobiphenyl	2014/12/24	89	50 - 130	95	50 - 130	80	%		
3868612	a-Chlordane	2014/12/24	77	50 - 130	89	50 - 130	<0.005	ug/L	NC	30
3868612	Aldrin + Dieldrin	2014/12/24							NC	30
3868612	Aldrin	2014/12/24	70	50 - 130	85	50 - 130	<0.005	ug/L	NC	30
3868612	alpha-BHC	2014/12/24	86	30 - 130	98	30 - 130	<0.005	ug/L		
3868612	Aroclor 1016	2014/12/24					<0.05	ug/L		
3868612	Aroclor 1221	2014/12/24					<0.05	ug/L		
3868612	Aroclor 1232	2014/12/24					<0.05	ug/L		
3868612	Aroclor 1242	2014/12/24					<0.05	ug/L	NC	30
3868612	Aroclor 1248	2014/12/24					<0.05	ug/L		
3868612	Aroclor 1254	2014/12/24					<0.05	ug/L		
3868612	Aroclor 1260	2014/12/24					<0.05	ug/L		
3868612	beta-BHC	2014/12/24	68	30 - 130	82	30 - 130	<0.005	ug/L		
3868612	Chlordane (Total)	2014/12/24							NC	30
3868612	delta-BHC	2014/12/24	86	30 - 130	90	30 - 130	<0.005	ug/L		
3868612	Dieldrin	2014/12/24	77	50 - 130	96	50 - 130	<0.005	ug/L	NC	30
3868612	Endosulfan I (alpha)	2014/12/24	80	50 - 130	87	50 - 130	<0.005	ug/L		
3868612	Endosulfan II	2014/12/24	77	50 - 130	90	50 - 130	<0.005	ug/L		
3868612	Endosulfan sulfate	2014/12/24	115	30 - 130	99	30 - 130	<0.005	ug/L		
3868612	Endrin aldehyde	2014/12/24	72	30 - 130	92	30 - 130	<0.005	ug/L		
3868612	Endrin ketone	2014/12/24	150 (1)	30 - 130	91	30 - 130	<0.005	ug/L		
3868612	Endrin	2014/12/24	83	50 - 130	95	50 - 130	<0.005	ug/L		
3868612	g-Chlordane	2014/12/24	77	50 - 130	89	50 - 130	<0.005	ug/L	NC	30
3868612	Heptachlor epoxide	2014/12/24	76	50 - 130	91	50 - 130	<0.005	ug/L		
3868612	Heptachlor	2014/12/24	93	50 - 130	96	50 - 130	<0.005	ug/L		
3868612	Hexachlorobenzene	2014/12/24	67	50 - 130	83	50 - 130	<0.005	ug/L	NC	30
3868612	Lindane	2014/12/24	87	50 - 130	95	50 - 130	<0.003	ug/L	NC	30
3868612	Methoxychlor	2014/12/24	104	50 - 130	101	50 - 130	<0.01	ug/L		
3868612	Mirex	2014/12/24	78	30 - 130	88	30 - 130	<0.005	ug/L	NC	40
3868612	o,p-DDD	2014/12/24	84	50 - 130	90	50 - 130	<0.005	ug/L		
3868612	o,p-DDE	2014/12/24	75	50 - 130	86	50 - 130	<0.005	ug/L		

Maxxam Job #: B401588
Report Date: 2015/01/05

QUALITY ASSURANCE REPORT(CONT'D)

Maxxam Analytics
Client Project #: 14180417000-2007
Site Location: B4B4887
Sampler Initials: NV

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
3868612	o,p-DDT + p,p-DDT	2014/12/24							NC	30
3868612	o,p-DDT	2014/12/24	89	50 - 130	92	50 - 130	<0.005	ug/L	NC	30
3868612	Octachlorostyrene	2014/12/24	72	30 - 130	78	30 - 130	<0.005	ug/L		
3868612	Oxychlorodane	2014/12/24	70	30 - 130	87	30 - 130	<0.005	ug/L		
3868612	p,p-DDD	2014/12/24	81	50 - 130	92	50 - 130	<0.005	ug/L		
3868612	p,p-DDE	2014/12/24	78	50 - 130	83	50 - 130	<0.005	ug/L		
3868612	p,p-DDT	2014/12/24	105	50 - 130	96	50 - 130	<0.005	ug/L	NC	30
3868612	Total PCB	2014/12/24							NC	30
3868612	Toxaphene	2014/12/24					<0.2	ug/L	NC	40

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) The recovery was above the upper control limit. This may represent a high bias in some results for this specific analyte. For results that were not detected (ND), this potential bias has no impact.

Maxxam Job #: B4O1588
Report Date: 2015/01/05

Maxxam Analytics
Client Project #: 14180417000-2007
Site Location: B4B4887
Sampler Initials: NV

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Cristina Carriere

Cristina Carriere, Scientific Services

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

MAXXAM ANALYTICS
4000 19st N.E
Calgary, Alberta, T2E 6P8
Phone: (403) 291-3077
Fax: (403) 291-9468

IMMEDIATE TEST
Maxxam
SUBCONTRACTING REQUEST FORM

Page #: 1

GOLDER ASSOCIATES LTD. -
CALGARY - NATIONAL
CONTRACT
Maxxam PM Wendy Sears

To: Maxxam Ontario (From Calgary)

20-Dec-14 10:10

Job# B4B4887

☐ Yes ☐ No International Sample/BioHazard (if yes, add copy o
☐ Yes ☐ No Special Protocol (if yes, Protocol _____)

Shaun Nowickij
B4O1588

to disposal)

MAF ENV-956

Sample ID	Matrix	Test(s) Required	Container	Date Sampled	Date Required
LK1838-07R \ MW12	GRWTR	OC Pesticides and PCB -Subcontract	1(1LAG)	2014/12/18 12:30	2015/01/06
LK1839-07R \ MW6	GRWTR	OC Pesticides and PCB -Subcontract	1(1LAG)	2014/12/18 13:00	2015/01/06

	Temp. 1	Temp. 2	Temp. 3	
Cooler #1	1	0	1	Custody Seal Present YES ✓ NO Custody Seal Intact YES ✓ NO Ice Present Upon Receipt YES ✓ NO
Cooler #2				Custody Seal Present YES NO Custody Seal Intact YES NO Ice Present Upon Receipt YES NO
Cooler #3				Custody Seal Present YES NO Custody Seal Intact YES NO Ice Present Upon Receipt YES NO

Receiving Maxxam Location: Maxxam Ontario (From Calgary)

JOB #

Relinquished by (Sign)

(Print)

Adalbert Tanyi

Date and Time

2014/12/19 11:19

Received by (Sign)

(Print)

MA GDALENA COP

Date and Time

2014/12/20 10:40

Subcontract Comments

ESUBOCSELW = ORGANOCHLORINE PESTICIDE (CCME)

NOTES:

- 1) Please call us if due date cannot be met. Please reference Sample ID on your report.
- 2) Include copy of this completed form, Client COC & signed final report to calgarycustomerservice@maxxamanalytics.com

Reporting Requirements:

National:

Regional:

SHIPPING INSTRUCTIONS

☐ Ship Immediately (highlight Yellow) ☐ Ship Cold
☐ Requires 9am ☐ Ship Room Temp
☐ Requires Sat. Delivery ☐ Ship Frozen
☐ Regular Ship next available day ☐ COC Must be Attached
Sender (Print) _____ Initial _____

SHIPPING DEPARTMENT CHECKLIST

☐ Correct Shipping location
☐ Correct Sample Ids (Paperwork vs Bottles)
☐ Yes ☐ No Special-Cooler, Ice, Tape-custody seal, Date&Sign
Date Shipped _____ Number of coolers _____
Shipper (Print) _____ Initial _____

GOLDER DATA QUALITY REVIEW CHECKLISTSite Location: Bar U Ranch National Historic Site, AB Sampling Date: December 18, 2014Golder Project Number: 1418041-1000Laboratory: Maxxam - CalgaryLab Submission Number: B4B4887(B4O1588-SC)

Was the Cooler Received at the lab under a sealed and intact custody seal?	<u>n/a</u>
Was proper chain of custody of the samples documented and kept?	<u>Yes</u>
Were sample temperatures acceptable when they reached lab?:	<u>Yes</u>
Were all samples analyzed and extracted within hold times?:	<u>Yes</u>
Has lab warranted all tests were in statistical control in CoA?:	<u>Yes</u>
Was sufficient sample provided for the requested analysis?	<u>Yes</u>
Has lab warranted all samples were analyzed with limited headspace present?:	<u>Yes</u>

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Surrogate Recovery	X			All laboratory QC results are within acceptance criteria, please see QA/QC appendix.
Method Blank Concentration	X			
Laboratory Duplicate RPD	X			
Matrix Spike Recovery	X			
Blank Spike Recovery	X			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration	X			All field QC samples are within alert limits.
Trip Blank Concentration			X	
Field Duplicate RPD			X	

Is data considered reliable (Yes/No/Suspect)?: Yes

If answer is "No" or "Suspect", describe and provide rationale:

Data Reviewed by (Print): Anita ColbertData Reviewed by (Signature): Anita ColbertDate: January 21, 2015

APPENDIX D QUALITY ASSURANCE/QUALITY CONTROL

QUALITY ASSURANCE/QUALITY CONTROL

In conjunction with the field investigations completed to date, a Quality Assurance/Quality Control (QA/QC) program was implemented to ensure the integrity of the groundwater sampling and analytical testing results.

1.0 FIELD PROGRAM

All field activities tasks were completed in accordance with Golder's Technical Field Procedures by trained Golder personnel. All field activities were documented in field notes and results were recorded on standard field forms. All field equipment involved in the sampling and monitoring of groundwater was decontaminated in accordance with Golder's Technical Procedures. Groundwater samples were collected using appropriate handling protocols and were placed in sample containers provided by Maxxam Analytics Inc. (Maxxam).

All re-useable field equipment involved in collecting samples was decontaminated between each sampling location. Groundwater samples were not directly contacted by hand. To help prevent cross-contamination, a new pair of clean nitrile gloves was used for the collection of each sample.

Samples were given unique identification numbers and the sampling containers were preserved in ice-filled coolers. Samples were logged onto formal chain-of-custody documents and transported to Maxxam in Calgary for chemical analysis. Maxxam is accredited by the Canadian Association for Laboratory Accreditation Inc.

Blind field duplicate groundwater samples were submitted for analysis. Trip and field blanks were submitted for analysis, as necessary, to evaluate the potential for cross-contamination during the sampling and transportation of the samples. Submission of blind field duplicate QC samples was at a minimum rate of 10% of total samples.

2.0 LABORATORY PROGRAM

The laboratory QA/QC program included adherence to laboratory sampling and analysis protocols (e.g., hold times, sample containers, preservatives, detection limits and approved methodology) and the analysis of laboratory method blanks, laboratory sample duplicates, surrogate recovery and chemical spikes.

The laboratory method blank analysis results were used to detect interferences or impurities introduced by the laboratory equipment, reagents, or solvents. Surrogate recovery is analyzed for organics by spiking samples with known quantities of surrogate chemicals which have similar chemical properties to the parameters being analyzed. The reported recovery provides an indication of the analytical method accuracy for that sample. Matrix spikes were conducted by adding known concentrations of the analyte of interest to a sample to evaluate the effects of the sample matrix on the analytical method. The analysis of selected samples in duplicate is used to evaluate the reproducibility of the analytical method.

3.0 DATA RECEPTION

Once laboratory analytical results were received, Golder completed a review of field and laboratory quality. This included review of laboratory QC performance to confirm results are within acceptance criteria, as well as evaluation of field duplicate and blank results to confirm they were within alert limits. Upon receipt of the analytical results, Relative

Percent Difference (RPD) values between the original samples and their blind field duplicates were calculated as follows:

$$RPD\% = \frac{|S - D|}{\frac{1}{2}(S + D)} \times 100$$

Where: RPD = relative percent difference

S = sample value

D = blind field duplicate or replicate value.

Since analytical error increases near the Reportable Detection Limit (RDL), an RPD was only calculated where the concentrations of both the original and blind field duplicate samples were greater than five times the RDL. The calculated RPDs were then compared to parameter specific alert limits.

Exceedances of the QC acceptance or alert criteria were investigated with the laboratory and, if warranted, a corrective action report was requested from the laboratory.

4.0 DATA QUALITY REVIEW RESULTS

Results of the data quality review are summarized in Table D1. The RPD calculations and QC results are presented in Tables D2 to D10.

One field duplicate and two field blank and one trip blank were also submitted to the laboratory as part of the groundwater QC program.

Based on the data quality review, 13 data quality issues have been identified. These issues did not have a material effect on the reliability of the data presented in this report.

The issues are discussed in detail in Table D1.

5.0 SUMMARY OF RESULTS

Based on the review of the QA/QC results, the data presented in this report are considered to be reliable with the exception of the total selenium result for MW1 and the field duplicate sample.

Table D1
Summary of Quality Control Sample Results
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Laboratory Job Number	Matrix	Laboratory Sample ID Affected	Test Affected	Data Quality Issue	Comments
B4B4360 (B4O0942-SC)	Groundwater	LJ9563	Total Phosphorus	Dissolved metal is greater than total metal result for total phosphorus.	Dissolved metals are ran out of field filtered and preserved sample containers where as total metals are ran out of unfiltered containers and therefore it is expected that total metals results will be higher than dissolved metals results. However the results are within limits of uncertainty. Therefore, the total metal result for total phosphorus for this sample should be considered reliable.
		LJ9563 and LJ9568	Total Potassium and Total Uranium	Dissolved metal is greater than total metal result for total potassium and total uranium.	Dissolved metals are ran out of field filtered and preserved sample containers where as total metals are ran out of unfiltered containers and therefore it is expected that total metals results will be higher than dissolved metals results. However the results are within acceptable limits of precision, the result for total potassium and total uranium for this sample is considered reliable.
		LJ9563 and LJ9568	Total Selenium	Dissolved metal is greater than total metal result for total selenium.	Dissolved metals are ran out of field filtered and preserved sample containers where as total metals are ran out of unfiltered containers and therefore it is expected that total metals results will be higher than dissolved metals results. The total selenium result is significantly below the applicable guideline. Therefore, the total metal result for total selenium for this sample is considered reliable.
		LJ9564	Total Potassium	Dissolved metal is greater than total metal result for total potassium.	Dissolved metals are ran out of field filtered and preserved sample containers where as total metals are ran out of unfiltered containers and therefore it is expected that total metals results will be higher than dissolved metals results. However the results are within acceptable limits of precision, the result for total potassium for this sample is considered reliable.
		LJ9565	Total Sodium and Total Sulphur	Dissolved metal is greater than total metal result for total sodium and total sulphur.	Dissolved metals are ran out of field filtered and preserved sample containers where as total metals are ran out of unfiltered containers and therefore it is expected that total metals results will be higher than dissolved metals results. However the results are within acceptable limits of precision, the result for total sodium and total sulphur for this sample is considered reliable.
		LJ9566	Total Selenium, Total Sulphur and Total Uranium	Dissolved metal is greater than total metal result for total selenium, total sulphur and total uranium.	Dissolved metals are ran out of field filtered and preserved sample containers where as total metals are ran out of unfiltered containers and therefore it is expected that total metals results will be higher than dissolved metals results. However the results are within acceptable limits of precision, the result for total selenium, total sulphur and total uranium for this sample is considered reliable.
		LJ9568	Total Lithium	Dissolved metal is greater than total metal result for total lithium.	Dissolved metals are ran out of field filtered and preserved sample containers where as total metals are ran out of unfiltered containers and therefore it is expected that total metals results will be higher than dissolved metals results. However the results are within limits of uncertainty. Therefore, the total metal result for total lithium for this sample should be considered reliable.
		LJ9565	D12-Benzo(a)pyrene and Terphenyl-D14	D12-benzo(a)pyrene and terphenyl-d14 surrogate recovery percentage outside acceptance range of 50-130% for batch 7761697.	1 of 3 surrogates can fall outside of the acceptance range of 50-130%. Under these circumstances, the d12-benzo(a)pyrene and terphenyl-d14 data reported can be considered reliable.

Notes:

n/a - not applicable

SC - subcontracted

Table D1 (continued)
Summary of Quality Control Sample Results
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Laboratory Job Number	Matrix	Laboratory Sample ID Affected	Test Affected	Data Quality Issue	Comments
B4B4887 (B4O1588-SC)	Groundwater	LK1839 and LK1840	D12-Benzo(a)pyrene	D12-benzo(a)pyrene surrogate recovery percentage outside acceptance range of 50-130% for batch 7761697.	1 of 3 surrogates can fall outside of the acceptance range of 50-130%. Under these circumstances, the d12-benzo(a)pyrene and terphenyl-d14 data reported can be considered reliable.
		Blank Spike	Dissolved Aluminum	Spiked blank recovery outside acceptance range of 80-120% for dissolved aluminum for batch 7762456.	For multi-parameter tests, 10% of parameters can fall outside of the acceptance range of 80-120%. Under these circumstances, the dissolved aluminum data reported can be considered reliable.
		Matrix Spike	Dissolved Antimony	Matrix spike recovery outside acceptance range of 80-120% for dissolved antimony for batch 7762456.	For multi-parameter tests, 10% of parameters can fall outside of the acceptance range of 80-120%. Under these circumstances, the dissolved antimony data reported can be considered reliable.
		Blank Spike	Total Aluminum	Spiked blank recovery outside acceptance range of 80-120% for total aluminum for batch 7761143.	For multi-parameter tests, 10% of parameters can fall outside of the acceptance range of 80-120%. Under these circumstances, the total aluminum data reported can be considered reliable.
		Matrix Spike	Endrin Ketone	Matrix spike recovery outside acceptance range of 30-130% for endrin ketone for batch 3868612.	For multi-parameter tests, 10% of parameters can fall outside of the acceptance range of 30-130%. Under these circumstances, the endrin ketone data reported can be considered reliable.

Notes:

n/a - not applicable

SC - subcontracted

Table D2
Summary of Field Duplicate Sample Results - Groundwater Petroleum Hydrocarbon Parameters
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Sample Location	Units	Alert Limit	RDL	MW1	DUP A	RPD %
Sample Collection Date				16/Dec/14	16/Dec/14	
Maxxam Sample ID				LJ9563	LJ9568	
Benzene	mg/L	>30%	0.0004	<0.00040	<0.00040	n/c
Toluene	mg/L	>30%	0.0004	<0.00040	<0.00040	n/c
Ethylbenzene	mg/L	>30%	0.0004	<0.00040	<0.00040	n/c
Xylenes (Total)	mg/L	>30%	0.0008	<0.00080	<0.00080	n/c
F1 (C ₆ -C ₁₀) - BTEX	mg/L	>30%	0.1	<0.10	<0.10	n/c
F2 (C ₁₀ -C ₁₆)	mg/L	>30%	0.1	<0.10	<0.10	n/c

Notes:

Bold/Underlined - RPD exceeds alert limit

BTEX - benzene, toluene, ethylbenzene, xylenes

F1, F2 - petroleum hydrocarbon fractions 1 and 2

mg/L - milligrams per litre

n/c - not calculated

RDL - reportable detection limit

RPD - relative percent difference

< - less than

> - greater than

RPD is not calculated if either the original or field duplicate sample has a result less than 5X the RDL

Table D3
Summary of Field Duplicate Sample Results - Groundwater Salinity Parameters
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Sample Location	Units	Alert Limit	RDL	MW1	DUP A	RPD %
Sample Collection Date				16/Dec/14	16/Dec/14	
Maxxam Sample ID				LJ9563	LJ9568	
Conductivity	µS/cm	>30%	1	4,700	4,700	0
pH	pH units	>30%	n/a	7.47	7.56	1
Total Dissolved Solids	mg/L	>30%	10	4,100	4,000	2
Dissolved Sulphate (SO ₄)	mg/L	>30%	20	2,800	2,600	7
Dissolved Chloride (Cl)	mg/L	>30%	1	13	13	0
Dissolved Nitrate (N)	mg/L	>30%	0.01	0.017	<0.010	n/c
Dissolved Nitrite (N)	mg/L	>30%	0.01	<0.010	<0.010	n/c

Notes:**Bold/Underlined** - RPD exceeds alert limit

mg/L - milligrams per litre

n/a - not applicable

n/c - not calculated

RDL - reportable detection limit

RPD - relative percent difference

< - less than

> - greater than

µS/cm - microSiemens per centimetre

RPD is not calculated if either the original or field duplicate sample has a result less than 5X the RDL

Table D4
Summary of Field Duplicate Sample Results - Groundwater Dissolved Metal Parameters
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Sample Location	Units	Alert Limit	RDL	MW1	DUP A	RPD %
Sample Collection Date				16/Dec/14	16/Dec/14	
Maxxam Sample ID				LJ9563	LJ9568	
Dissolved Aluminum (Al)	mg/L	>25%	0.003	0.005	0.0064	n/c
Dissolved Antimony (Sb)	mg/L	>25%	0.0006	<0.00060	<0.00060	n/c
Dissolved Arsenic (As)	mg/L	>25%	0.0002	0.00076	0.00067	n/c
Dissolved Barium (Ba)	mg/L	>25%	0.01	0.03	0.029	n/c
Dissolved Beryllium (Be)	mg/L	>25%	0.001	<0.0010	<0.0010	n/c
Dissolved Boron (B)	mg/L	>25%	0.02	0.093	0.097	n/c
Dissolved Cadmium (Cd)	mg/L	>25%	0.00002	<0.000020	<0.000020	n/c
Dissolved Calcium (Ca)	mg/L	>25%	0.3	350	360	3
Dissolved Chromium (Cr)	mg/L	>25%	0.001	<0.0010	<0.0010	n/c
Dissolved Cobalt (Co)	mg/L	>25%	0.0003	0.0028	0.0029	4
Dissolved Copper (Cu)	mg/L	>25%	0.0002	0.00049	0.00038	n/c
Dissolved Iron (Fe)	mg/L	>25%	0.06	0.21	0.22	n/c
Dissolved Lead (Pb)	mg/L	>25%	0.0002	<0.00020	<0.00020	n/c
Dissolved Lithium (Li)	mg/L	>25%	0.02	0.067	0.072	n/c
Dissolved Magnesium (Mg)	mg/L	>25%	0.2	290	280	4
Dissolved Manganese (Mn)	mg/L	>25%	0.004	1.8	1.9	5
Dissolved Molybdenum (Mo)	mg/L	>25%	0.0002	0.0012	0.0012	0
Dissolved Nickel (Ni)	mg/L	>25%	0.0005	0.011	0.011	0
Dissolved Phosphorus (P)	mg/L	>25%	0.1	0.10	<0.10	n/c
Dissolved Potassium (K)	mg/L	>25%	0.3	9.8	9.9	1
Dissolved Selenium (Se)	mg/L	>25%	0.0002	0.0066	0.0056	16
Dissolved Silicon (Si)	mg/L	>25%	0.1	5.2	5.2	0
Dissolved Silver (Ag)	mg/L	>25%	0.0001	<0.00010	<0.00010	n/c
Dissolved Sodium (Na)	mg/L	>25%	0.5	370	390	5
Dissolved Strontium (Sr)	mg/L	>25%	0.02	4.3	4.8	11
Dissolved Sulphur (S)	mg/L	>25%	1	770	800	4
Dissolved Thallium (Tl)	mg/L	>25%	0.0002	<0.00020	<0.00020	n/c
Dissolved Tin (Sn)	mg/L	>25%	0.001	<0.0010	<0.0010	n/c
Dissolved Titanium (Ti)	mg/L	>25%	0.001	<0.0010	<0.0010	n/c
Dissolved Uranium (U)	mg/L	>25%	0.0001	0.020	0.020	0
Dissolved Vanadium (V)	mg/L	>25%	0.001	<0.0010	<0.0010	n/c
Dissolved Zinc (Zn)	mg/L	>25%	0.003	<0.0030	<0.0030	n/c

Notes:**Bold/Underlined** - RPD exceeds alert limit

mg/L - milligrams per litre

n/c - not calculated

RDL - reportable detection limit

RPD - relative percent difference

< - less than

> - greater than

RPD is not calculated if either the original or field duplicate sample has a result less than 5X the RDL

Table D5
Summary of Field Duplicate Sample Results - Groundwater Total Metal Parameters
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Sample Location	Units	Alert Limit	RDL	MW1	DUP A	RPD %
Sample Collection Date				16/Dec/14	16/Dec/14	
Maxxam Sample ID				LJ9563	LJ9568	
Total Aluminum (Al)	mg/L	>25%	0.003	0.53	0.5	6
Total Antimony (Sb)	mg/L	>25%	0.0006	<0.00060	<0.00060	n/c
Total Arsenic (As)	mg/L	>25%	0.0002	0.0014	0.0013	7
Total Barium (Ba)	mg/L	>25%	0.01	0.073	0.073	0
Total Beryllium (Be)	mg/L	>25%	0.001	<0.0010	<0.0010	n/c
Total Boron (B)	mg/L	>25%	0.02	0.11	0.1	10
Total Cadmium (Cd)	mg/L	>25%	0.00002	0.00028	0.00028	0
Total Calcium (Ca)	mg/L	>25%	0.3	440	430	2
Total Chromium (Cr)	mg/L	>25%	0.001	0.0012	0.0013	n/c
Total Cobalt (Co)	mg/L	>25%	0.0003	0.0044	0.0045	2
Total Copper (Cu)	mg/L	>25%	0.0002	0.0051	0.0048	6
Total Iron (Fe)	mg/L	>25%	0.06	1.5	1.5	0
Total Lead (Pb)	mg/L	>25%	0.0002	0.001	0.00099	n/c
Total Lithium (Li)	mg/L	>25%	0.02	0.071	0.071	n/c
Total Magnesium (Mg)	mg/L	>25%	0.2	290	290	0
Total Manganese (Mn)	mg/L	>25%	0.004	2.5	2.4	4
Total Molybdenum (Mo)	mg/L	>25%	0.0002	0.0013	0.0013	0
Total Nickel (Ni)	mg/L	>25%	0.0005	0.014	0.014	0
Total Phosphorus (P)	mg/L	>25%	0.1	<0.10	0.14	n/c
Total Potassium (K)	mg/L	>25%	0.3	8.5	8.6	1
Total Selenium (Se)	mg/L	>25%	0.0002	0.00034	0.00031	n/c
Total Silicon (Si)	mg/L	>25%	0.1	5.7	6.4	12
Total Silver (Ag)	mg/L	>25%	0.0001	<0.00010	<0.00010	n/c
Total Sodium (Na)	mg/L	>25%	0.5	390	400	3
Total Strontium (Sr)	mg/L	>25%	0.1	6.1	6.0	2
Total Sulphur (S)	mg/L	>25%	1	960	930	3
Total Thallium (Tl)	mg/L	>25%	0.0002	<0.00020	<0.00020	n/c
Total Tin (Sn)	mg/L	>25%	0.001	<0.0010	<0.0010	n/c
Total Titanium (Ti)	mg/L	>25%	0.001	0.032	0.029	10
Total Uranium (U)	mg/L	>25%	0.0001	0.018	0.018	0
Total Vanadium (V)	mg/L	>25%	0.001	0.0024	0.0017	n/c
Total Zinc (Zn)	mg/L	>25%	0.003	0.026	0.026	0

Notes:**Bold/Underlined** - RPD exceeds alert limit

mg/L - milligrams per litre

n/c - not calculated

RDL - reportable detection limit

RPD - relative percent difference

< - less than

> - greater than

RPD is not calculated if either the original or field duplicate sample has a result less than 5X the RDL

Table D6
Summary of Field Duplicate Sample Results - Groundwater Polycyclic Aromatic Hydrocarbon Parameters
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Sample Location	Units	Alert Limit	RDL	MW1	DUP A	RPD %
Sample Collection Date				16/Dec/14	16/Dec/14	
Maxxam Sample ID				LJ9563	LJ9568	
Acenaphthene	mg/L	>30%	0.0001	<0.00010	<0.00010	n/c
Acenaphthylene	mg/L	>30%	0.0001	<0.00010	<0.00010	n/c
Acridine	mg/L	>30%	0.0002	<0.00020	<0.00020	n/c
Anthracene	mg/L	>30%	0.00001	<0.000010	<0.000010	n/c
Benzo(a)anthracene	mg/L	>30%	0.0000085	<0.0000085	<0.0000085	n/c
Benzo(b&j)fluoranthene	mg/L	>30%	0.0000085	<0.0000085	<0.0000085	n/c
Benzo(k)fluoranthene	mg/L	>30%	0.0000085	<0.0000085	<0.0000085	n/c
Benzo(g,h,i)perylene	mg/L	>30%	0.0000085	<0.0000085	<0.0000085	n/c
Benzo(c)phenanthrene	mg/L	>30%	0.00005	<0.000050	<0.000050	n/c
Benzo(a)pyrene	mg/L	>30%	0.0000075	<0.0000075	<0.0000075	n/c
Benzo[a]pyrene equivalency	mg/L	>30%	0.01	<0.010	<0.010	n/c
Benzo[e]pyrene	mg/L	>30%	0.00005	<0.000050	<0.000050	n/c
Chrysene	mg/L	>30%	0.0000085	<0.0000085	<0.0000085	n/c
Dibenz(a,h)anthracene	mg/L	>30%	0.0000075	<0.0000075	<0.0000075	n/c
Fluoranthene	mg/L	>30%	0.00001	<0.000010	<0.000010	n/c
Fluorene	mg/L	>30%	0.00005	<0.000050	<0.000050	n/c
Indeno(1,2,3-cd)pyrene	mg/L	>30%	0.0000085	<0.0000085	<0.0000085	n/c
2-Methylnaphthalene	mg/L	>30%	0.0001	<0.00010	<0.00010	n/c
Naphthalene	mg/L	>30%	0.0001	<0.00010	<0.00010	n/c
Phenanthrene	mg/L	>30%	0.00005	<0.000050	<0.000050	n/c
Perylene	mg/L	>30%	0.00005	<0.000050	<0.000050	n/c
Pyrene	mg/L	>30%	0.00002	<0.000020	<0.000020	n/c
Quinoline	mg/L	>30%	0.0002	<0.00020	<0.00020	n/c

Notes:**Bold/Underlined** - RPD exceeds alert limit

mg/L - milligrams per litre

n/c - not calculated

RDL - reportable detection limit

RPD - relative percent difference

< - less than

> - greater than

RPD is not calculated if either the original or field duplicate sample has a result less than 5X the RDL

Table D7
Summary of Field Duplicate Sample Results - Groundwater Organochlorinated Pesticide Parameters
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Sample Location	Units	Alert Limit	RDL	MW1	DUP A	RPD %
Sample Collection Date				16/Dec/14	16/Dec/14	
Maxxam Sample ID				LJ9563	LJ9568	
Aldrin	ug/L	>25%	0.005	<0.005	<0.005	n/c
Dieldrin	ug/L	>25%	0.005	<0.005	<0.005	n/c
a-Chlordane	ug/L	>25%	0.005	<0.005	<0.005	n/c
g-Chlordane	ug/L	>25%	0.005	<0.005	<0.005	n/c
o,p-DDD	ug/L	>25%	0.005	<0.005	<0.005	n/c
p,p-DDD	ug/L	>25%	0.005	<0.005	<0.005	n/c
o,p-DDE	ug/L	>25%	0.005	<0.005	<0.005	n/c
p,p-DDE	ug/L	>25%	0.005	<0.005	<0.005	n/c
o,p-DDT	ug/L	>25%	0.005	<0.005	<0.005	n/c
p,p-DDT	ug/L	>25%	0.005	<0.005	<0.005	n/c
Lindane	ug/L	>25%	0.003	<0.003	<0.003	n/c
Endosulfan I (alpha)	ug/L	>25%	0.005	<0.005	<0.005	n/c
Endosulfan II	ug/L	>25%	0.005	<0.005	<0.005	n/c
Endrin	ug/L	>25%	0.005	<0.005	<0.005	n/c
Heptachlor	ug/L	>25%	0.005	<0.005	<0.005	n/c
Heptachlor epoxide	ug/L	>25%	0.005	<0.005	<0.005	n/c
Hexachlorobenzene	ug/L	>25%	0.005	<0.005	<0.005	n/c
Hexachlorobutadiene	ug/L	>25%	0.009	<0.009	<0.009	n/c
Hexachloroethane	ug/L	>25%	0.01	<0.01	<0.01	n/c
Methoxychlor	ug/L	>25%	0.01	<0.01	<0.01	n/c
Aroclor 1016	ug/L	>25%	0.05	<0.05	<0.05	n/c
Aroclor 1221	ug/L	>25%	0.05	<0.05	<0.05	n/c
Aroclor 1232	ug/L	>25%	0.05	<0.05	<0.05	n/c
Aroclor 1242	ug/L	>25%	0.05	<0.05	<0.05	n/c
Aroclor 1248	ug/L	>25%	0.05	<0.05	<0.05	n/c
Aroclor 1254	ug/L	>25%	0.05	<0.05	<0.05	n/c
Aroclor 1260	ug/L	>25%	0.05	<0.05	<0.05	n/c
Aroclor 1262	ug/L	>25%	0.05	<0.05	<0.05	n/c
Aroclor 1268	ug/L	>25%	0.05	<0.05	<0.05	n/c
alpha-BHC	ug/L	>25%	0.005	<0.005	<0.005	n/c
beta-BHC	ug/L	>25%	0.005	<0.005	<0.005	n/c
delta-BHC	ug/L	>25%	0.005	<0.005	<0.005	n/c
Hexachlorocyclopentadiene	ug/L	>25%	0.02	<0.02	<0.02	n/c
Endosulfan sulfate	ug/L	>25%	0.005	<0.005	<0.005	n/c
Endrin aldehyde	ug/L	>25%	0.005	<0.005	<0.005	n/c
Endrin ketone	ug/L	>25%	0.005	<0.005	<0.005	n/c
Mirex	ug/L	>25%	0.005	<0.005	<0.005	n/c
Octachlorostyrene	ug/L	>25%	0.005	<0.005	<0.005	n/c
Oxychlordane	ug/L	>25%	0.005	<0.005	<0.005	n/c
Toxaphene	ug/L	>25%	0.2	<0.2	<0.2	n/c

Notes:**Bold/Underlined** - RPD exceeds alert limit

mg/L - milligrams per litre

n/c - not calculated

RDL - reportable detection limit

RPD - relative percent difference

< - less than

> - greater than

RPD is not calculated if either the original or field duplicate sample has a result less than 5X the RDL

Table D8
Summary of Field Blank and Trip Blank Sample Results - Petroleum Hydrocarbons Parameters
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Parameter	Units	Alert Limit	RDL	Field Blank	Do the results exceed the Alert Limit?	Trip Blank	Do the results exceed the Alert Limit?
Sample Collection Date				16/Dec/14		16/Dec/14	
Maxxam Sample ID				LJ9570		LJ9569	
Benzene	mg/L	>5X RDL	0.0004	<0.00040	no	<0.00040	no
Toluene	mg/L	>5X RDL	0.0004	<0.00040	no	<0.00040	no
Ethylbenzene	mg/L	>5X RDL	0.0004	<0.00040	no	<0.00040	no
Xylenes (Total)	mg/L	>5X RDL	0.0008	<0.00080	no	<0.00080	no
F1 (C ₆ -C ₁₀) - BTEX	mg/L	>2X RDL	0.1	<0.10	no	<0.10	no
F2 (C ₁₀ -C ₁₆)	mg/L	>2X RDL	0.1	<0.10	no	<0.10	no

Notes:**Bold/Underlined** - value exceeds alert limit

BTEX - benzene, toluene, ethylbenzene, xylenes

F1, F2 - petroleum hydrocarbon fractions 1 and 2

mg/L - milligrams per litre

RDL - reportable detection limit

< - less than

> - greater than

Alert limit is 5X the RDL for BTEX and 2X the RDL for F1 and F2

Table D9
Summary of Field Blank Sample Results -Total Metals Parameters
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Parameter	Units	Alert Limit	RDL	Field Blank	Do the results exceed the Alert Limit?
Sample Collection Date				18/Dec/14	
Maxxam Sample ID				LK1841	
Total Aluminum (Al)	mg/L	>5X RDL	0.003	0.0031	no
Total Antimony (Sb)	mg/L	>5X RDL	0.0006	<0.00060	no
Total Arsenic (As)	mg/L	>5X RDL	0.0002	<0.00020	no
Total Barium (Ba)	mg/L	>5X RDL	0.01	<0.010	no
Total Beryllium (Be)	mg/L	>5X RDL	0.001	<0.0010	no
Total Boron (B)	mg/L	>5X RDL	0.02	<0.020	no
Total Cadmium (Cd)	mg/L	>5X RDL	0.00002	0.000058	no
Total Calcium (Ca)	mg/L	>5X RDL	0.3	<0.30	no
Total Chromium (Cr)	mg/L	>5X RDL	0.001	<0.0010	no
Total Cobalt (Co)	mg/L	>5X RDL	0.0003	<0.00030	no
Total Copper (Cu)	mg/L	>5X RDL	0.0002	<0.00020	no
Total Iron (Fe)	mg/L	>5X RDL	0.06	<0.060	no
Total Lead (Pb)	mg/L	>5X RDL	0.0002	<0.00020	no
Total Lithium (Li)	mg/L	>5X RDL	0.02	<0.020	no
Total Magnesium (Mg)	mg/L	>5X RDL	0.2	<0.20	no
Total Manganese (Mn)	mg/L	>5X RDL	0.004	<0.0040	no
Total Molybdenum (Mo)	mg/L	>5X RDL	0.0002	<0.00020	no
Total Nickel (Ni)	mg/L	>5X RDL	0.0005	<0.00050	no
Total Phosphorus (P)	mg/L	>5X RDL	0.1	<0.10	no
Total Potassium (K)	mg/L	>5X RDL	0.3	<0.30	no
Total Selenium (Se)	mg/L	>5X RDL	0.0002	<0.00020	no
Total Silicon (Si)	mg/L	>5X RDL	0.1	<0.10	no
Total Silver (Ag)	mg/L	>5X RDL	0.0001	<0.00010	no
Total Sodium (Na)	mg/L	>5X RDL	0.5	<0.50	no
Total Strontium (Sr)	mg/L	>5X RDL	0.02	<0.020	no
Total Sulphur (S)	mg/L	>5X RDL	0.2	<0.20	no
Total Thallium (Tl)	mg/L	>5X RDL	0.0002	<0.00020	no
Total Tin (Sn)	mg/L	>5X RDL	0.001	<0.0010	no
Total Titanium (Ti)	mg/L	>5X RDL	0.001	<0.0010	no
Total Uranium (U)	mg/L	>5X RDL	0.0001	<0.00010	no
Total Vanadium (V)	mg/L	>5X RDL	0.001	<0.0010	no
Total Zinc (Zn)	mg/L	>5X RDL	0.003	<0.0030	no

Notes:**Bold/Underlined** - value exceeds alert limit

mg/L - milligrams per litre

RDL - reportable detection limit

< - less than

> - greater than

Alert limit is 5X the RDL for BTEX and 2X the RDL for F1 and F2

Table D10
Summary of Field Blank Sample Results - Polycyclic Aromatic Hydrocarbon
Bar U Ranch National Historic Site, Longview, Alberta
Parks Canada Agency

Parameter	Units	Alert Limit	RDL	Field Blank	Do the results exceed the Alert Limit?
Sample Collection Date				16/Dec/14	
Maxxam Sample ID				LJ9570	
Acenaphthene	mg/L	>5X RDL	0.0001	<0.00010	no
Acenaphthylene	mg/L	>5X RDL	0.0001	<0.00010	no
Acridine	mg/L	>5X RDL	0.0002	<0.00020	no
Anthracene	mg/L	>5X RDL	0.00001	<0.000010	no
Benzo(a)anthracene	mg/L	>5X RDL	0.0000085	<0.0000085	no
Benzo(b&j)fluoranthene	mg/L	>5X RDL	0.0000085	<0.0000085	no
Benzo(k)fluoranthene	mg/L	>5X RDL	0.0000085	<0.0000085	no
Benzo(g,h,i)perylene	mg/L	>5X RDL	0.0000085	<0.0000085	no
Benzo(c)phenanthrene	mg/L	>5X RDL	0.00005	<0.000050	no
Benzo(a)pyrene	mg/L	>5X RDL	0.0000075	<0.0000075	no
Benzo[a]pyrene equivalency	mg/L	>5X RDL	0.01	<0.010	no
Benzo[e]pyrene	mg/L	>5X RDL	0.00005	<0.000050	no
Chrysene	mg/L	>5X RDL	0.0000085	<0.0000085	no
Dibenz(a,h)anthracene	mg/L	>5X RDL	0.0000075	<0.0000075	no
Fluoranthene	mg/L	>5X RDL	0.00001	<0.000010	no
Fluorene	mg/L	>5X RDL	0.00005	<0.000050	no
Indeno(1,2,3-cd)pyrene	mg/L	>5X RDL	0.0000085	<0.0000085	no
2-Methylnaphthalene	mg/L	>5X RDL	0.0001	<0.00010	no
Naphthalene	mg/L	>5X RDL	0.0001	<0.00010	no
Phenanthrene	mg/L	>5X RDL	0.00005	<0.000050	no
Perylene	mg/L	>5X RDL	0.00005	<0.000050	no
Pyrene	mg/L	>5X RDL	0.00002	<0.000020	no
Quinoline	mg/L	>5X RDL	0.0002	<0.00020	no

Notes:**Bold/Underlined** - value exceeds alert limit

mg/L - milligrams per litre

RDL - reportable detection limit

< - less than

> - greater than

Alert limit is 5X the RDL for BTEX and 2X the RDL for F1 and F2

APPENDIX E NCSCS

CCME National Classification System for Contaminated Sites (2008, 2010 v 1.2)
Pre-Screening Checklist

Question	Response (yes / no)	Comment
1. Are Radioactive material, Bacterial contamination or Biological hazards likely to be present at the site?	No	If yes, do not proceed through the NCSCS. Contact applicable regulatory agency immediately.
2. Are there no contamination exceedances (known or suspected)? Determination of exceedances may be based on: 1) CCME environmental quality guidelines; 2) equivalent provincial guidelines/standards if no CCME guideline exists for a specific chemical in a relevant medium; or 3) toxicity benchmarks derived from the literature for chemicals not covered by CCME or provincial guidelines/standards.	No	If yes (i.e., there are no exceedances), do not proceed through the NCSCS.
3. Have partial/incompleted or no environmental site investigations been conducted for the Site?	No	If yes, do not proceed through the NCSCS.
4. Is there direct and significant evidence of impacts to humans at the site, or off-site due to migration of contaminants from the site?	No	If yes, automatically rate the site as Class 1, a priority for remediation or risk management, regardless of the total score obtained should one be calculated (e.g., for comparison with other Class 1 sites).
5. Is there direct and significant evidence of impacts to ecological receptors at the site, or off-site due to migration of contaminants from the site?	No	Some low levels of impact to ecological receptors are considered acceptable, particularly on commercial and industrial land uses. However, if ecological effects are considered to be severe, the site may be categorized as Class 1, regardless of the numerical total NCSCS score. For the purpose of application of the NCSCS, effects that would be considered severe include observed effects on survival, growth or reproduction which could threaten the viability of a population of ecological receptors at the site. Other evidence that qualifies as severe adverse effects may be determined based on professional judgement and in consultation with the relevant jurisdiction.
6. Are there indicators of significant adverse effects in the exposure zone (i.e., the zone in which receptors may come into contact with contaminants)? Some examples are as follows: -Hydrocarbon sheen or NAPL in the exposure zone -Severely stressed biota or devoid of biota; -Presence of material at ground surface or sediment with suspected high concentration of contaminants such as ore tailings, sandblasting grit, slag, and coal tar.	No	If yes, automatically rate the site as Class 1, a priority for remediation or risk management, regardless of the total score obtained should one be calculated (e.g., for comparison with other Class 1 sites).
7. Do measured concentrations of volatiles or unexploded ordnances represent an explosion hazard ?	No	If yes, automatically rate the site as Class 1, a priority for remediation or risk management, and do not continue until the safety risks have been addressed. Consult your jurisdiction's occupational health and safety guidance or legislation on exposive hazards and measurement of lower explosive limits.

If none of the above applies, proceed with the NCSCS scoring.

CCME National Classification System for Contaminated Sites (2008, 2010 v 1.2)
Summary of Site Conditions

Subject Site:	Bar U Ranch National Historic Site	
Civic Address: <i>(or other description of location)</i>	Bar U Ranch National Historic Site, Longview, Alberta	
Site Common Name : <i>(if applicable)</i>		
Site Owner or Custodian: <i>(Organization and Contact Person)</i>	Parks Canada Agency	
Legal description or metes and bounds:		
Approximate Site area:	Approximately 1,600 ha in size.	
PID(s): <i>(or Parcel Identification Numbers [PIN] if untitled Crown land)</i>	Unknown	
Centre of site: <i>(provide latitude/longitude or UTM coordinates)</i>	Latitude:	_____ degrees _____ min _____ secs
	Longitude:	_____ degrees _____ min _____ secs
	UTM Coordinate:	Northing 5673215 Easting 603554
Site Land Use:	Current:	Former waste area
	Proposed:	Unknown
Site Plan	To delineate the bounds of the Site a site plan MUST be attached. The plan must be drawn to scale indicating the boundaries in relation to well-defined reference points and/or legal descriptions. Delineation of the contamination should also be indicated on the site plan.	
Provide a brief description of the Site:	<p>Site was historically used as an active ranch between 1881 to 1991 and has since become a National Historic Site. It consists of 35 structures and a visitor orientation centre. Onsite buildings include barns, sheds, pens, and various other support structures. There are two waste middens constructed in coulees on the north portion of the ranch. Waste Midden #1 is approximately 35 m by 8 m and Waste Midden #2 is approximately 60 m by 10 m.</p> <p>The Site is located approximately 13 km south of Longview, AB. Pekisko Creek passes through the Site.</p>	

CCME National Classification System for Contaminated Sites (2008, 2010 v 1.2)
Summary of Site Conditions

Affected media and Contaminants of Potential Concern (COPC):	Affected media groundwater. COPC include petroleum hydrocarbons, salinity, dissolved and total metals, polycyclic aromatic hydrocarbons, organochlorine pesticides.
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Please fill in the "letter" that best describes the level of information available for the site being assessed

Site Letter Grade

C

If letter grade is F, do not continue, you must have a minimum of a Phase I Environmental Site Assessment or equivalent.

Scoring Completed By:	Anita Colbert, Dipl. Tech.
Date Scoring Completed:	20-Feb-15

CCME National Classification System for Contaminated Sites (2008, 2010 v 1.2)

User's Guide - Instructions

1) Please review the following overview of contents. The revised CCME National Classification System for Contaminated Sites (NCSCS) consists of a pre-screening checklist, summary of site conditions, summary score sheet, and three instruction/worksheet pages for the user to fill out: Contaminant Characteristics, Migration Potential and Exposure. For ease of printing, the method of evaluation for scoring each section of the worksheet is provided in a separate Instructions tab. Reference material is also provided to assist with the evaluation. A brief description of each sheet is as follows:

Pre-Screening Checklist - Used to determine if the Site can either be considered a Class 1 site (to be remediated immediately) or more information must be collected before the Site can be ranked, or other hazards exist at the Site that must be addressed first before the Site can be ranked using the revised NCSCS.

Site Description Sheet - Summarizes Site information. It also indicates the level of information available (Site Letter Grade) for the site to conduct the NCSCS scoring evaluation. The known/potential contaminants of concern and affected media will also be summarized here.

Contaminant Characteristics Instructions & Worksheet - Prompts the user for information related to the contaminants of potential concern (COPC) found at the site.

Migration Potential Instructions & Worksheet - Prompts the user for information related to physical transport processes which may move contamination to neighboring sites or re-distribute contamination within a site. Migration potential includes many of the exposure pathways, but is not limited to exposure pathways. Migration potential does not require clearly defined receptors.

Exposure Instructions & Worksheet - Prompts the user for information related to exposure pathways and receptors which may be located on the site.

Summary Score Sheet - Generates a total site score by adding up the scores generated on each of the three worksheets and provides the corresponding Site Classification. It also provides an estimate of certainty in the score provided (Certainty Percentage).

Reference Material - Additional information which may be useful to refer to when conducting the evaluation.

- Contaminant Hazard Ranking
- Examples of Persistent Substances
- Examples of Substances in the Various Chemical Classes
- Chemical-specific Properties
- Range of Values of Hydraulic Conductivity and Permeability

The worksheet titles and sub headings are as follows.

I. Contaminant Characteristics

1. Residency Media
2. Chemical Hazard
3. Contaminant Exceedance Factor
4. Contaminant Quantity
5. Modifying Factors

II. Migration Potential

1. Groundwater Movement
2. Surface water Movement
3. Soil
4. Vapour
5. Sediment Movement
6. Modifying Factors

III. Exposure

1. Human Receptors
 - A. Known Impact
 - B. Potential
 - a. Land Use
 - b. Accessibility
 - c. Exposure Route
2. Human Modifying Factors
3. Ecological Receptors
 - A. Known Impact
 - B. Potential
 - a. Terrestrial
 - b. Aquatic
4. Ecological Modifying Factors
 - a. Species at Risk
 - b. Aesthetics
5. Other Receptors
 - a. Permafrost

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2) This is an electronic form which will prompt the user for information. Based on the answers provided, a score is calculated for the contaminated site in question. In most cases, the user will be asked to select amongst two or more choices in a drop down checklist. To access the drop down checklist, move the mouse towards the right side of the "action box". If a drop down is available, an arrow will appear, which must be selected to access the drop down choices.

An "action box" requires input from the user. All action boxes have an amber background.

action box

3) When assigning scores for each factor, it is highly recommended to give a rationale (a column has been provided for this purpose in Worksheets I, II and III). Information that would be useful in justifying the scores assigned may include: a statement of any assumptions, a description of site-specific information, and references for any data sources (e.g., site visit, personal interview, site assessment reports, or other documents consulted).

4) The Site Letter Grade is related to the level of information available for the Site (as defined by the User) and provides an indication of completeness of information based on the level of investigation and remediation work that has been carried out at the site. More detailed descriptions of the various categories are provided below.

Site Letter Detailed Descriptions:

Grade:

- F **Pre Phase I ESA** – No environmental investigations have been conducted or there are only partial or incomplete Phase I ESA for the Site. It is not recommended to continue through the NCSCS when insufficient data are available. In these cases, it will generally be necessary to conduct a Phase I ESA or other site investigation tasks in order to complete the NCSCS scoring.
- E **Phase I ESA** – A preliminary desk-top type study has been conducted, involving non-intrusive data collection to determine whether there is a potential for the Site to be contaminated and to provide information to direct any intrusive investigations. Data collected may include a review of available information on current site conditions and history of the property, a site inspection and interviews with personnel familiar with the Site. [Note: This stage is similar to "Phase I: Site Information Assessment" as described in Guidance Document on the Management of Contaminated Sites in Canada (CCME 1997).]
- D **Limited Phase II ESA** – An initial intrusive investigation and assessment of the property has been conducted, generally focusing on potential sources of contamination, to determine whether there is contamination present above the relevant screening guidelines or criteria, and to broadly define soil and groundwater conditions; samples have been collected and analyzed to identify, characterize and quantify contamination that may be present in air, soil, groundwater, surface water or building materials. [Note: This stage is similar to "Phase II: Reconnaissance Testing Program" as described in Guidance Document on the Management of Contaminated Sites in Canada (CCME 1997).]
- C **Detailed Phase II ESA** – Further intrusive investigations have been conducted to characterize and delineate the contamination, to obtain detailed information on the soil and groundwater conditions, to identify the contaminant pathways, and to provide other information required to develop a remediation plan. [Note: This stage is similar to "Phase III: Detailed Testing Program" as described in Guidance Document on the Management of Contaminated Sites in Canada (CCME 1997).]
- B **Risk Assessment with or without Remedial Plan or Risk Management Strategy** – A risk assessment has been completed, and if the risk was found to be unacceptable, a site-specific remedial action plan has been designed to mitigate environmental and health concerns associated with the Site, or a risk management strategy has been developed.
- A **Confirmation Sampling** – Remedial work, monitoring, and/or compliance testing have been conducted and confirmatory sampling demonstrates whether contamination has been removed or stabilized effectively and whether cleanup or risk management objectives have been attained.

5) A few terms are used throughout which require definition, they are as follows:

Known - refers to scores that are assigned based on documented scientific and/or technical observations

Potential - refers to scores that are assigned when something is not known, though it may be suspected

Allowed Potential - If, in a given category, known and potential scores are provided by the user, the checklist will typically default to the "known" score. If a "known" score is provided, the "allowed potential" score will equal zero. Exceptions can be found within the Modifying Factors categories in each worksheet where there are often several independent questions. Therefore, "known" and "potential" scores are allowed to contribute to the total modifying factor score.

Raw - refers to score totals which have not been adjusted down to the total maximum score for the given category. In most cases the possible total raw score is greater than the maximum allowed

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Note: For some questions in the worksheets, the option selected will determine whether a "known" or "potential" score is assigned. In these cases, if "Do Not Know" is selected, a score will automatically be listed as "potential", whereas all of the other options in the list will provide a "known" score.

6) **Certainty Percentage:** The ratio of "Known" to "Potential" responses reflects the relative certainty, or confidence, of the resulting final score and the classification. The NCSCS system defines this ratio as the "Certainty Percentage". The Certainty Percentage is generated from the number of sections assigned scores based on "known" information divided by the total number of sections. A high percentage indicates that more is known about the Site, and therefore there is more confidence in the ranking, whereas a low percentage suggests that the ranking should be treated with caution.

7) **Site Classification Categories:** Sites should not be ranked relative to one another. Sites must be classified on their individual characteristics in order to determine the appropriate classification (Class 1, 2, 3, or N) according to their priority for action, or Class INS (Insufficient Information) for sites that require further information before they can be classified. The classification groupings are as follows:

Class 1 - High Priority for Action (Total NCSCS Score greater than 70)

The available information indicates that action (e.g., further site characterization, risk management, remediation, etc.) is required to address existing concerns. Typically, Class 1 sites indicate high concern for several factors, and measured or observed impacts have been documented.

Class 2 - Medium Priority for Action (Total NCSCS Score between 50 and 69.9)

The available information indicates that there is high potential for adverse impacts, although the threat to human health and the environment is generally not imminent. There will tend not to be indication of off-site contamination, however, the potential for this was rated high and therefore some action is likely required.

Class 3 - Low Priority for Action (Total NCSCS Score between 37 and 49.9)

The available information indicates that this site is currently not a high concern. However, additional investigation may be carried out to confirm the site classification, and some degree of action may be required.

Class N - Not a Priority for Action (Total NCSCS Score less than 37)

The available information indicates there is probably no significant environmental impact or human health threats. There is likely no need for action unless new information becomes available indicating greater concerns, in which case the site should be re-examined.

Class INS - Insufficient Information (>15% of Responses are "Do Not Know")

There is insufficient information to classify the site. In this event, additional information is required to address data gaps.

8) **Additional Complementary Tools to the NCSCS**

The CCME Soil Quality Index (SoQI) is a complementary tool that focuses more on evaluating the relative hazard, by comparing contaminant concentrations with their respective soil quality guidelines. The SoQI uses three factors for its calculations, namely: 1) scope (% of contaminants that do not meet their respective guidelines), 2) frequency (% of individual tests of contaminants that do not meet their respective guidelines), and 3) amplitude (the amount by which the contaminants do not meet their respective guidelines). The soil quality index can be used to compare different contaminated sites with similar types of contamination as well as to see if the jurisdictional requirements have been met after remediation of a particular site.

The NCSCS was not developed for and is not readily applicable for the assessment of sites with a significant marine or aquatic component. Environmental conditions at marine and aquatic sites are best measured in the bed sediments as they act as long-term reservoirs of chemicals to the aquatic environment and to organisms living in or having direct contact with sediments. The CCME Sediment Quality Index (SeQI) provides a convenient means of summarizing sediment quality data and can complement the NCSCS. The SeQI provides a mathematical framework for assessing sediment quality conditions by comparing contaminant concentrations with their respective sediment quality guidelines.

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(I) Contaminant Characteristics

Bar U Ranch National Historic Site

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method of Evaluation	Notes
1. Residency Media (replaces physical state)				
Which of the following residency media are known (or strongly suspected) to have one or more exceedances of the applicable CCME guidelines? yes = has an exceedance or strongly suspected to have an exceedance no = does not have an exceedance or strongly suspected not to have an exceedance		Available information indicated contamination in soil and groundwater in the waste midden area. It is suspected that sediment may be contaminated in the vicinity of these seepage areas.	The overall score is calculated by adding the individual scores from each residency media (having one or more exceedance of the most conservative media specific and land-use appropriate CCME guideline). Summary tables of the Canadian Environmental Quality Guidelines for soil, water (aquatic life, non-potable groundwater environments, and agricultural water uses) and sediment are available on the CCME website at http://www.ccme.ca/publications/ceqg_rcqe.html?category_id=124 . For potable groundwater environments, guidelines for Canadian Drinking Water Quality (for comparison with groundwater monitoring data) are available on the Health Canada website at http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/sum_guide-res_recom/index_e.html .	An increasing number of residency media containing chemical exceedances often equates to a greater potential risk due to an increase in the number of potential exposure pathways.
A. Soil	Yes			
Yes No Do Not Know				
B. Groundwater	Yes			
Yes No Do Not Know				
C. Surface water	No			
Yes No Do Not Know				
D. Sediment	Yes			
Yes No Do Not Know				
"Known" -score "Potential" - score	6 ---			
2. Chemical Hazard				
What is the relative degree of chemical hazard of the contaminant in the list of hazard rankings proposed by the Federal Contaminated Sites Action Plan (FCSAP)? High Medium Low Do Not Know	High	The score of 'High' was selected based on the presence of cadmium contamination. Cadmium is a Confirmed Human Carcinogen.	The relative degree of chemical hazard should be selected based on the most hazardous contaminant known or suspected to be present at the site. The degree of hazard has been defined by the Federal Contaminated Sites Action Plan (FCSAP) and a list of substances with their associated hazard (Low, Medium and High) has been provided as a separate sheet in this file. <i>See Attached Reference Material for Contaminant Hazard Rankings.</i>	Hazard as defined in the revised NCS pertains to the physical properties of a chemical which can cause harm. Properties can include toxic potency, propensity to biomagnify, persistence in the environment, etc. Although there is some overlap between hazard and contaminant exceedance factor below, it will not be possible to derive contaminant exceedance factors for many substances which have a designated chemical hazard designation, but don't have a CCME guideline. The purpose of this category is to avoid missing a measure of toxic potential.
"Known" -score	8			
"Potential" - score	---			
3. Contaminant Exceedance Factor				
What is the ratio between the measured contaminant concentration and the applicable CCME guidelines (or other "standards")? Mobile NAPL High (>100x) Medium (10x to 100x) Low (1x to 10x) Do Not Know	High (>100x)	The December 2014 analytical data was used to determine this score. Example total iron concentration of 200 mg/L in MW6 versus guideline value of 0.3 mg/L.	Ranking of contaminant "exceedance" is determined by comparing contaminant concentrations with the <i>most conservative media-specific and land-use appropriate CCME</i> environmental quality guidelines. Ranking should be based on contaminant with greatest exceedance of CCME guidelines. Ranking of contaminant hazard as high, medium and low is as follows: High = One or more measured contaminant concentration is greater than 100 X appropriate CCME guidelines Medium = One or more measured contaminant concentration is 10 - 99.99 X appropriate CCME guidelines Low = One or more measured contaminant concentration is 1 - 9.99 X appropriate CCME guidelines Mobile NAPL = Contaminant is a non-aqueous phase liquid (i.e., due to its low solubility, it does not dissolve in water, but remains as a separate liquid) and is present at a sufficiently high saturation (i.e., greater than residual NAPL saturation) such that there is significant potential for mobility either downwards or laterally. Other standards may include local background concentration or published toxicity benchmarks. Results of toxicity testing with site samples can be used as an alternative. This approach is only relevant for contaminants that do not biomagnify in the food web, since toxicity tests would not indicate potential effects at higher trophic levels. High = lethality observed. Medium = no lethality, but sub lethal effects observed. Low = neither lethal nor sub lethal effects observed.	In the event that elevated levels of a material with no associated CCME guidelines are present, check provincial and USEPA environmental criteria. Hazard Quotients (sometimes referred to as a screening quotient in risk assessments) refer to the ratio of measured concentration to the concentration believed to be the threshold for toxicity. A similar calculation is used here to determine the contaminant exceedance factor (CEF). Concentrations greater than one times the applicable CCME guideline (i.e., CEF=>1) indicate that risks are possible. Mobile NAPL has the highest associated score (8) because of its highly concentrated nature and potential for increase in the size of the impacted zone.
"Known" -score "Potential" - score	6 ---			

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(I) Contaminant Characteristics

Bar U Ranch National Historic Site

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method of Evaluation	Notes
4. Contaminant Quantity (known or strongly suspected)				
What is the known or strongly suspected quantity of all contaminants? 				

Contaminant Characteristic Total

Raw Total Scores- "Known"	26
Raw Total Scores- "Potential"	0
Raw Combined Total Scores	26
Total Score (Raw Combined / 40 * 33)	21.5

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(II) Migration Potential (Evaluation of contaminant migration pathways)
Bar U Ranch National Historic Site

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
1. Groundwater Movement				
A. Known COPC exceedances and an operable groundwater pathway within and/or beyond the property boundary.				
i) For potable groundwater environments , 1) groundwater concentrations exceed background concentrations and 1X the Guideline for Canadian Drinking Water Quality (GCDWQ) or 2) there is known contact of contaminants with groundwater, based on physical evidence of groundwater contamination. For non-potable environments (typically urban environments with municipal services), 1) groundwater concentrations exceed 1X the applicable non potable guidelines or modified generic guidelines (which exclude ingestion of drinking water pathway) or 2) there is known contact of contaminants with groundwater, based on physical evidence of groundwater impacts. ii) Same as (i) except the information is not known but <u>strongly suspected</u> based on indirect observations. iii) Meets GCDWQ for potable environments ; meets non-potable criteria or modified generic criteria (excludes ingestion of drinking water pathway) for non-potable environments or Absence of groundwater exposure pathway (i.e., there is no aquifer (see definition at right) at the site or there is an adequate isolating layer between the aquifer and the contamination, and within 5 km of the site there are no aquatic receiving environments and the groundwater does not daylight).	12	Groundwater contamination was detected at the Site, in comparison to the Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life (1999), CCME Water Quality Guidelines for the Protection of Agricultural Water Uses (1999) and Health Canada Guidelines for Canadian Drinking Water Quality (CDWQ) (Health Canada 2014) and Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites (2010) There are twenty-two water wells within a 1 km radius of the Site. It was previously confirmed that privately owned groundwater wells are located within 500 m and Parks Canada drinking water wells are approximately 700 m from the middens . Subsurface investigations conducted to-date did not investigate potential domestic use aquifer (DUA) pathway at the Site.	Review chemical data and evaluate groundwater quality. The evaluation method concentrates on 1) a potable or non-potable groundwater environment; 2) the groundwater flow system and its potential to be an exposure pathway to known or potential receptors An aquifer is defined as a geologic unit that yields groundwater in usable quantities and drinking water quality. The aquifer can currently be used as a potable water supply or could have the potential for use in the future. Non-potable groundwater environments are defined as areas that are serviced with a reliable alternative water supply (most commonly provided in urban areas). The evaluation of a non-potable environment will be based on a site specific basis. Physical evidence includes significant sheens, liquid phase contamination, or contaminant saturated soils. Seeps and springs are considered part of the groundwater pathway. In Arctic environments, the potability and evaluation of the seasonal active layer (above the permafrost) as a groundwater exposure pathway will be considered on a site-specific basis.	The 1992 NCS rationale evaluated the off-site migration as a regulatory issue. The exposure assessment and classification of hazards should be evaluated regardless of the property boundaries. Someone experienced must provide a thorough description of the sources researched to determine the presence/absence of a groundwater supply source in the vicinity of the contaminated site. This information must be documented in the NCS Site Classification Worksheet including contact names, phone numbers, e-mail correspondence and/or reference maps/reports and other resources such as internet links. Note that for potable groundwater that also daylights into a nearby surface water body, the more stringent guidelines for both drinking water and protection of aquatic life should be considered. Selected References <u>Potable Environments</u> Guidelines for Canadian Drinking Water Quality: www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/sum_guide-res_recom/index_e.html <u>Non-Potable Environments</u> Canadian Water Quality Guidelines for Protection of Aquatic Life. CCME. 1999 www.ccme.ca Compilation and Review of Canadian Remediation Guidelines, Standards and Regulations. Science Applications International Corporation (SAIC Canada), report to Environment Canada, January 4, 2002.
	9			
	0			
	12			
	Score 12			
NOTE: If a score is assigned here for Known COPC Exceedances, then you can skip Part B (Potential for groundwater pathway) and go to Section 2 (Surface Water Pathway)				
B. Potential for groundwater pathway.				
a. Relative Mobility High Moderate Low Insignificant Do Not Know			Organics Koc (L/kg) Koc < 500 (i.e., log Koc < 2.7) Koc = 500 to 5000 (i.e., log Koc = 2.7 to 3.7) Koc = 5,000 to 100,000 (i.e., log Koc = 3.7 to 5) Koc > 100,000 (i.e., log Koc > 5) Metals with higher mobility at acidic conditions pH < 5 pH = 5 to 6 pH > 6 Metals with higher mobility at alkaline conditions pH > 8.5 pH = 7.5 to 8.5 pH < 7.5	Reference: US EPA Soil Screening Guidance (Part 5 - Table 39) If a score of zero is assigned for relative mobility, it is still recommended that the following sections on potential for groundwater pathway be evaluated and scored. Although the Koc of an individual contaminant may suggest that it will be relatively immobile, it is possible that, with complex mixtures, there could be enhanced mobility due to co-solvent effects. Therefore, the Koc cannot be relied on solely as a measure of mobility. An evaluation of other factors such as containment, thickness of confining layer, hydraulic conductivities and precipitation infiltration rate are still useful in predicting potential for groundwater migration, even if a contaminant is expected to have insignificant mobility based on its chemistry alone.
	Do Not Know			
	Score 2			
b. Presence of engineered sub-surface containment? No containment Partial containment Full containment Do Not Know			Review the existing engineered systems or natural attenuation processes for the site and determine if full or partial containment is achieved. Full containment is defined as an engineered system or natural attenuation processes, monitored as being effective, which provide for full capture and/or treatment of contaminants. All chemicals of concern must be contained for "Full Containment" scoring. Natural attenuation must have sufficient data, and reports cited with monitoring data to support steady state conditions and the attenuation processes. If there is no containment or insufficient natural attenuation process, this category is evaluated as high. If there is less than full containment or if uncertain, then evaluate as medium. In Arctic environments, permafrost will be evaluated, as appropriate, based on detailed evaluations, effectiveness and reliability to contain/control contaminant migration.	Someone experienced must provide a thorough description of the sources researched to determine the containment of the source at the contaminated site. This information must be documented in the NCS Site Classification Worksheet including contact names, phone numbers, e-mail correspondence and/or reference maps, geotechnical reports or natural attenuation studies and other resources such as internet links. Selected Resources: United States Environmental Protection Agency (USEPA) 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater. EPA/600/R-98/128. Environment Canada – Ontario Region – Natural Attenuation Technical Assistance Bulletins (TABs) Number 19 –21.
	Do Not Know			
	Score 1.5			

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(II) Migration Potential (Evaluation of contaminant migration pathways)
Bar U Ranch National Historic Site

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
c. Thickness of confining layer over aquifer of concern or groundwater exposure pathway 3 m or less including no confining layer or discontinuous confining layer 3 to 10 m > 10 m Do Not Know	<div>Score0.5</div> <div>Do Not Know</div>		The term "confining layer" refers to geologic material with little or no permeability or hydraulic conductivity (such as unfractured clay); water does not pass through this layer or the rate of movement is extremely slow. Measure the thickness and extent of materials that will impede the migration of contaminants to the groundwater exposure pathway. The evaluation of this category is based on: 1) The presence and thickness of saturated subsurface materials that impede the vertical migration of contaminants to lower aquifer units which can or are used as drinking water sources or 2) The presence and thickness of unsaturated subsurface materials that impede the vertical migration of contaminants from the source location to the saturated zone (e.g., water table aquifer, first hydrostratigraphic unit or other groundwater pathway).	
d. Hydraulic conductivity of confining layer >10 ⁻⁴ cm/s or no confining layer 10 ⁻⁴ to 10 ⁻⁶ cm/s <10 ⁻⁶ cm/s Do Not Know	<div>Score0.5</div> <div>Do Not Know</div>		Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure in the Reference Material sheet). Unfractured clays should be scored low. Silts should be scored medium. Sand, gravel should be scored high. The evaluation of this category is based on: 1) The presence and hydraulic conductivity ("K") of saturated subsurface materials that impede the vertical migration of contaminants to lower aquifer units which can or are used as a drinking water source, groundwater exposure pathway or 2) The presence and permeability ("k") of unsaturated subsurface materials that impede the vertical migration of contaminants from the source location to the saturated water table aquifer, first hydrostratigraphic unit or other groundwater pathway.	
B. Potential for groundwater pathway.				
e. Precipitation infiltration rate (Annual precipitation factor x surface soil relative permeability factor) High Moderate Low Very Low None Do Not Know	<div>Score0.4</div> <div>Do Not Know</div>		<u>Precipitation</u> Refer to Environment Canada precipitation records for relevant areas. Divide annual precipitation by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score). <u>Permeability</u> For surface soil relative permeability (i.e., infiltration) assume: gravel (1), sand (0.6), loam (0.3) and pavement or clay (0). Multiply the surface soil relative permeability factor with precipitation factor to obtain the score for precipitation infiltration rate.	
f. Hydraulic conductivity of aquifer >10 ⁻² cm/s 10 ⁻² to 10 ⁻⁴ cm/s <10 ⁻⁴ cm/s Do Not Know	<div>Score1</div> <div>Do Not Know</div>		Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" in the Reference Material sheet).	
Potential groundwater pathway total	5.9	Note: If a "known" score is provided, the "potential" score is disallowed.		
Allowed Potential score	---			
Groundwater pathway total	12			

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(II) Migration Potential (Evaluation of contaminant migration pathways)
Bar U Ranch National Historic Site

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
2. Surface Water Movement				
A. Demonstrated migration of COPC in surface water above background conditions				
Known concentrations of surface water: i) Concentrations exceed background concentrations and exceed CCME CWQG for protection of aquatic life, irrigation, livestock water, and/or recreation (whichever uses are applicable at the site) by >1 X; or There is known contact of contaminants with surface water based on site observations. or In the absence of CWQG, chemicals have been proven to be toxic based on site specific testing (e.g. toxicity testing; or other indicator testing of exposure). ii) Same as (i) except the information is not known but <u>strongly suspected</u> based on indirect observations. iii) Meets CWQG or absence of surface water exposure pathway (i.e., Distance to nearest surface water is > 5 km.) 				

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(II) Migration Potential (Evaluation of contaminant migration pathways)
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Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
d. Run-off potential High (rainfall run-off score > 0.6) Moderate (0.4 < rainfall run-off score <0.6) Low (0.2 < rainfall run-off score <0.4) Very Low (0 < rainfall run-off score < 0.2) None (rainfall run-off score = 0) Do Not Know Score	<div>Do Not Know</div> 0.4		<u>Rainfall</u> Refer to Environment Canada precipitation records for relevant areas. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score). The former definition of "annual rainfall" did not include the precipitation as snow. This minor adjustment has been made. The second modification was the inclusion of permeability of surface materials as an evaluation factor. <u>Permeability</u> For infiltration assume: gravel (0), sand (0.3), loam (0.6) and pavement or clay (1). Multiply the infiltration factor with precipitation factor to obtain rainfall run off score.	Selected Sources: Environment Canada web page link: www.msc.ec.gc.ca Snow to rainfall conversion apply ratio of 15 (snow):1(water)
e. Flood potential 1 in 2 years 1 in 10 years 1 in 50 years Not in floodplain Do Not Know Score	<div>Do Not Know</div> 0.5		Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	
Potential surface water pathway total	6.9			
Allowed Potential score	---	Note: If a "known" score is provided, the "potential" score is disallowed.		
Surface water pathway total	8			
3. Surface Soils (potential for dust, dermal and ingestion exposure)				
A. Demonstrated concentrations of COPC in surface soils (top 1.5 m)				
COPCs measured in surface soils exceed the CCME soil quality guideline. Strongly suspected that soils exceed guidelines COPCs in surface soils does not exceed the CCME soil quality guideline or is not present (i.e., bedrock). Score	<div>12</div> <div>9</div> <div>0</div> <div>Go to Potential</div> ---	Analytical data was not provided for Golder's review.	Collect all available information on quality of surface soils (i.e., top 1.5 metres) at the site. Evaluate available data against Canadian Soil Quality Guidelines. Select appropriate guidelines based on current (or proposed future) land use (i.e, agricultural, residential/parkland, commercial, or industrial), and soil texture if applicable (i.e., coarse or fine).	Selected References: CCME. 1999. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health www.ccme.ca
NOTE: If a score is assigned here for Demonstrated Concentrations in Surface Soils, then you can skip Part B (Potential for a surface soils migration pathway) and go to Section 4 (Vapour)				
B. Potential for a surface soils (top 1.5 m) migration pathway				
a. Are the soils in question covered? Exposed Vegetated Landscaped Paved Do Not Know Score	<div>Vegetated</div> 4	Grazing by cattle in the vicinity of the waste middens.	Consult engineering or risk assessment reports for the site. Alternatively, review photographs or perform a site visit. Landscaped surface soils must include a minimum of 0.5 m of topsoil.	The possibility of contaminants in blowing snow have not been included in the revised NCS as it is difficult to assess what constitutes an unacceptable concentration and secondly, spills to snow or ice are most efficiently mitigated while freezing conditions remain.
b. For what proportion of the year does the site remain covered by snow? 0 to 10% of the year 10 to 30% of the year More than 30% of the year Do Not Know Score	<div>>30% of year</div> 0		Consult climatic information for the site. The increments represent the full span from soils which are always wet or covered with snow (and therefore less likely to generate dust) to those soils which are predominantly dry and not covered by snow (and therefore are more likely to generate dust).	
Potential surface soil pathway total	4			
Allowed Potential score	4	Note: If a "known" score is provided, the "potential" score is disallowed		
Soil pathway total	4			

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(II) Migration Potential (Evaluation of contaminant migration pathways)
Bar U Ranch National Historic Site

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
4. Vapour				
A. Demonstrated COPCs in vapour.				
Vapour has been measured (indoor or outdoor) in concentrations exceeding risk based concentrations.	12	Vapour studies have not been conducted at the Site.	Consult previous investigations, including human health risk assessments, for reports of vapours detected.	
Strongly suspected (based on observations and/or modelling)	9			
Vapour has not been measured and volatile hydrocarbons have not been found in site soils or groundwater.	0			
	0			
Score	0			
NOTE: If a score is assigned here for Demonstrated COPCs in Vapour, then you can skip Part B (Potential for COPCs in vapour) and go to Section 5 (Sediment)				
B. Potential for COPCs in vapour				
a. Relative Volatility based on Henry's Law Constant, H' (dimensionless) High (H' > 1.0E-1) Moderate (H' = 1.0E-1 to 1.0E-3) Low (H' < 1.0E-3) Not Volatile Do Not Know		Metals are not volatile.	Reference: US EPA Soil Screening Guidance (Part 5 - Table 36) Provided in Attached Reference Materials	If the Henry's Law Constant for a substance indicates that it is not volatile, and a score of zero is assigned here for relative volatility, then the other three questions in this section on Potential for COPCs will be automatically assigned scores of zero and you can skip to section 5.
	Do Not Know			
Score	2.5			
b. What is the soil grain size? Fine Coarse Do Not Know		Data not provided to Golder.	Review soil permeability data in engineering reports. The greater the permeability of soils, the greater the possible movement of vapours. Fine-grained soils are defined as those which contain greater than 50% by mass particles less than 75 µm mean diameter (D50 < 75 µm). Coarse-grained soils are defined as those which contain greater than 50% by mass particles greater than 75 µm mean diameter (D50 > 75 µm).	
	Do Not Know			
Score	3			
c. Is the depth to the source less than 10m? Yes No Do Not Know			Review groundwater depths below grade for the site.	
	Do Not Know			
Score	1			
d. Are there any preferential pathways? Yes No Do Not Know			Visit the site during dry summer conditions and/or review available photographs. Where bedrock is present, fractures would likely act as preferential pathyways.	Preferential pathways refer to areas where vapour migration is more likely to occur because there is lower resistance to flow than in the surrounding materials. For example, underground conduits such as sewer and utility lines, drains, or septic systems may serve as preferential pathways. Features of the building itself that may also be preferential pathways include earthen floors, expansion joints, wall cracks, or foundation perforations for subsurface features such as utility pipes, sumps, and drains.
	Do Not Know			
Score	1			
Potential vapour pathway total	7.5	Note: If a "known" score is provided, the "potential" score is disallowed.		
Allowed Potential score	---			
Vapour pathway total	0			

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
5. Sediment Movement				
A. Demonstrated migration of sediments containing COPCs				
There is evidence to suggest that sediments originally deposited to the site (exceeding the CCME sediment quality guidelines) have migrated. Strongly suspected (based on observations and/or modelling) Sediments have been contained and there is no indication that sediments will migrate in future. or Absence of sediment exposure pathway (i.e., within 5 km of the site there are no aquatic receiving environments, and therefore no sediments).	12	Data not provided to Golder.	Review sediment assessment reports. Evidence of migration of contaminants in sediments must be reported by someone experienced in this area.	Usually not considered a significant concern in lakes/marine environments, but could be very important in rivers where transport downstream could be significant.
	9			
	0			
	Go to Potential			
Score	---			
NOTE: If a score is assigned here for Demonstrated Migration of Sediments, then you can skip Part B (Potential for Sediment Migration) and go to Section 6 (Modifying Factors)				
B. Potential for sediment migration		Note: If a "known" score is provided, the "potential" score is disallowed.	Review existing sediment assessments. If sediment coring has been completed, it may indicate that historically contaminated sediments have been covered over by newer "clean" sediments. This assessment will require that cores collected demonstrate a low concentration near the top and higher concentration with sediment depth. Review existing sediment assessments. If the sediments present at the site are in a river, select "no" for this question. Review existing sediment assessments. It is important that the assessment is made under worst case flows (high yearly flows). Under high yearly flows, areas which are commonly depositional	
a. Are the sediments having COPC exceedances capped with sediments having no exceedances ("clean sediments")? Yes No Do Not Know	Do Not Know			
	2			
	No			
b. For lakes and marine habitats, are the contaminated sediments in shallow water and therefore likely to be affected by tidal action, wave action or propeller wash? Yes No Do Not Know	0			
	Do Not Know			
	2			
Potential sediment pathway total	4			
Allowed Potential score	4			
Sediment pathway total	4			

CCME National Classification System (2008, 2010 v 1.2)
(II) Migration Potential (Evaluation of contaminant migration pathways)
Bar U Ranch National Historic Site

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
6. Modifying Factors				
Are there subsurface utility conduits in the area affected by contamination? Yes No Do Not Know			Consult existing engineering reports. Subsurface utilities can act as conduits for contaminant migration.	
	No			
Known	0			
Potential	0			

Migration Potential Total			
Raw "known" total	20		Note: If "Known" and "Potential" scores are provided, the checklist defaults to known. Therefore, the total "Potential" Score may not reflect the sum of the individual "Potential" scores.
Raw "potential" total	8.0		
Raw combined total	28.0		
Total (max 33)	14.4		

(III) Exposure (Demonstrates the presence of an exposure pathway and receptors)

Bar U Ranch National Historic Site

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
1. Human				
A. Known exposure				
Documented adverse impact or high quantified exposure which has or will result in an adverse effect, injury or harm or impairment of the safety to humans as a result of the contaminated site. (Class 1 Site*)	22	Risk assessment studies have not been conducted for the Site.	*Where adverse effects on humans are documented, the site should be automatically designated as a Class 1 site (i.e., action required). There is no need to proceed through the NCS in this case. However, a scoring guideline (22) is provided in case a numerical score for the site is still desired (e.g., for comparison with other Class 1 sites). This category can be based on the outcomes of risk assessments and applies to studies which have reported Hazard Quotients >1 for noncarcinogenic chemicals and incremental cancer risks that exceed acceptable levels defined by the jurisdiction for carcinogenic chemicals (for most jurisdictions this is typically either >10 ⁻⁵ or >10 ⁻⁶). Known impacts can also be evaluated based on blood testing (e.g. blood lead >10 ug/dL) or other health based testing. This category can be based on the outcomes of risk assessments and applies to studies which have reported Hazard Quotients of less than 0.2 for non-carcinogenic chemicals and incremental lifetime cancer risks for carcinogenic chemicals that are within acceptable levels as defined by the jurisdiction (for most jurisdictions this is less than either 10 ⁻⁶ or 10 ⁻⁵).	Known adverse impact includes domestic and traditional food sources. Adverse effects based on food chain transfer to humans and/or animals can be scored in this category. However, the weight of evidence must show a direct link of a contaminated food source/supply and subsequent ingestion/transfer to humans. Any associated adverse effects to the environment are scored separately later in this worksheet. Someone experienced must provide a thorough description of the sources researched to evaluate and determine the quantified exposure/impact (adverse effect) in the vicinity of the contaminated site. Selected References: Health Canada – Federal Contaminated Site Risk Assessment in Canada Parts 1 and 2 Guidance on Human Heath Screening Level Risk Assessments (www.hc-sc.gc.ca/ewh-semt/pubs/contam/site/index_e.html) United States Environmental Protection Agency, Integrated Risk Information System (IRIS) – http://toxnet.nlm.nih.gov
Same as above, but "Strongly Suspected" based on observations or indirect evidence.	10			
No quantified or suspected exposures/impacts in humans.	0			
Go to Potential				
Score	---			
NOTE: If a score is assigned here for Known Exposure, then you can skip Part B (Potential for Human Exposure) and go to Section 2 (Human Exposure Modifying Factors)				
B. Potential for human exposure				
a) Land use (provides an indication of potential human exposure scenarios) Agricultural Residential / Parkland Commercial Industrial Do Not Know		Moderate access restrictions.	Review zoning and land use maps over the distances indicated. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place. Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	This is the main "receptor" factor used in site scoring. A higher score implies a greater exposure and/or exposure of more sensitive human receptors (e.g., children).
Score	Agricultural			
	3			
b. Indicate the level of accessibility to the contaminated portion of the site (e.g., the potential for coming in contact with contamination) Limited barriers to prevent site access; contamination not covered Moderate access or no intervening barriers, contaminants are covered. Remote locations in which contaminants not covered. Controlled access or remote location and contaminants are covered Do Not Know		Review location and structures and contaminants at the site and determine if there are intervening barriers between the site and humans. A low rating should be assigned to a (covered) site surrounded by a fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.		
Score	Mod. access, covered			
	1			
B. Potential for human exposure				
c) Potential for intake of contaminated soil, water, sediment or foods for operable or potentially operable pathways, as identified in Worksheet II (Migration Potential). i) direct contact Is dermal contact with contaminated surface water, groundwater, sediments or soils anticipated? Yes No Do Not Know		No buildings within 30 m radius of the waste middens.	If soils or potable groundwater are present exceeding their respective CCME guidelines, dermal contact is assumed. Exposure to surface water, non-potable groundwater or sediments exceeding their respective CCME guidelines will depend on the site. Select "Yes" if dermal exposure to surface water, non-potable groundwater or sediments is expected. For instance, dermal contact with sediments would not be expected in an active port. Only soils in the top 1.5 m are defined by CCME (2003) as surface soils. If contaminated soils are only located deeper than 1.5 m, direct contact with soils is not anticipated to be an operable contaminant exposure pathway.	Exposure via the skin is generally believed to be a minor exposure route. However for some organic contaminants, skin exposure can play a very important component of overall exposure. Dermal exposure can occur while swimming in contaminated waters, bathing with contaminated surface water/groundwater and digging in contaminated dirt, etc.
Score	No			
	0			
ii) inhalation (i.e., inhalation of dust, vapour) Vapour - Are there inhabitable buildings on the site within 30 m of soils or groundwater with volatile contamination as determined in Worksheet II (Migration Potential)? Yes No Do Not Know		No buildings within 30 m radius of the waste middens.	If inhabitable buildings are on the site within 30 m of soils or groundwater exceeding their respective guidelines for volatile chemicals, there is a potential of risk to human health (Health Canada, 2004). Review site investigations for location of soil samples (having exceedances of volatile substances) relative to buildings. Refer to (II) Migration Potential worksheet, 4B.a). <i>Potential for COPCs in Vapour</i> for a definition of volatility. Consult grain size data for the site. If soils (containing exceedances of the CCME soil quality guidelines) predominantly consist of fine material (having a median grain size of 75 microns; as defined by CCME (2006)) then these soils are more likely to generate dusts.	Exposure via the lungs (inhalation) can be a very important exposure pathway. Inhalation can be via both particulates (dust) and gas (vapours). Vapours can be a problem where buildings have been built on former industrial sites or where volatile contaminants have migrated below buildings resulting in the potential for vapour intrusion. Assesses the potential for humans to be exposed to vapours originating from site soils. The closer the receptor is to a source of volatile chemicals in soil, the greater the potential of exposure. Also, coarser-grained soil will convey vapour much more efficiently in the soil than finer grained material such as clays and silts. General Notes; Someone experienced must provide a thorough description of the sources researched to determine the presence/absence of a vapour migration and/or dust generation in the vicinity of the contaminated site. This information must be documented in the NCS Site Classification Worksheet including contact names, phone numbers, e-mail correspondence and/or reference maps/reports and other resource such as internet links. Selected References; Canadian Council of Ministers of the Environment (CCME). 2006. Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. PN 1332. www.ccme.ca Golder, 2004. Soil Vapour Intrusion Guidance for Health Canada Screening Level Risk Assessment (SLRA) Submitted to Health Canada, Burnaby, BC
Score	No			
	0			
Dust - If there is contaminated surface soil (e.g. top 1.5 m) , indicate whether the soil is fine or coarse textured. If it is known that surface soil is not contaminated, enter a score of zero. Fine Coarse Surface soil is not contaminated or absent (bedrock) Do Not Know Texture				
Score	Do Not Know			
	2			
inhalation total	2			

Bar U Ranch National Historic Site

NOTE: If a score is assigned here for Known Exposure, then you can skip Part B (Potential for Ecological Exposure) and go to Section 4 (Ecological Exposure Modifying Factors)

CCME National Classification System (2008, 2010 v 1.2)
(III) Exposure (Demonstrates the presence of an exposure pathway and receptors)
Bar U Ranch National Historic Site

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes
B. Potential for ecological exposure (for the contaminated portion of the site)				
a) Terrestrial i) Land use Agricultural (or Wild lands) Residential/Parkland Commercial Industrial Do Not Know Score	<div>Do Not Know</div> <div>1.5</div>		Review zoning and land use maps. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration). Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Wild lands are grouped with agricultural land due to the similarities in receptors that would be expected to occur there (e.g., herbivorous mammals and birds) and the similar need for a high level of protection to ensure ecological functioning. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	
ii) Uptake potential Direct Contact - Are plants and/or soil invertebrates likely exposed to contaminated soils at the site? Yes No Do Not Know Score	<div>Do Not Know</div> <div></div> <div>0.5</div>		If contaminated soils are located within the top 1.5 m, it is assumed that direct contact of soils with plants and soil invertebrates is an operable exposure pathway. Exposure to soils deeper than 1.5 m is possible, but less likely.	
iii) Ingestion (i.e., wildlife or domestic animals ingesting contaminated food items, soils or water) Are terrestrial animals likely to be ingesting contaminated water at the site? Yes No Do Not Know Score Are terrestrial animals likely to be ingesting contaminated soils at the site? Yes No Do Not Know Score Can the contamination identified bioaccumulate? Yes No Do Not Know Score Distance to sensitive terrestrial ecological area 0 to 300 m 300 m to 1 km 1 to 5 km > 5 km Do Not Know Score	<div>Do Not Know</div> <div>0.5</div> <div></div> <div>Do Not Know</div> <div>0.5</div> <div>Do Not Know</div> <div>0.5</div> <div>Do Not Know</div> <div>1.5</div>	Lead	Refer to an Ecological Risk Assessment for the site. If there is contaminated surface water at the site, assume that terrestrial organisms will ingest it. Refer to an Ecological Risk Assessment report. Most animals will co-ingest some soil while eating plant matter or soil invertebrates. Bioaccumulation of contaminants within food items is considered possible if: 1) The Log(Kow) of the contaminant is greater than 4 (as per the chemical characteristics work sheet) and concentrations in soils exceed the most conservative CCME soil quality guideline for the intended land use, or 2) The contaminant in collected tissue samples exceeds the Canadian Tissue Residue Guidelines. It is considered that within 300 m of a site, there is a concern for contamination. Therefore an environmental receptor located within this area of the site will be subject to further evaluations. It is also considered that any environmental receptor located greater than 5 km will not be a concern for evaluation. Review Conservation Authority mapping and literature including Canadian Council on Ecological Areas link: www.ccea.org	Environmental receptors include: local, regional or provincial species of interest or significance; arctic environments (on a site specific basis); nature preserves, habitats for species at risk, sensitive forests, natural parks or forests.
Raw Terrestrial Total Potential Allowed Terrestrial Total Potential	<div>5</div> <div>---</div>	Note if a "Known" Ecological Effects score is provided, the "Potential" score is disallowed.		
B. Potential for ecological exposure (for the contaminated portion of the site)				
b) Aquatic i) Classification of aquatic environment Sensitive Typical Not Applicable (no aquatic environment present) Do Not Know Score	<div>Typical</div> <div>1</div>		"Sensitive aquatic environments" include those in or adjacent to shellfish or fish harvesting areas, marine parks, ecological reserves and fish migration paths. Also includes those areas deemed to have ecological significance such as for fish food resources, spawning areas or having rare or endangered species. "Typical aquatic environments" include those in areas other than those listed above.	
ii) Uptake potential Does groundwater daylighting to an aquatic environment exceed the CCME water quality guidelines for the protection of aquatic life at the point of contact? Yes No (or Not Applicable) Do Not Know Score Distance from the contaminated site to an important surface water resource 0 to 300 m 300 m to 1 km 1 to 5 km > 5 km Do Not Know Score Are aquatic species (i.e., forage fish, invertebrates or plants) that are consumed by predatory fish or wildlife consumers, such as mammals and birds, likely to accumulate contaminants in their tissues? Yes No Do Not Know Score	<div>Yes</div> <div>1</div> <div></div> <div>Do Not Know</div> <div>1.5</div> <div></div> <div>Do Not Know</div> <div>0.5</div>		Groundwater concentrations of contaminants at the point of contact with an aquatic receiving environment can be estimated in three ways: 1) by comparing collected nearshore groundwater concentrations to the CCME water quality guidelines (this will be a conservative comparison, as contaminant concentrations in groundwater often decrease between nearshore wells and the point of discharge). 2) by conducting groundwater modeling to estimate the concentration of groundwater immediately before discharge. 3) by installing water samplers, "peepers", in the sediments in the area of daylighting groundwater. It is considered that within 300 m of a site, there is a concern for contamination. Therefore an environmental receptor or important water resource located within this area of the site will be subject to further evaluation. It is also considered that any environmental receptor located greater than 5 km away will not be a concern for evaluation. Review Conservation Authority mapping and literature including Canadian Council on Ecological Areas link: www.ccea.org Bioaccumulation of food items is possible if: 1) The Log(Kow) of the contaminant is greater than 4 (as per the chemical characteristics work sheet) and concentrations in sediments exceed the CCME ISQGs. 2) The contaminant in collected tissue samples exceeds the CCME tissue quality guidelines.	Environmental receptors include: local, regional or provincial species of interest or significance, sensitive wetlands and fens and other aquatic environments.
Raw Aquatic Total Potential Allowed Aquatic Total Potential	<div>4</div> <div>---</div>	Note if a "Known" Ecological Effects score is provided, the "Potential" score is disallowed.		

Definition	Score	Rationale for Score (document any assumptions, reports, or site-specific information; provide references)	Method Of Evaluation	Notes	
4. Ecological Exposure Modifying Factors					
a) Known occurrence of a species at risk. Is there a potential for a species at risk to be present at the site? Yes No Do Not Know	<div>Yes</div> <div>2</div> <div>---</div>	Species at risk include: grizzly bear, woodland caribou, western toad, common nighthawk, yellow rail, olive-sided flycatcher, Lewis' woodpecker, westslope cutthroat trout - Alberta population, rusty blackbird, Canada warbler , ferruginous hawk , plains bison, and wolverines.	Consult any ecological risk assessment reports. If information is not present, utilize on-line databases such as Eco Explorer. Regional, Provincial (Environment Ministries), or Federal staff (Fisheries and Oceans or Environment Canada) should be able to provide some guidance.	Species at risk include those that are extirpated, endangered, threatened, or of special concern. For a list of species at risk, consult Schedule 1 of the federal Species at Risk Act (http://www.sararegistry.gc.ca/species/schedules_e.cfm?id=1). Many provincial governments may also provide regionally applicable lists of species at risk. For example, in British Columbia, consult: BCMWLAP. 2005. Endangered Species and Ecosystems in British Columbia. Provincial red and blue lists. Ministry of Sustainable Resource Management and Water, Land and Air Protection. http://srmwww.gov.bc.ca/atrisk/red-blue.htm	
Score					
b) Potential impact of aesthetics (e.g., enrichment of a lake or tainting of food flavor). Is there evidence of aesthetic impact to receiving water bodies? Yes No Do Not Know Is there evidence of olfactory impact (i.e., unpleasant smell)? Yes No Do Not Know Is there evidence of increase in plant growth in the lake or water body? Yes No Do Not Know Is there evidence that fish or meat taken from or adjacent to the site smells or tastes different? Yes No Do Not Know	<div>Yes</div> <div>2</div> <div>---</div> <div>No</div> <div>0</div> <div>---</div> <div>No</div> <div>0</div> <div>---</div> <div>No</div> <div>0</div> <div>---</div>	The closest surface water body is Pekisko Creek which is 300 m southeast of the Waste Middens.	Documentation may consist of environmental investigation reports, press articles, petitions or other records. Examples of olfactory change can include the smell of a COPC or an increase in the rate of decay in an aquatic habitat. A distinct increase of plant growth in an aquatic environment may suggest enrichment. Nutrients e.g., nitrogen or phosphorous releases to an aquatic body can act as a fertilizer. Some contaminants can result in a distinctive change in the way food gathered from the site tastes or smells.	This Item will require some level of documentation by user, including contact names, addresses, phone numbers, e-mail addresses. Evidence of changes must be documented, please attach copy of report containing relevant information.	
Ecological Modifying Factors Total - Known					4
Ecological Modifying Factors Total - Potential					---
Raw Ecological Total - Known					16
Raw Ecological Total - Potential					0
Raw Ecological Total					16
Ecological Total (Max 18)					16.0
5. Other Potential Contaminant Receptors					
a) Exposure of permafrost (leading to erosion and structural concerns) Are there improvements (roads, buildings) at the site dependant upon the permafrost for structural integrity? Yes No Do Not Know Is there a physical pathway which can transport soils released by damaged permafrost to a nearby aquatic environment? Yes No Do Not Know	<div>No</div> <div>0</div> <div>---</div> <div>No</div> <div>0</div> <div>---</div>	Permafrost is not expected at the Site.	Consult engineering reports, site plans or air photos of the site. When permafrost melts, the stability of the soil decreases, leading to erosion. Human structures, such as roads and/or buildings are often dependent on the stability that the permafrost provides. Melting permafrost leads to a decreased stability of underlying soils. Wind or surface run-off erosion can carry soils into nearby aquatic habitats. The increased soil loadings into a river can cause an increase in total dissolved solids and a resulting decrease in aquatic habitat quality. In addition, the erosion can bring contaminants from soils to aquatic environments.	Plants and lichens provide a natural insulating layer which will help prevent thawing of the permafrost during the summer. Plants and lichens may also absorb less solar radiation. Solar radiation is turned into heat which can also cause underlying permafrost to melt.	
Other Potential Receptors Total - Known					0
Other Potential Receptors Total - Potential					0
Exposure Total					
Raw Human Health + Ecological Total - Known		22	Only includes "Allowed potential" - if a "Known" score was supplied under a given category then the "Potential" score was not included.		
Raw Human Health + Ecological Total - Potential		9			
Raw Total		31			
Exposure Total (max 34)		22.9			

CCME National Classification System (2008, 2010 v 1.2) **Score Summary**

Scores from individual worksheets are tallied in this worksheet.
Refer to this sheet after filling out the revised NCS completely.

I. Contaminant Characteristics

	Known	Potential
1. Residency Media	6	---
2. Chemical Hazard	8	---
3. Contaminant Exceedance Factor	6	---
4. Contaminant Quantity	2	---
5. Modifying Factors	4	---

Raw Total Score 26 0

Raw Total Score (Known + Potential) 26

Adjusted Total Score (Raw Total / 40 * 33) 21.5 (max 33)

II. Migration Potential

	Known	Potential
1. Groundwater Movement	12	---
2. Surface Water Movement	8	---
3. Soil	---	4
4. Vapour	0	---
5. Sediment Movement	---	4
6. Modifying Factors	0	0

Raw Total Score 20 8

Raw Total Score (Known + Potential) 28

Adjusted Total Score (Raw Total / 64 * 33) 14.4 (max 33)

III. Exposure

	Known	Potential
1. Human Receptors		
A. Known Impact	---	
B. Potential		
a. Land Use		3
b. Accessibility		1
c. Exposure Route		
i. Direct Contact		0
ii. Inhalation		2
iii. Ingestion		3
2. Human Receptors Modifying Factors	6	---
Raw Total Human Score	6	9

Raw Total Human Score (Known + Potential) 15

Adjusted Total Human Score 15.0 (maximum 22)

3. Ecological Receptors

A. Known Impact	12	
B. Potential		
a. Terrestrial		---
b. Aquatic		---
4. Ecological Receptors Modifying Factors	4	---
Raw Total Ecological Score	16	0

Raw Total Ecological Score (Known + Potential) 16

Adjusted Total Ecological Score 16.0 (maximum 18)

5. Other Receptors

0	0
---	---

Total Other Receptors Score (Known + Potential) 0

Total Exposure Score (Human + Ecological + Other) 31.0

Adjusted Total Exposure Score (Total Exposure / 46 * 34) 22.9 (max 34)

Site Score

Bar U Ranch National Historic Site

Site Letter Grade	C
Certainty Percentage	81%
% Responses that are "Do Not Know"	5%

Total NCSCS Score for site	58.8
Site Classification Category	2

Site Classification Categories*:

- Class 1 - High Priority for Action (Total NCS Score >70)
- Class 2 - Medium Priority for Action (Total NCS Score 50 - 69.9)
- Class 3 - Low Priority for Action (Total NCS Score 37 - 49.9)
- Class N - Not a Priority for Action (Total NCS Score <37)
- Class INS - Insufficient Information (>15% of responses are "Do Not Know")

* NOTE: The term "action" in the above categories does not necessarily refer to remediation, but could also include risk assessment, risk management or further site characterization and data collection.

CCME National Classification System (2008, 2010 v 1.2)

Contaminant Hazard Ranking

(Based on the Proposed Hazard Ranking developed for the FCSAP Contaminated Sites Classification System)

This information is used in Sheet I (Contaminant Characteristics), section 2 (Chemical Hazard).

Chemical/Parameter	Hazard	CEPA	Carcinogenicity	Notes
Acetaldehyde	H	*	PHC	
Acetone	L			
Acrolein	H	*		
Acrylonitrile	H	*	PHC	
Alachlor	M			
Aldicarb	H			
Aldrin	H			
Allyl Alcohol	H			
Aluminum	L			
Ammonia	L	*		
Antimony	H			
Arsenic	H	*		
Atrazine	M			
Azinphos-Methyl	H			
Barium	L			
Bendiocarb	H			
Benzene	H	*	CHC	BTEX
Benztidine	H	*	CHC	
Beryllium	H		CHC	
Biphenyl, 1,1-	M			
2,3,4,5-Bis(2-Butylene)tetrahydro-2-furfural	H			
Bis(Chloromethyl)Ether	H	*	CHC	
Bis(2-Chloroethyl)Ether	H		CHC	
Bis(2-Chloroisopropyl)Ether	H			
Bis(2-Ethylhexyl)Phthalate	H	*		PH
Boron	L			
Bromacil	M			
Bromate	M			
Bromochlorodifluoromethane	M	*		HM
Bromochloromethane	H	*		HM
Bromodichloromethane	H			HM
Bromoform (Tribromomethane)	H		PHC	HM
Bromomethane	M			HM
Bromotrifluoromethane	M	*		HM
Bromoxynil	H			
Butadiene, 1,3-	H	*	CHC	
Cadmium	H	*	CHC	
Carbofuran	M			
Carbon Tetrachloride (Tetrachloromethane)	H		PHC	HM
Captafol	M			
Chloramines	M	*		
Chloride	L			
Chloroaniline, P-	H			
Chlorobenzene (mono)	M			
Chlorobenzilate	M			
Chlorodimeform	M			
Chloroform	H		PHC	HM
Chloromethane	M			
Chloromethyl Methyl Ether	M	*		
(4-Chlorophenyl)Cyclopropylmethanone, O-((4-Nitrophenyl)Methyl)Oxime	H			
Chlorinated Benzenes				
Monochlorobenzene	M			
Dichlorobenzene, 1,2- (O-DCB)	M			
Dichlorobenzene, 1,3- (M-DCB)	M			
Dichlorobenzene, 1,4- (P-DCB)	H			
Trichlorobenzene, 1,2,3-	M			
Trichlorobenzene, 1,2,4-	M			
Trichlorobenzene, 1,3,5-	M			
Tetrachlorobenzene, 1,2,3,4-	M			
Tetrachlorobenzene, 1,2,3,5-	M			
Tetrachlorobenzene, 1,2,4,5-	M			
Pentachlorobenzene	M			
Hexachlorobenzene	H			

Chemical/Parameter	Hazard	CEPA	Carcinogenicity	Notes
Chlorinated Ethanes				
Dichloroethane, 1,1-	M			
Dichloroethane, 1,2- (Ethylene Dichloride (EDC))	H		PHC	
Trichloroethane, 1,1,1-	H	*		
Trichloroethane, 1,1,2-	M			
Tetrachloroethane, 1,1,1,2-	M			
Tetrachloroethane, 1,1,2,2-	M			
Chlorinated Ethenes				
Monochloroethene (Vinyl Chloride)	H	*	CHC	
Dichloroeth(y)ene, 1,1-	H			
Dichloroeth(y)ene, 1,2- (cis or trans)	M			
Trichloroeth(y)ene (TCE)	H	*		
Tetrachloroeth(y)ene (PCE)	H	*		
Chlorinated Phenols		*		
Monochlorophenols	M			
Chlorophenol, 2-	M			
Dichlorophenols				
Dichlorophenol, 2,4-	M			
Trichlorophenols				
Trichlorophenol, 2,4,5-	H			
Trichlorophenol, 2,4,6-	H		PHC	
Tetrachlorophenols				
Tetrachlorophenol, 2,3,4,6-	H			
Pentachlorophenol (PCP)	H			
Chloromethane	M			HM
Chlorophenol, 2-	M			CP
Chloroethanol	H			
Chlorpyrifos	H			
Chromium (Total)	M	*		
Chromium (III)	L	*		
Chromium (VI)	H	*	CHC	
Coal Tar	H		CHC	Refer to PAHs
Cobalt	L			
Copper	L			
Creosote	M	*		Refer to PAHs
Crocidolite	L			
Cyanide (Free)	H			
Cyanazine	M			
Dibenzofuran	H	*		DF
Dibromoethane, 1,2- (Ethylene Dibromide (EDB))	H		PHC	
1,2-Dibromo-3-Chloropropane	H		PHC	
Dibromochloromethane	M	*		HM
Dibromotetrafluoroethane	M			
Dichlorobenzene, 1,2- (O-DCB)	M			CB
Dichlorobenzene, 1,3- (M-DCB)	M			CB
Dichlorobenzene, 1,4- (P-DCB)	H			CB
Dichlorobenzidine, 3,3'-	H		PHC	
DDD	H			
DDE	H			
DDT	H		PHC	
Deltamethrin	M			
Diazinon	M			
Dicamba	H			
Dichloroethane, 1,1-	H			CEA
Dichloroethane, 1,2- (EDC)	H		PHC	CEA
Dichloroeth(y)ene, 1,1-	H			CEE
Dichloroeth(y)ene, Cis-1,2-	M			CEE
Dichloroeth(y)ene, Trans-1,2-	M			CEE
Dichloromethane (Methylene Chloride)	H		PHC	HM
Dichlorophenol, 2,4-	M			CP
Dichloropropane, 1,2-	H			
Dichloropropene, 1,3-	H		PHC	
Diclofop-Methyl	H			
Didecyl Dimethyl Ammonium Chloride	H			
Dieldrin	H			
Dimethoate	H			
Diethyl Phthalate	M			PH
Diethylene Glycol	L			GL
Dimethyl Phthalate	M			PH
Dimethylphenol, 2,4-	L			
Dinitrophenol, 2,4-	M			
Dinitrotoluene, 2,4-	H			
Dinoseb	H			
Di-n-octyl Phthalate	H			
Dioxane, 1,4-	H		PHC	
Dioxins/Furans	H			
Diquat	M			
Diuron	M			

Chemical/Parameter	Hazard	CEPA	Carcinogenicity	Notes
Endosulfan	H			
Endrin	H			
Ethylbenzene	M			BTEX
Ethylene Dibromide (EDB)	H		PHC	
Ethylene Glycol	L			GL
Ethylene Oxide	H		CHC	
Fluoroacetamide	M			
Fluorides	L	*		
Glycols				
Ethylene Glycol	L			
Diethylene Glycol	L			
Propylene Glycol	L			
Glyphosate	M			
Halogenated Methanes				
Bromochlorodifluoromethane	M	*		
Bromochloromethane	M	*		
Bromodichloromethane	H		PHC	
Bromomethane	M			
Bromotrifluoromethane	M	*		
Chloroform	M		PHC	HM
Chloromethane	M			
Dibromochloromethane	M			
Dichloromethane (Methylene Chloride)	H		PHC	
Methyl Bromide	M	*		
Tetrachloromethane (Carbon Tetrachloride)	H			
Tribromomethane (Bromoform)	H			
Trihalomethanes (THM)	M			
Heptachlor	H			
Heptachlor Epoxide	H			
Hexachlorobenzene	H		PHC	
Hexachlorobutadiene	H			
Hexachlorocyclohexane, Gamma	H		PHC	
Hexachloroethane	H		PHC	
Hydrobromofluorocarbons (HBFCs)	M	*		
Hydrochlorofluorocarbons (HCFCs)	M	*		
3-Iodo-2-propynyl Butyl Carbamate	H			
Iron	L			
Lead	H	*		neurotoxins / teratogens
Lead Arsenate	H			
Leptophos	H			
Lindane	H			
Linuron	H			
Lithium	L			
Malathion	M			
Manganese	L			
Mercury	H	*		
Methamidophos	H			
Methoxychlor	H			
Methyl Bromide (Bromomethane)	M	*		
2-Methyl-4-chloro-phenoxy Acetic Acid	M			
Methyl Ethyl Ketone	L			
Methyl Isobutyl Ketone	L			
Methyl Mercury	H			
Methyl-Parathion	H			
Methyl Tert Butyl Ether (MTBE)	M			
Metolachlor	M			
Metribuzin	H			
Molybdenum	L			
Monochloramine	M			
Monocrotophos	H			
Nickel	H	*		CEPA - inhalation
Nitritotriacetic Acid	H		PHC	
Nitrate	L			
Nitrite	M			
Nonylphenol + Ethoxylates	H	*		
Organotins				
Tributyltin	H			
Tricyclohexyltin	H			
Triphenyltin	H			
Parathion	H			
Paraquat (as Dichloride)	H			
Pentachlorobenzene	M			CB
Pentachlorophenol (PCP)	H			CP

Chemical/Parameter	Hazard	CEPA	Carcinogenicity	Notes
Petroleum Hydrocarbons				Ranking based upon fraction of toxic and mobile components in product. Lighter compounds such as benzene are more toxic and mobile.
Petroleum Hydrocarbons (Gasoline)	H			
Petroleum Hydrocarbons (Kerosene incl. Jet Fuels)	H			
Petroleum Hydrocarbons (Diesel incl Heating Oil)	M			
Petroleum Hydrocarbons (Heavy Oils)	L			
Petroleum Hydrocarbons (CCME F1)	H			
Petroleum Hydrocarbons (CCME F2)	M			
Petroleum Hydrocarbons (CCME F3)	L			
Petroleum Hydrocarbons (CCME F4)	L			
Phenol	L			
Phenoxy Herbicides	M			
Phorate	H			
Phosphamidon	H			
Phthalate Esters				
Bis(2-Ethylhexyl)Phthalate	H	*		
Diethyl Phthalate	H			
Dimethyl Phthalate	H			
Di-n-octyl Phthalate	H			
Polybrominated Biphenyls (PBB)	H	*		
Polychlorinated Biphenyls (PCB)	H			
Polychlorinated Terphenyls	H	*		
Polycyclic Aromatic Hydrocarbons	H	*	PHC	
Acenaphthene	M			
Acenaphthylene	M			
Acridine	H			
Anthracene	M			
Benzo(a)anthracene	H		PHC	
Benzo(a)pyrene	H		PHC	
Benzo(b)fluoranthene	H		PHC	
Benzo(g,h,i)perylene	H			
Benzo(k)fluoranthene	H		PHC	
Chrysene	M			
Dibenzo(a,h)anthracene	H		PHC	
Fluoranthene	M			
Fluorene	M			
Indeno(1,2,3-c,d)pyrene	H		PHC	
Methylnaphthalenes	M			
Naphthalene	M			
Phenanthrene	M			
Pyrene	M			
Quinoline	H			
Propylene Glycol	L			GL
Radium	H			
Radon	H			
Selenium	M			
Silver	L			
Simazine	M			
Sodium	L			
Strontium-90	H			
Strychnine	H			
Styrene	H			
Sulphate	L			
Sulphide	L			
2,3,7,8-Tetrachlorodibenzo-p-dioxins (TCDD)	H	*		DF
Tebuthiuron	H			
Tetrachloroeth(yl)ene (PCE)	H	*		CEE
Tetraethyl Lead	H			
Tetrachlorobenzene, 1,2,3,4-	H			CB
Tetrachlorobenzene, 1,2,3,5-	H			CB
Tetrachlorobenzene, 1,2,4,5-	H			CB
Tetrachloroethane, 1,1,1,2-	M			CEA
Tetrachloroethane, 1,1,2,2-	M			CEA
Tetrachlorophenol, 2,3,4,6-	H			CP
Tetramethyl Lead	H	*		
Thallium	M			
Thiophene	M			
Tin	L			
Toluene	M			BTEX
Toxaphene	H			
Triallate	M			
Tribromomethane (Bromoform)	H			HM
Tributyltetradecylphosphonium Chloride	H	*		
Trichlorobenzene, 1,2,3-	H			CB
Trichlorobenzene, 1,2,4-	H			CB
Trichlorobenzene, 1,3,5-	H			CB
Trichloroethane, 1,1,1-	H	*		CEA
Trichloroethane, 1,1,2-	M			CEA
Trichloroeth(yl)ene (TCE)	H	*		CEE

Chemical/Parameter	Hazard	CEPA	Carcinogenicity	Notes
Tricyclohexyltin Hydroxide	H			
Trichlorophenol, 2,4,5-	H			CP
Trichlorophenol, 2,4,6-	H		PHC	CP
Trifluralin	H			
Trihalomethanes (THM)	M			
Tris(2,3-Dibromopropyl)phosphate	H			
Tritium	L			
Uranium (Non-radioactive) / (Radioactive)	M/H			
Vanadium	M			
Vinyl Chloride	H	*	CHC	CEE
Xylenes	M			BTEX
Zinc	L			

H = High Hazard

M = Medium Hazard

L = Low Hazard

Hazard ratings based on a number of factors including potential human and ecological health effects.

PHC = Potential Human Carcinogen

CHC = Confirmed Human Carcinogen

BTEX = benzene, toluene, ethylbenzene, and xylenes

CB = chlorobenzenes

CEA = chlorinated ethanes

CEE = chlorinated ethenes

CP = chlorophenols

DF = dioxins and furans

GL = glycols

HM = halomethanes

PAH = polycyclic aromatic hydrocarbons

PH = phthalate esters

CCME National Classification System (2008, 2010 v 1.2)
Reference Material (Information to assist in scoring)

Examples of Persistent Substances

This information is used in Sheet I (Chemical Characteristics), section 5 (Modifying Factors).

aldrin	dieldrin	PCBs
benzo(a)pyrene	hexachlorobenzene	PCDDs/PCDFs (dioxins and furans)
chlordane	methylmercury	toxaphene
DDT	mirex	alkylated lead
DDE	octachlorostyrene	

Examples of Substances in the Various Chemical Classes

This information is used in Sheet I (Chemical Characteristics), section 5 (Modifying Factors).

Chemical Class	Examples *
inorganic substances (including metals)	arsenic, barium, cadmium, hexavalent chromium, copper, cyanide, fluoride, lead, mercury, nickel, selenium, sulphur, zinc; brines or salts
volatile petroleum hydrocarbons	benzene, toluene, ethylbenzene, xylenes, PHC F1
light extractable petroleum hydrocarbons	PHC F2
heavy extractable petroleum hydrocarbons	PHC F3
PAHs	Benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, naphthalene, phenanthrene, pyrene
phenolic substances	phenol, pentachlorophenol, chlorophenols, nonchlorinated phenols (e.g., 2,4-dinitrophenol, cresol, etc.)
chlorinated hydrocarbons	PCBs, tetrachloroethylene, trichloroethylene, dioxins and furans, trichlorobenzene, tetrachlorobenzene, pentachlorobenzene, hexachlorobenzene
halogenated methanes	carbon tetrachloride, chloroform, dichloromethane
phthalate esters	di-isononyl phthalate (DINP), di-isodecyl phthalate (DIDP), di-2-ethylhexyl phthalate (DEHP)
pesticides	DDT, hexachlorocyclohexane

* Note: Specific chemicals that belong to the various classes are not limited to those listed in this table. These lists are not exhaustive and are meant just to provide examples of substances that are typically encountered.

Chemical-specific Properties

(Adapted from USEPA Soil Screening Criteria)

The information on Koc is used in Sheet II (Migration Potential), section 1,B,a (Relative Mobility).

The information on the dimensionless Henry's law constant is used in Sheet II (Migration Potential), section 4,B,a (Relative Volatility).

The information on log Kow is used in Sheet III (Exposure), section 3,B,a,iii (Potential for Ecological Exposure - terrestrial ingestion), and section 3,B,b,ii (Potential for Ecological Exposure - aquatic uptake potential).

CAS No.	Compound	Solubility in Water @ 20-25°C (mg/L)	Henry's Law Constant (atm-m3/mol)	Dimensionless Henry's law constant (HLC [atm-m3/mol] * 41) (25 °C).	log Kow	Log Koc (L/kg)
83-32-9	Acenaphthene	4.24E+00	1.55E-04	6.36E-03	3.92	3.85
67-64-1	Acetone	1.00E+06	3.88E-05	1.59E-03	-0.24	-0.24
309-00-2	Aldrin	1.80E-01	1.70E-04	6.97E-03	6.5	6.39
120-12-7	Anthracene	4.34E-02	6.50E-05	2.67E-03	4.55	4.47
56-55-3	Benz(a)anthracene	9.40E-03	3.35E-06	1.37E-04	5.7	5.6
71-43-2	Benzene	1.75E+03	5.55E-03	2.28E-01	2.13	1.77
205-99-2	Benzo(b)fluoranthene	1.50E-03	1.11E-04	4.55E-03	6.2	6.09
207-08-9	Benzo(k)fluoranthene	8.00E-04	8.29E-07	3.40E-05	6.2	6.09
65-85-0	Benzoic acid	3.50E+03	1.54E-06	6.31E-05	1.86	—
50-32-8	Benzo(a)pyrene	1.62E-03	1.13E-06	4.63E-05	6.11	6.01
111-44-4	Bis(2-chloroethyl)ether	1.72E+04	1.80E-05	7.38E-04	1.21	1.19
117-81-7	Bis(2-ethylhexyl)phthalate	3.40E-01	1.02E-07	4.18E-06	7.3	7.18
75-27-4	Bromodichloromethane	6.74E+03	1.60E-03	6.56E-02	2.1	1.74
75-25-2	Bromoform	3.10E+03	5.35E-04	2.19E-02	2.35	1.94
71-36-3	Butanol	7.40E+04	8.81E-06	3.61E-04	0.85	0.84
85-68-7	Butyl benzyl phthalate	2.69E+00	1.26E-06	5.17E-05	4.84	4.76
86-74-8	Carbazole	7.48E+00	1.53E-08	6.26E-07	3.59	3.53
75-15-0	Carbon disulfide	1.19E+03	3.03E-02	1.24E+00	2	1.66
56-23-5	Carbon tetrachloride	7.93E+02	3.04E-02	1.25E+00	2.73	2.24
57-74-9	Chlordane	5.60E-02	4.86E-05	1.99E-03	6.32	5.08
106-47-8	p-Chloroaniline	5.30E+03	3.31E-07	1.36E-05	1.85	1.82
108-90-7	Chlorobenzene	4.72E+02	3.70E-03	1.52E-01	2.86	2.34
124-48-1	Chlorodibromomethane	2.60E+03	7.83E-04	3.21E-02	2.17	1.8
67-66-3	Chloroform	7.92E+03	3.67E-03	1.50E-01	1.92	1.6
95-57-8	2-Chlorophenol	2.20E+04	3.91E-04	1.60E-02	2.15	—
218-01-9	Chrysene	1.60E-03	9.46E-05	3.88E-03	5.7	5.6
72-54-8	DDD	9.00E-02	4.00E-06	1.64E-04	6.1	6
72-55-9	DDE	1.20E-01	2.10E-05	8.61E-04	6.76	6.65
50-29-3	DDT	2.50E-02	8.10E-06	3.32E-04	6.53	6.42
53-70-3	Dibenz(a,h)anthracene	2.49E-03	1.47E-08	6.03E-07	6.69	6.58
84-74-2	Di-n-butyl phthalate	1.12E+01	9.38E-10	3.85E-08	4.61	4.53
95-50-1	1,2-Dichlorobenzene	1.56E+02	1.90E-03	7.79E-02	3.43	2.79
106-46-7	1,4-Dichlorobenzene	7.38E+01	2.43E-03	9.96E-02	3.42	2.79
91-94-1	3,3-Dichlorobenzidine	3.11E+00	4.00E-09	1.64E-07	3.51	2.86
75-34-3	1,1-Dichloroethane	5.06E+03	5.62E-03	2.30E-01	1.79	1.5
107-06-2	1,2-Dichloroethane	8.52E+03	9.79E-04	4.01E-02	1.47	1.24
75-35-4	1,1-Dichloroethylene	2.25E+03	2.61E-02	1.07E+00	2.13	1.77
156-59-2	cis-1,2-Dichloroethylene	3.50E+03	4.08E-03	1.67E-01	1.86	1.55
156-60-5	trans-1,2-Dichloroethylene	6.30E+03	9.38E-03	3.85E-01	2.07	1.72
120-83-2	2,4-Dichlorophenol	4.50E+03	3.16E-06	1.30E-04	3.08	—
78-87-5	1,2-Dichloropropane	2.80E+03	2.80E-03	1.15E-01	1.97	1.64
542-75-6	1,3-Dichloropropene	2.80E+03	1.77E-02	7.26E-01	2	1.66
60-57-1	Dieldrin	1.95E-01	1.51E-05	6.19E-04	5.37	4.33
84-66-2	Diethylphthalate	1.08E+03	4.50E-07	1.85E-05	2.5	2.46
105-67-9	2,4-Dimethylphenol	7.87E+03	2.00E-06	8.20E-05	2.36	2.32
51-28-5	2,4-Dinitrophenol	2.79E+03	4.43E-07	1.82E-05	1.55	—
121-14-2	2,4-Dinitrotoluene	2.70E+02	9.26E-08	3.80E-06	2.01	1.98
606-20-2	2,6-Dinitrotoluene	1.82E+02	7.47E-07	3.06E-05	1.87	1.84
117-84-0	Di-n-octyl phthalate	2.00E-02	6.68E-05	2.74E-03	8.06	7.92
115-29-7	Endosulfan	5.10E-01	1.12E-05	4.59E-04	4.1	3.33
72-20-8	Endrin	2.50E-01	7.52E-06	3.08E-04	5.06	4.09
100-41-4	Ethylbenzene	1.69E+02	7.88E-03	3.23E-01	3.14	2.56
206-44-0	Fluoranthene	2.06E-01	1.61E-05	6.60E-04	5.12	5.03
86-73-7	Fluorene	1.98E+00	6.36E-05	2.61E-03	4.21	4.14
76-44-8	Heptachlor	1.80E-01	1.09E-03	4.47E-02	6.26	6.15
1024-57-3	Heptachlor epoxide	2.00E-01	9.50E-06	3.90E-04	5	4.92
118-74-1	Hexachlorobenzene	6.20E+00	1.32E-03	5.41E-02	5.89	4.74
87-68-3	Hexachloro-1,3-butadiene	3.23E+00	8.15E-03	3.34E-01	4.81	4.73
319-84-6	a-HCH (a-BHC)	2.00E+00	1.06E-05	4.35E-04	3.8	3.09
319-85-7	b-HCH (b-BHC)	2.40E-01	7.43E-07	3.05E-05	3.81	3.1
58-89-9	g -HCH (Lindane)	6.80E+00	1.40E-05	5.74E-04	3.73	3.03
77-47-4	Hexachlorocyclopentadiene	1.80E+00	2.70E-02	1.11E+00	5.39	5.3

CAS No.	Compound	Solubility in Water @ 20-25°C (mg/L)	Henry's Law Constant (atm-m3/mol)	Dimensionless Henry's law constant (HLC [atm-m3/mol] * 41) (25 °C).	log Kow	Log Koc (L/kg)
67-72-1	Hexachloroethane	5.00E+01	3.89E-03	1.59E-01	4	3.25
193-39-5	Indeno(1,2,3-cd)pyrene	2.20E-05	1.60E-06	6.56E-05	6.65	6.54
78-59-1	Isophorone	1.20E+04	6.64E-06	2.72E-04	1.7	1.67
7439-97-6	Mercury	—	1.14E-02	4.67E-01	—	—
72-43-5	Methoxychlor	4.50E-02	1.58E-05	6.48E-04	5.08	4.99
74-83-9	Methyl bromide	1.52E+04	6.24E-03	2.56E-01	1.19	1.02
75-09-2	Methylene chloride	1.30E+04	2.19E-03	8.98E-02	1.25	1.07
95-48-7	2-Methylphenol	2.60E+04	1.20E-06	4.92E-05	1.99	1.96
91-20-3	Naphthalene	3.10E+01	4.83E-04	1.98E-02	3.36	3.3
98-95-3	Nitrobenzene	2.09E+03	2.40E-05	9.84E-04	1.84	1.81
86-30-6	N-Nitrosodiphenylamine	3.51E+01	5.00E-06	2.05E-04	3.16	3.11
621-64-7	N-Nitrosodi-n-propylamine	9.89E+03	2.25E-06	9.23E-05	1.4	1.38
1336-36-3	PCBs	—	—	—	5.58	5.49
87-86-5	Pentachlorophenol	1.95E+03	2.44E-08	1.00E-06	5.09	—
108-95-2	Phenol	8.28E+04	3.97E-07	1.63E-05	1.48	1.46
129-00-0	Pyrene	1.35E-01	1.10E-05	4.51E-04	5.11	5.02
100-42-5	Styrene	3.10E+02	2.75E-03	1.13E-01	2.94	2.89
79-34-5	1,1,2,2-Tetrachloroethane	2.97E+03	3.45E-04	1.41E-02	2.39	1.97
127-18-4	Tetrachloroethylene	2.00E+02	1.84E-02	7.54E-01	2.67	2.19
108-88-3	Toluene	5.26E+02	6.64E-03	2.72E-01	2.75	2.26
8001-35-2	Toxaphene	7.40E-01	6.00E-06	2.46E-04	5.5	5.41
120-82-1	1,2,4-Trichlorobenzene	3.00E+02	1.42E-03	5.82E-02	4.01	3.25
71-55-6	1,1,1-Trichloroethane	1.33E+03	1.72E-02	7.05E-01	2.48	2.04
79-00-5	1,1,2-Trichloroethane	4.42E+03	9.13E-04	3.74E-02	2.05	1.7
79-01-6	Trichloroethylene	1.10E+03	1.03E-02	4.22E-01	2.71	2.22
95-95-4	2,4,5-Trichlorophenol	1.20E+03	4.33E-06	1.78E-04	3.9	—
88-06-2	2,4,6-Trichlorophenol	8.00E+02	7.79E-06	3.19E-04	3.7	—
108-05-4	Vinyl acetate	2.00E+04	5.11E-04	2.10E-02	0.73	0.72
75-01-4	Vinyl chloride	2.76E+03	2.70E-02	1.11E+00	1.5	1.27
108-38-3	m-Xylene	1.61E+02	7.34E-03	3.01E-01	3.2	2.61
95-47-6	o-Xylene	1.78E+02	5.19E-03	2.13E-01	3.13	2.56
106-42-3	p-Xylene	1.85E+02	7.66E-03	3.14E-01	3.17	2.59

Source: United States Environmental Protection Agency. 1996. Soil Screening Guidance: Technical Background Document. EPA/540/R-95/128
(<http://www.epa.gov/superfund/resources/soil/toc.htm#p5>)

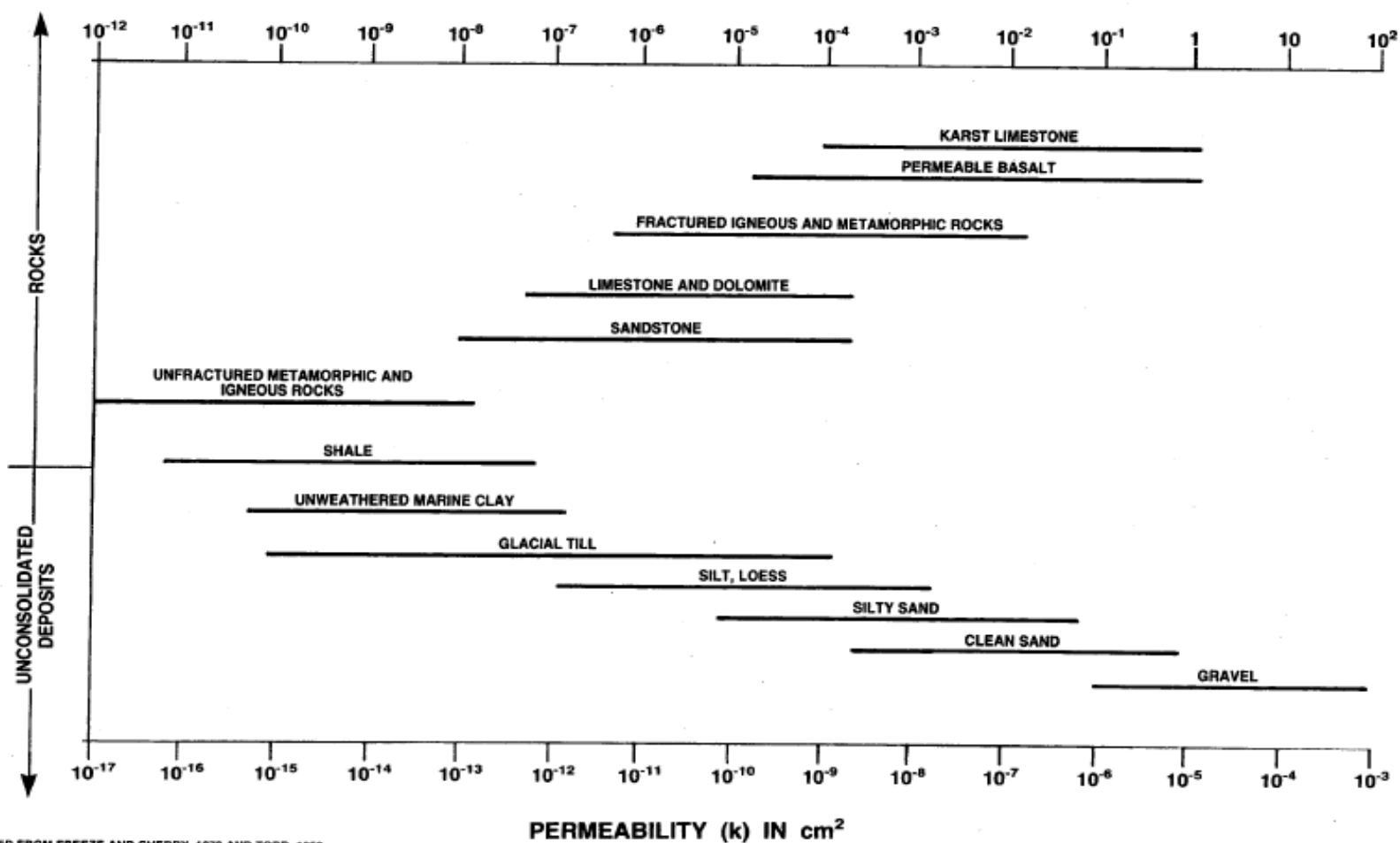
CAS = Chemical Abstracts Service

Kow = Octanol/water partition coefficient

RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY

The information on Koc is used in Sheet II (Migration Potential), section 1,B,f (Hydraulic Conductivity)

HYDRAULIC CONDUCTIVITY (K) IN cm/s



MODIFIED FROM FREEZE AND CHERRY, 1979 AND TODD, 1959