FINAL

Phase Two Environmental Site Assessment

1280, 1288, 1290 & 1294 Wharf Street and 607 Annland Street
Pickering, Ontario

Prepared for:

R.B Morgan Construction
1289 Wharf Street
Pickering, Ontario, L1W 1A2

Attn: Mr. Ralph Morgan

October 11, 2016

Pinchin File: 103341.001

MEMBER OF
THE PINCHIN GROUP

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1.0 EXECUTIVE SUMMARY

Pinchin Ltd. (Pinchin) was retained by R.B Morgan Construction (Client), to complete a Phase Two Environmental Site Assessment (Phase Two ESA) of the property located at 1280, 1288, 1290 & 1294 Wharf Street and 607 Annland Street in Pickering, Ontario (hereafter referred to as the Site or Phase Two Property). The Phase Two Property is presently developed with the following buildings:

- A commercial building used for storage located at 1294 Wharf Street (Site Building A);
- A residential dwelling located at 1290 Wharf Street (Site Building B);
- A residential dwelling located at 1288 Wharf Street (Site Building C);
- A residential dwelling located at 1280 Wharf Street (Site Building D); and
- A residential dwelling located at 607 Annland Street (Site Building E).

Collectively, the above-noted buildings are hereafter referred to as the Site Buildings. In addition to the Site Buildings, there are approximately five storage sheds/detached garages located on-Site. A Record of Site Condition (RSC) submittal to the Ontario Ministry of the Environment and Climate Change (MOECC, formerly the Ontario Ministry of the Environment) is a mandatory requirement when a land use changes to a more sensitive land use and as such, to support the RSC submission, the Phase Two ESA was conducted in accordance with the Province of Ontario's *Ontario Regulation 153/04: Records of Site Condition – Part XV.1 of the Act*, which was last amended by Ontario Regulation 333/13 on December 13, 2013 (O. Reg. 153/04).

The objectives of this Phase Two ESA were to assess the soil and groundwater quality in relation to two areas of potential environmental concern (APECs) and related potentially contaminating activities (PCAs) and contaminants of potential concern (COPCs) identified in a Phase One ESA completed by Pinchin in accordance with O. Reg. 153/04. The identified APECs, PCAs and COPCs are summarized in the following table:

APEC	**Location of APEC on Phase Two Property**	**PCA**	**Location of PCA (on-Site or off-Site)**	**COPCs**	**Media Potentially Impacted (Groundwater, Soil and/or Sediment)**
APEC #1	East portion of the Phase One Property.	Item 28 – Gasoline and Associated Products Storage in Fixed Tanks (former UST located at 640 Liverpool Road)	Off-Site	PHCs VOCs PAHs	Soil and Groundwater

APEC	Location of APEC on Phase Two Property	PCA	Location of PCA (on-Site or off-Site)	COPCs	Media Potentially Impacted (Groundwater, Soil and/or Sediment)
APEC #2	East portion of the Phase One Property.	Other – Exterior Chemical Storage (drum storage area adjacent to the Site, at 640 Liverpool Road)	Off-Site	PHCs VOCs PAHs	Soil and Groundwater

Notes:

PHCs – petroleum hydrocarbon fractions F1-F4

PAHs – polycyclic aromatic hydrocarbons

VOCs – volatile organic compounds

A plan showing the locations of the identified APECs and PCAs with respect to the Phase Two Property and surrounding properties is attached as Figure 4.

The Phase Two ESA was completed by Pinchin between May 20, 2016 and May 30, 2016, and included the advancement of three boreholes at the Phase Two Property, all of which were completed as groundwater monitoring wells to facilitate the sampling of groundwater and the assessment of groundwater flow. The boreholes were advanced to depths ranging from approximately 6.22 to 6.36 metres below ground surface (mbgs). Select soil samples collected from each of the borehole locations were submitted for laboratory analysis of volatile organic compounds (VOCs), petroleum hydrocarbons (PHCs) fractions 1 through 4 (F1-F4), and polycyclic aromatic hydrocarbons (PAHs). In addition, groundwater samples were collected from each of the newly-installed monitoring wells, and submitted for laboratory analysis of VOCs, PHCs, and PAHs.

Based on Site-specific information, the applicable regulatory standards for the Phase Two Property were determined to be the *"Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition",* provided in the MOECC document entitled, "*Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*" dated April 15, 2011 *(Table 2 Standards)* for coarse-textured soils and residential/parkland/institutional property use.

The laboratory results for the submitted soil and groundwater samples indicated that all reported concentrations for the parameters analyzed met the corresponding *Table 2 Standards*.

It is the opinion of the Qualified Person (QP) who supervised the Phase Two ESA that the applicable *Table 2 Standards* for soil and groundwater at the Phase Two Property have been met as of the Certification Date of [MONTH DAY, YEAR] and that no further subsurface investigation is required in relation to assessing the environmental quality of soil and groundwater at the Phase Two Property.

This Executive Summary is subject to the same standard limitations as contained in the report and must be read in conjunction with the entire report.

2.0 INTRODUCTION

A Phase Two ESA is defined as an “assessment of property conducted in accordance with the regulations by or under the supervision of a QP to determine the location and concentration of one or more contaminants in the land or water on, in or under the property”. Under O. Reg. 153/04, the purpose of a Phase Two ESA is as follows:

- To determine the location and concentration of contaminants in the land or water on, in or under the Phase Two Property;
- To obtain information about environmental conditions in the land or water on, in or under the Phase Two Property necessary to undertake a Risk Assessment, in accordance with O. Reg. 153/04, with respect to one or more contaminants of concern; and
- To determine if applicable Site Condition Standards and standards specified in a Risk Assessment for contaminants on, in or under the Phase Two Property were met as of the certification date by developing an understanding of the geological and hydrogeological conditions at the Phase Two Property and conducting one or more rounds of field sampling for all contaminants associated with any APEC identified in the Phase Two ESA sampling and analysis plan (SAP) and for any such contaminants identified during subsequent Phase Two ESA activities and analyses of environmental conditions at the Phase Two Property.

This Phase Two ESA was conducted at the request of the Client in relation to the future redevelopment of the Phase Two Property from its current commercial and residential land use to residential land use. An RSC submittal to the MOECC is a mandatory requirement when a land use changes to a more sensitive land use and as such, to support the RSC submission, the Phase Two ESA was conducted in accordance with O. Reg. 153/04.

2.1 Site Description

This Phase Two ESA was completed for all of Lots 8, 9, 10, 11 and 12 and Part of Lot 5 of Registered Plan M-89, City of Pickering, located at the municipal addresses of 1280, 1288, 1290 & 1294 Wharf Street and 607 Annland Street, Pickering, Ontario. The Phase Two Property is 5,550 m^2 (1.37 acres) in size and is bounded by Wharf Street to the south, residential and commercial use to the east, Annland Street to the north, and residential land use to the west. A Key Map showing the Phase Two Property location is provided on Figure 1 and a detailed plan of the Phase Two Property and surrounding lands is provided on Figure 2 (all Figures are provided within Section 9.0).

The Phase One Property is presently developed with the following buildings:

- A commercial building use for boat storage located at 1294 Wharf Street (Site Building A);
- A residential dwelling located at 1290 Wharf Street (Site Building B);
- A residential dwelling located at 1288 Wharf Street (Site Building C);
- A residential dwelling located at 1280 Wharf Street (Site Building D); and
- A residential dwelling located at 607 Annland Street (Site Building E).

Collectively, the above-noted buildings are hereafter referred to as the Site Buildings. In addition to the Site Buildings, there are approximately five storage sheds/detached garages located on-Site.

A summary of the pertinent details of the Phase Two Property is provided in the following table:

Detail	**Source/Reference**	**Information**
Legal Description	Legal Survey Drawing provided by Client	Lots 8, 9, 10, 11 and 12 and Part of Lot 5 of Registered Plan M-89, City of Pickering
Municipal Address	http://image.durham.ca/yourDurhamMap/, City of Pickering, Client	1280, 1288, 1290 & 1294 Wharf Street and 607 Annland Street, Pickering, Ontario
Parcel Identification Number (PIN)	Legal Survey Drawing provided by Client	26319 – 0616 26319 – 0617 26319 – 0617 26319 – 0619 26319 – 0620 26319 – 0613
Current Owner	Client	607 Annland Street and 1280 Wharf Street - R.B. Morgan 1290 and 1294 Wharf Street – Wharf Street Marina 1288 Wharf Street – Janice Brook
Owner Contact Information	Client	Mr. Ralph Morgan c/o R.B. Morgan Construction, 1289 Wharf Street, Pickering, Ontario L1W 1A2 Phone: 905-837-5621 ralph@rbmc.ca

Detail	Source/Reference	Information
Current Occupant	Client	Various private individuals
Occupant Contact Information	Client	NA
Client	Authorization to Proceed Form for Pinchin Proposal	R.B. Morgan Construction.
Client Contact Information	Authorization to Proceed Form for Pinchin Proposal	Mr. Ralph Morgan, 1289 Wharf Street, Pickering, Ontario L1W 1A2 Phone: 905-837-5621 ralph@rbmc.ca
Site Area	Legal Survey Drawing provided by Client	5,550 m^2 (1.37 acres)
Current Zoning	https://www.pickering.ca/en/cityhall/resources/op6.pdf, City of Pickering Official Plan	Urban Residential – Low Density Area
Centroid UTM Co-ordinate	Google Earth™	790459.95 Easting
		434857.26 Northing

A legal survey showing the Phase Two Property is provided in Appendix A (all Appendices are provided in Section 10.0).

2.2 Property Ownership

The entirety of the Phase Two Property consisting of seven legal lots situated at the municipal addresses of 1280, 1288, 1290 & 1294 Wharf Street and 607 Annland Street, Pickering, Ontario and is currently owned by the Client (R.B. Morgan Construction), located at 1289 Wharf Street, Pickering, Ontario. Contact information for the Phase Two Property owner is provided in the preceding section.

Pinchin was retained by Mr. Ralph Morgan of the Client to conduct the Phase Two ESA of the Site. Contact information for Mr. Morgan is provided in the preceding section.

2.3 Current and Proposed Future Uses

The Phase Two Property is presently utilized for mixed residential and commercial purposes and it is Pinchin's understanding that the Client intends to redevelop the Phase Two Property for residential land use.

Given that the future land use is changing to a more sensitive land use, there is a mandatory requirement that an RSC be filed as per Section 168.3.1 of the Province of Ontario's *Environmental Protection Act.*

2.4 Applicable Site Condition Standards

The Phase Two Property is a mixed commercial and residential property located within the City of Pickering and the proposed future land use is residential. It is Pinchin's understanding that potable water for the Site and surrounding area is supplied by the Region of Durham, with Lake Ontario serving as the water source. It is Pinchin's understanding that groundwater is not likely used to supply potable water to the Site or surrounding areas, although a search on January 18, 2016 of the Ministry of the Environment and Climate Change (MOECC) well records database was conducted to confirm all properties within 300 m of the Site are supplied by a municipal drinking water system. Five water well records were identified ranging from 100 m to 300 m. It is possible that some wells within a 300 m radius of the Site could be used for drinking water purposes, although it is unknown if the water wells currently exist or have been decommissioned. Based on the above conditions, the Site was assumed as having potential potable groundwater conditions.

Bedrock was not encountered at any of the boreholes completed at the Phase Two Property during the Phase Two ESA, which were advanced to a maximum depth ranging between 6.22 to 6.36 mbgs and, as such, the Phase Two Property is not a shallow soil property as defined in Section 43.1 of O. Reg. 153/04.

The Phase Two Property does not contain a water body nor is it located within 30 metres of a water body and the use of standards for properties situated within 30 metres of a water body is not required.

Section 41 of O. Reg. 153/04 states that a property is classified as an "environmentally sensitive area" if the pH of the surface soil (less than 1.5 mbgs) is less than 5 or greater than 9, if the pH of the subsurface soil (greater than 1.5 mbgs) is less than 5 or greater than 11, or if the property is an area of natural significance or is adjacent to or contains land within 30 metres of an area of natural significance. A total of 2 representative soil samples (including 1 field duplicate sample) collected from the boreholes advanced at the Phase Two Property were submitted for pH analysis. The pH analytical results are summarized in Table 1 (all Tables are provided in Section 9.0). The pH values measured in the submitted soil samples were within the limits for non-sensitive sites. The Phase Two Property is also not an area of natural significance and it is not adjacent to, nor does it contain land within 30 metres of, an area of natural significance. As such, the Phase Two Property is not an environmentally sensitive area.

As discussed further in Section 6.4, based on the results of grain size analysis from representative soil samples collected during the Phase Two ESA, and the observed stratigraphy at the borehole locations at the Phase Two Property, it is the QP's opinion that over one-third of the overburden at the Phase Two Property is coarse-textured as defined by O. Reg. 153/04. Therefore, the soil at the Phase Two Property has been considered coarse-textured for the purpose of establishing the applicable MOECC Site Condition Standards.

Based on the above, the appropriate Site Condition Standards for the Phase Two Property are the *Table 2 Standards* for:

- Coarse-textured soils;
- Residential/parkland/institutional property use; and,
- In potable groundwater conditions.

As such, all analytical results have been compared to these *Table 2 Standards*.

3.0 BACKGROUND INFORMATION

3.1 Physical Setting

The Phase Two Property is located in the south portion of the City of Pickering at an elevation of approximately 80 metres above mean sea level (mamsl). The topography of the Phase Two Property is generally flat with little relief. The properties surrounding the Phase Two Property are at an equivalent grade with a gradual decrease in elevation towards the west. There are no drainage features (e.g., open ditches or swales) present on-Site. Surface water (e.g., storm runoff) is inferred to run overland and drain into the on-Site municipal storm sewer catch basins.

No water bodies were identified on the Phase One Property or on surrounding properties within the Phase One Study Area, with the exception of Frenchman's Bay, which is located approximately 40 m west of the Phase One Property.

3.2 Past Investigations

3.2.1 Summary of Previous Environmental Investigations by Others

Reports summarizing the following environmental investigations completed by others and by Pinchin and pertaining to the Phase Two Property were reviewed as part of the Pinchin Phase One ESA:

- Report entitled "*Confirmatory Soil Sampling for 1289 Wharf Street, Pickering, ON",* prepared for R. B. Morgan Construction, by Fisher Environmental Ltd. (Fisher), and dated April 3, 2007 (2007 Fisher 1289 Wharf Street Confirmatory Soil Sampling Report).

Pinchin reviewed the available soil sample analytical data provided in the above-referenced report to assess whether there are any known soil impacts at the other property within the Phase One Study Area.

Given the available information on the characteristics of the Phase One Property and its future land use (i.e., residential), the applicable Site Condition Standards, as defined by the MOECC in the document "*Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*", dated April 15, 2011, are:

- *Table 2: Full Depth Generic Site Condition Standards in a Potable Groundwater Condition* (*Table 2 Standards*) for residential property use (i.e., the proposed future use of the Phase One Property) and coarse-textured soils.

As such, the analytical data provided in the previous reports were compared with the *Table 2 Standards* to assess whether there are any known areas in the Phase One Study Area where soil has parameter concentrations exceeding the *Table 2 Standards.*

A summary of salient information identified in the reports is provided below.

2007 Fisher 1289 Wharf Street Confirmatory Soil Sampling Report

The 2007 Fisher 1289 Wharf Street Confirmatory Soil Sampling Report presented the findings of the confirmatory soil sampling which took place following the removal of two underground storage tanks (USTs) at 1289 Wharf Street. This property is located approximately 15 m south of the Phase One Property and is situated hydraulically transgradient of the Phase One Property relative to the inferred groundwater flow direction. The USTs were reportedly formerly located approximately 60 m south of the Phase One Property. The following salient information was provided in the above-noted report:

- Between March 21, 2007 and March 27, 2007, two 3,000 gallon (11,356 L) gasoline USTs were removed from the property located at 1289 Wharf Street. The USTs were reportedly historically used for fuelling boats;
- Prior to removal, the remaining contents of the tanks were pumped out and removed for disposal. The tanks were inspected and were found to be in good condition (i.e., no visible signs of holes or pitting). No stains or signs of spills were noted on the ground surface within the tank excavation;
- Following the removal of the USTs, Fisher collected eight confirmatory soil samples from the floor and walls of the excavation. The soil samples were submitted to the laboratory for analysis of petroleum hydrocarbons (PHC) Fractions 1 to 4 (F1-F4);
- The analytical results were compared to the Table 3 (coarse-grained soil, industrial/commercial/community land use, non-potable groundwater environment) of the

MOECC document entitled "*Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*" dated March 9, 2004 (the *2004 Table 3 Standards*). All reported concentrations in the soil verification samples collected from the final limits of the excavation that were submitted for analysis of PHCs (F1-F4) were below their respective *2004 Table 3 Standards;* and

- Following the excavation and confirmatory soil analysis, the area was backfilled with clean fill material and compacted.

Pinchin compared the verification soil sample analytical results reported in the 2007 Fisher 1289 Wharf Street Confirmatory Soil Sampling Report to the currently applicable *Table 2 Standards.* All reported concentrations in the soil verification samples collected from the final limits of the excavation that were submitted for analysis of PHCs (F1-F4) were below their respective *Table 2 Standards.* Pinchin notes that the above-noted USTs represent a PCA, however, based on the results of the confirmatory soil sampling, as well as the separation distance between these off-Site USTs and the Site, the USTs do not represent an APEC for the Phase One Property.

3.2.2 Pinchin Phase One ESA Summary

From January 21, 2016 through February 12, 2016, Pinchin conducted a Phase One ESA in support of the future filing of an RSC for the Phase Two Property. The Phase One ESA consisted of a Site visit, interviews with Site personnel, records review, evaluation of information, and preparation of a written report which was completed under the supervision of a QP. A plan showing the Phase One Study Area is attached as Figure 3.

The Phase One ESA was completed recently (i.e., within three months of the start of the Phase Two ESA) and in accordance with the requirements of O. Reg. 153/04. Therefore, the information provided within the Phase One ESA Report is considered adequate such that it can be relied upon for the purpose of this Phase Two ESA and future filing of an RSC.

Based on information obtained during the Phase One ESA, a total of 2 APECs and corresponding potentially contaminating activities (PCAs) and COPCs were identified that could potentially affect the environmental condition of the subsurface media on, in or under the Phase Two Property. The COPCs associated with each APEC were determined based on a review of the PCAs and substances associated with the related activities, and on several sources of information, including but not limited to, Pinchin's experience with environmental contamination and hazardous substances, common industry practices for analysis of such contaminants and point sources, literature reviews of COPCs and associated hazardous substances, and evaluations of contaminant mobility and susceptibility for migration in the subsurface.

The following table presents the APECs and their associated PCAs and COPCs:

Summary of APECs

APEC	Location of APEC on Phase Two Property	PCA	Location of PCA (on-Site or off-Site)	COPCs	Media Potentially Impacted (Groundwater, Soil and/or Sediment)
APEC #1	640 Liverpool Road, located adjacent to the east and hydraulically upgradient of the Phase One Property	Item 28 – Gasoline and Associated Products Storage in Fixed Tanks (former UST located at 640 Liverpool Road)	Off-Site	PHCs VOCs PAHs	Soil and Groundwater
APEC #2	640 Liverpool Road, located adjacent to the east and hydraulically upgradient of the Phase One Property	Other – Exterior Chemical Storage (drum storage area adjacent to the Site, at 640 Liverpool Road)	Off-Site	PHCs VOCs PAHs	Soil and Groundwater

Notes:

PHCs – petroleum hydrocarbon fractions F1-F4

PAHs – polycyclic aromatic hydrocarbons

VOCs – volatile organic compounds

A plan showing the locations of the identified APECs and PCAs with respect to the Phase Two Property and surrounding properties is attached as Figure 4.

3.2.3 Use of Previous Analytical Data

None of the previous investigations documented in the above-referenced reports included subsurface investigations at the Site. As such, no soil and groundwater quality data from these previous environmental investigations were relied upon in preparing this Phase Two ESA report.

4.0 SCOPE OF INVESTIGATION

4.1 Overview of Site Investigation

The scope of work for this Phase Two ESA was prepared to address the APECs identified at the Phase Two Property and consisted of the following:

- Prepared a health and safety plan and arranged for the completion of underground utility locates prior to the commencement of drilling activities;
- Developed a detailed SAP prior to the advancement of the boreholes and the installation of the monitoring wells. The SAP was outlined in the document entitled "*Sampling and Analysis Plan for Phase Two Environmental Site Assessment, 1280, 1288, 1290 & 1294 Wharf Street and 607 Annland Street, Pickering, Ontario*, which is provided in Appendix B. Based on Pinchin's knowledge of the surrounding properties and known hydrogeological conditions, boreholes were advanced at the Phase Two Property to a maximum drilling depth ranging between 6.22 and 6.36 mbgs;
- Retained Strata Drilling Group Inc. (Strata) to advance boreholes and complete monitoring well installations using a Geoprobe 7822DT^{TM} drill rig. Strata is licensed by the MOECC in accordance with Ontario Regulation 903 (as amended) (O. Reg. 903) to undertake borehole drilling/well installation activities. Strata advanced three boreholes at the Phase Two Property to investigate the potential for soil contaminants associated with the APECs identified in the Phase One ESA. All three of the advanced boreholes were instrumented with a monitoring well in accordance with O. Reg. 903 for the purpose of monitoring hydrogeological conditions and groundwater quality on-Site;
- Collected soil samples at regular intervals within each borehole;
- Field screened soil samples for petroleum-derived vapours in soil headspace using a combustible gas indicator (CGI) calibrated to hexane and solvent-derived vapours in soil headspace using a photoionization detector (PID), in addition to visual and olfactory considerations;
- Submitted a minimum of one "worst case" soil sample from each borehole for chemical analysis of:
  - PHCs F1-F4;
  - VOCs; and,
  - PAHs;
- Developed each of the newly-installed monitoring wells prior to the collection of groundwater samples;
- Submitted one representative groundwater sample from each of the newly-installed monitoring wells for the chemical analysis of the following parameters:
  - PHCs F1-F4;
  - VOCs;

  - PAHs;
- Submitted one duplicate soil sample and one duplicate groundwater sample for chemical analysis of the above-noted parameters for quality assurance/quality control (QA/QC) purposes;
- Submitted one trip blank for the groundwater sampling program for the chemical analysis of VOCs/PHCs F1 for QA/QC purposes;
- Submitted four representative soil samples for the laboratory analysis of grain size and two representative soil samples (including one field duplicate soil samples) for the laboratory analysis of pH in order to confirm the appropriate MOECC Site Condition Standards;
- Conducted groundwater monitoring at each of the newly-installed groundwater monitoring wells by measuring depth to groundwater from both the top of casing and ground surface reference points, and assessing the presence/absence of non-aqueous phase liquid (NAPL) using an oil/water interface probe;
- Retained an Ontario Land Surveyor (OLS) to survey the location and geodetic elevations of the boreholes and newly-installed monitoring wells;
- Compared the soil and groundwater analytical results to the applicable criteria stipulated in the *Table 2 Standards*; and,
- Prepared a report (this report) documenting the findings of the Phase Two ESA which meets the reporting requirements listed in *Schedule E* and *Table 1 – Mandatory Requirements for Phase Two Environmental Site Assessment Reports* of O. Reg. 153/04.

4.2 Media Investigated

The scope of work for this Phase Two ESA was prepared to address the APECs and corresponding media at the Phase Two Property as identified through completion of the Phase One ESA.

The media of concern for the Phase Two ESA were soil. Pinchin included the assessment of groundwater as part of the Phase Two ESA to investigate groundwater quality in relation to a former off-Site UST (APEC #1), and an exterior off-Site chemical storage area (APEC #2). Note that due to the historical industrial land use at the Phase Two Property, the Phase Two Property is not an enhanced investigation property requiring mandatory sampling and analysis of groundwater. Pinchin did not conduct sediment sampling as part of this Phase Two ESA as there are no surface water bodies and, therefore no sources of sediment, present on-Site.

For assessing the soil at the Phase Two Property for the presence of COPCs, a total of three boreholes were advanced at locations across the Phase Two Property for the purpose of collecting soil samples. A total of seven soil samples, comprising select “worst case” samples collected from each of the boreholes, were submitted for laboratory analysis of the COPCs.

For assessing the groundwater at the Phase Two Property for the presence of COPCs, groundwater monitoring wells were installed in all boreholes completed at the Phase Two Property to permit the collection of groundwater samples. A total of three groundwater samples, comprising samples collected from each of the newly installed monitoring wells (MW16-1, MW16-2, and MW16-3) were submitted to the analytical laboratory for analysis of the COPCs.

4.3 Phase One Conceptual Site Model

A conceptual site model (CSM) was created to provide a summary of the findings of the Phase One ESA. The Phase One CSM is summarized in Figures 1 through 4, which illustrate the following features within the Phase One Study Area, where present:

- Existing buildings and structures;
- Water bodies located in whole or in part within the Phase One Study Area;
- Areas of natural significance located in whole or in part within the Phase One Study Area;
- Drinking water wells located at the Phase One Property;
- Land use of adjacent properties;
- Roads within the Phase One Study Area;
- PCAs within the Phase One Study Area, including the locations of tanks; and
- APECs at the Phase One Property.

The following provides a narrative summary of the Phase One CSM:

- The Phase One Property is an irregular-shaped parcel of land approximately 1.37 acres (0.55 hectares) in size located north of Wharf Street and south of Annland Street, approximately 60 m west of Liverpool Road in Pickering, Ontario. The Phase One Property is improved with four residential dwellings and one commercial building utilized for storage purposes (Site Buildings) located throughout the Phase One Property. In addition to the Site Buildings, there are approximately five storage sheds/detached garages located on-Site. The Phase One Property has been used for residential purposes, and more recently for commercial storage. There is no record of industrial use or of a commercial use (e.g., garage, bulk liquid dispensing facility or dry cleaner) that would require classifying the Phase One Property as an enhanced investigation property.

- The nearest water body is Frenchman’s Bay (Lake Ontario), which is located approximately 40 m west of the Phase One Property.
- No areas of natural significance were identified within the Phase One Study Area.
- No drinking water wells were located on the Phase One Property.
- Wharf Street is located adjacent to the south of the Phase One Property. The adjacent properties to the west are occupied by residential and/or storage yards. To the north of the Phase One Property is Annland Street. The property to the east of the Phase One Property is occupied by John Avis Haulage Limited. Historical records indicate that the property located to the east of the Phase One Property was historically equipped with a private UST. A drum storage area was observed on this property at the time of the Site reconnaissance.
- A total of seven PCAs were identified within the Phase One Study Area, consisting of seven PCAs within the Phase One Study Area, outside of the Phase One Property. As shown on Figure 4, two of the off-Site PCAs are a former UST and an exterior chemical storage area located on the property immediately east of the Phase One Property (640 Liverpool Road). Groundwater flow within the Phase One Study Area is interpreted to be to the west towards Frenchman’s Bay and these off-Site PCAs are inferred to be upgradient of the Phase One Property. All other PCAs identified within the Phase One Study Area do not represent APECs at the Phase One Property. Figure 4 provides a detailed summary of the APECs and associated PCAs and COPCs.
- Underground utilities at the Phase One Property provide potable water, natural gas, electrical, telephone, cable and sewer services are provided to some of the Site Buildings. These services enter the Site Buildings through subsurface conduit or overhead lines running from Wharf Street or Annland Street. Plans were not available to confirm the depths of these utilities but they are estimated to be located approximately 2 to 3 mbgs. The depth to groundwater at the Phase One Property is estimated to be approximately 2.5 mbgs, which coincides with the approximate depth to the water table. As such, it is possible that the utility corridors may act as preferential pathways for contaminant distribution and transport in the event that shallow subsurface contaminants exist at the Phase One Property.
- The Phase One Property and the surrounding properties located within the Phase One Study Area are located within clay plains with the primary native material consisting of sand and clay. Bedrock is expected to consist of sandstone, shale, dolostone, and siltstone of the Georgian Bay Formation. Based on information provided in the Water Well Information System database, soil stratigraphy in the vicinity of the Site was found to consist of a layer of fill material, followed by clay and stones, overlaying layers of clay and sand.

- The Phase One Property is generally flat, with a slight slope down towards the west. The area surrounding the Phase One Property slopes gradually to the west towards Frenchman's Bay. Local groundwater flow is inferred to be to the west, based on the topography of the area surrounding the Phase One Property and the location of Frenchman's Bay.

There were no deviations from the Phase One ESA requirements specified in O. Reg. 153/04 or absence of information that have resulted in uncertainty that would affect the validity of the Phase One CSM.

4.4 Deviations from Sampling and Analysis Plan

The following deviations from the SAP occurred during the completion of the Phase Two ESA investigation activities:

- Boreholes MW16-1 through MW16-3 were advanced to a depths ranging from 6.22 to 6.36 mbgs as opposed to 6.10 mbgs as stipulated in the SAP;
- The SAP originally recommended monitoring groundwater one month after initial sampling, however due to the low concentrations of COPCs, follow-up groundwater monitoring was not necessary.

No other notable constraints and limitations with respect to the SAP were documented during the field activities, and as such Pinchin has conducted the Phase Two ESA in a manner generally consistent with the SAP provided in Appendix B.

It is the QP's opinion that the above-noted deviations from the SAP did not affect the investigation of the APECs for COPCs and had no impact on the overall findings and conclusions of the Phase Two ESA.

4.5 Impediments

Pinchin had full access to the Phase Two Property throughout the completion of the Phase Two ESA.

5.0 INVESTIGATION METHOD

5.1 General

The Phase Two ESA field work was conducted in accordance with Pinchin's standard operating procedures (SOPs) as provided in the SAP, which have been developed in accordance with the procedures and protocols provided in the MOECC document entitled "*Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario*", dated December 1996, in the Association of Professional Geoscientists of Ontario document entitled *"Guidance for Environmental Site Assessments under Ontario Regulation 153/04 (as amended)"*, dated April 2011, and in O. Reg. 153/04.

Deviations from Pinchin's SOPs, and the rationale for the deviations, are summarized as follows:

- Groundwater sampling was completed at the newly installed monitoring wells following the Low Flow Sampling Protocol. The Low Flow Sampling Protocol requires that all measured field parameters show stability (i.e., be within certain thresholds over three consecutive readings) prior to sample collection. However, due to limited groundwater volume and low groundwater recharge rates, three consecutive measurement readings could not be achieved (two readings or less) from each of the monitoring wells. Of the measurement readings, stable temperature readings (± 3% over three consecutive readings) could not be achieved for MW16-1 (± 5.6 % over two consecutive readings), and MW16-3 (one reading taken before well went dry). It was the opinion of the QP that short term variations in ambient temperature at the time of sampling due to changes in cloud cover resulted in periodic heating of the purge water in the flow-through cell where the temperature probe was located. As such, the apparent temperature instability was discounted and, given that all other field parameters met the stability requirements and approximately two well volumes had been purged, the QP considered the groundwater to be representative and suitable for sampling.

5.2 Drilling and Excavating

Pinchin retained Strata to advance a total of 3 boreholes (MW16-1 through MW16-3) at the Phase Two Property on May 20, 2016 to investigate the potential presence of COPCs associated with the APECs identified in the Phase One ESA. All of the advanced boreholes (MW16-1 through MW16-3) were completed as monitoring wells in accordance with O. Reg. 903 for the purpose of monitoring hydrogeological conditions and groundwater quality on-Site. The boreholes were drilled to a maximum depth of 6.36 mbgs using a Geoprobe 7822DT™ drill rig. Upon completion of the drilling and monitoring well installations, Strata completed and filed a Water Well Record with the MOECC for the well cluster in accordance with O. Reg. 903.

The locations of the boreholes, monitoring wells were selected using the following rationale:

- MW16-1 – Completed in the east portion of the Phase Two Property adjacent to a former UST and chemical drum storage area located at 640 Liverpool Road, in order to investigate soil quality in relation to APECs #1;
- MW16-2 – Completed in the east portion of the Phase Two Property adjacent and slightly downgradient to former a UST and chemical drum storage area located at 640 Liverpool Road, in order to investigate soil quality in relation to APECs #1 and #2; and,

- MW16-3 – Completed in the northeast portion of the Phase Two Property in order to investigate a former UST located at 640 Liverpool Road, in order to investigate soil quality in relation to APECs #1.

In addition, all three installed on-Site monitoring wells were sampled by Pinchin during the Phase Two ESA investigation based on the following rationale:

- Monitoring well MW16-1 was sampled in order to investigate groundwater quality in relation to former UST and chemical drum storage area located at 640 Liverpool Road, in order to investigate groundwater quality in relation to APECs #1;
- Monitoring well MW16-2 was sampled in order to investigate groundwater quality in relation to a former UST and chemical drum storage area located at 640 Liverpool Road, in order to investigate groundwater quality in relation to APECs #1 and #2;
- Monitoring well MW16-3 was sampled in order to investigate groundwater quality in relation to a former UST located at 640 Liverpool Road, in order to investigate groundwater quality in relation to APECs #1;

The locations of the boreholes, all of which were completed as monitoring wells, are provided on Figure 5. A description of the subsurface stratigraphy encountered during the drilling program is documented in the borehole logs included in Appendix C. Well completion details and elevation data are provided in Table 2 and on the borehole logs provided in Appendix C.

Measures taken to minimize the potential for cross-contamination during the borehole drilling program included:

- The use of dedicated, disposable PVC soil sample liners for soil sample collection during direct-push drilling;
- The use of dedicated, pre-cleaned augers for each borehole location;
- The extraction of soil samples from the interior of the sampling device (where possible), rather than from areas in contact with the sampler walls;
- The cleaning of all non-dedicated drilling and soil sampling equipment (i.e., auger flights, spatulas used for sample collection) before initial use and between sample and borehole locations; and
- The use of dedicated and disposable nitrile gloves for all soil sample handling.

Soil samples were collected at continuous intervals during direct-push drilling at a general frequency of one soil sample for every 0.75 metres drilled.

No excavating activities (e.g., test pitting) were completed as part of the Phase Two ESA.

5.3 Soil Sampling

Soil samples were collected in the boreholes at regular intervals using 5.08 centimetre (cm) outer diameter (OD) direct push soil samplers with dedicated single-use sample liners.

Discrete soil samples were collected from the dedicated sample liners by Pinchin personnel using a stainless-steel spatula which was cleaned with Alconox^{TM} after collecting each sample. Dedicated and disposable nitrile gloves were worn during the collection of each soil sample. A portion of each sample was placed in a resealable plastic bag for field screening and a portion was containerized in laboratory-supplied glass sampling jars. Following sample collection, the sample jars were placed into dedicated coolers with ice for storage pending transport to Maxxam Analytics Inc. (Maxxam) in Mississauga, Ontario. Formal chain of custody records were maintained between Pinchin and the staff at Maxxam.

Subsurface soil conditions were logged on-Site by Pinchin personnel at the time of borehole drilling. Based on the soil samples recovered during the borehole drilling program, the soil stratigraphy at the drilling locations generally consists of fill material comprised of clay with trace silt and organic material and to a maximum depth of approximately 0.76 mbgs, followed by clayey silt, sandy silt till, silty sand till, and/or sand that extended to the maximum investigation depth of 6.1 mbgs. Moist to wet soil conditions were generally observed between 2.13 and 5.33 mbgs.

No odours or staining were observed in the soil samples collected during the borehole drilling program.

A detailed description of the subsurface stratigraphy encountered during the borehole drilling program is documented in the borehole logs included in Appendix C.

5.4 Field Screening Measurements

Soil samples were collected at each of the sampling intervals during the drilling activities and analyzed in the field for solvent-derived vapour concentrations in soil headspace with a RKI Eagle II™ PID and for petroleum-derived vapour concentrations in soil headspace with an RKI Eagle II™ CGI operated in methane elimination mode. The soil samples collected for field-screening purposes were placed in resealable plastic bags. The plastic bags were stored in a warm environment for a minimum of five minutes and agitated in order to release organic vapours within the soil pore space prior to analysis with the PID and CGI.

Based on a review of the operator’s manual, the RKI Eagle II™ PID has an accuracy/precision of up to 0.1 parts per million (ppm). The PID was calibrated prior to field use by the equipment supplier, Maxim Environmental & Safety Inc. (Maxim) according to Maxim’s standard operating procedures. A copy of Maxim’s calibration record for the PID is provided in Appendix D.

Based on a review of the operator's manual, the RKI Eagle™ CGI has an accuracy/precision of up to +/- 25 ppm, or +/- 5% of the reading (whichever is greater). The CGI was calibrated prior to field use by Maxim according to Maxim's standard operating procedures. A copy of Maxim's calibration record for the CGI is provided in Appendix D.

In general, the soil samples with the highest measured vapour concentrations (i.e., "worst case") from a given borehole were submitted for laboratory analysis. Sample depth and visual and olfactory observations of potential contaminants were also used in conjunction with the vapour concentrations in making the final selection of "worst case" soil samples for laboratory analysis.

Soil samples collected during the drilling activities completed on May 20, 2016, were field screened for petroleum-derived and solvent-derived vapour concentrations using the RKI Eagle™ CGI and PID. The solvent-derived, organic vapour concentrations measured in the soil samples were relatively low, ranging from less than 5 ppm by volume (ppm$_v$) to a maximum of 2 ppm$_v$, which are generally not indicative of soil with solvent-derived impacts. Petroleum-derived vapour concentrations measured in the soil samples ranged from less than 5 ppm$_v$ to a maximum of 155 ppm$_v$, which can potentially be indicative of soil with PHC presence, but are may also represent natural soil conditions. Given the absence of olfactory indicators of PHC impacts in soil, the primary considerations in selecting soil samples for submission was petroleum-derived vapour concentrations, sample depth, and samples collected near the water table were considered to represent "worst case" samples with respect to assessing potential impacts.

5.5 Groundwater Monitoring Well Installation

Following soil sampling, Strata installed a groundwater monitoring well in boreholes MW16-1, MW16-2, and MW16-3, under the full-time monitoring of a Pinchin field representative. To accommodate the well installations, each borehole was overdrilled using 15.24 cm (6-inch) diameter solid stem augers to a maximum depth of 6.36 mbgs using the Geoprobe 7822DT™.

Each of the monitoring wells was constructed with 51-millimetre (2-inch) inner diameter (ID) flush-threaded schedule 40 polyvinyl chloride (PVC) risers followed by a 3.05 metre length of No. 10 slot PVC screen. Each well screen was sealed at the bottom using a threaded cap and each riser was sealed at the top with a lockable J-plug cap. Silica sand was placed around and above the screened interval to form a filter pack around the well screen. A layer of bentonite was placed above the silica sand and was extended to just below the ground surface. A 5.08 cm OD Schedule 40 PVC outer casing, approximately 45.72 cm in length, was installed in each well around the top of the riser and into the top of the bentonite seal. A bentonite seal was then placed between the riser and outer casing. A protective flush-mount cover and/or aboveground monument casing was installed at the ground surface over each riser pipe and outer casing and cemented in place.

All monitoring wells were installed in accordance with O. Reg. 903. The monitoring well construction details are provided in Table 2 and on the borehole logs in Appendix C. Upon completion of the monitoring well installations, Strata completed and filed a Water Well Record with the MOECC for the well cluster. A copy of the MOECC Water Well Record is provided in Appendix E.

The monitoring wells were developed on May 24, 2016 in accordance with Pinchin's SOP for well development by removing a minimum of three standing water column volumes using an inertial hand pump consisting of dedicated Waterra polyethylene tubing and foot valves. The well development activities were completed a minimum of 24 hours prior to the groundwater sampling activities.

Measures taken to minimize the potential for cross-contamination during well installation and well development included the following:

- The use of dedicated, pre-cleaned augers for overdrilling each borehole location;
- The use of dedicated and disposable nitrile gloves for handling well materials during well installation and during well development; and,
- The use of dedicated polyethylene tubing and foot valves for each well.

5.6 Groundwater Field Measurements of Water Quality Parameters

Water quality parameters were measured during the low-flow purging and sampling procedure completed on May 26, 2016 at monitoring wells MW16-1, MW16-2, and MW16-3. The quantity of sediment content observed in samples collected at monitoring well MW16-3 on May 26, 2016 appeared higher than acceptable for submission by Pinchin on May 26, 2016, and was resampled on May 30, 2016

Measurements of the water quality parameters oxidation-reduction potential, dissolved oxygen, temperature, specific conductance, pH and turbidity were made during purging using a flow-through cell and a YSI-556™ water quality meter (YSI Water Quality Meter). The YSI Water Quality Meter was calibrated prior to use by the equipment supplier (Maxim) in accordance with the manufacturer's specifications.

Field-measured parameters were recorded from the YSI Water Quality Meter at regular intervals in order to determine stabilized groundwater geochemical conditions and hence representative groundwater sampling conditions, in general accordance with the criteria stipulated in the Low Flow Sampling Protocol provided as an appendix in the SAP.

The field parameter values measured over the course of the low flow sampling activities are provided in the field-measured parameters monitoring logs provided in Appendix F. It should be noted that representative groundwater sampling conditions were determined by Pinchin personnel utilizing the field parameter stabilization criteria noted within the Low Flow Sampling Protocol as well as additional factors including total purge time and purge volume.

5.7 Groundwater Sampling

The monitoring wells were sampled a minimum of 24 hours after the completion of well development activities (see Section 5.5). Monitoring wells MW16-1 to MW16-3 were sampled in accordance with the Low Flow Sampling Protocol with some deviation as described below.

Well purging was completed using a Waterra Spectra Field-Pro low flow self-contained suction lift pumping unit (peristaltic pump) and dedicated 0.64-cm (1/4-inch) ID polyethylene and silicone tubing.

A YSI Water Quality Meter connected to a flow-through cell was used to monitor water quality parameters during groundwater purging to assess whether water quality parameter stabilization (i.e., steady-state conditions) was achieved prior to sample collection. The flow rate of the peristaltic pump was adjusted to minimize drawdown of the water table and the introduction of sediment into the samples.

After attempting Low Flow Sampling as per Pinchin's SOP, monitoring wells MW16-1 to MW16-3 were not sampled in accordance with the Low Flow Sampling Protocol because the wells could not sustain a yield and were purged to dryness even when pumping at the lowest possible pumping rate. Following recovery after purging these wells/this well to dryness, groundwater samples for volatile parameter (i.e., VOCs and PHCs F1) analysis were collected using a dedicated inertial pump comprised of Waterra polyethylene tubing and a foot valve, and groundwater samples for PHCs (F2-F4), and PAHs analysis were collected using the peristaltic pump and dedicated 0.64-cm (1/4-inch) ID polyethylene tubing. Groundwater samples were collected at each well by pumping groundwater directly into new laboratory-supplied sample bottles at a pumping rate of less than 0.5 litres per minute.

Following sample collection, the sample bottles were placed into dedicated coolers with ice for storage pending transport to Maxxam. Formal chain of custody records were maintained between Pinchin and the staff at Maxxam.

5.8 Sediment Sampling

Sediment sampling was not completed as part of this Phase Two ESA.

5.9 Analytical Testing

All collected soil and groundwater samples were delivered to Maxxam for analysis. Maxxam is an independent laboratory accredited by the Canadian Association for Laboratory Accreditation. Formal chain of custody records of the sample submissions were maintained between Pinchin and the staff at Maxxam. Maxxam conducted the laboratory analysis in accordance with the MOECC document entitled

"Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" dated March 9, 2004 and revised on July 1, 2011 (*Analytical Protocol)*.

5.10 Residue Management Procedures

Soil cuttings generated by the borehole drilling program were containerized in two 205-L drums that were stored near the borehole locations of the Phase Two Property.

One composite soil sample (representative of the excess soil cuttings generated by the borehole drilling program) collected from the boreholes was submitted for the laboratory analysis of the leachate concentrations of inorganics, VOCs, PCBs and benzo(a)pyrene in accordance with the Toxicity Characteristic Leachate Procedure (TCLP) analysis as per Ontario Regulation 347/90 (O. Reg. 347/90) in order to characterize the soil cuttings for off-Site disposal purposes. The TCLP analytical results are provided in Appendix G, which illustrate that the excess soil cuttings are classified as non-hazardous waste in accordance with O. Reg. 347/90.

Excess water produced during well purging activities and equipment cleaning was containerized in Two 205-L drums that were stored near the borehole locations of the Phase Two Property.

Pinchin notes that at the time of writing, the drums of excess soil cuttings, purge water and equipment cleaning fluids have not been removed from the Phase Two Property. Pinchin will assist the Client in arranging for disposal of these materials.

5.11 Elevation Surveying

On June 20, 2016, J.D. Barnes Limited (J.D. Barnes), an OLS, surveyed the horizontal positioning and the vertical elevation of each of the on-Site monitoring wells and borehole locations relative to the southwest corner of a concrete hydro transformer pad on the north side of Wharf Street immediately west of dwelling No. 1294 with an elevation of 79.00 metres. The location of the benchmark utilized to complete the survey is shown on Figure 5.

A plan of survey of the Phase Two Property showing the locations and elevations of each monitoring well and borehole, as provided by J.D. Barnes, is included in Appendix A.

5.12 Quality Assurance and Quality Control Measures

The QA/QC protocols that were followed during borehole drilling and soil and groundwater sampling so that representative samples were obtained are described in the following subsections.

5.12.1 Sample Containers, Preservation, Labelling, Handling and Custody of Samples

Soil and groundwater samples were containerized within laboratory-prepared sample containers in accordance with the *Analytical Protocol*.

The following soil sample containers and preservatives were used:

- VOCs and PHCs F1: 40 millilitre (mL) glass vials with septum-lids, pre-charged with methanol preservative; and
- PHCs F2-F4, PAHs, pH and grain size: 120 or 250 mL unpreserved clear glass wide-mouth jars with a Teflon^{TM}–lined lid.

The following groundwater sample containers and preservatives were used:

- VOCs and PHCs F1: 40 mL clear glass vials with septum-lids, pre-charged with sodium bisulphate preservative;
- PHCs F2-F4: 500 mL amber glass bottles with Teflon^{TM}–lined lids, pre-charged with sodium bisulphate preservative; and
- PAHs: 500 mL unpreserved amber glass bottles with Teflon^{TM}–lined lids;

Trip blank water samples for VOC parameter analysis were provided by Maxxam in 40 mL clear glass vials filled with VOC-free water.

The soil sampling trip blank for BTEX and PHCs analysis consisted of two 40 mL clear glass vials that were pre-charged with methanol preservative.

Each soil, groundwater, and QA/QC sample was labelled with a unique sample identifier along with the company name, sampling date, Pinchin project number and analysis required.

Each sample was placed in a cooler on ice immediately upon collection and prior to submission to Maxxam for analysis. Formal chain of custody records of the sample submissions were maintained between Pinchin and the staff at Maxxam.

5.12.2 Equipment Cleaning Procedures

Dedicated, single-use PVC sample liners were used for each soil sample collected, which precluded the need for drilling equipment cleaning during soil sample collection. Equipment utilized in soil sample collection and handling (i.e., spatulas used to remove soil from the sample liners) was cleaned with a solution of Alconox™ detergent and potable water prior to initial use and between samples.

During groundwater monitoring activities, the oil/water interface probe used to measure water levels and the YSI Water Quality Meter used for groundwater field parameter measurements were cleaned with a solution of Alconox™ detergent and potable water prior to initial use and between well locations.

5.12.3 Field Quality Control Measures

A total of 1 field duplicate soil sample was collected by Pinchin during the Phase Two ESA for analysis of one or more of the COPCs. The frequency of field duplicate soil sample analysis complied with the requirement that one field duplicate soil sample is analyzed for every ten regular soil samples submitted for analysis of the COPCs. The soil sample field duplicate pairings and corresponding analytical schedules are summarized as follows:

- Soil sample “MW16-3 SA5” and its corresponding field duplicate “DUP-1” were submitted for laboratory analysis of VOCs, PHCs, PAHs, and pH;

A total of one field duplicate groundwater sample was collected by Pinchin during the Phase Two ESA for analysis of the COPCs. The frequency of field duplicate groundwater sample analysis complied with the requirement that one field duplicate groundwater sample is analyzed for every ten regular groundwater samples submitted for analysis of the COPCs. The groundwater sample field duplicate pairings and corresponding analytical schedules are summarized as follows:

- Groundwater sample “MW16-2” and its corresponding field duplicate “DUP-1” were submitted for laboratory analysis of VOCs, PHCs, and PAHs;

One laboratory-prepared trip blank was analyzed for VOC parameters to comply with the requirement that one trip blank is analyzed for each submission of groundwater samples for VOC parameter analysis. As a further field quality control measure, one soil sampling trip blank was analyzed for PHCs F1.

The calibrations of the RKI Eagle™ CGI/PID used for field screening and the YSI Water Quality Meter used for water quality parameter measurements were checked by the equipment supplier (Maxim Environmental) prior to use in the field by Pinchin.

Maxim Environmental completed the calibration checks in accordance with the equipment manufacturers’ specifications and/or Maxim’s SOPs.

5.12.4 QA/QC Sampling Program Deviations

There were no deviations from the QA/QC sampling program outlined in the SAP with the following exception:

- Laboratory Certificate B6A5189 – The cooler custody seal was not present and intact.

The soil samples were submitted and delivered to Maxxam from the Pinchin office in Oshawa, Ontario, within one cooler under supervision of Maxxam’s designated courier service. Based on the use of the absence of field indications of impacts, the designated Maxxam courier service and that the concentrations of the parameters in the submitted soil samples are below their respective *Table 2 Standards,* it is Pinchin’s opinion that the soil samples were unlikely compromised. As such, there is no evidence of positive bias due to ambient conditions during transport of the sample containers/samples to and from the laboratory and the Phase Two Property.

6.0 REVIEW AND EVALUATION

6.1 Geology

Based on the stratigraphic information obtained from the soil samples recovered during the drilling activities completed as part of the Phase Two ESA, the asphalt-covered ground surface at the Phase Two Property is underlain by clay with trace silt and organics in the fill material to a maximum depth of approximately 0.76 mbgs. The native soil underlying the surficial soil fill materials is generally comprised of clayey silt, sandy silt till, silty sand till, and/or sand that extended to the maximum investigation depth of 6.1 mbgs. The water table is located within this unit at a depth of approximately 4.7 to 5.1 mbgs and this uppermost water bearing unit represents an unconfined aquifer.

The following table provides a summary of the primary geologic units observed during borehole drilling at the Phase Two Property:

Geologic Unit	Estimated Thickness (metres)	Top Elevation (mamsl)	Bottom Elevation (mamsl)	Properties
Clay Fill	0.0 – 0.76	79.78 – 79.82 (Ground Surface)	79.02 – 79.06	Unsaturated
Unconfined Aquifer	0.76 – 6.10	79.02 – 79.06	73.68 – 73.72	Saturated below 4.77 to 5.33 mbgs (water table)

A review of the available physiographical data indicates that the Site and the surrounding properties located within the area are located within clay plains. Bedrock is expected to consist of sandstone, shale, dolostone, and siltstone of the Georgian Bay Formation. Based on information provided in the Water Well Information System database, soil stratigraphy in the vicinity of the Site was found to consist of a layer of fill material, followed by clay and stones, overlaying layers of clay and sand. No bedrock outcrops were observed on-Site or in the surrounding area.

A cross-section summarizing the subsurface geological conditions have been provided as Figure 7.

The APECs investigated by the Phase Two ESA related to PHCs, VOCs, and PAHs associated with the former off-Site UST (APEC #1) and to PHCs, VOCs, and PAHs associated with off-Site exterior chemical storage (APEC #2). Impacts on groundwater quality, if any, from PHCs, VOCs, and/ PAHs contaminants in APEC #1 and APEC #2 would be expected in the groundwater zone and, as such, the water table groundwater quality within the unconfined aquifer for APEC #1 and APEC #2 was assessed during the Phase Two ESA.

No groundwater impacts were identified in the unconfined aquifer and, as such, assessment of groundwater quality at deeper depths was not required.

6.2 Groundwater Elevations and Flow Direction

The wells screens in each monitoring well installed by Pinchin were of a consistent length (i.e., 3.05 metres). All monitoring wells were installed at depth intervals intended to investigate groundwater quality in the within the unconfined aquifer. Given that PHCs were a COPC for groundwater at the Phase Two Property, the monitoring wells were installed at the Phase Two Property within APECs #1 and 2 such that the well screens intersected the water table.

Groundwater monitoring occurred on both May 24, and May 26, 2016. The following summarizes the findings of a groundwater monitoring event completed on May 24, 2016:

- The depths to groundwater measured within the on-Site monitoring wells installed within the unconfined aquifer ranged from 4.77 mbgs at monitoring well MW16-3 to 5.09 mbgs at monitoring well MW16-2.
- The calculated groundwater elevations within the groundwater monitoring wells installed within the unconfined aquifer ranged between 74.75 mamsl at MW16-1 and 74.97 mamsl at MW16-3.
- No non-aqueous phase liquid (NAPL) thicknesses were measured with the oil/water interface probe in any of the groundwater monitoring wells.

The following summarizes the findings of a groundwater monitoring event completed on May 26, 2016

- The depths to groundwater measured within the on-Site monitoring wells installed within the unconfined aquifer ranged from 4.77 mbgs at monitoring well MW16-3 to 5.10 mbgs at monitoring well MW16-2.
- The calculated groundwater elevations within the groundwater monitoring wells installed within the unconfined aquifer ranged between 74.70 mamsl at MW16-2 and 75.03 mamsl at MW16-3.
- No non-aqueous phase liquid (NAPL) thicknesses were measured with the oil/water interface probe in any of the groundwater monitoring wells.
- The depths to groundwater measured on May 26, 2016 within the on-Site monitoring wells installed within the unconfined aquifer were generally consistent with the previous round of measured water levels. The maximum change in depth to groundwater was

observed at monitoring well MW16-1 and MW16-3, where the water level decreased by 0.06 metres between the two events at MW16-1, and increased by 0.06 metres between the two events at monitoring well MW16-3.

The surveyed ground surface elevations adjacent to each well and measured distance between the ground surface elevations and tops of the well riser pipes were utilized in conjunction with the measured depths to groundwater to calculate the groundwater level elevation data. The measured depths to groundwater and calculated groundwater elevation measurements, and the results of NAPL monitoring for all monitoring events are summarized in Tables 3 and 4, respectively.

The inferred groundwater flow vectors and calculated groundwater elevation contour intervals at the Phase Two Property based on depth to groundwater measurements on May 24, 2016 are shown on Figure 6. The groundwater elevation contours were created using Golden Software Incorporated's 'Surfer' contouring software version 10.7.972 (updated March 5, 2012) by applying a 'triangulation with linear interpolation' gridding method with 0.1 metre contour spacing.

All depth to groundwater measurements in each of the on-Site groundwater monitoring wells were used to calculate the groundwater elevation contours. As shown on Figure 6, the calculated groundwater surface elevation contours indicate that groundwater flow across the Phase Two Property is generally to the southeast in the unconfined aquifer.

6.3 Groundwater Hydraulic Gradients

6.3.1 Groundwater Horizontal Hydraulic Gradients

The plotted groundwater surface elevation contours (as shown on Figures 6) were utilized to estimate horizontal hydraulic gradient values for the unconfined aquifer at the Phase Two Property. The horizontal hydraulic gradient can be estimated by dividing the difference between two groundwater contour values by the distance between the two plotted groundwater contours. The distance between select groundwater contours can be determined by drawing a straight line which transects each contour in a perpendicular fashion on the plotted groundwater contour figure.

By utilizing groundwater contours which are closely spaced, the estimated maximum horizontal hydraulic gradient for the unconfined aquifer at the Phase Two Property is approximately 0.03.

By utilizing groundwater contours which are more distantly spaced, the estimated minimum horizontal gradient for the unconfined aquifer at the Phase Two Property is approximately 0.02.

By utilizing the two most distant (highest and lowest) groundwater elevation contours plotted at the Phase Two Property, a normalized horizontal hydraulic gradient value for the unconfined aquifer at the Phase

Two Property using groundwater surface elevations measured on May 26, 2016, was estimated to be approximately 0.025.

6.3.2 Groundwater Vertical Hydraulic Gradients

Nested monitoring wells were not installed at the Phase Two Property as part of the Phase Two ESA. As such, vertical hydraulic gradients were not determined.

6.4 Soil Texture

Four soil samples collected from the boreholes advanced at the Phase Two Property were submitted for 75 micron single-sieve grain size analysis. The soil samples selected for analysis were considered to be representative of the stratigraphic units most likely to be impacted based on the stratigraphy observed during borehole drilling. As indicated in Table 1, two soil samples (MW16-1 SA4 and MW16-1 SA7) that were representative of the native sand and silty sand till material present at the Phase Two Property were classified as coarse-textured (52% coarse-grained soil for both samples) and two representative samples (MW16-2 SA5 and MW16-3 SA5) of the native sandy silt till present at the Phase Two Property were classified as medium to fine-textured (46% and 36% coarse-grained soil, respectively).

Based on these grain size analysis results and the observed stratigraphy at the borehole locations at the Phase Two Property, it is the QP's opinion that over one-third of the overburden at the Phase Two Property is coarse as defined by O. Reg. 153/04. Therefore, the soil at the Phase Two Property was interpreted to be coarse-textured for the purpose of determining the MOECC Site Condition Standards applicable to the Phase Two Property.

6.5 Soil Field Screening

Soil vapour headspace concentrations measured in the soil samples collected as part of this Phase Two ESA are presented in the borehole logs. Soil vapour headspace values measured with the CGI in methane elimination mode ranged from 0 ppm by volume (ppm$_{v}$) in several of the collected soil samples to a maximum of 155 ppm$_{v}$ in soil sample MW16-3 SA7 collected from borehole MW16-1 at a depth of approximately 1.52 to 6.10 mbgs. Soil vapour headspace values measured with the PID ranged from 0 ppm by volume (ppm$_{v}$) in several of the collected soil samples to a maximum of 2 ppm$_{v}$ in soil samples MW16-1 SA4, SA7, and SA8 collected from borehole MW16-1 at a depth of approximately 1.52 to 6.10 mbgs.

Two most apparent "worst case" soil samples, based on vapour concentrations as well as visual and/or olfactory considerations, recovered from each borehole were submitted for laboratory analysis of VOCs, PHCs (F1-F4), and/or PAHs.

6.6 Soil Quality

A total of three boreholes were advanced at the Phase Two Property at the locations shown on Figure 5 in order to assess for the presence of subsurface impacts resulting from the APECs identified in the Pinchin Phase One ESA. Select soil samples were collected from each of the advanced boreholes and submitted for laboratory analysis of the COPCs. The depth intervals of the soil samples submitted for analysis of the COPCs ranged between 2.29 to 3.05 mbgs and 4.57 to 5.18 mbgs. The soil sample locations, depths, and laboratory analyses are summarized in Table 1 and in the borehole logs.

The soil sample analytical results were compared to the *Table 2 Standards* and the following subsections provide a discussion of the findings.

6.6.1 VOCs

The soil sample analytical results for VOCs, along with the corresponding *Table 2 Standards*, are presented in Table 1. As indicated in Table 1, all reported concentrations of VOCs in the soil samples submitted for analysis were below the *Table 2 Standards*.

6.6.2 PHCs F1-F4

The soil sample analytical results for PHCs F1-F4, along with the corresponding *Table 2 Standards*, are presented in Table 1. As indicated in Table 1, all reported concentrations of PHCs F1- F4 in the soil samples submitted for analysis were below the *Table 2 Standards*.

6.6.3 PAHs

The soil sample analytical results for PAHs, along with the corresponding *Table 2 Standards*, are presented in Table 1. As indicated in Table 1, all reported concentrations of PAHs in the soil samples submitted for analysis were below the *Table 2 Standards*.

6.6.4 General Comments on Soil Quality

The soil sample results show no evidence of chemical or biological transformations of chemical parameters in the subsurface.

Given that groundwater sampling at the Phase Two Property has not identified any impacts related to VOCs, PHCs F1-F4, and PAH parameters (see Section 6.7), there is no evidence that the soil at the Phase Two Property is acting as a contaminant source for the groundwater.

The soil sample analytical results also show no evidence of NAPLs in the subsurface at the Site. In addition, no evidence of NAPL was observed during borehole drilling.

6.7 Groundwater Quality

Groundwater samples were collected from monitoring wells MW16-1, MW16-2, and MW16-3 and submitted for analysis of the COPCs to assess for the presence of subsurface impacts within the APECs identified in the Pinchin Phase One ESA. The locations of the monitoring wells are shown on Figure 5. The groundwater sample collection depths and laboratory analysis are summarized in Table 5.

The groundwater sample analytical results were compared to the *Table 2 Standards* and the following subsections provide a discussion of the findings.

6.7.1 VOCs

The groundwater analytical results for VOCs, along with the corresponding *Table 2 Standards*, are presented in Table 5. As indicated in Table 5, all reported concentrations of VOCs in the groundwater samples submitted for analysis were below the *Table 2 Standards.*

6.7.2 PHCs F1-F4

The groundwater analytical results for PHCs F1-F4, along with the corresponding *Table 2 Standards*, are presented in Table 5. As indicated in Table 5, all reported concentrations of PHCs F1-F4 in the groundwater samples submitted for analysis met the *Table 2 Standards.*

6.7.3 PAHs

The groundwater analytical results for PAHs, along with the corresponding *Table 2 Standards*, are presented in Table 5. As indicated in Table 5, all reported concentrations of PAHs in the groundwater samples submitted for analysis met the *Table 2 Standards*.

6.7.4 General Comments on Groundwater Quality

The groundwater sample results show no evidence of chemical or biological transformations of chemical parameters in the subsurface.

The groundwater sample analytical results also show no evidence of NAPLs in the subsurface at the Site.

6.8 Sediment Quality

Sediment sampling was not completed as part of this Phase Two ESA.

6.9 Quality Assurance and Quality Control Results

QA/QC comprises technical activities that are used to measure or assess the effect of errors or variability in sampling and analysis. It may also include specification of acceptance criteria for the data and corrective actions to be taken when they are exceeded. QA/QC also includes checks performed to evaluate laboratory analytical quality, checks designed to assess the combined influence of field sampling and laboratory analysis, and checks to specifically evaluate the potential for cross contamination during sampling and sample handling.

The QA/QC samples collected and submitted for analysis by Pinchin during the Phase Two ESA consisted of the following:

- Field duplicate soil and groundwater samples to assess the suitability of field sampling methods and laboratory performance; and
- A trip blank water sample to assess whether ambient conditions during transport of groundwater sample containers from the analytical laboratory to the Phase Two Property and back to the analytical laboratory may have biased the groundwater sample results with respect to volatile constituents.

In addition to the above, laboratory quality control activities and sample checks employed by Maxxam included:

- Method blanks - where a clean sample is processed simultaneously with and under the same conditions (i.e., using the same reagents and solvents) as the samples being analyzed. These are used to confirm whether the instrument, reagents and solvents used are contaminant free;
- Laboratory duplicates - where two samples obtained from the sample container are analyzed. These are used to evaluate laboratory precision;
- Surrogate spike samples - where a known mass of compound not found in nature (e.g., deuterated compounds such as toluene-d8) but that has similar characteristics to the analyzed compounds is added to a sample at a known concentration. These are used to assess the recovery efficiency;
- Matrix spike samples - where a known mass of target analyte is added to a matrix sample with known concentrations. These are used to evaluate the influence of the matrix on a method's recovery efficiency; and
- Use of standard or certified reference materials - a reference material where the content or concentration has been established to a very high level of certainty (usually by a national regulatory agency). These are used to assess accuracy.

The results of the field QA/QC samples are discussed in the following subsections.

6.9.1 Soil Duplicate Results

During borehole soil sampling activities, a total of one separate soil duplicate sample pairs were submitted for laboratory analysis. The field duplicate samples were collected by vertically splitting the soil cores into two halves, with one half collected as the regular sample and the other half collected as the field duplicate sample. The sample pairings and corresponding laboratory analyses are as follows:

During borehole soil sampling activities, one soil duplicate sample pair, consisting of soil sample "MW16-3 SA5" and its corresponding field duplicate "DUP-1", were submitted for laboratory analysis of VOCs, PHCs, PAHs, and pH.

The quality of the analytical results was evaluated by calculating relative percent differences (RPDs) for the parameters analyzed for the original and field duplicate samples. The RPD for each parameter was calculated using the following equation:

$$\text{RPD} = \frac{(\text{Original Concentration} - \text{Duplicate Concentration}) \times 100}{(\text{Original Concentration} + \text{Duplicate Concentration})/2}$$

An RPD was not calculated unless the parameter concentration in both the original and duplicate sample had detectable concentrations above the corresponding practical quantitation limit for the parameter, which is equal to five times the lowest laboratory reportable detection limit (RDL).

The calculated RPDs for the original and field duplicate soil samples have been compared to performance standards provided in the *Analytical Protocol.* Pinchin notes that although these performance standards only strictly apply to laboratory duplicate samples, they have been considered suitable for comparison to the field duplicate soil sample results as well.

The calculated RPDs values met the performance standards with the exception of the following:

- The RPD values for soil sample pairing MW16-3 SA5/DUP-1, collected from borehole MW16-3 at a depth of 3.05 to 3.81 mbgs, exceeded the corresponding performance standard of 30% for the analytical results reported for PHCs F2 (RPD of 131%).

The primary cause of the elevated RPD values and discrepancies observed in the analytical results for soil sample pairings MW16-3 SA5/DUP-1 is inferred to be heterogeneity in the matrix of the soil materials from which the samples were collected. Pinchin notes that fill materials are generally more variable in terms of parameter concentrations in comparison to native, undisturbed soil deposits. As such, the observed variances in RPDs for these sample pairings are not expected to reflect deficiencies in sampling or analytical methods. Furthermore, all parameter concentrations in the soil sample pairings are below the corresponding *Table 2 Standards* so the apparent lack of precision is not considered a concern. Based on Pinchin's review of the calculated RPD values for the remainder of the collected soil duplicate sample pairings, the level of observed variance in the reported analytical results is considered acceptable for the purpose of meeting the data quality objectives of this Phase Two ESA.

6.9.2 Groundwater Sample Duplicate Results

During groundwater sampling activities, one groundwater duplicate sample pair, consisting of groundwater sample “MW16-2” and its corresponding field duplicate “DUP-1” were submitted for laboratory analysis of VOCs, PHCs, and PAHs

The calculated RPDs for the original and field duplicate groundwater samples have been compared to performance standards provided in the *Analytical Protocol.* Pinchin notes that although these performance standards only strictly apply to laboratory duplicate samples, they have been considered suitable for comparison to the field duplicate groundwater sample results as well.

Each of the calculated RPDs met the corresponding performance standard.

Based on Pinchin’s review of the calculated RPD values for the submitted groundwater sample duplicate pairings, the level of observed variance in the reported analytical results is considered acceptable for the purpose of meeting the data quality objectives of this Phase Two ESA.

6.9.3 Groundwater Trip Blank Results

A trip blank sample, consisting of VOC and PHC (F1)-free water contained within a set of VOC/PHC (F1) sample vials, were prepared by Maxxam and accompanied the groundwater sample containers during transportation to the Phase Two Property and were stored in the coolers with the VOC/PHC (F1) groundwater samples in the field and during transportation back to Maxxam. A total of one trip blank sample was submitted to Maxxam for chemical analysis of VOCs.PHCs (F1) during the groundwater sampling activities completed as part of this Phase Two ESA.

As indicated in Table 5, the concentrations of the VOC/PHCs (F1) parameters analyzed in the trip blank sample were below the laboratory RDLs. These findings indicate that ambient conditions during the transportation of the sample containers to and from the Phase Two Property, and during groundwater sampling, did not positively bias the VOCs/PHCs (F1) parameter analytical results for the groundwater samples.

6.9.4 Deviations from Analytical Protocol

There were no deviations from the holding times, preservation methods, storage requirements and container types specified in the *Analytical Protocol* during the completion of the Phase Two ESA, with the following exception:

- Laboratory Certificate B6A5189 – The cooler custody seal was not present and intact. The soil samples were submitted and delivered to Maxxam from the Pinchin office in Oshawa, Ontario, within one cooler under supervision of Maxxam’s designated courier service. Based on absence of field indications of impacts, the use of the designated

Maxxam courier service and that the concentrations of the parameters in the submitted soil samples are below their respective *Table 2 Standards,* it is Pinchin's opinion that the soil samples were unlikely compromised.

6.9.5 Laboratory Certificates of Analysis

Pinchin has reviewed the laboratory Certificates of Analysis provided by Maxxam for the samples submitted during the Phase Two ESA and confirms the following:

- All laboratory Certificates of Analysis contain a complete record of the sample submission and analysis and meet the requirements of Section 47(3) of O. Reg. 153/04;
- A laboratory Certificate of Analysis has been received for each sample submitted for analysis during the Phase Two ESA;
- All laboratory Certificates of Analysis have been included in full in Appendix G; and
- All of the analytical data reported in the Certificates of Analysis have been summarized, in full, in Tables 1 and 5.

6.9.6 Laboratory Comments Regarding Sample Analysis

Maxxam routinely conducts internal QA/QC analyses in order to satisfy regulatory QA/QC requirements. The results of the Maxxam QA/QC analyses for the submitted soil samples are summarized in the laboratory Certificates of Analyses provided in Appendix G. Also included in Appendix G are all correspondences between the laboratory and staff at Pinchin.

The following summarizes comments noted by Maxxam on the laboratory Certificates of Analysis for the submitted samples:

- Laboratory Certificate B6A5189 – The average temperature of the package containing the samples was 6.3ºC. The average temperature of the samples should be less than 10ºC and satisfies the QA/QC requirements;
- Laboratory Certificate B6A5189 – The cooler custody seal was not present and intact. The soil samples were submitted and delivered to Maxxam from the Pinchin office in Oshawa, Ontario, within one cooler under supervision of Maxxam's designated courier service. Based on the absence of field indications of impacts, the use of the designated Maxxam courier service and that the concentrations of the parameters in the submitted soil samples are below their respective *Table 2 Standards,* it is Pinchin's opinion that the soil samples were unlikely compromised; and,

- Laboratory Certificate B6A5189 – Revised Report (2016/07/06) Additional analyses was included as per client request. The additional sample analysis was for pH parameters of soil samples MW16-3 SA5 and DUP-1.

The following summarizes comments noted by Maxxam on the laboratory Certificates of Analysis for the submitted groundwater samples:

- Laboratory Certificate B6B0019 - The average temperature of the package containing the samples was 7.3ºC. The average temperature of the samples should be less than 8 degrees Celsius and satisfies the QA/QC requirements;
- Laboratory Certificate B6B0019 - For samples BH16-1, BH16-2, BH16-3, and DUP-1, all 40mL vials for F1BTEX and VOC analyses contained visible sediment. Based on Pinchin’s field observations, the volume of sediment in the submitted groundwater sample containers was a trace to minor amount. Given that these parameters are volatile constituents and are not expected to sorb to soil particles, the presence of trace to minor amounts sediment in the sample vials is not anticipated to result in significant sample bias. Furthermore, Pinchin notes that all reported concentrations of PHCs F1 for the submitted groundwater samples were below the corresponding *Table 2 Standard*. As such, the presence of sediment does not alter the conclusion that the concentrations of PHCs F1 in the submitted groundwater samples are below the *Table 2 Standards*;
- Laboratory Certificate B6B0019 – Maxxam indicated that all groundwater sample containers submitted for laboratory analysis of PHCs F2-F4 and PAHs contained visible sediment that was included in the laboratory extraction. Based on Pinchin’s field observations, the volume of sediment in the submitted groundwater sample containers was a trace to minor amount. These parameters have a tendency to sorb to soil particles. As such, the reported concentrations of PHCs F2-F4 and PAHs in the submitted groundwater samples may be positively biased. However, Pinchin notes that all reported concentrations of PHCs F2-F4 and PAHs for the submitted groundwater samples were below the corresponding *Table 2 Standards*. As such, the presence of sediment does not alter the conclusion that the concentrations of PHCs F2-F4 and PAHs in the submitted groundwater samples are below the *Table 2 Standards*; and,
- Laboratory Certificate B6B0019 – Revised Report (2016/07/11) IDs changed as per client request. The IDs of the samples BH16-1, BH16-2, and BH16-3 were changed to MW16-1, MW16-2, and MW16-3, respectively, to match the soil sample IDs.

The results of the QA/QC analyses were reviewed by the project staff at Maxxam and observed to be within the laboratory’s internal requirements. Pinchin has also reviewed the laboratory Certificates of

Analysis and has confirmed that the results of the analyses are acceptable for the purpose of meeting the data quality objectives of this Phase Two ESA.

The following general comments apply to the laboratory Certificates of Analysis received from Maxxam as part of this Phase Two ESA:

- The temperatures of the submitted soil and groundwater samples upon receipt met the sample preservation requirements of the *Analytical Protocol* of 6.8 ± 1ºC (between 6.3 and 7.3ºC); and,
- The custody seal was present and intact on all submissions, with the exception of the laboratory certificate B6A5189. The soil samples were submitted and delivered to Maxxam from the Pinchin office in Oshawa, Ontario, within one cooler under supervision of Maxxam's designated courier service. Based on the use of the absence of field indications of impacts, the designated Maxxam courier service and that the concentrations of the parameters in the submitted soil samples are below their respective *Table 2 Standards,* it is Pinchin's opinion that the soil samples were unlikely compromised.

6.9.7 QA/QC Sample Summary

The overall evaluation of the QA/QC sample results indicates no issues with respect to field collection methods and laboratory performance, and no apparent bias due to ambient conditions at the Phase Two Property and during transportation of the sample containers/samples to and from the analytical laboratory.

As such, it is the QP's opinion that the soil and groundwater analytical data obtained during the Phase Two ESA are representative of actual Site conditions and are appropriate for meeting the objective of assessing whether the soil and groundwater at the Phase Two Property meets the applicable MOECC Site Condition Standards.

6.10 Phase Two Conceptual Site Model

The Phase One Property is an irregular-shaped parcel of land approximately 1.37 acres (0.55 hectares) in size located north of Wharf Street and south of Annland Street, approximately 60 m west of Liverpool Road in Pickering, Ontario. The Phase One Property is improved with four residential dwellings and one commercial building utilized for storage purposes (Site Buildings) located throughout the Phase One Property. In addition to the Site Buildings, there are approximately five storage sheds/detached garages located on-Site. The Phase One Property has been used for residential purposes, and more recently for commercial storage. There is no record of industrial use or of a commercial use (e.g., garage, bulk liquid dispensing facility or dry cleaner) that would require classifying the Phase One Property as an enhanced investigation property. A key map showing the Phase Two Property location is provided as Figure 1.

A Phase One CSM was created during the Pinchin Phase One ESA in order to provide a detailed visualization of the APECs which could occur on, in, under, or affecting the Phase Two Property. The Phase One CSM is summarized in Figures 1 through 4, which illustrate the following features within the Phase One Study Area, where present:

- Existing buildings and structures;
- Water bodies located in whole or in part within the Phase One Study Area;
- Areas of natural significance located in whole or in part within the Phase One Study Area;
- Drinking water wells located at the Phase One Property;
- Land use of adjacent properties;
- Roads within the Phase One Study Area;
- PCAs within the Phase One Study Area, including the locations of tanks; and
- APECs at the Phase One Property.

The following subsections expand on the Phase One CSM with the information collected during the completion of the Phase Two ESA.

6.10.1 Potentially Contaminating Activities

The Phase One ESA identified a total of two PCAs within the Phase One Study Area that could potentially affect the environmental condition of the subsurface media on, in or under the Phase Two Property. Both of these PCAs were not located on the Phase Two Property.

The PCAs and their corresponding APECs at the Phase Two Property are summarized in the following table:

Area of Potential Environmental Concern	Location of Area of Potential Environmental Concern on Phase One Property	Potentially Contaminating Activity	Location of PCA (On-Site or Off-Site)	Contaminants of Potential Concern	Media Potentially Impacted (Groundwater, Soil and/or Sediment)
APEC #1	East portion of the Phase One Property.	Item 28 – Gasoline and Associated Products Storage in	Off-Site	PHCs VOCs PAHs	Soil and Groundwater

Area of Potential Environmental Concern	Location of Area of Potential Environmental Concern on Phase One Property	Potentially Contaminating Activity	Location of PCA (On-Site or Off-Site)	Contaminants of Potential Concern	Media Potentially Impacted (Groundwater, Soil and/or Sediment)
		Fixed Tanks (former UST located at 640 Liverpool Road)			
APEC #2	East portion of the Phase One Property.	Other – Exterior Chemical Storage (drum storage area adjacent to the Site, at 640 Liverpool Road)	Off-Site	PHCs VOCs PAHs	Soil and Groundwater

Figure 4 shows the locations of the off-Site PCAs/APECs located within the Phase One Study Area.

6.10.2 Areas of Potential Environmental Concern

The Phase Two ESA included an assessment of soil and groundwater quality within each of the APECs. A summary of the findings for each of the APECs is provided below.

APEC #1

A PCA associated 640 Liverpool Road property was listed in the List of Technical Standards & Safety Authority (TSSA) Expired Facilities as an expired self-serve private fuel outlet, as of December 20, 1989. This property was also listed in the Private and Retail Storage Tanks database for having a private tank with a capacity of 13,638 L and is located adjacent to the east and inferred to be hydraulically upgradient of the Phase One Property, and the UST associated with this operation represents an environmental concern for the Phase One Property. The subsurface investigation of APEC #1 completed by Pinchin as part of the Phase Two ESA included the advancement of boreholes completed as groundwater monitoring wells (MW16-1 and MW16-2). The soil and groundwater samples submitted from the boreholes/monitoring wells completed within APEC #1 met the *Table 2 Standards*.

APEC #2

A PCA associated with a drum storage area was identified at 640 Liverpool Road during the Site Reconnaissance located at the property adjacent to the east of the Phase One Property. The subsurface investigation of APEC #2 completed by Pinchin as part of the Phase Two ESA included the advancement of boreholes and a groundwater monitoring wells (MW16-1, MW16-2, and MW16-3). The soil and groundwater samples submitted from the boreholes/monitoring wells completed within APEC #2 met the *Table 2 Standards*.

The following table summarizes the boreholes and monitoring wells completed to investigate each of the APECs:

APEC	Investigation Location
APEC #1	MW16-2
APEC #2	MW16-1, MW16-2, and MW16-3

* Soil sampling only

** Groundwater sampling only

6.10.3 Subsurface Utilities and Construction Features

Underground utilities at the Phase Two Property provide potable water, natural gas, electrical, telephone, cable and sewer services are provided to some of the Site Buildings. These services enter the Site Buildings through subsurface conduit or overhead lines running from Wharf Street or Annland Street. Plans were not available to confirm the depths of these utilities but they are estimated to be located approximately 2 to 3 mbgs. The vicinity where subsurface activities were occurring did not have sanitary or sewer lines entering the property, and electrical was provided to Building A by overhead wires. As such, the migration and distribution of contaminants is expected to have not been affected by the any potential underground utilities.

6.10.4 Physical Setting

Based on the work completed as part of this Phase Two ESA, the following subsections provide a summary of the physical setting of the Phase Two Property.

<u>Stratigraphy</u>

The observed stratigraphy at the borehole locations completed for the Phase Two ESA generally consisted of clay with trace silt and organics in the fill material to a maximum depth of approximately 0.76 mbgs. The native soil underlying the surficial soil fill materials is generally comprised of clayey silt, sandy silt till, silty sand till, and/or sand that extended to the maximum investigation depth of 6.1 mbgs. The water table is located within this unit at a depth of approximately 3.7 to 5.1 mbgs and this uppermost water bearing unit represents an unconfined aquifer. The borehole locations are shown on Figure 5.

Across-section summarizing the subsurface geological conditions at the time of the Phase Two ESA (i.e., prior to redevelopment) have been provided as Figure 7.

Hydrogeological Characteristics

The groundwater flow direction in the unconfined aquifer at the Phase Two Property is inferred to be towards the southeast (see Figure 6).

The horizontal hydraulic gradient within the unconfined aquifer at the Phase Two Property was estimated to be 0.02. Nested monitoring wells were not installed at the Phase Two Property as part of the Phase Two ESA. As such, vertical hydraulic gradients were not determined.

Depth to Bedrock and Shallow Soil Property Assessment

Bedrock was not encountered at any of the borehole locations up to the maximum depth drilled of approximately 6.36 mbgs and based on the available water well records in the area, bedrock depth at the Phase Two Property is approximately 6.5 mbgs. As such, the Phase Two Property is not a shallow soil property, as defined by Section 43.1 of O. Reg. 153/04.

Depth to Water Table

The water table at the Phase Two Property is located primarily within the shallow sandy silt, sand, and/or sandy clay unit located that has been interpreted to be an unconfined aquifer. The depth to the water table across the Phase Two Property ranges from approximately 4.77 to 5.10 mbgs.

Site Sensitivity

The pH values measured in the submitted soil samples were within the limits for non-sensitive sites. The Phase Two Property is also not an area of natural significance and it is not adjacent to, nor does it contain land within 30 metres of, an area of natural significance. As such, the Phase Two Property is not an environmentally sensitive area as defined by Section 41 of O. Reg. 153/04.

Soil Imported to Phase Two Property

No soil was imported to the Phase Two Property during completion of the Phase Two ESA.

Proposed Buildings and Other Structures

Pinchin understands that the future use of the Phase Two Property will be for a residential development that is still in the planning stages and the configuration of the Phase Two Property, including proposed building locations, has yet to be confirmed.

6.10.5 Applicable Site Condition Standards

Based on the grain size analysis of representative soil samples collected during the Phase Two ESA and the observed stratigraphy at the borehole locations, Pinchin concluded that over one-third of the overburden at the Phase Two Property is coarse-textured as defined by O. Reg. 153/04 and Site Condition Standards for coarse-textured soil were applied.

Based on the information obtained from the Phase One and Two ESAs, the appropriate Site Condition Standards for the Phase Two Property are:

- "Table 2: Full Depth Generic Site Condition Standards for Use in a Potable Ground Water Condition", provided in the Ontario Ministry of the Environment and Climate Change (MOECC, formerly the Ontario Ministry of the Environment) document entitled, "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" dated April 15, 2011 (*Table 2 Standards*) for:
  - Coarse-textured soils; and
  - Residential/parkland/institutional property use.

6.10.6 Contaminants Exceeding Applicable Site Condition Standards in Soil

All soil samples collected during the Phase Two ESA met the applicable *Table 2 Standards* for the parameters analyzed.

6.10.7 Contaminants Exceeding Applicable Site Condition Standards in Groundwater

All groundwater samples collected during the Phase Two ESA met the applicable *Table 2 Standards* for the parameters analyzed.

6.10.8 Meteorological and Climatic Conditions

The groundwater table was observed to fluctuate slightly in elevation (i.e., a maximum difference of 6 centimetres) over two rounds of groundwater monitoring completed on May 24, 2016 and May 26, 2016. The minor temporal groundwater table fluctuations are expected to have had a minimal effect on contaminant distribution throughout the Phase Two Property. As such, it is the QP's opinion that meteorological or climatic conditions have not influenced the distribution or migration of the contaminants at the Phase Two Property.

6.10.9 Soil Vapour Intrusion

No volatile parameters were identified at concentrations exceeding the *Table 2 Standards*. As such, soil vapour intrusion into buildings at the Phase Two Property is not considered a concern.

6.10.10 Contaminant Exposure Assessment

Given that all soil and groundwater samples collected during the Phase Two ESA met the applicable *Table 2 Standards*, Pinchin considered that an evaluation of potential exposure pathways and receptors was unnecessary.

7.0 CONCLUSIONS

Pinchin completed a Phase Two ESA at the Phase Two Property in accordance with the requirements stipulated in O. Reg. 153/04 for the purpose of filing an RSC. The RSC is required by the Client in relation to the future redevelopment of the Phase Two Property from its current commercial and residential land use to residential land use. An RSC submittal to the MOECC is a mandatory requirement when a land use changes to a more sensitive land use and as such, to support the RSC submission, the Phase Two ESA was conducted in accordance with O. Reg. 153/04.

The Phase Two ESA completed by Pinchin included the advancement of three boreholes at the Phase Two Property, all of which were completed as groundwater monitoring wells to facilitate the sampling of groundwater.

Based on Site-specific information, the applicable regulatory standards for the Phase Two Property were determined to be the *Table 2 Standards* for residential land use and coarse-textured soils. Soil samples were collected from each of the borehole location and submitted for laboratory analysis of VOCs, PHCs, PAHs. In addition, groundwater samples were collected from the three newly-installed monitoring wells, and submitted for laboratory analysis of VOCs, PHCs, and PAHs.

The laboratory results for the submitted soil and groundwater samples indicated that all reported concentrations for the parameters analyzed met the corresponding *Table 2 Standards*. The maximum reported soil and groundwater concentrations for the parameters analyzed are summarized in Tables 6 and 7, respectively.

It is the opinion of the QP who supervised the Phase Two ESA that the applicable *Table 2 Standards* for soil and groundwater at the Phase Two Property have been met as of the Certification Date of [MONTH DAY, YEAR] and that no further subsurface investigation is required in relation to assessing the environmental quality of soil and groundwater at the Phase Two Property.

7.1 Signatures

This Phase Two ESA was undertaken under the supervision of Peter Roberts, P.Eng., QP_{ESA} in accordance with the requirements of O. Reg. 153/04 to support the filing of an RSC for the Phase Two Property.

7.2 Limitations

This Phase Two ESA was performed for R.B. Morgan Construction (Client) in order to investigate potential environmental impacts at 1280, 1288, 1290 & 1294 Wharf Street and 607 Annland Street in Pickering, Ontario (Site). The term recognized environmental condition means the presence or likely presence of any hazardous substance on a property under conditions that indicate an existing release, past release, or a material threat of a release of a hazardous substance into structures on the property or into the ground, groundwater, or surface water of the property. This Phase Two ESA does not quantify the extent of the current and/or recognized environmental condition or the cost of any remediation.

Conclusions derived are specific to the immediate area of study and cannot be extrapolated extensively away from sample locations. Samples have been analyzed for a limited number of contaminants that are expected to be present at the Site, and the absence of information relating to a specific contaminant does not indicate that it is not present.

No environmental site assessment can wholly eliminate uncertainty regarding the potential for recognized environmental conditions on a property. Performance of this Phase Two ESA to the standards established by Pinchin is intended to reduce, but not eliminate, uncertainty regarding the potential for recognized environmental conditions on the Site, and recognizes reasonable limits on time and cost.

This Phase Two ESA was performed in general compliance with currently acceptable practices for environmental site investigations, and specific Client requests, as applicable to this Site.

This report was prepared for the exclusive use of the Client, subject to the conditions and limitations contained within the duly authorized proposal. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of the third parties.

If additional parties require reliance on this report, written authorization from Pinchin will be required. Pinchin disclaims responsibility of consequential financial effects on transactions or property values, or requirements for follow-up actions and costs. No other warranties are implied or expressed. Furthermore, this report should not be construed as legal advice.

Pinchin will not be responsible for any consequential or indirect damages. Pinchin will only be liable for damages resulting from the negligence of Pinchin. Pinchin will not be liable for any losses or damage if the Client has failed, within a period of two years following the date upon which the claim is discovered (Claim Period), to commence legal proceedings against Pinchin to recover such losses or damage unless the laws of the jurisdiction which governs the Claim Period which is applicable to such claim provides that the applicable Claim Period is greater than two years and cannot be abridged by the contract between the Client and Pinchin, in which case the Claim Period shall be deemed to be extended by the shortest additional period which results in this provision being legally enforceable.

Pinchin makes no other representations whatsoever, including those concerning the legal significance of its findings, or as to other legal matters touched on in this report, including, but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to interpretation and these interpretations may change over time.

8.0 REFERENCES

The following documents provided information used in this report:

- Association of Professional Geoscientists of Ontario. Guidance for Environmental Site Assessments under Ontario Regulation 153/04 (as amended). April 2011.
- Ontario Ministry of the Environment. Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario. December 1996.
- Ontario Ministry of the Environment. Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. March 9, 2004 amended July 1, 2011.
- Ontario Ministry of the Environment. Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act. April 15, 2011.
- Pinchin Ltd. Phase One Environmental Site Assessment, 1280, 1288, 1290 & 1294 Wharf Street and 607 Annland Street, Pickering, Ontario. Prepared for R.B. Morgan Construction, September, 2016.
- Province of Ontario. Environmental Protection Act, R.S.O 1990, Chapter E.19.
- Province of Ontario. R.R.O. 1990, Regulation 347, General – Waste Management, as amended by Ontario Regulation 234/11.
- Province of Ontario. Ontario Regulation 153/04: Records of Site Condition – Part XV.1 of the Act. Last amended by Ontario Regulation 333/13 on December 13, 2013 .
- U.S. Environmental Protection Agency - Region 1. Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells. Revised January 19, 2010.

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Template: Master Report for RSC Phase Two ESA Report – Unimpacted Site, EDR, May 13, 2016

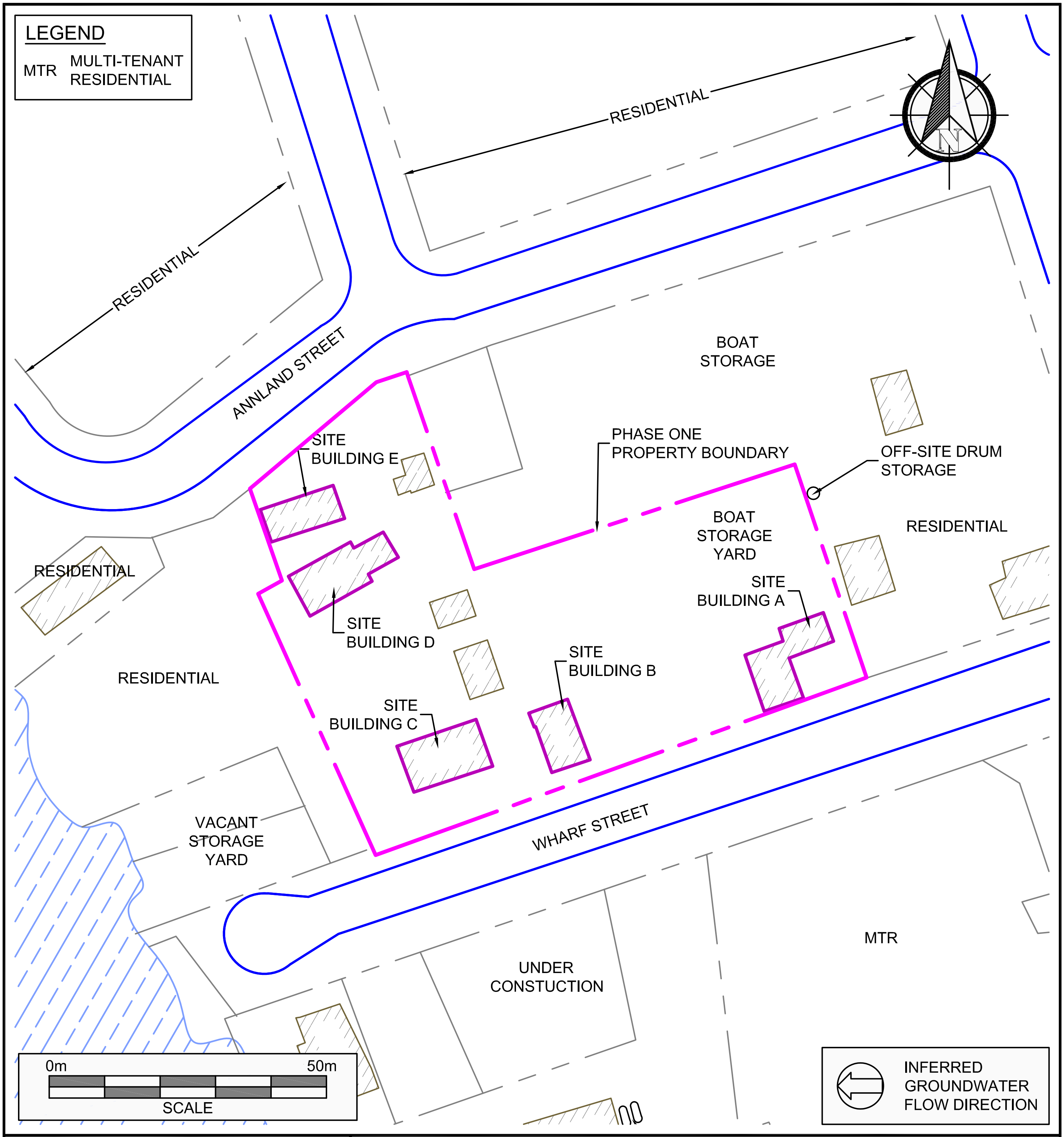
9.0 FIGURES AND TABLES

PROJECT NAME
PHASE TWO ENVIRONMENTAL SITE ASSESSMENT

CLIENT NAME
R.B. MORGAN CONSTRUCTION

PROJECT LOCATION
1280, 1288, 1290, 1294 WHARF STREET
AND 607 ANNLAND STREET, PICKERING, ONTARIO

FIGURE NAME			FIGURE NO.
KEY MAP			1
SCALE AS SHOWN	PROJECT NO. 103341.001	DATE OCT. 2016	



PINCHIN

PROJECT NAME
PHASE TWO ENVIRONMENTAL SITE ASSESSMENT

CLIENT NAME
R.B. MORGAN CONSTRUCTION

PROJECT LOCATION
1280, 1288, 1290, 1294 WHARF STREET
AND 607 ANNLAND STREET, PICKERING, ONTARIO

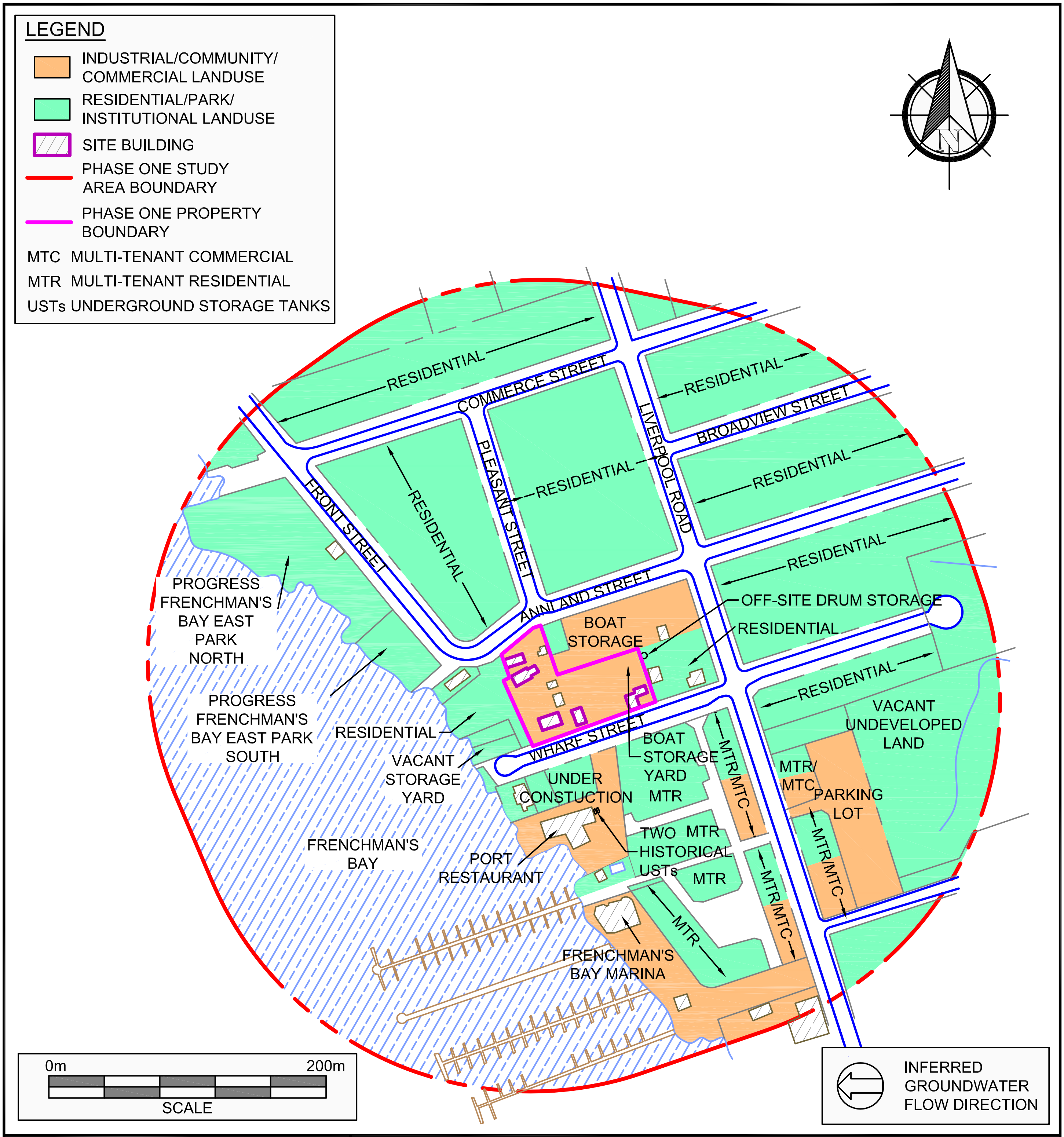
FIGURE NAME
PHASE ONE PROPERTY

FIGURE NO.
2

SCALE
AS SHOWN

PROJECT NO.
103341.001

DATE
OCT. 2016



LEGEND

- 🟧 INDUSTRIAL/COMMUNITY/ COMMERCIAL LANDUSE
- 🟩 RESIDENTIAL/PARK/ INSTITUTIONAL LANDUSE
- ▨ SITE BUILDING
- — PHASE ONE STUDY AREA BOUNDARY
- — PHASE ONE PROPERTY BOUNDARY

MTC	MULTI-TENANT COMMERCIAL
MTR	MULTI-TENANT RESIDENTIAL
USTs	UNDERGROUND STORAGE TANKS

PINCHIN

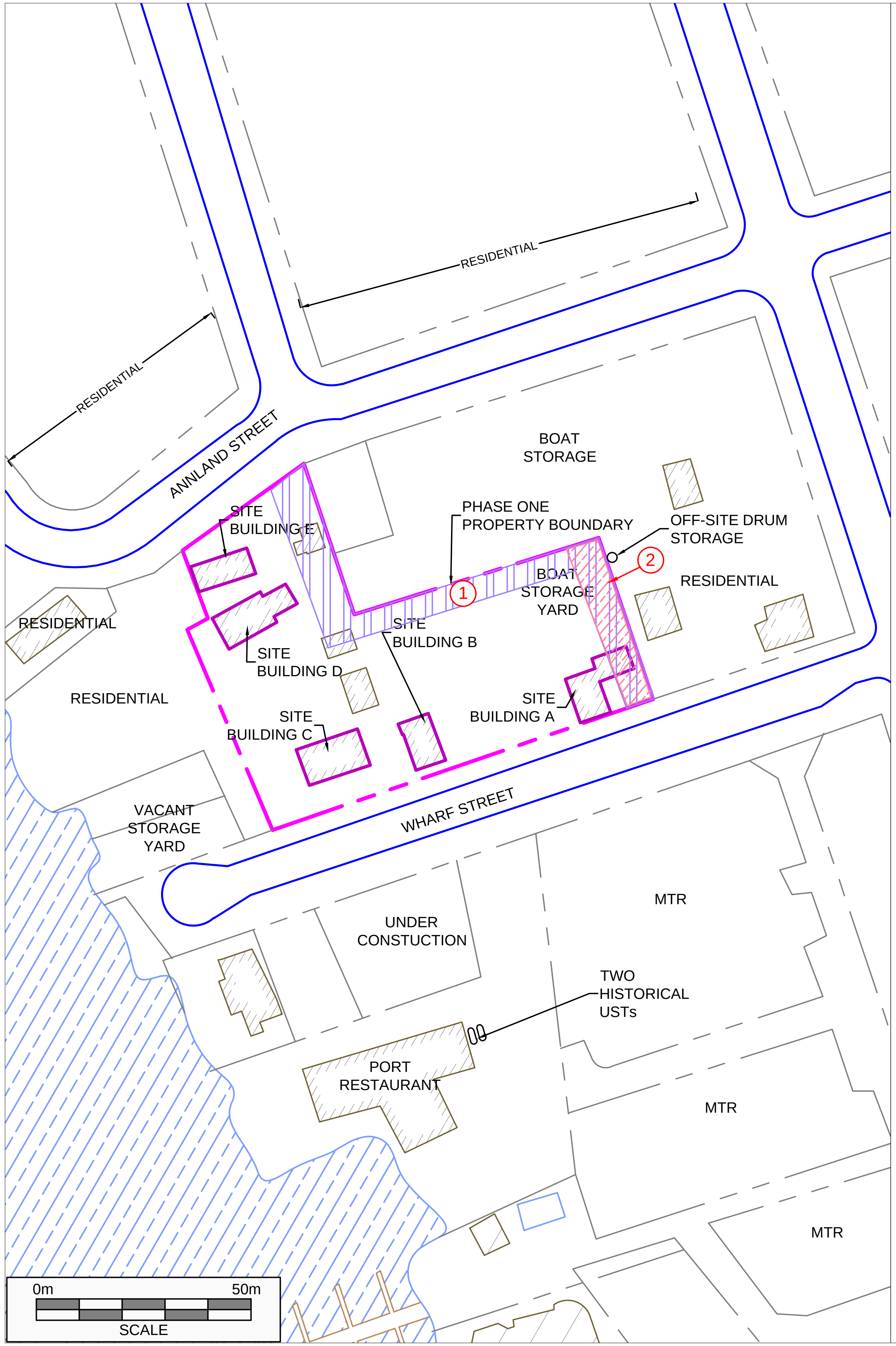
PROJECT NAME
PHASE TWO ENVIRONMENTAL SITE ASSESSMENT

CLIENT NAME
R.B. MORGAN CONSTRUCTION

PROJECT LOCATION
1280, 1288, 1290, 1294 WHARF STREET
AND 607 ANNLAND STREET, PICKERING, ONTARIO

FIGURE NAME
PHASE ONE STUDY AREA

SCALE	PROJECT NO.	DATE	FIGURE NO.
AS SHOWN	103341.001	OCT. 2016	3



Area of Potential Environmental Concern	Location of Area of Potential Environmental Concern on Phase One Property	Potentially Contaminating Activity	Location of PCA (On-Site or Off-Site)	Contaminants of Potential Concern	Media Potentially Impacted (Groundwater, Soil and/or Sediment)
APEC #1	East portion of the Phase One Property.	Item 28 – Gasoline and Associated Products Storage in Fixed Tanks (former UST located at 640 Liverpool Road)	Off-Site	PHCs VOCs PAHs	Soil and Groundwater
APEC #2	East portion of the Phase One Property.	Other – Exterior Chemical Storage (drum storage area adjacent to the Site, at 640 Liverpool Road)	Off-Site	PHCs VOCs PAHs	Soil and Groundwater

INFERRED GROUNDWATER FLOW DIRECTION ⇦

LEGEND

①	APEC NUMBER (AREA OF POTENTIAL ENVIRONMENTAL CONCERN)
BTEX	BENZENE, TOLUENE, ETHYLBENZENE AND XYLENES
PAHs	POLYCYCLIC AROMATIC HYDROCARBON
PHCs	PETROLEUM HYDROCARBON FRACTIONS F1-F4
VOCs	VOLATILE ORGANIC COMPOUNDS
NA	NOT APPLICABLE
▥	APEC1 (APPROX. EXTENT)
▨	APEC2 (APPROX. EXTENT)

PINCHIN

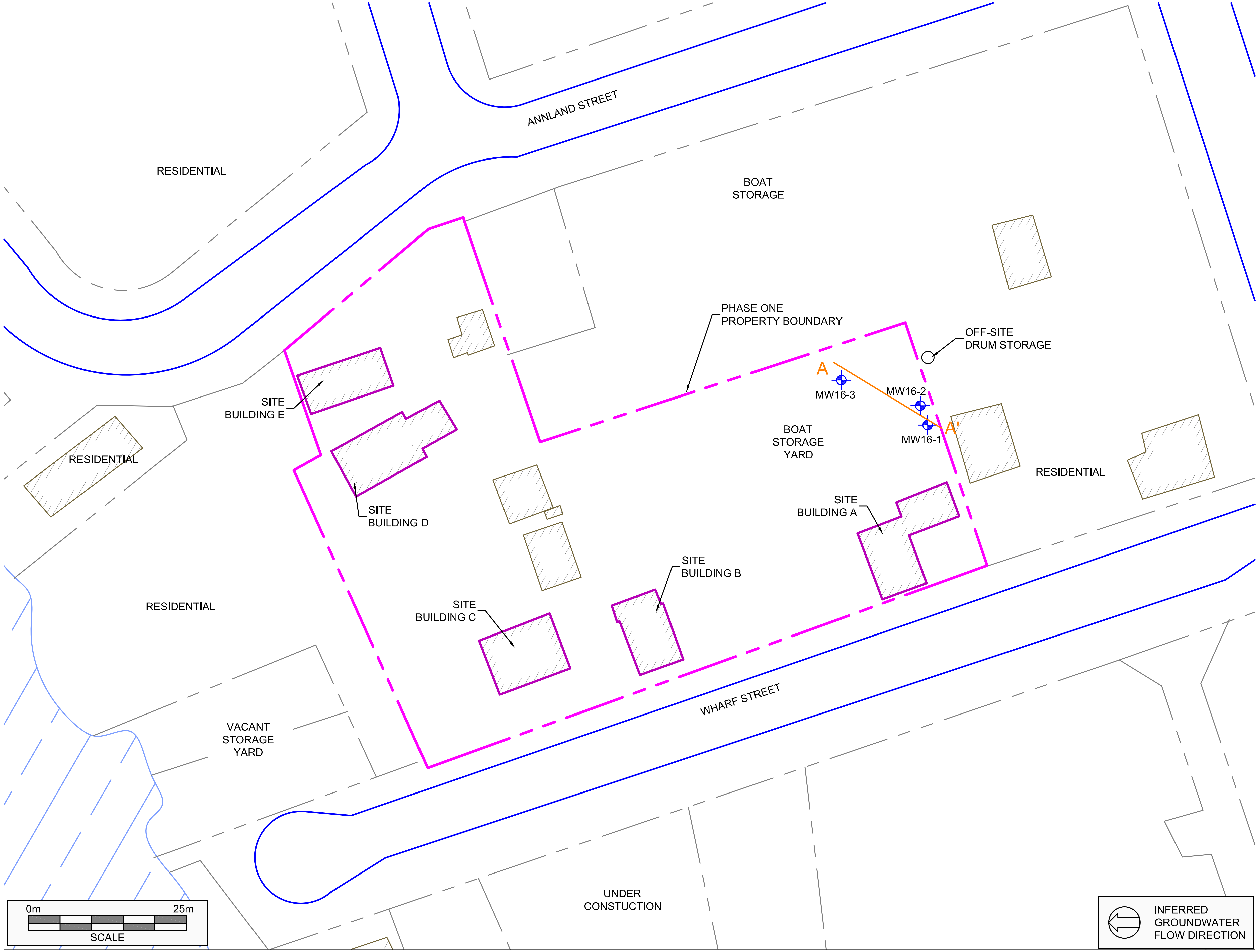
PROJECT NAME
PHASE TWO ENVIRONMENTAL SITE ASSESSMENT

CLIENT NAME
R.B. MORGAN CONSTRUCTION

PROJECT LOCATION
1280, 1288, 1290, 1294 WHARF STREET AND 607 ANNLAND STREET, PICKERING, ONTARIO

FIGURE NAME
AREAS OF POTENTIAL ENVIRONMENTAL CONCERN

SCALE	PROJECT NO.
AS SHOWN	103341.001
DATE	FIGURE NO.
OCT. 2016	4



LEGEND

⌖ MONITORING WELL

A A' CROSS SECTION

PINCHIN

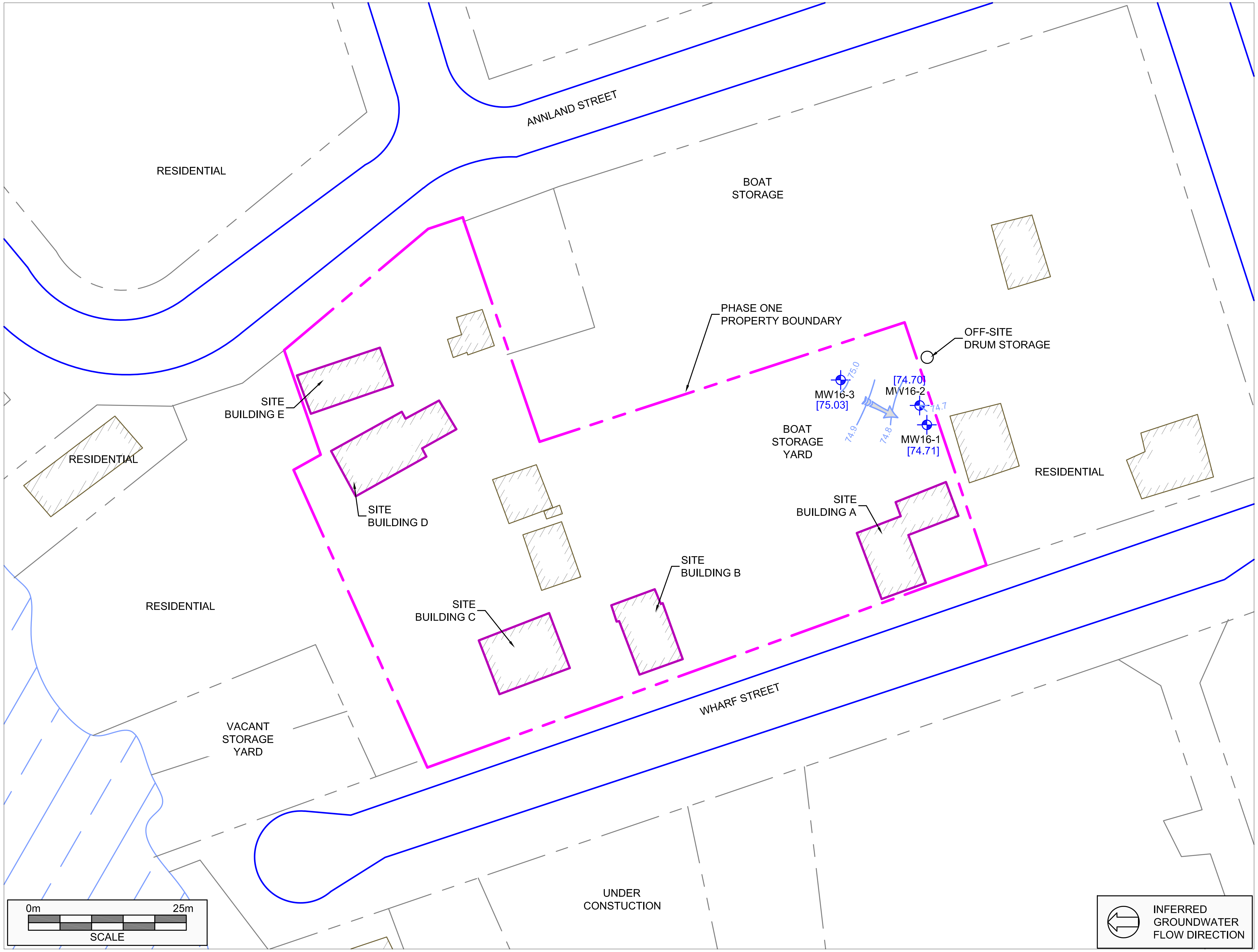
PROJECT NAME
PHASE TWO ENVIRONMENTAL SITE ASSESSMENT

CLIENT NAME
R.B. MORGAN CONSTRUCTION

PROJECT LOCATION
1280, 1288, 1290, 1294 WHARF STREET AND 607 ANNLAND STREET, PICKERING, ONTARIO

FIGURE NAME
BOREHOLE AND MONITORING WELL LOCATION

SCALE	PROJECT NO.
AS SHOWN	103341.001
DATE	FIGURE NO.
OCT. 2016	5



LEGEND

⌖ MONITORING WELL

[74.71] GROUNDWATER ELEVATION

74.7 GROUNDWATER CONTOUR ELEVATION

⇦ GROUNDWATER FLOW DIRECTION ARROW

PINCHIN

PROJECT NAME

PHASE TWO ENVIRONMENTAL SITE ASSESSMENT

CLIENT NAME

R.B. MORGAN CONSTRUCTION

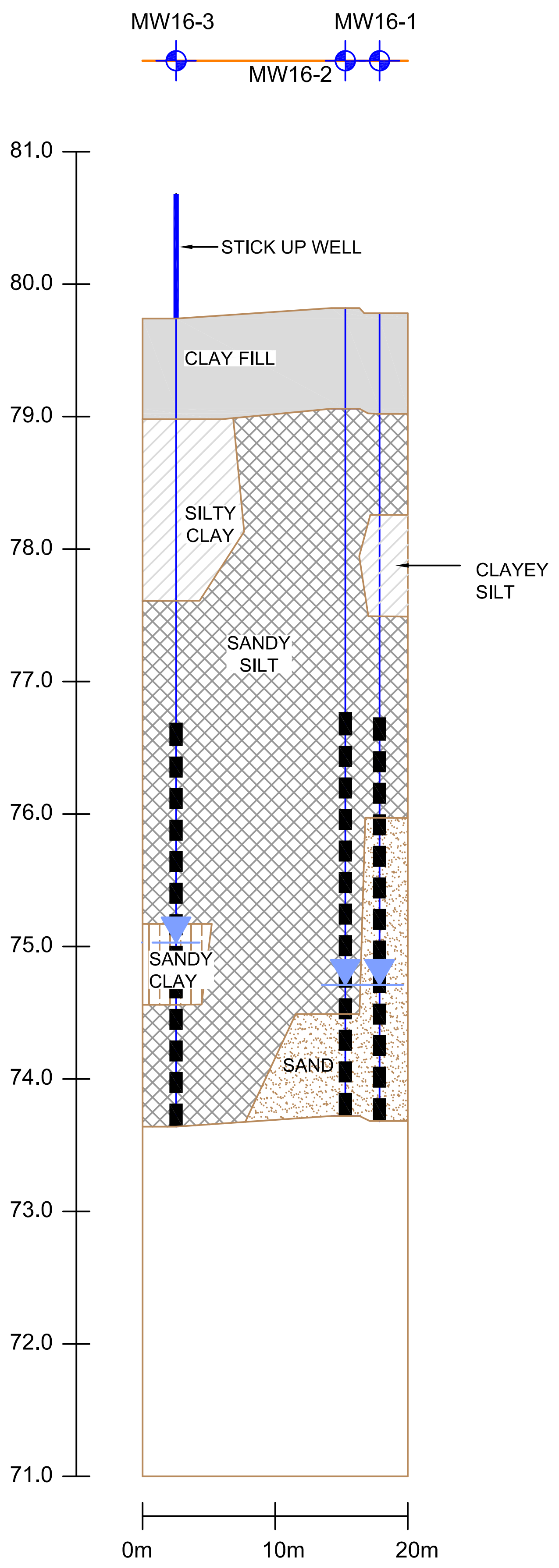
PROJECT LOCATION

1280, 1288, 1290, 1294 WHARF STREET AND 607 ANNLAND STREET, PICKERING, ONTARIO

FIGURE NAME

GROUNDWATER ELEVATION PLAN

SCALE	PROJECT NO.
AS SHOWN	103341.001
DATE	FIGURE NO.
OCT. 2016	6



INFERRED GROUNDWATER FLOW DIRECTION

LEGEND

⌖ MONITORING WELL

▩ CLAY FILL

▨ CLAYEY SILT/SILTY CLAY

▥ SANDY CLAY

▦ SANDY SILT/SILT SAND

░ SAND

mREL METRE RELATIVE TO ELEVATION LEVEL

WELL CASING/BENTONITE

▼ MEASURED GROUNDWATER ELEVATION

■ WELL SCREEN

PINCHIN

PROJECT NAME PHASE TWO ENVIRONMENTAL SITE ASSESSMENT	
CLIENT NAME R.B. MORGAN CONSTRUCTION	
PROJECT LOCATION 1280, 1288, 1290, 1294 WHARF STREET AND 607 ANNLAND STREET, PICKERING, ONTARIO	
FIGURE NAME CROSS SECTION A-A'	
SCALE AS SHOWN	PROJECT NO. 103341.001
DATE OCT. 2016	FIGURE NO. 7

TABLE 1

SOIL ANALYTICAL RESULTS

R.B. Morgan Construction

1289 Wharf Street, Pickering, Ontario

Sample Designation	*MW16-1 SA1*	*MW16-1 SA4*	*MW16-1 SA7*	*MW16-2 SA5*	*MW16-2 SA6*	*MW16-3 SA5*	*MW16-3 SA7*	*DUP-1*	***MOECC Table 2 Standards***
Sample Collection Date (dd/mm/yyyy)	*20/05/2016*	*20/05/2016*	*20/05/2016*	*20/05/2016*	*20/05/2016*	*20/05/2016*	*20/05/2016*	*20/05/2016*	
Sample Depth (mbgs)	*0.00-0.76*	*2.29-3.05*	*4.57-5.33*	*3.05-3.81*	*3.81-4.57*	*3.05-3.81*	*4.57-5.18*	*3.05-3.81*	
Sample Location	*BH1*	*BH1*	*BH1*	*BH2*	*BH2*	*BH3*	*BH3*	*BH3*	
Laboratory Certificate of Analysis No.	*B6A5189*	*B6A5189*	*B6A5189*	*B6A5189*	*B6A5189*	*B6A5189*	*B6A5189*	*B6A5189*	
Date of Analysis (dd/mm/yyyy)	*27/05/2016*	*27/05/2016 - 31/05/2016*	*27/05/2016 - 31/05/2016*	*27/05/2016 - 31/05/2016*	*27/05/2016 - 31/05/2016*	*27/05/2016 - 31/05/2016*	*27/05/2016 - 31/05/2016*	*27/05/2016 - 31/05/2016*	
Miscellaneous Parameters									
pH (pH Units)	7.37	-	-	-	7.78	7.8	-	7.91	NV
Sieve #200 <0.075 mm (%)	-	48	48	54	-	64	-	-	NV
Sieve #200 >0.075 mm (%)	-	52	52	46	-	36	-	-	NV
Soil Texture	-	Coarse	Coarse	Fine	-	Fine	-	-	NV
Volatile Organic Compounds									
Acetone	NV	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	16
Benzene	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.21
Bromodichloromethane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	1.5
Bromoform	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.27
Bromomethane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.05
Carbon Tetrachloride	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.05
Chlorobenzene	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	2.4
Chloroform	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.05
Dibromochloromethane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	2.3
1,2-Dichlorobenzene	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	1.2
1,3-Dichlorobenzene	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	4.8
1,4-Dichlorobenzene	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.083
1,1-Dichloroethane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.47
1,2-Dichloroethane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.05
1,1-Dichloroethylene	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.05
Cis-1,2-Dichloroethylene	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	1.9
Trans-1,2-Dichloroethylene	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.084
1,2-Dichloropropane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.05
Cis-1,3-Dichloropropylene	NV	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	NV
Trans-1,3-Dichloropropylene	NV	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	NV
Ethylbenzene	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	1.1
Ethylene Dibromide	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.05
Methyl Ethyl Ketone	NV	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	16
Methylene Chloride	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.1
Methyl Isobutyl Ketone	NV	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.7
Methyl-t-Butyl Ether	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.75
Styrene	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.7
1,1,1,2-Tetrachloroethane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.058
1,1,2,2-Tetrachloroethane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.05
Toluene	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	2.3
Tetrachloroethylene	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.28
1,1,1-Trichloroethane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.38
1,1,2-Trichloroethane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.05
Trichloroethylene	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.061
Vinyl Chloride	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.02
m-Xylene & p-Xylene	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	NV
o-Xylene	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	NV
Total Xylenes	NV	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	3.1
Dichlorodifluoromethane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	16
Dioxane, 1,4-	NV	NV	NV	NV	NV	NV	NV	NV	1.8
Hexane(n)	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	2.8
Trichlorofluoromethane	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	4
1,3-Dichloropropene (cis + trans)	NV	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.05
Petroleum Hydrocarbons (PHCs)									
PHCs F1 (C_6 - C_{10})	NV	<10	<10	<10	<10	<10	<10	<10	55
PHCs F2 ($>C_{10}$ - C_{16})	NV	17	41	33	34	11	19	53	98
PHCs F3 ($>C_{16}$ - C_{34})	NV	58	170	130	150	<50	61	180	300
PHCs F4 ($>C_{34}$ - C_{50})	NV	<50	64	<50	56	<50	<50	64	2800
Polycyclic Aromatic Hydrocarbons									
Acenaphthene	NV	<0.0050	<0.0050	0.0092	<0.0050	<0.0050	<0.0050	<0.0050	7.9
Acenaphthylene	NV	<0.0050	<0.0050	0.025	<0.0050	<0.0050	<0.0050	<0.0050	0.15
Anthracene	NV	<0.0050	<0.0050	0.048	<0.0050	<0.0050	<0.0050	<0.0050	0.67
Benzo(a)anthracene	NV	<0.0050	<0.0050	0.28	<0.0050	<0.0050	<0.0050	<0.0050	0.5
Benzo(a)pyrene	NV	<0.0050	<0.0050	0.21	<0.0050	<0.0050	<0.0050	<0.0050	0.3
Benzo(b/j)fluoranthene	NV	<0.0050	<0.010	0.2	<0.010	<0.0050	<0.0050	<0.0050	0.78
Benzo(ghi)perylene	NV	<0.0050	<0.0050	0.078	<0.0050	<0.0050	<0.0050	<0.0050	6.6
Benzo(k)fluoranthene	NV	<0.0050	<0.0050	0.079	<0.0050	<0.0050	<0.0050	<0.0050	0.78
Chrysene	NV	<0.0050	0.014	0.2	0.016	<0.0050	0.0056	<0.0050	7
Dibenzo(a,h)anthracene	NV	<0.0050	<0.0050	0.025	<0.0050	<0.0050	<0.0050	<0.0050	0.1
Fluoranthene	NV	<0.0050	0.0069	0.42	0.0066	<0.0050	<0.0050	<0.0050	0.69
Fluorene	NV	<0.0050	<0.0050	0.0078	<0.0050	<0.0050	<0.0050	<0.0050	62
Indeno(1,2,3-cd)pyrene	NV	<0.0050	<0.0050	0.11	<0.0050	<0.0050	<0.0050	<0.0050	0.38
1-Methylnaphthalene	NV	<0.0050	0.0078	0.0079	<0.0050	<0.0050	<0.0050	<0.0050	0.99
2-Methylnaphthalene	NV	<0.0050	0.0078	0.0081	<0.0050	<0.0050	<0.0050	<0.0050	0.99
Naphthalene	NV	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.6
Phenanthrene	NV	<0.0050	0.0072	0.13	<0.0050	<0.0050	<0.0050	<0.0050	6.2
Pyrene	NV	<0.0050	0.0065	0.39	0.0053	<0.0050	<0.0050	<0.0050	78
Methylnaphthalene, 2-(1-)	NV	<0.0071	0.016	0.016	<0.0071	<0.0071	<0.0071	<0.0071	0.99

Notes:

MOECC Table 3 Standards*	Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, April 15, 2011, Table 2 Standards, Coarse-Textured Soils, Potable Groundwater Condition, for Residentail/Parkland/ Institutional Property Use.
BOLD	Exceeds Site Condition Standard
BOLD	Reportable Detection Limit Exceeds Site Condition Standard
Units	All Units In Micrograms Per Gram, Unless Otherwise Noted
(##)	Bracketed Values Indicate Laboratory Duplicate Results
mbgs	Metres Below Ground Surface
mS/cm	MilliSiemens Per Centimetre
NV	No Value

TABLE 2

GROUNDWATER MONITORING WELL ELEVATIONS AND CONSTRUCTION DETAILS

R.B. Morgan Construction

1289 Wharf Street, Pickering, Ontario

Monitoring Well	*Ground Surface Elevation (mamsl)*	*Top of Pipe Elevation (mamsl)*	*Well Construction Details*						
			Total Well Depth (mbgs)	*Stick-Up Height (metres)*	*Well Diameter (centimetres)*	*Screen Slot Size*	*Monitoring Well Screen Interval (mbgs)*	*Screen Length (metres)*	*Sealant Thickness (metres)*
MW16-1	79.78	79.65	6.22	-0.13	5.08	010	3.17-6.22	3.05	2.59
MW16-2	79.82	79.71	6.28	-0.11	5.08	010	3.23-6.28	3.05	2.59
MW16-3	79.74	80.68	6.36	0.94	5.08	010	3.31-6.36	3.05	2.59

Notes:

mamsl	Metres Above Mean Sea Level
mbgs	Metres Below Ground Surface

TABLE 3
GROUNDWATER MONITORING - WATER LEVELS
R.B. Morgan Construction
1289 Wharf Street, Pickering, Ontario

Monitoring Well	*Ground Surface Elevation (mamsl)*	*Top of Pipe Elevation (mamsl)*	*Stick-Up Height (metres)*	*Date of Monitoring (dd/mm/yyyy)*	*Calculated Depth to Groundwater from Surface (mbgs)*	*Measured Depth to Groundwater from Top of Pipe (metres)*	*Groundwater Elevation (mamsl)*	*Visual/Olfactory Observations*
MW16-1	79.78	79.65	-0.13	24/05/2016	5.01	4.91	74.75	No sheen or odours, no product, substantial sediment, opaque, grey
				26/05/2016	5.07	4.94	74.71	No sheen or odours, no product, some sediment, opaque, brown
MW16-2	79.82	79.71	-0.11	24/05/2016	5.09	4.94	74.78	No sheen or odours, no product, substantial sediment, opaque, grey
				26/05/2016	5.10	5.02	74.70	No sheen or odours, no product, little sediment, translucent, grey/brown
MW16-3	79.74	80.68	0.94	24/05/2016	4.77	5.71	74.97	No sheen or odours, no product, substantial sediment, opaque, brown
				26/05/2016	4.71	5.65	75.03	No sheen or odours, no product, substantial sediment, opaque, brown

Notes:

mamsl	Metres Above Mean Sea Level
mbgs	Metres Below Ground Surface

TABLE 4
GROUNDWATER MONITORING - NON-AQUEOUS PHASE LIQUIDS
R.B. Morgan Construction
1289 Wharf Street, Pickering, Ontario

Monitoring Well	Top of Pipe Elevation (mamsl)	Date of Monitoring (dd/mm/yyyy)	LNAPL					DNAPL				
			Measured Depth to Top of LNAPL from Top of Pipe (metres)	Measured Depth to Bottom of LNAPL from Top of Pipe (metres)	LNAPL Thickness (metres)	Top of LNAPL Elevation (mamsl)	Bottom of LNAPL Elevation (mamsl)	Measured Depth to Top of DNAPL from Top of Pipe (metres)	Measured Depth to Bottom of DNAPL from Top of Pipe (metres)	DNAPL Thickness (metres)	Top of DNAPL Elevation (mamsl)	Bottom of DNAPL Elevation (mamsl)
MW16-1	79.65	24/05/2016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		26/05/2016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW16-2	79.71	24/05/2016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		26/05/2016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW16-3	80.68	24/05/2016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		26/05/2016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

DNAPL	Dense Non-Aqueous Phase Liquid
LNAPL	Light Non-Aqueous Phase Liquid
mamsl	Metres Above Mean Sea Level
mbgs	Metres Below Ground Surface
ND	Not Detected

TABLE 5

GROUNDWATER ANALYTICAL RESULTS

R.B. Morgan Construction

1289 Wharf Street, Pickering, Ontario

Sample Designation	*BH16-1*	*BH16-2*	*BH16-3*	*DUP-1*	*Trip Blank*	***MOECC Table 3 Standards****
Sample Collection Date (dd/mm/yyyy)	*26/05/2016*	*26/05/2016*	*30/05/2015*	*26/05/2016*	*NA*	
Sample Depth (mbgs)	*5.065-6.220*	*5.100-6.280*	*4.710-6.36*	*5.065-6.220*	*NA*	
Sample Location	*MW1*	*MW2*	*MW3*	*MW1*	*NA*	
Laboratory Certificate of Analysis No.	*B6B0019*	*B6B0019*	*B6B0019*	*B6B0019*	*B6B0019*	
Date of Analysis (dd/mm/yyyy)	*02/06/2016 - 06/06/2016*	*02/06/2016 - 06/06/2016*	*02/06/2016 - 06/06/2016*	*02/06/2016 - 06/06/2016*	*02/06/2016 - 06/06/2016*	
Volatile Organic Compounds						
Acetone	<10	<10	<10	<10	<10	130000
Benzene	<0.20	<0.20	<0.20	<0.20	<0.20	44
Bromodichloromethane	<0.50	<0.50	<0.50	<0.50	<0.50	85000
Bromoform	<1.0	<1.0	<1.0	<1.0	<1.0	380
Bromomethane	<0.50	<0.50	<0.50	<0.50	<0.50	5.6
Carbon Tetrachloride	<0.20	<0.20	<0.20	<0.20	<0.20	0.79
Chlorobenzene	<0.20	<0.20	<0.20	<0.20	<0.20	630
Chloroform	<0.20	<0.20	<0.20	<0.20	<0.20	2.4
Dibromochloromethane	<0.50	<0.50	<0.50	<0.50	<0.50	82000
1,2-Dichlorobenzene	<0.50	<0.50	<0.50	<0.50	<0.50	4600
1,3-Dichlorobenzene	<0.50	<0.50	<0.50	<0.50	<0.50	9600
1,4-Dichlorobenzene	<0.50	<0.50	<0.50	<0.50	<0.50	8
1,1-Dichloroethane	<0.20	<0.20	<0.20	<0.20	<0.20	320
1,2-Dichloroethane	<0.50	<0.50	<0.50	<0.50	<0.50	1.6
1,1-Dichloroethylene	<0.20	<0.20	<0.20	<0.20	<0.20	1.6
Cis-1,2-Dichloroethylene	<0.50	<0.50	<0.50	<0.50	<0.50	1.6
Trans-1,2-Dichloroethylene	<0.50	<0.50	<0.50	<0.50	<0.50	1.6
1,2-Dichloropropane	<0.20	<0.20	<0.20	<0.20	<0.20	16
Cis-1,3-Dichloropropylene	<0.30	<0.30	<0.30	<0.30	<0.30	NV
Trans-1,3-Dichloropropylene	<0.40	<0.40	<0.40	<0.40	<0.40	NV
Ethylbenzene	<0.20	<0.20	<0.20	<0.20	<0.20	2300
Ethylene Dibromide	<0.20	<0.20	<0.20	<0.20	<0.20	0.25
Methyl Ethyl Ketone	<10	<10	<10	<10	<10	470000
Methylene Chloride	<2.0	<2.0	<2.0	<2.0	<2.0	610
Methyl Isobutyl Ketone	<5.0	<5.0	<5.0	<5.0	<5.0	140000
Methyl-t-Butyl Ether	<0.50	<0.50	<0.50	<0.50	<0.50	190
Styrene	<0.50	<0.50	<0.50	<0.50	<0.50	1300
1,1,1,2-Tetrachloroethane	<0.50	<0.50	<0.50	<0.50	<0.50	3.3
1,1,2,2-Tetrachloroethane	<0.50	<0.50	<0.50	<0.50	<0.50	3.2
Toluene	<0.20	<0.20	<0.20	<0.20	<0.20	18000
Tetrachloroethylene	<0.20	<0.20	<0.20	<0.20	<0.20	1.6
1,1,1-Trichloroethane	<0.20	<0.20	<0.20	<0.20	<0.20	640
1,1,2-Trichloroethane	<0.50	<0.50	<0.50	<0.50	<0.50	4.7
Trichloroethylene	<0.20	<0.20	<0.20	<0.20	<0.20	1.6
Vinyl Chloride	<0.20	<0.20	<0.20	<0.20	<0.20	0.5
m-Xylene & p-Xylene	<0.20	<0.20	<0.20	<0.20	<0.20	NV
o-Xylene	<0.20	<0.20	<0.20	<0.20	<0.20	NV
Total Xylenes	<0.20	<0.20	<0.20	<0.20	<0.20	4200
Dichlorodifluoromethane	<1.0	<1.0	<1.0	<1.0	<1.0	4400
Dioxane, 1,4-	-	-	-	-	-	1900000
Hexane(n)	<1.0	<1.0	<1.0	<1.0	<1.0	51
Trichlorofluoromethane	<0.50	<0.50	<0.50	<0.50	<0.50	2500
1,3-Dichloropropene (cis + trans)	<0.50	<0.50	-	<0.50	<0.50	5.2
Petroleum Hydrocarbons (PHCs)						
PHCs F1 (C_6 - C_{10})	<25	<25	<25	<25	<25	750
PHCs F2 (>C_{10} - C_{16})	<100	<100	<100	<100	NV	150
PHCs F3 (>C_{16} - C_{34})	<200	<200	<200	<200	NV	500
PHCs F4 (>C_{34} - C_{50})	<200	<200	<200	<200	NV	500
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	<0.050	<0.050	<0.050	<0.050	NV	600
Acenaphthylene	<0.050	<0.050	<0.050	<0.050	NV	1.8
Anthracene	<0.050	<0.050	<0.050	<0.050	NV	2.4
Benzo(a)anthracene	<0.050	<0.050	<0.050	<0.050	NV	4.7
Benzo(a)pyrene	<0.010	<0.010	<0.010	<0.010	NV	0.81
Benzo(b/j)fluoranthene	<0.050	<0.050	<0.050	<0.050	NV	0.75
Benzo(ghi)perylene	<0.050	<0.050	<0.050	<0.050	NV	0.2
Benzo(k)fluoranthene	<0.050	<0.050	<0.050	<0.050	NV	0.4
Chrysene	<0.050	<0.050	<0.050	<0.050	NV	1
Dibenzo(a,h)anthracene	<0.050	<0.050	<0.050	<0.050	NV	0.52
Fluoranthene	<0.050	<0.050	<0.050	<0.050	NV	130
Fluorene	<0.050	<0.050	<0.050	<0.050	NV	400
Indeno(1,2,3-cd)pyrene	<0.050	<0.050	<0.050	<0.050	NV	0.2
1-Methylnaphthalene	<0.050	<0.050	<0.050	<0.050	NV	1800
2-Methylnaphthalene	<0.050	<0.050	<0.050	<0.050	NV	1800
Naphthalene	<0.050	<0.050	<0.050	<0.050	NV	1400
Phenanthrene	<0.030	<0.030	<0.030	<0.030	NV	580
Pyrene	<0.050	<0.050	<0.050	<0.050	NV	68
Methylnaphthalene, 2-(1-)	<0.071	<0.071	<0.071	<0.071	NV	1800

Notes:

MOECC Table 3 Standards*	Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, April 15, 2011, Table 3 Standards, Coarse-Textured Soils, Potable Groundwater Condition, for All Types of Property Use.
BOLD	Exceeds Site Condition Standard
BOLD	Reportable Detection Limit Exceeds Site Condition Standard
Units	All Units In Micrograms Per Litre
(##)	Bracketed Values Indicate Laboratory Duplicate Results
mbgs	Metres Below Ground Surface
NA	Not Applicable

TABLE 6
MAXIMUM CONCENTRATIONS IN SOIL
R.B. Morgan Construction
1289 Wharf Street, Pickering, Ontario

Parameter	*Maximum Concentration*	*Sample Designation*	*Sample Location*	*Sample Depth (mbgs)*
Volatile Organic Compounds				
Acetone	<0.50	All Samples	NA	NA
Benzene	<0.020	All Samples	NA	NA
Bromodichloromethane	<0.050	All Samples	NA	NA
Bromoform	<0.050	All Samples	NA	NA
Bromomethane	<0.050	All Samples	NA	NA
Carbon Tetrachloride	<0.050	All Samples	NA	NA
Chlorobenzene	<0.050	All Samples	NA	NA
Chloroform	<0.050	All Samples	NA	NA
Dibromochloromethane	<0.050	All Samples	NA	NA
1,2-Dichlorobenzene	<0.050	All Samples	NA	NA
1,3-Dichlorobenzene	<0.050	All Samples	NA	NA
1,4-Dichlorobenzene	<0.050	All Samples	NA	NA
Dichlorodifluoromethane	<0.050	All Samples	NA	NA
1,1-Dichloroethane	<0.050	All Samples	NA	NA
1,2-Dichloroethane	<0.050	All Samples	NA	NA
1,1-Dichloroethylene	<0.050	All Samples	NA	NA
cis-1,2-Dichloroethylene	<0.050	All Samples	NA	NA
trans-1,2-Dichloroethylene	<0.050	All Samples	NA	NA
1,2-Dichloropropane	<0.050	All Samples	NA	NA
1,3-Dichloropropene (Total)	<0.050	All Samples	NA	NA
Ethylbenzene	<0.020	All Samples	NA	NA
Ethylene Dibromide	<0.050	All Samples	NA	NA
Hexane	<0.050	All Samples	NA	NA
Methyl Ethyl Ketone	<0.50	All Samples	NA	NA
Methyl Isobutyl Ketone	<0.50	All Samples	NA	NA
Methyl t-Butyl Ether (MTBE)	<0.050	All Samples	NA	NA
Methylene Chloride	<0.050	All Samples	NA	NA
Styrene	<0.050	All Samples	NA	NA
1,1,1,2-Tetrachloroethane	<0.050	All Samples	NA	NA
1,1,2,2-Tetrachloroethane	<0.050	All Samples	NA	NA
Tetrachloroethylene	<0.050	All Samples	NA	NA
Toluene	<0.020	All Samples	NA	NA
1,1,1-Trichloroethane	<0.050	All Samples	NA	NA
1,1,2-Trichloroethane	<0.050	All Samples	NA	NA
Trichloroethylene	<0.050	All Samples	NA	NA
Trichlorofluoromethane	<0.050	All Samples	NA	NA
Vinyl Chloride	<0.020	All Samples	NA	NA
Xylenes (Total)	<0.020	All Samples	NA	NA
Petroleum Hydrocarbons (PHCs)				
PHCs F1 (C_6 - C_{10})	<10	All Samples	NA	NA
PHCs F2 (>C_{10} - C_{16})	53	DUP-1	BH3	3.05-3.81
PHCs F3 (>C_{16} - C_{34})	180	DUP-1	BH3	3.05-3.81
PHCs F4 (>C_{34} - C_{50})	64	MW16-1 SA7, DUP-1	BH1, BH3	4.57-5.33, 3.05-3.81
Polycyclic Aromatic Hydrocarbons				
Acenaphthene	0.0096	DUP-1	BH3	3.05-3.81
Acenaphthylene	0.025	MW16-2 SA5	BH2	3.05-3.81
Anthracene	0.048	MW16-2 SA5	BH2	3.05-3.81
Benzo(a)anthracene	0.28	MW16-2 SA5	BH2	3.05-3.81
Benzo(a)pyrene	0.21	MW16-2 SA5	BH2	3.05-3.81
Benzo(b)fluoranthene	0.2	MW16-2 SA5	BH2	3.05-3.81
Benzo(ghi)perylene	0.078	MW16-2 SA5	BH2	3.05-3.81
Benzo(k)fluoranthene	0.079	MW16-2 SA5	BH2	3.05-3.81
Chrysene	0.2	MW16-2 SA5	BH2	3.05-3.81
Dibenzo(a,h)anthracene	0.025	MW16-2 SA5	BH2	3.05-3.81
Fluoranthene	0.42	MW16-2 SA5	BH2	3.05-3.81
Fluorene	0.0078	MW16-2 SA5	BH2	3.05-3.81
Indeno(1,2,3-cd)pyrene	0.11	MW16-2 SA5	BH2	3.05-3.81
1-Methylnaphthalene (**SEE FOOTNOTE 6**)	0.0079	All Samples	NA	NA
2-Methylnaphthalene (**SEE FOOTNOTE 6**)	0.0081	MW16-2 SA5, MW16-1 SA7	BH2, BH1	3.05-3.81, 4.57-5.33
Naphthalene	<0.0050	All Samples	NA	NA
Phenanthrene	0.13	MW16-2 SA5	BH2	3.05-3.81
Pyrene	0.39	MW16-2 SA5	BH2	3.05-3.81
Methylnaphthalene, 2-(1-)	-	All Samples	NA	NA

Notes:

Units	All Units In Micrograms Per Gram, Unless Otherwise Noted
mbgs	Metres Below Ground Surface
mS/cm	MilliSiemens Per Centimetre
NA	Not Applicable

TABLE 7
MAXIMUM CONCENTRATIONS IN GROUNDWATER
R.B. Morgan Construction
1289 Wharf Street, Pickering, Ontario

Parameter	***Maximum Concentration***	***Sample Designation***	***Sample Location***	***Sample Depth (mbgs)***
Volatile Organic Compounds				
Acetone	<10	All Samples	NA	NA
Benzene	<0.20	All Samples	NA	NA
Bromodichloromethane	<0.50	All Samples	NA	NA
Bromoform	<1.0	All Samples	NA	NA
Bromomethane	<0.50	All Samples	NA	NA
Carbon Tetrachloride	<0.20	All Samples	NA	NA
Chlorobenzene	<0.20	All Samples	NA	NA
Chloroform	<0.20	All Samples	NA	NA
Dibromochloromethane	<0.50	All Samples	NA	NA
1,2-Dichlorobenzene	<0.50	All Samples	NA	NA
1,3-Dichlorobenzene	<0.50	All Samples	NA	NA
1,4-Dichlorobenzene	<0.50	All Samples	NA	NA
Dichlorodifluoromethane	<1.0	All Samples	NA	NA
1,1-Dichloroethane	<0.20	All Samples	NA	NA
1,2-Dichloroethane	<0.50	All Samples	NA	NA
1,1-Dichloroethylene	<0.20	All Samples	NA	NA
cis-1,2-Dichloroethylene	<0.50	All Samples	NA	NA
trans-1,2-Dichloroethylene	<0.50	All Samples	NA	NA
1,2-Dichloropropane	<0.20	All Samples	NA	NA
1,3-Dichloropropene (Total)	<0.50	All Samples	NA	NA
Ethylbenzene	<0.20	All Samples	NA	NA
Ethylene Dibromide	<0.20	All Samples	NA	NA
Hexane	<1.0	All Samples	NA	NA
Methyl Ethyl Ketone	<10	All Samples	NA	NA
Methyl Isobutyl Ketone	<5.0	All Samples	NA	NA
Methyl t-Butyl Ether (MTBE)	<0.50	All Samples	NA	NA
Methylene Chloride	<2.0	All Samples	NA	NA
Styrene	<0.50	All Samples	NA	NA
1,1,1,2-Tetrachloroethane	<0.50	All Samples	NA	NA
1,1,2,2-Tetrachloroethane	<0.50	All Samples	NA	NA
Tetrachloroethylene	<0.20	All Samples	NA	NA
Toluene	<0.20	All Samples	NA	NA
1,1,1-Trichloroethane	<0.20	All Samples	NA	NA
1,1,2-Trichloroethane	<0.50	All Samples	NA	NA
Trichloroethylene	<0.20	All Samples	NA	NA
Trichlorofluoromethane	<0.50	All Samples	NA	NA
Vinyl Chloride	<0.20	All Samples	NA	NA
Xylenes (Total)	<0.20	All Samples	NA	NA
Petroleum Hydrocarbons (PHCs)				
PHCs F1 (C_6 - C_{10})	<25	All Samples	NA	NA
PHCs F2 (>C_{10} - C_{16})	<100	All Samples	NA	NA
PHCs F3 (>C_{16} - C_{34})	<200	All Samples	NA	NA
PHCs F4 (>C_{34} - C_{50})	<200	All Samples	NA	NA
Polycyclic Aromatic Hydrocarbons				
Acenaphthene	<0.050	All Samples	NA	NA
Acenaphthylene	<0.050	All Samples	NA	NA
Anthracene	<0.050	All Samples	NA	NA
Benzo(a)anthracene	<0.050	All Samples	NA	NA
Benzo(a)pyrene	<0.010	All Samples	NA	NA
Benzo(b)fluoranthene	<0.050	All Samples	NA	NA
Benzo(ghi)perylene	<0.050	All Samples	NA	NA
Benzo(k)fluoranthene	<0.050	All Samples	NA	NA
Chrysene	<0.050	All Samples	NA	NA
Dibenzo(a,h)anthracene	<0.050	All Samples	NA	NA
Fluoranthene	<0.050	All Samples	NA	NA
Fluorene	<0.050	All Samples	NA	NA
Indeno(1,2,3-cd)pyrene	<0.050	All Samples	NA	NA
Methylnaphthalene 2-(1-)	<0.071	All Samples	NA	NA
Naphthalene	<0.050	All Samples	NA	NA
Phenanthrene	<0.030	All Samples	NA	NA
Pyrene	<0.050	All Samples	NA	NA

Notes:

Units	All Units In Micrograms Per Litre
mbgs	Metres Below Ground Surface

10.0 APPENDICES

APPENDIX A

Legal Survey and Survey Data

THIS PLAN HAS BEEN UPDATED TO SHOW THE LOCATION OF MONITORING WELLS 16-1,16-2 AND 16-3 SURVEYED ON JUNE 20, 2016

PLAN OF SURVEY OF

LOTS 8, 9, 10, 11, 12 AND 16 AND PART OF LOT 5 REGISTERED PLAN M-89

(GEOGRAPHIC TOWNSHIP OF PICKERING)
NOW IN THE

CITY OF PICKERING

REGIONAL MUNICIPALITY OF DURHAM

SCALE 1 : 250

5 0 5 10 15 metres

J.D. BARNES LIMITED

METRIC DISTANCES AND/OR COORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

NOTES

BEARINGS ARE UTM GRID, DERIVED FROM OBSERVED REFERENCE POINTS A, B AND C, BY REAL TIME NETWORK (RTN) OBSERVATIONS, UTM ZONE 17, NAD83 (CSRS) (2010.0).

DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.99988400.

INTEGRATION DATA

OBSERVED REFERENCE POINTS (ORPs): UTM ZONE 17, NAD83 (CSRS) (2010.0).

COORDINATES TO URBAN ACCURACY PER SECTION 14 (2) OF O.REG 216/10.

POINT ID	EASTING	NORTHING
ORP Ⓐ	654 094.59	4 853 169.06
ORP Ⓑ	654 154.91	4 853 191.20
ORP Ⓒ	654 280.91	4 853 238.22

COORDINATES CANNOT, IN THEMSELVES, BE USED TO RE-ESTABLISH CORNERS OR BOUNDARIES SHOWN ON THIS PLAN.

FOR BEARING COMPARISON PURPOSES A ROTATION ANGLE OF 1°21'10" COUNTER-CLOCKWISE WAS APPLIED TO P1, P2 AND P3

LEGEND

■	DENOTES	SURVEY MONUMENT FOUND
□	DENOTES	SURVEY MONUMENT SET
SIB	DENOTES	STANDARD IRON BAR
SSIB	DENOTES	SHORT STANDARD IRON BAR
IB	DENOTES	IRON BAR
IP	DENOTES	IRON PIPE
ø	DENOTES	ROUND
WIT	DENOTES	WITNESS
℄	DENOTES	CENTRELINE
MEAS	DENOTES	MEASURED
967	DENOTES	W.N. WILDMAN, O.L.S.
P1	DENOTES	REGISTERED PLAN M-89
P2	DENOTES	EXPROPRIATION PLAN 95
P3	DENOTES	PLAN OF SURVEY BY H. FLIM LTD.,O.L.S. DATED AUGUST 12, 1969 (W.O. 3905)

ASSOCIATION OF ONTARIO LAND SURVEYORS
PLAN SUBMISSION FORM
1961810
THIS PLAN IS NOT VALID UNLESS IT IS AN EMBOSSED ORIGINAL COPY ISSUED BY THE SURVEYOR
In accordance with Regulation 1026, Section 29(3).

ALL SET SSIB MONUMENTS WERE USED DUE TO PROXIMITY OF UNDERGROUND UTILITIES IN ACCORDANCE WITH SECTION 11 (4) OF O.REG. 525/91.

ALL SURVEYED LIMITS HAVE BEEN CONFIRMED BY BOUNDARIES ACT PLAN 128.

BENCHMARK

ELEVATIONS HERON ARE GEODETIC AND ARE REFERRED TO CITY OF PICKERING BENCHMARK No. R-39, HAVING A PUBLISHED ELEVATION OF 82.555m, (CVGD-1928:1978)

SITE BENCHMARK

SOUTHWEST CORNER OF CONCRETE HYDRO TRANSFORMER PAD ON THE NORTH SIZE OF WHARF STREET IMMEDIATLY WEST OF DWELLING No. 1294

ELEVATION 79.00 m

SURVEYOR'S CERTIFICATE

I CERTIFY THAT:

1. THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT, THE SURVEYORS ACT AND THE REGULATIONS MADE UNDER THEM.
2. THE SURVEY WAS COMPLETED ON NOVEMBER 16, 2015.

NOVEMBER 19, 2015
DATE

R. Mc RAE
ONTARIO LAND SURVEYOR

ALL SURVEYED LIMITS HAVE BEEN CONFIRMED BY BOUNDARIES ACT PLAN 128.

J.D.BARNES LIMITED
SURVEYING
MAPPING
GIS
LAND INFORMATION SPECIALISTS
110 SCOTIA COURT, #40, WHITBY, ON L1N 8Y7
T: (905) 723-1212 F: (905) 723-4234 www.jdbarnes.com

DRAWN BY: N.M.	CHECKED BY: R.M.	REFERENCE NO.: 15-25-097-00
FILE: G:\15-25-097\00\15-25-097-00.dgn		DATED: NOV 19 2015

PLOTTED: NOV 19 2015

APPENDIX B

Sampling and Analysis Plan

FINAL

Sampling and Analysis Plan for Phase Two Environmental Site Assessment

1280, 1288, 1290 &1294 Wharf Street and 607 Annland Street
Pickering, Ontario

Prepared for:

R.B Morgan Construction
1289 Wharf Street
Pickering, Ontario, L1W 1A2

Attn: Mr. Ralph Morgan

June 16, 2016

Pinchin File: 103341.001

MEMBER OF THE PINCHIN GROUP

Issued To:	**R.B Morgan Construction**
Contact:	**Mr. Ralph Morgan**
Issued On:	**June 16, 2016**
Pinchin File:	**103341.001**
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1.0 INTRODUCTION

Pinchin Ltd. (Pinchin) has prepared this Sampling and Analysis Plan (SAP) for the Phase Two Environmental Site Assessment (ESA) to be performed at the property located at 1280, 1288, 1290 &1294 Wharf Street and 607 Annland Street in Pickering, Ontario (hereafter referred to as the Site or Phase Two Property). The Phase Two Property is presently developed with the following properties:

- A commercial building use for storage located at 1294 Wharf Street (Site Building A);
- A residential dwelling located at 1290 Wharf Street (Site Building B);
- A residential dwelling located at 1288 Wharf Street (Site Building C);
- A residential dwelling located at 1280 Wharf Street (Site Building D); and
- A residential dwelling located at 607 Annland Street (Site Building E).

Collectively, the above-noted buildings are hereafter referred to as the Site Buildings. In addition to the Site Buildings, there are approximately five storage sheds/detached garages located on-Site.

A Key Map showing the Phase Two Property location is provided on Figure 1 (all Figures are located in Appendix I).

The Phase Two ESA will be conducted at the request of R.B Morgan Construction (Client) in relation to the future redevelopment of the Phase Two Property from its current mixed commercial and residential land use to residential land use. A Record of Site Condition (RSC) submittal to the Ontario Ministry of Environment and Climate Change (MOECC, formerly the Ontario Ministry of the Environment) is a mandatory requirement when a land use changes to a more sensitive land use and as such, to support the RSC submission, the Phase Two ESA will be conducted in accordance with the Province of Ontario's *Ontario Regulation 153/04: Records of Site Condition – Part XV.1 of the Act*, which was last amended by Ontario Regulation 333/13 on December 13, 2013 (O. Reg. 153/04).

This SAP provides the scope of work and procedures for completing the field investigation for the Phase Two ESA. The Phase Two ESA will be performed in accordance with the scope of work, and terms and conditions described in the proposal entitled *"Proposal for Phase Two Environmental Site Assessment and Record of Site Condition Filing"*, prepared for the Client, dated April 21, 2016.

2.0 AREAS OF POTENTIAL ENVIRONMENTAL CONCERN

The objectives of the Phase Two ESA will be to assess soil and groundwater quality at the Phase Two Property in relation to two areas of potential environmental concern (APECs) and related potentially contaminating activities (PCAs) and contaminants of potential concern (COPCs) identified in a Phase One ESA completed by Pinchin in accordance with O. Reg. 153/04, the findings of which are provided in the draft report entitled "*Phase One Environmental Site Assessment Report, 1280, 1288, 1290 &1294 Wharf Street and 607 Annland Street, Pickering, Ontario",* prepared for the Client. The APECs and corresponding PCAs are summarized on Figure 2.

The identified APECs, PCAs and COPCs are summarized in the following table:

Area of Potential Environmental Concern	**Location of Area of Potential Environmental Concern on Phase One Property**	**Potentially Contaminating Activity**	**Location of PCA (On-Site or Off-Site)**	**Contaminants of Potential Concern**	**Media Potentially Impacted (Groundwater, Soil and/or Sediment)**
APEC #1 (Former UST located at 640 Liverpool Road)	640 Liverpool Road, located adjacent to the east and hydraulically upgradient of the Phase One Property	Item 28 – Gasoline and Associated Products Storage in Fixed Tanks (former UST located at 640 Liverpool Road)	Off-Site	PHCs VOCs PAHs	Soil and Groundwater
APEC #2	640 Liverpool Road, located adjacent to the east and hydraulically upgradient of the Phase One Property	Other – Exterior Chemical Storage (drum storage area adjacent to the Site, at 640 Liverpool Road)	Off-Site	PHCs VOCs PAHs	Soil and Groundwater

Notes:

PHCs – petroleum hydrocarbon fractions F1-F4

PAHs – polycyclic aromatic hydrocarbons

VOCs – volatile organic compounds

3.0 SCOPE OF WORK

The information obtained from the Phase One ESA, in particular the Phase One Conceptual Site Model, was used to determine the environmental media requiring investigation during the Phase Two ESA (i.e., soil and groundwater), the locations and depths for sample collection, and the parameters to be analyzed for the samples submitted from each APEC. The Phase Two ESA scope of work will include the advancement of three boreholes, all of which will be completed as groundwater monitoring wells. The proposed borehole and groundwater monitoring well locations are provided on Figure 3.

Table 1 in Appendix II provides a detailed summary of the proposed Phase Two ESA scope of work, including:

- Boreholes and/or groundwater monitoring wells to be completed within each APEC and the COPCs to be analyzed for samples collected in each APEC.
- Media to be sampled at each sampling location, the sampling system (see Section 7.0), the soil sampling depth intervals, monitoring well screen intervals and the sampling frequency.
- Number of samples per borehole or groundwater monitoring well to be collected and submitted for laboratory analysis.

Note that the soil sampling depth intervals (i.e., borehole depths), monitoring well screen intervals and sampling frequency are based on Pinchin's current knowledge of subsurface conditions, including the estimated depth to groundwater of approximately 6.1 metres below ground surface (mbgs), and may be revised based on the actual subsurface conditions encountered.

Additional scope of work items include the following:

- Submission of up to 2 surface soil samples (0 to 1.5 mbgs) and up to 2 subsurface soil samples (deeper than 1.5 mbgs) for pH analysis;
- Submission of up to 4 soil samples for grain size analysis;
- Elevation surveying by an Ontario Licensed Surveyor of the ground surface elevations of all borehole and monitoring well locations, and the top of pipe elevations for all groundwater monitoring wells;
- Depth to water measurements of all newly-installed monitoring wells, including assessment for non-aqueous phase liquid. Depth to water measurements will be made during well development and groundwater sampling, and one month following groundwater sampling.
- Completion of groundwater sampling using low-flow purging and sampling methods as per SOP-EDR023 (see Section 6.0), unless well yields are too low to permit this method to be used. For well(s) where low flow sampling cannot be employed, groundwater sampling will be conducted using the well volume method described in SOP-EDR008.

4.0 DATA QUALITY OBJECTIVES

The data quality objectives (DQOs) for the Phase Two ESA will be to obtain unbiased analytical data that are representative of actual soil and groundwater conditions at the Phase Two Property. This will be accomplished by implementing a quality assurance/quality control (QA/QC) program, as described in Section 5.0, and by completing the field work in accordance with Pinchin's standard operating procedures (SOPs), as described in Section 6.0. Pinchin's SOPs are based in part on the MOECC's *"Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario"*, dated December 1996 and the Association of Professional Geoscientists of Ontario document entitled *"Guidance for Environmental Site Assessments under Ontario Regulation 153/04 (as amended)"*, dated April 2011.

The DQOs are intended to minimize uncertainty in the analytical data set such that the data are considered reliable enough to not affect the conclusions and recommendations of the Phase Two ESA and to meet the overall objective of the Phase Two ESA, which is to assess the environmental quality of the Phase Two Property in relation to the identified APECs.

5.0 QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

5.1 Non-Dedicated Sampling and Monitoring Equipment Cleaning

Based on the proposed scope of work, the following non-dedicated sampling and monitoring equipment will be used during completion of the Phase Two ESA:

- Interface probe.
- Water level tape.
- Spatula for soil sampling.
- Hollow-stem augers.
- Split-spoon samplers.
- Submersible pump.
- Flow-through cell for groundwater sampling.

All of the above-listed equipment will be cleaned prior to initial use and between samples or sampling locations, as appropriate, following the equipment cleaning procedures described in SOP-EDR009. Any non-dedicated sampling or monitoring equipment not listed above that is used during the Phase Two ESA will also be cleaned in accordance with SOP-EDR009.

5.2 Trip Blanks

A trip blank is a set of VOC sample vials filled by the analytical laboratory with VOC-free distilled water and shipped with the groundwater sample containers. Trip blanks will be stored with the sample containers provided by the analytical laboratory during travel to the Phase Two Property, while on the Phase Two Property, and during travel from the Phase Two Property back to the analytical laboratory. The sample containers comprising a trip blank will not be opened in the field.

One trip blank will accompany each submission to the laboratory. Each trip blank will be submitted for analysis of VOCs and PHCs F1. Based on the scope of work and anticipated field work schedule for the Phase Two ESA, it is estimated that analysis of one trip blank will be required. Additional trip blanks will be submitted if there are additional laboratory submissions.

5.3 Field Duplicate Samples

Field duplicate soil and groundwater samples will be collected for laboratory analysis in accordance with SOP-EDR025 at a frequency of one sample for every ten samples submitted for laboratory analysis, with a minimum of one sample per media sampled per COPC.

5.4 Calibration Checks On Field Instruments

5.4.1 Field Screening Instruments

The photoionization detector (PID) and combustible gas indicator (CGI) used for the field screening of soil samples will be calibrated in accordance with the procedures described in SOP-EDR003. Calibration checks will also be made at the frequency specified in SOP-EDR003.

Records of the calibration and calibration checks of the PID and CGI, including any calibration sheets provided by the equipment supplier, will be kept for inclusion in the Phase Two ESA report.

5.4.2 Water Quality Measurement Instruments

Water quality instruments used to measure field parameters during groundwater sampling will be calibrated in accordance with the procedures described in SOP-EDR016. Calibration checks will also be made at the frequency specified in SOP-EDR016.

Records of the calibration and calibration checks of the probes/instruments used for water quality parameter measurements, including any calibration sheets provided by the equipment supplier, will be kept for inclusion in the Phase Two ESA report.

6.0 STANDARD OPERATING PROCEDURES

The proposed field investigation for the Phase Two ESA will require the following SOPs to be followed:

- Borehole drilling (SOP-EDR006).
- Soil sampling (SOP-EDR013 and SOP-EDR019).
- Field screening (SOP-EDR003).
- Monitoring well installation (SOP-EDR007).
- Monitoring well development (SOP-EDR017).
- Field measurement of water quality indicators (SOP-EDR016).
- Groundwater sampling (SOP-EDR008 and/or SOP-EDR023).
- QA/QC sampling (SOP-EDR025).
- Non-dedicated field equipment decontamination (SOP-EDR009).

The above-referenced SOPs are provided in Appendix III. Each SOP includes a section describing the specific requirements for Phase Two ESAs completed to support the filing of an RSC in accordance with O. Reg. 153/04.

Any deviations from the SOPs will be summarized in the Phase Two ESA report.

7.0 SAMPLING SYSTEM

The borehole and monitoring well locations in all APECs will be selected following a judgemental sampling system. Boreholes and monitoring wells will be placed at locations where the potential for COPCs to be present is considered the highest (i.e., “worst case”), as per the following:

- Boreholes and monitoring wells will be completed adjacent to the former off-Site underground storage tanks (APEC #1).
- A borehole will be completed adjacent to the exterior chemical storage area (APEC #2).
- Monitoring wells intended to assess groundwater impacts from an off-Site PCA will be installed along the property boundary closest to the PCA (APECs #1 to #2).

In addition, the field screening results for soil samples collected from each borehole will be used to select “worst case” samples for laboratory analysis.

The sampling system that will be used for each APEC is summarized in Table 1.

8.0 PHYSICAL IMPEDIMENTS

Pinchin does not anticipate any physical impediments that will limit access to the Phase Two Property during completion of the Phase Two ESA.

It is the QP's opinion that the impediments to full access to the Phase Two Property will not affect the investigation of the APECs for COPCs and will have no impact on the overall findings and conclusions of the Phase Two ESA.

9.0 LIMITATIONS

This Sampling and Analysis Plan (SAP) has been prepared to summarize the general scope of work and field procedures to be followed for the Phase Two ESA that will be performed for R. B. Morgan Construction (Client) in order to investigate potential environmental impacts at 1280, 1288, 1290 & 1294 Wharf Street and 607 Annland Street in Pickering, Ontario (Site). The term recognized environmental condition means the presence or likely presence of any hazardous substance on a property under conditions that indicate an existing release, past release, or a material threat of a release of a hazardous substance into structures on the property or into the ground, groundwater, or surface water of the property. The Phase Two ESA will not quantify the extent of the current and/or recognized environmental condition or the cost of any remediation.

Conclusions derived from the Phase Two ESA will be specific to the immediate area of study and cannot be extrapolated extensively away from sample locations. Samples will be analyzed for a limited number of contaminants that are expected to be present at the Site, and the absence of information relating to a specific contaminant does not indicate that it is not present.

No environmental site assessment can wholly eliminate uncertainty regarding the potential for recognized environmental conditions on a property. Performance of the Phase Two ESA to the standards established by Pinchin is intended to reduce, but not eliminate, uncertainty regarding the potential for recognized environmental conditions on the Site, and recognizes reasonable limits on time and cost.

The Phase Two ESA will be performed in general compliance with currently acceptable practices for environmental site investigations, and specific Client requests, as applicable to this Site.

This SAP was prepared for the exclusive use of the Client, subject to the conditions and limitations contained within the duly authorized proposal. Any use which a third party makes of this SAP, or any reliance on or decisions to be made based on it, are the responsibility of the third parties.

If additional parties require reliance on this SAP, written authorization from Pinchin will be required. Pinchin disclaims responsibility of consequential financial effects on transactions or property values, or requirements for follow-up actions and costs. No other warranties are implied or expressed. Furthermore, this SAP should not be construed as legal advice.

Pinchin will not be responsible for any consequential or indirect damages. Pinchin will only be liable for damages resulting from the negligence of Pinchin. Pinchin will not be liable for any losses or damage if the Client has failed, within a period of two years following the date upon which the claim is discovered (Claim Period), to commence legal proceedings against Pinchin to recover such losses or damage unless the laws of the jurisdiction which governs the Claim Period which is applicable to such claim provides that the applicable Claim Period is greater than two years and cannot be abridged by the contract between the Client and Pinchin, in which case the Claim Period shall be deemed to be extended by the shortest additional period which results in this provision being legally enforceable.

Pinchin makes no other representations whatsoever, including those concerning the legal significance of its findings, or as to other legal matters touched on in this SAP, including, but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to interpretation and these interpretations may change over time.

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Template: RSC Sampling and Analysis Plan, February 16, 2016

APPENDIX I

Figures

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PINCHIN

PROJECT NAME
SAMPLING ANALYSIS PLAN FOR PHASE TWO ENVIRONMENTAL SITE ASSESSMENT

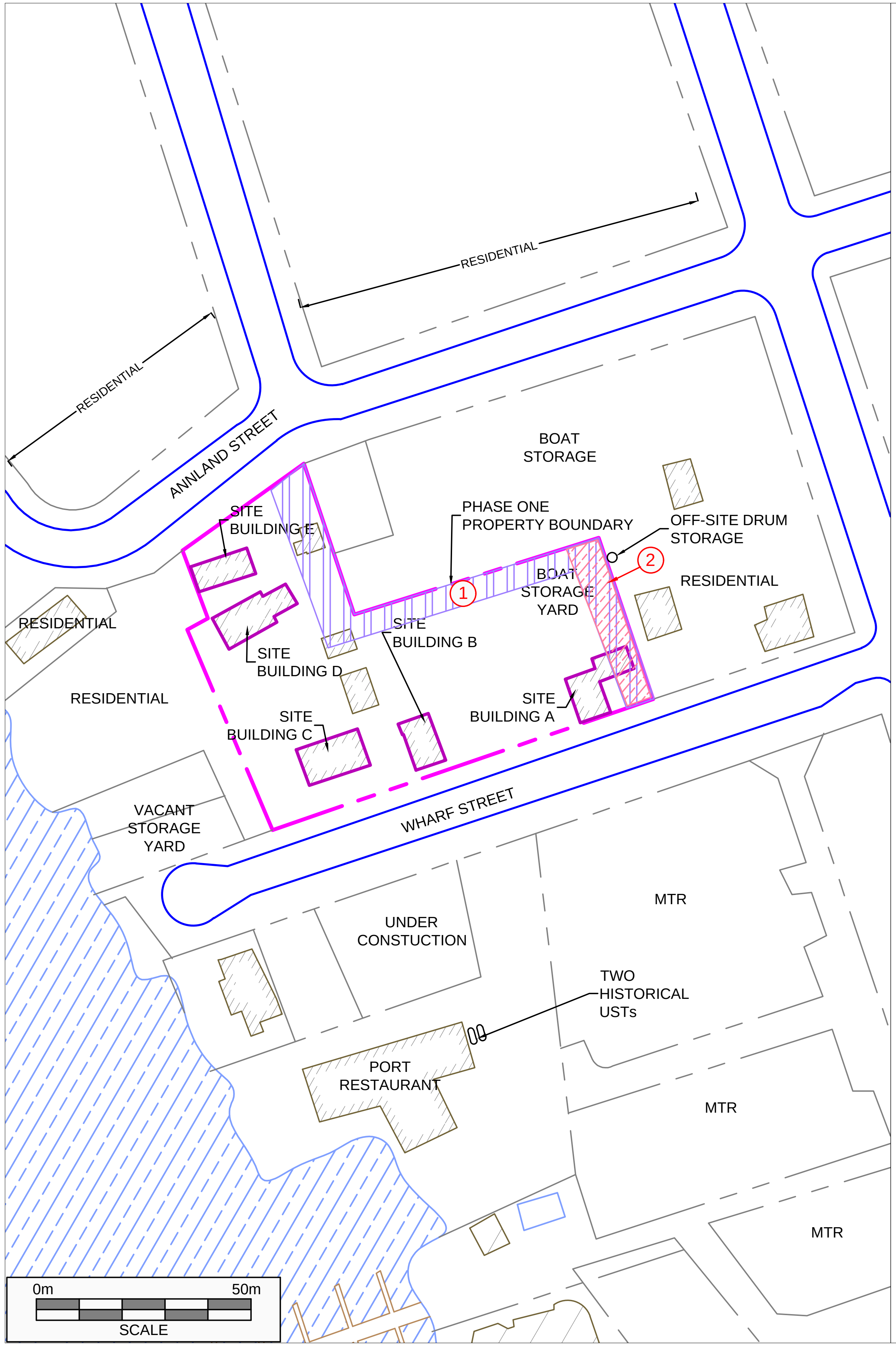
CLIENT NAME
R.B. MORGAN CONSTRUCTION

PROJECT LOCATION
1280, 1288, 1290, 1294 WHARF STREET
AND 607 ANNLAND STREET, PICKERING, ONTARIO

FIGURE NAME
KEY MAP

FIGURE NO.
1

SCALE	PROJECT NO.	DATE
AS SHOWN	103341.001	OCT. 2016



Area of Potential Environmental Concern	Location of Area of Potential Environmental Concern on Phase One Property	Potentially Contaminating Activity	Location of PCA (On-Site or Off-Site)	Contaminants of Potential Concern	Media Potentially Impacted (Groundwater, Soil and/or Sediment)
APEC #1	East portion of the Phase One Property.	Item 28 – Gasoline and Associated Products Storage in Fixed Tanks (former UST located at 640 Liverpool Road)	Off-Site	PHCs VOCs PAHs	Soil and Groundwater
APEC #2	East portion of the Phase One Property.	Other – Exterior Chemical Storage (drum storage area adjacent to the Site, at 640 Liverpool Road)	Off-Site	PHCs VOCs PAHs	Soil and Groundwater

INFERRED GROUNDWATER FLOW DIRECTION

LEGEND

①	APEC NUMBER (AREA OF POTENTIAL ENVIRONMENTAL CONCERN)
BTEX	BENZENE, TOLUENE, ETHYLBENZENE AND XYLENES
PAHs	POLYCYCLIC AROMATIC HYDROCARBON
PHCs	PETROLEUM HYDROCARBON FRACTIONS F1-F4
VOCs	VOLATILE ORGANIC COMPOUNDS
NA	NOT APPLICABLE
▨	APEC1 (APPROX. EXTENT)
▨	APEC2 (APPROX. EXTENT)

PINCHIN

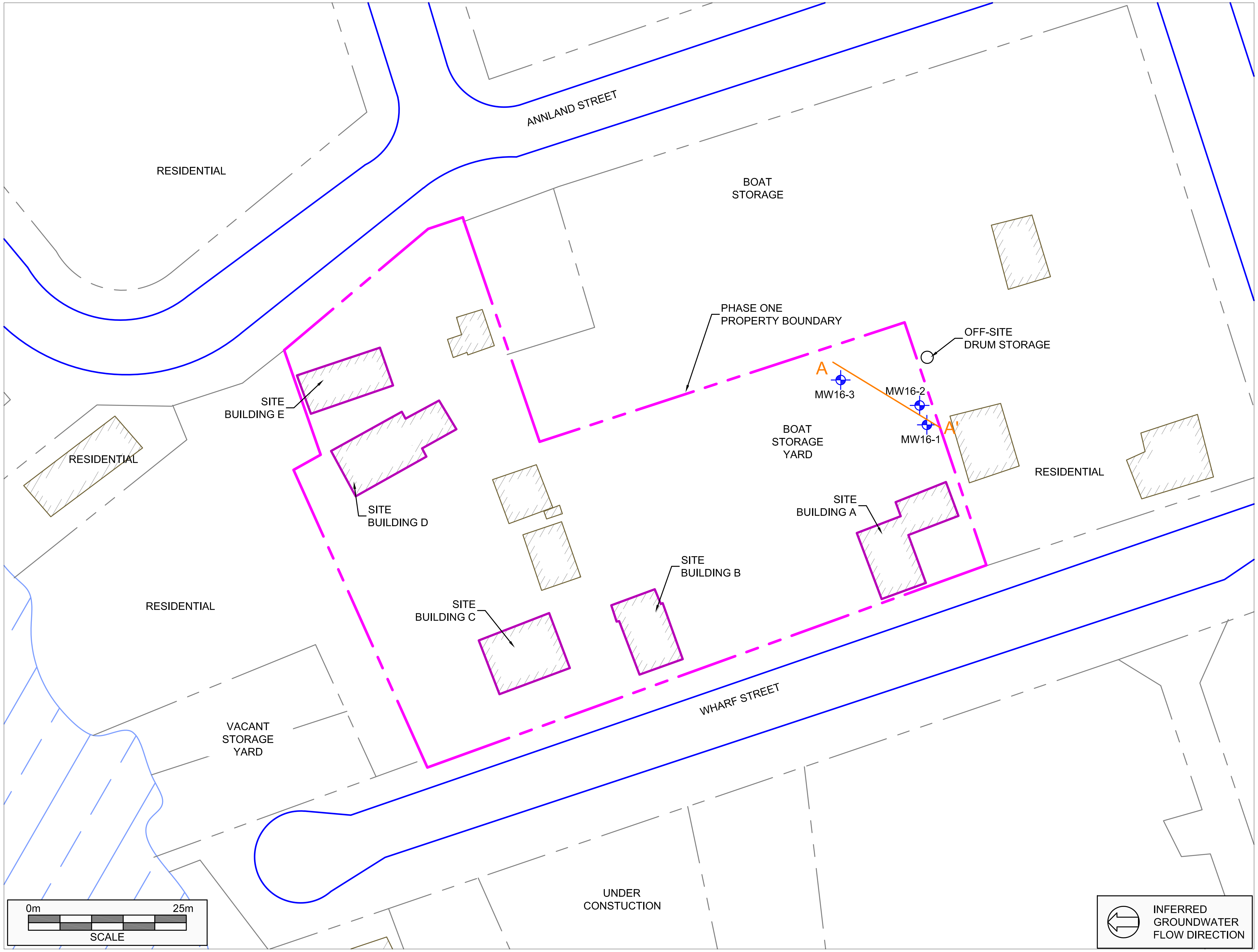
PROJECT NAME
SAMPLING ANALYSIS PLAN FOR PHASE TWO ENVIRONMENTAL SITE ASSESSMENT

CLIENT NAME
R.B. MORGAN CONSTRUCTION

PROJECT LOCATION
1280, 1288, 1290, 1294 WHARF STREET AND 607 ANNLAND STREET, PICKERING, ONTARIO

FIGURE NAME
AREAS OF POTENTIAL ENVIRONMENTAL CONCERN

SCALE	PROJECT NO.
AS SHOWN	103341.001
DATE	FIGURE NO.
OCT. 2016	2



LEGEND

⌖	MONITORING WELL
A A'	CROSS SECTION

PINCHIN

PROJECT NAME
SAMPLING ANALYSIS PLAN FOR PHASE TWO ENVIRONMENTAL SITE ASSESSMENT

CLIENT NAME
R.B. MORGAN CONSTRUCTION

PROJECT LOCATION
1280, 1288, 1290, 1294 WHARF STREET AND 607 ANNLAND STREET, PICKERING, ONTARIO

FIGURE NAME
PROPOSED BOREHOLE AND MONITORING WELL LOCATION

SCALE AS SHOWN	PROJECT NO. 103341.001
DATE OCT. 2016	FIGURE NO. 3

APPENDIX II

Tables

TABLE 1

PHASE TWO ENVIRONMENTAL SITE ASSESSMENT

R.B. Morgan Construction

1280, 1288, 1290 & 1294 Wharf Street and 607 Annland Street, Pickering, Ontario

			COPCs								
APEC #	***Sampling Location***	***Media Sampled***	***PHCs***	***VOCs***	***PAHs***	***Number of Samples Submitted for Analysis***	***Soil Sampling Depth Interval (mbgs)***	***Screen Interval (mbgs)***	***Sampling Frequency***	***Sampling System***	***Rationale/Notes***
1 and 2	MW16-1	Soil	●	●	●	3	0 - 6.1	NA	Continous/Soil cores every 1.5 m	Judgemental	Assess soil and groundwater quality in relation to a former off-Site fuel oil UST and off-Site exterior chemical storage area (APEC #1 and APEC#2).
		Groundwater	●	●	●	1	NA	3.05 - 6.1	NA	Judgemental	
	MW16-2	Soil	●	●	●	2	0 - 6.1	NA	Continous/Soil cores every 1.5 m	Judgemental	Assess soil and groundwater quality in relation to a former off-Site fuel oil UST and off-Site exterior chemical storage area (APEC #1 and APEC#2).
		Groundwater	●	●	●	1	NA	3.05 - 6.1	NA	Judgemental	
2	MW16-3	Soil	●	●	●	2	0 - 6.1	NA	Continous/Soil cores every 1.5 m	Judgemental	Assess soil and groundwater quality in relation to off-Site exterior chemical storage area (APEC#2).
		Groundwater	●	●	●	1	NA	3.05 - 6.1	NA	Judgemental	

Notes:

PHCs	Petroleum Hydrocarbon	APEC	Area of Potential Environmental Concern
VOCs	Volatile Organic Compo	m	Metres
PAHs	Polycyclic Aromatic Hyd	mbgs	Metres Below Ground Surface
		NA	Not Applicable
		PCA	Potentially Contaminating Activity
		SOP	Standard Operating Procedure
		UST	Underground Storage Tank
		mbfs	Metres Below Floor Surface

APPENDIX III

Pinchin Standard Operating Procedures

SOP – EDR003 – REV003 – FIELD SCREENING OF SOIL SAMPLES

Title:	Field Screening of Soil Samples
Practice:	EDR
First Effective Date:	June 16, 2009
Version:	003
Version Date:	April 29, 2016
Author:	Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	2016.04.29 10:44:44 -04'00'

TABLE OF CONTENTS

1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	June 16, 2009	N/A	MEM
001	November 26, 2010	Update approval signature	FG
002	September 25, 2013	Revised SOP to reflect current practices/Added section on O.Reg. 153/04 compliance	RLM
003	April 29, 2016	Updated Section 4.0/Modified time between readings to 1 hour	RLM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) presents the quantitative and qualitative methods to be used by Pinchin field personnel for field screening soil samples for potential impacts during field investigations.

The quantitative part of field screening consists of the measurement of vapour concentrations in soil sample headspace in order to assess the potential for volatile constituents to be present in the soil. The soil vapour readings obtained from these measurements are then used to assist in selecting potential “worst case” soil samples for submission to the laboratory for analysis. There are no regulatory standards for comparison with soil headspace vapour readings and we are using the general principal that the sample with the highest soil headspace vapour concentration from a group of samples is often the most likely to be impacted by volatile constituents.

The qualitative part of field screening includes assessing the soil for visual or olfactory indicators of potential contamination and is used in conjunction with the soil headspace vapour readings to select “worst case” soil samples to be submitted for laboratory analysis.

Note that soil vapour measurements have limited value when selecting “worst case” soil samples for laboratory analysis of non-volatile parameters such as metals. Visual observations of the presence of staining and debris (e.g., brick fragments and other building materials, coal ash, etc.), along with sample depth and likely migration pathways are to be factored into selecting the samples. The sample with the highest soil headspace vapour reading is not automatically selected under these circumstances.

Soil samples collected for soil vapour measurement must not be submitted for laboratory analysis except for analysis of non-volatile parameters (i.e., metals and inorganics) or grain size analysis.

This SOP also applies to the field screening of sediment samples but for simplicity, only soil samples are referred to below.

3.0 OVERVIEW

Not applicable.

4.0 DISTRIBUTION

This is an on-line document. Paper copies are valid only on the day they are printed. Refer to the author if you are in any doubt about the accuracy of this document.

This SOP will be distributed to all Pinchin staff and others as follows:

- Posted to the SOP section of the EDR Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at Pinchin West, Le Groupe Gesfor Poirier and Pinchin LeBlanc for distribution as appropriate.

5.0 PROCEDURE

5.1 Equipment and Supplies

- Resealable plastic bags (e.g., Ziploc®);
- (Note that small capacity bags (e.g., 500 millilitre capacity) bags are preferred over larger sized bags. When conducting headspace screening of a set of soil samples, the size of bag used should be consistent throughout in order to maintain the same approximate headspace volume in each bag.);
- Combustible gas indicator (CGI) capable of operating in methane-elimination and/or photo-ionization detector (PID);
- (The Project Manager will be responsible for selecting the appropriate instrument(s) for each project. CGIs (e.g., RKI Eagle or Gastechtor) are acceptable for screening of petroleum hydrocarbons (PHCs) and related compounds, whereas PIDs (e.g., MiniRAE) are acceptable for screening for volatile organic compounds (VOCs), including chlorinated solvents, but can also be used when screening for PHCs. For many projects, it will be appropriate to employ both a CGI and a PID.); and
- Calibration equipment (e.g., calibration gas, regulators, tubing, calibration bags, etc. as provided by the equipment supplier).

5.2 Soil Headspace Vapour Measurement Procedure

The procedure for conducting soil headspace vapour measurements for soil sample headspace is as follows:

1. Unless pre-calibrated by the equipment supplier, calibrate the CGI/PID as per the instrument manufacturer’s instructions before commencing soil vapour measurements. Record the date and time of calibration, and type and concentration of the calibration gas

used in the field logbook or field forms;

2. Label the plastic bag with the sample number;
3. Create a split soil sample by splitting the sample core vertically (i.e., along the longitudinal axis) with one half used for soil headspace vapour measurement and the other half used to fill sample jars for laboratory analysis of volatile parameters (e.g., VOCs and PHCs (F1 fraction)). In other words, the depth interval of the soil subjected to soil headspace vapour measurements should be the same as the depth interval from which samples for volatile parameters are collected. This procedure doesn't apply to grab samples but is to be completed when soil cores are obtained, such as sampling with dual tube samplers, split-spoon samplers and hand augers. For grab samples, soil used for laboratory analysis and soil headspace vapour measurements should be collected from proximal locations;
4. Place the soil into the plastic bag until the bag is approximately one-quarter full as soon as possible after the sampling device is retrieved/opened;
5. Seal the bag and break apart the soil by manually kneading the soil in the sealed bag;
6. Allow the soil sample to equilibrate at ambient temperature for a minimum of 5 minutes but no longer than one hour before taking a soil headspace vapour measurement. The exception to this is that during winter conditions, the soil samples should be placed in a heated environment (e.g., building interior) to warm up for a minimum of 15 minutes before taking soil vapour measurements;
7. Do not store the bagged soil samples in direct sunlight prior to taking soil headspace vapour measurements;
8. When conducting soil headspace vapour measurements with a CGI, make sure it is switched to methane elimination mode;
9. When completing soil headspace vapour measurements of a soil sample using both a PID and CGI, the vapour measurement using the PID should be made first;
10. Immediately before taking a soil headspace vapour measurement, gently agitate the bag and then create a small opening in the top of the bag. Insert the tip of the CGI/PID into the headspace of the bag and quickly reseal the bag around the tip to minimize leakage. If there is any water inside the bag, ensure that the tip does not contact the water;
11. Record the maximum vapour concentration measured within the first 10 seconds after inserting the tip of the CGI/PID into the bag. Note any anomalies that occur during the taking of the measurement (e.g., if the readings displayed by the instrument progressively increase and do not reach an obvious peak);

12. Remove the tip of the CGI/PID from the bag and reseal the bag immediately in case additional soil headspace vapour measurements are needed. If the soil headspace vapour is measured for a sample using a PID and an additional measurement with a CGI is required, wait a minimum of five minutes after the bag is resealed before taking the measurement with the CGI;
13. Before completing the next soil headspace vapour measurement, allow the CGI/PID to reach “zero” or “baseline”. If the CGI/PID does not return to “zero” or “baseline” it should be recalibrated before further soil headspace vapour measurements are made;
14. At the discretion of the Project Manager, a calibration check of the CGI/PID should be completed at least once per day or at a frequency of once per 100 soil headspace vapour measurements (for projects where numerous soil headspace vapour measurements are made on a daily basis such as a large remediation project); and
15. A calibration check is made by measuring the concentration of a sample of the calibration gas with the CGI/PID without making any adjustments to the instrument beforehand and comparing the measured concentration with the known concentration. The comparison of the measured concentration versus the actual concentration of the calibration gas indicates how much the instrument’s calibration may have been altered during soil headspace vapour measurements, which is known as “instrument drift”. Should the calibration check show instrument drift of more than 10%, the CGI/PID needs to be recalibrated before completing further soil headspace vapour measurements. Record all pertinent information for the calibration check (e.g., date and time, initial measured concentration, calibration gas type and concentration) in the field logbook or field forms.

5.3 Visual Screening

Visual screening consists of examining the soil sample for potential indicators of contamination as per the following:

1. Visually examine the soil sample, including breaking apart a portion of the sample;
2. Note any indications of a mottled appearance, dark discolouration or staining, free-phase product or unusual colour;
3. Note any indications of non-soil constituents, such as brick, asphalt, wood or concrete fragments, coal fragments, coal ash, etc.; and
4. Record the findings of the visual screening in the field logbook or field forms. If there is no visual evidence of impacts this should be noted.

5.4 Olfactory Screening

Record in the field logbook or field forms the presence of any odours noted during sample collection and visual screening. Field staff are not expected to directly smell soil samples to assess the presence/absence of odours.

If it is possible to identify the likely type of odour (e.g., PHC-like, solvent-like, etc.) then this information should be recorded along with a comment on the severity of the odour (e.g., slight, strong, etc.). If the odour cannot be readily identified, it should be described in the field notes as “unidentified odour”.

If no odours are observed, this information should also be recorded in the field logbook or field forms.

5.5 Additional Considerations for O. Reg. 153/04 Phase Two ESA Compliance

When completing a Phase Two Environmental Assessment (ESA) in accordance with Ontario Regulation 153/04, the following additional procedures must be undertaken:

- Calibration of the CGI/PID must be completed at the beginning of each field day and calibration checks must be made either at the end of each field day or after every 100 soil vapour readings (whichever occurs first); and
- Thorough records of the CGI/PID calibration and calibration checks must be kept, including any calibration sheets provided by the equipment supplier. The Quality Assurance/Quality Control section of the Phase Two ESA report requires a discussion of field screening instrument calibration, and equipment calibration records must be appended to the Phase Two ESA report.

6.0 TRAINING

The Practice Leader is responsible for identifying the training needs of Environmental Due Diligence and Remediation (EDR) staff and ensuring that staff are trained and competent before undertaking work assignments.

All trained personnel are responsible for identifying coaching or re-training needs (if they are uncomfortable with work assignments that have been assigned).

The careful application of *Health & Safety Training* by each employee is an integral part of all activities and is assumed as part of this SOP.

7.0 MAINTENANCE OF SOP

1 Year.

8.0 REFERENCES

Association of Professional Geoscientists of Ontario, *Guidance for Environmental Site Assessments under Ontario Regulation 153/04 (as amended),* April 2011.

Ontario Ministry of the Environment, *Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario*, December 1996.

9.0 APPENDICES

None.

I:\2016 SOP Updates\SOP - EDR003 - REV003 - Field Screening of Soil Samples.docx

Template: Master SOP Template – February 2014

SOP – EDR006 – REV002 – BOREHOLE DRILLING

Title:	Borehole Drilling
Practice:	EDR
First Effective Date:	November 25, 2010
Version:	002
Version Date:	April 29, 2016
Author:	Francesco Gagliardi and Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	2016.04.29 10:47:37 -04'00'

TABLE OF CONTENTS

1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	November 25, 2010	N/A	FG
001	November 22, 2013	Streamlined text to reflect most common current practices/Removed sections covered by other SOPs	RLM
002	April 29, 2016	Updated Section 4.0	RLM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) presents a description of the methods employed for the completion of boreholes and the collection of subsurface soil samples.

Boreholes are typically completed to determine geologic conditions for hydrogeologic evaluation, to allow the installation of monitoring wells, and to allow for the collection of subsurface soil samples for laboratory analysis.

Several methods are available for the collection of shallow subsurface soil samples using hand-held equipment (e.g., hand augers, post-hole augers). However, the use of a drill rig, equipped with direct-push tooling, solid-stem augers and/or hollow-stem augers, is the most common method used by Pinchin to advance boreholes and will be the focus of this SOP.

A detailed discussion of all the various drilling rigs and drilling methods (e.g., direct push, augering, sonic drilling, air/water/mud rotary drilling, etc.) is beyond the scope of this SOP. The Project Manager will be responsible for determining the appropriate drill rig and drilling method for the site investigation.

The majority of the site investigations completed by Pinchin involve relatively straightforward drilling within the overburden within a one aquifer system. In some situations, such as when multiple aquifers are spanned by a borehole, when drilling into bedrock or when there are known impacts in the shallow subsurface, drilling using telescoped casing methods may be appropriate. Telescoped casing and bedrock drilling methods are beyond the scope of this SOP. In these situations, the Project Manager, in consultation with the drilling contractor, will be required to confirm the drilling requirements and procedures.

3.0 OVERVIEW

Not applicable.

4.0 DISTRIBUTION

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This SOP will be distributed to all Pinchin staff and others as follows:

- Posted to the SOP section of the EDR Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at Pinchin West, Le Groupe Gesfor Poirier and Pinchin LeBlanc for distribution as appropriate.

5.0 PROCEDURE

5.1 General

The overall borehole drilling program is to be managed in accordance with SOP-EDR005. In particular, utility locates must be completed in accordance with SOP-EDR021 before any drilling activities commence.

All non-dedicated drilling and sample collection equipment must be decontaminated in accordance with SOP-EDR009.

The majority of the site investigations completed by Pinchin involve relatively straightforward drilling within the overburden within a one aquifer system. In some situations, such as when multiple aquifers are spanned by a borehole, when drilling into bedrock or when there are known impacts in the shallow subsurface, drilling using telescoped casing methods may be appropriate. Telescoped casing drilling methods are beyond the scope of this SOP. In these situations, the Project Manager, in consultation with the drilling contractor, will be required to confirm the drilling requirements and procedures.

5.2 Prior Planning and Preparation

The planning requirements for borehole drilling programs are covered in detail in SOP-EDR005.

As noted above, the type of drilling rig and drilling method will be determined by the Project Manager when scoping out the site investigation. In some cases, a switch in drilling rig and/or drilling method may be required depending on site conditions. For example, if bedrock is encountered in the subsurface at a depth above the water table, bedrock coring would be required to advance the borehole deep enough to install a monitoring well.

5.3 Borehole Drilling Procedures

Once the final location for a proposed boring has been selected and utility clearances are complete, one last visual check of the immediate area should be performed before drilling proceeds. This last visual check should confirm the locations of any adjacent utilities (subsurface or overhead) and verification of adequate clearance.

In some instances, in particular where there is uncertainty regarding the location of buried utilities or the borehole is being completed near a buried utility, the use of a hydro-excavating (hydro-vac) unit will be required to advance the borehole to a depth below the bottom of the utility. The hydro-vac uses a combination of high-pressure water and high-suction vacuum (in the form of a vacuum truck) to excavate soil. This is also known as "daylighting". The need to use a hydro-vac will be determined by the Project Manager.

If it is necessary to relocate any proposed borehole due to terrain, utilities, access, etc., the Project Manager must be notified and an alternate location will be selected.

5.4 Borehole Nomenclature

If a borehole is advanced strictly for the purpose of soil sampling and no monitoring well is installed, the borehole should be identified as "BHxx". If a monitoring well is installed in a borehole, the borehole should be identified as "MWxx".

To avoid confusion, for site investigations involving both boreholes and monitoring wells, the numerical identifiers are to be sequential (e.g., there should not be a BH01 and MW01 for the same project).

When completing supplemental drilling programs, the borehole number should start at either the next sequential number after last borehole number used in the first stage, or label them as '100 series', '200 series', etc. as appropriate (e.g., BH101, MW102, etc. for the first series of additional boreholes).

It is also acceptable to add the 2 digit year either before or after the borehole or monitoring well name (e.g., 14-MW101 or MW101-14).

5.5 Borehole Advancement

Each borehole will be advanced incrementally to permit intermittent or continuous sampling as specified by the Project Manager. Typically, the sampling frequency is one sample for every 2.5 or 5 feet (0.75 or 1.5 metres) the borehole is advanced. At the discretion of the Project Manager, soil samples may be collected at a lower frequency in homogeneous soil or at a higher frequency if changes in stratigraphy or other visual observations warrant it.

5.6 Direct-Push Drilling

This method is most commonly used at Pinchin to obtain representative samples of the subsurface soil material at a site. Direct-push drilling is achieved by driving a steel sampler into the subsurface at 1.5 metre intervals until the desired depth is achieved. The samplers are advanced by the drilling rig by means of a hydraulic hammer. For each soil sample run, a dedicated PVC sample liner is placed within the steel sampler which collects the soil as the sampler is advanced. After each sample run, a new sampler is assembled and it is advanced deeper down the open borehole.

There are generally two methods of direct-push drilling which are used:

- Dual-tube sampling; and
- Macro-core sampling.

A dual-tube sampler consists of an 8.25 centimetre (cm) inner diameter steel tooling (outer tube), equipped with a steel cutting-shoe affixed to the advancing end. A smaller diameter steel tooling, consisting of a 5.75 cm inner diameter (inner tube), fits within the outer tube and contains a PVC sample liner within. These two tubes form the completed dual-tube sampler. The completed dual-tube sampler has a length of 1.5 metres.

A macro-core sampler consists of the smaller inner tube (mentioned above) used independently. The macro-core sampler measures approximately 1.5 metres in length.

The difference in drilling methods is typically determined by soil conditions. Where soil conditions consist of tight or dense soil types (e.g., silts or clays), the macro-core sampling method may be used as this method provides less resistance to advancing the sampler. In soil types that are less resistive (e.g., loose sands), the dual-tube sampler may be used.

5.7 Auger Drilling (Split-Spoon)

The auger drilling method for borehole advancement and sampling involves using an auger drill rig to advance the borehole to the desired sampling depth and sampling with a split-spoon sampler. Borehole advancement with hollow stem augers is the preferred drilling method when sampling with split-spoon samplers as it minimizes the potential from sloughed material to reach the bottom of a borehole and possibly cross-contaminate samples when the split-spoon is driven beyond the bottom of the borehole. Solid stem augers can be used when drilling at sites with cohesive soils (e.g., silty clay), provided that the borehole remains open after the augers are removed from the ground prior to driving the split-spoon sampler.

The split-spoon sampler, consists of an 18- or 24-inch (0.45 or 0.60 metres) long, 2-inch (5.1 cm) outside diameter tube, which comes apart lengthwise into two halves.

Once the borehole is advanced to the target depth, the sampler is driven continuously for either 18 or 24 inches (0.45 or 0.60 metres) by a 140-pound (63.5 kg) hammer. The hammer may be lifted and dropped by either the cathead and rope method, or by using an automatic or semi-automatic drop system.

The number of blows applied in each 6-inch (0.15 metre) increment is counted until one of the following occurs:

- A total of 50 blows have been applied during any one of the 6-inch (0.15 metre) increments described above;
- A total of 100 blows have been applied;

- There is no advancement of the sampler during the application of ten successive blows of the hammer (i.e., the spoon is "bouncing" on a cobble or bedrock); or
- The sampler has advanced the complete 18 or 24 inches (0.45 or 0.60 metre) without the limiting blow counts occurring as described above.

On the field form, record the number of blows required to drive each 6-inch (0.15 metre) increment of penetration. The first 6 inches is considered to be a seating drive.

The sum of the number of blows required for the second and third 6 inches (0.15 metres) of penetration is termed the "standard penetration resistance" or the "N-value". This information is typically provided on the borehole logs included in our site investigation reports.

The drill rods are then removed from the borehole and the split-spoon sampler unthreaded from the drill rods.

Caution must be used when drilling with augers below the groundwater table, particularly in sandy or silty soils. These soils tend to heave or "blow back" up the borehole due to the difference in hydraulic pressure between the inside of the borehole and the undisturbed formation soil. If blowback occurs, the drilling contractor will introduce water or drilling mud into the borehole or inside of the hollow-stem augers (if used) to equalize the hydraulic pressure and permit drilling deeper to proceed.

Heaving conditions and the use of water or drilling mud must be noted on the field logs, including the approximate volume of water or drilling mud used.

5.8 Auger Drilling (Direct Sampling)

In some jurisdictions it may be acceptable to collect soil samples directly from auger flights when using solid stem augers.

When sampling directly from auger flights, care must be exercised not to collect soils that were in direct contact with the auger or that were smeared along the edge of the borehole.

5.9 Borehole Advancement In Bedrock

It is sometimes possible to advance augers through weathered bedrock but borehole advancement through competent bedrock requires alternate drilling procedures. Bedrock drilling can be accomplished by advancing core barrels or tri-cone bits using air rotary or water rotary drilling methods. A description of the various bedrock drilling procedures is beyond the scope of this SOP.

The bedrock drilling method selected will depend in part on the type of bedrock, the borehole depth required, whether bedrock core logging is required, whether telescoped casing is required, etc. The Project Manager, in consultation with the drilling contractor, will determine the best method for advancing boreholes in competent bedrock.

5.10 Borehole Soil Sample Logging and Collection

Regardless of the method used to retrieve soil from the subsurface, the methods used to log and collect soil samples are the same:

1. After the driller opens the split-spoon sampler or PVC liner, measure the length of the soil core retained in the sampler in inches or centimetres. Be sure to be consistent in the use of metric or imperial units, and that the units used are clearly noted in the field notes. The percentage of soil retained versus the length of the sampler is known as "sample recovery" and this information is presented on the borehole logs within our Phase II ESA reports;
2. Dedicated, disposable nitrile gloves are to be worn during soil logging and sampling;
3. When using a PVC liner with direct-push sampling, there is usually sufficient sample recovery to permit the collection of two soil samples from each sample run. In this case, if the sample recovery is greater than 2.5 feet, divide the recovered soil into two depth intervals and log/collect a sample from each interval. Split-spoon samplers typically are not long enough nor provide enough sample to divide a sample run into two. However, if a recovered sample contains distinct stratigraphic units (e.g., fill material and native material, obviously impacted soil and non-impacted soil), the distinct units are to be sampled separately. It is especially important that potentially impacted soil (e.g., fill material, obviously impacted soil) is not mixed with potentially unimpacted soil (e.g., native soil, soil without obvious impacts) to form one sample;
4. Discard the top several centimetres in each core as this material is the most likely to have sloughed off the borehole wall and may not be representative of the soil from the intended depth interval;
5. To minimize the potential for cross-contamination, scrape the exterior of the soil core with a clean, stainless-steel putty knife, trowel or similar device to remove any smeared soil. Note that is not practical and can be skipped if the soil is non-cohesive (e.g., loose sand);
6. Split the soil core longitudinally along the length of the sampler and to the extent practical, collect the soil samples for laboratory analysis from the centre of the core (i.e., soil that has not contacted the sampler walls). When sampling directly from augers, soils in direct contact with the auger or soils retained on the augers that may have been in contact with the edge of the borehole should not be collected;
7. Collect soil samples for potential volatile parameter analysis and field screening (in that order) as soon as possible after the core is opened. The length of time between opening the sampler and sample collection for these parameters should not exceed 2 minutes. It

is important to follow this as it minimizes the potential for volatile constituents in the soil to be lost. See SOP-EDR003 for additional details regarding the collection of soil samples for field screening;

8. Drillers are not to open the split-spoon sampler or PVC liner until instructed to do so. If drilling and sample retrieval is occurring at a rate faster than Pinchin staff are able to sample and log the soil cores, the drillers are to be instructed to slow down or stop until further notice. This will prevent a back log of soil cores from accumulating and minimize the exposure of the soil cores to ambient conditions. This is particularly important when sampling for VOCs;
9. Collect soil samples for the remaining parameters to be analyzed;
10. Soil samples are to be labelled and handled in accordance with SOP-EDR013;
11. Record the parameters sampled for, the type(s) and number of sample containers, and the time and date of sample collection in the field notes;
12. Determine the soil texture in accordance with SOP-EDR019 and record this information in the field notes;
13. Soil samples collected for soil headspace vapour measurement must not be submitted for laboratory analysis except for analysis of non-volatile parameters (i.e., metals and inorganics) or grain size analysis;
14. Immediately following collection, place each sample container in a cooler containing ice bags or ice packs;
15. After the maximum borehole drilling depth is reached, measure the borehole depth with a weighted measuring tape and record the total depth in the field notes if the borehole diameter is large enough to permit measurement; and
16. Borehole Backfilling.

Following completion of each borehole in which a well is not installed, it must be properly backfilled with bentonite and/or bentonite grout by the drilling contractor. The drilling contractor is to be consulted to confirm the proper borehole abandonment procedures required by the local regulations (e.g., Ontario Regulation 903 (as amended) for Ontario sites).

Drill cuttings are not be used to backfill boreholes.

Record the borehole backfilling method and materials used in the field notes.

5.11 Borehole Location Documentation

For each borehole, complete the following to document its location:

1. Photograph the completed borehole location. Close up photographs of the borehole are to be taken as well as more distant photographs that show the location of site landmarks relative to the borehole so that the photograph can be used to locate the borehole in the future; and
2. Using a measuring tape or measuring wheel, measure the distance between the borehole and a nearby landmark (e.g., corner of the nearest building) and provide a borehole location sketch in the field notes. Measurements are to be made at right angles relative to the orientation of the landmark or to a fixed axis (e.g., relative to true north). If required by the Project Manager, measure the UTM coordinates of the borehole with a hand-held GPS device.

5.12 Field Notes

The field notes must document all drilling equipment used, sample depths and measurements collected during the borehole drilling activities. The field notes must be legible and concise such that the entire borehole drilling and soil sampling event can be reconstructed later for future reference. The field notes are to be recorded on the field forms or in a field book.

5.13 Additional Considerations for O. Reg. 153/04 Phase Two ESA Compliance

None. Following this SOP will be sufficient to comply with the Ontario Regulation 153/04 requirements for Phase Two Environmental Site Assessments.

6.0 TRAINING

The Practice Leader is responsible for identifying the training needs of Environmental Due Diligence and Remediation (EDR) staff and ensuring that staff are trained and competent before undertaking work assignments.

All trained personnel are responsible for identifying coaching or re-training needs (if they are uncomfortable with work assignments that have been assigned).

The careful application of Health & Safety Training by each employee is an integral part of all activities and is assumed as part of this SOP.

7.0 MAINTENANCE OF SOP

1 Year.

8.0 REFERENCES

Canadian Standards Association, *Phase II Environmental Site Assessment, CSA Standard Z769-00 (R2008)*, dated 2000 and reaffirmed in 2008.

Association of Professional Geoscientists of Ontario, *Guidance for Environmental Site Assessments under Ontario Regulation 153/04 (as amended)*, April 2011.

9.0 APPENDICES

None.

I:\2016 SOP Updates\SOP - EDR006 - REV002 - Borehole Drilling.docx

Template: Master SOP Template – February 2014

SOP – EDR007 – REV003 – MONITORING WELL DESIGN AND CONSTRUCTION

Title:	Monitoring Well Design and Construction
Practice:	EDR
First Effective Date:	August 03, 2009
Version:	003
Version Date:	April 29, 2016
Author:	Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	2016.04.29 10:49:02 -04'00'

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1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	August 03, 2009	N/A	MEM
001	November 26, 2010	Update approval signatures	FG
002	November 15, 2013	Streamlined to cross reference AAPGO guidance document/Added section on O. Reg. 153/04 compliance	RLM
003	April 29, 2016	Updated Section 4.0/Added procedure for outer casing installation in Ontario	RLM

2.0 SCOPE AND APPLICATION

Monitoring wells are installed in overburden and bedrock to enable the collection of groundwater samples from water bearing formations at project sites. For some projects, monitoring wells are also used to monitor for combustible gases in the subsurface.

A monitoring well consists of two parts: the well screen and the well casing (also known as the well riser). The well screen allows groundwater to enter the well from the formation adjacent to the well so that it can be sampled. The well casing allows access to the well from the ground surface.

In Ontario, the regulatory requirements for monitoring well installation are provided in Ontario Regulation 903. All drilling contractors who install groundwater monitoring wells in Ontario must be licensed with the Ontario Ministry of the Environment and Climate Change (MOECC). In addition, for any well installed at a depth of greater than 3.0 metres below ground surface, a Water Well Record must be prepared by the drilling contractor and submitted to the MOECC and the well owner (typically our client).

The design and construction of soil vapour monitoring wells is beyond the scope of this SOP and is described in SOP-EDR018.

3.0 OVERVIEW

Not applicable.

4.0 DISTRIBUTION

This is an on-line document. Paper copies are valid only on the day they are printed. Refer to the author if you are in any doubt about the accuracy of this document.

This SOP will be distributed to all Pinchin staff and others as follows:

- Posted to the SOP section of the EDR Practice Line on the Pinchin Orchard; and

- Distributed to senior staff at Pinchin West, Le Groupe Gesfor Poirier and Pinchin LeBlanc for distribution as appropriate.

5.0 PROCEDURE

5.1 General Considerations

5.1.1 Borehole and Well Diameters

The borehole diameter must be sufficient in size to accommodate the well casing, sand pack and seal materials. In Ontario, the borehole diameter and annular space surrounding the monitoring well must meet the requirements of Ontario Regulation 903. Other provinces have similar requirements that must be considered. It is the Project Manager's responsibility to be aware of specific provincial requirements. Wherever possible, 2-inch (5.1. centimetre) interior diameter monitoring wells should be installed as they permit the use of most sampling and monitoring devices, and will generally provide greater water volume for sampling, especially in low permeability soils. Monitoring wells with interior diameters between 1-inch (2.5 centimetres) and 1.5-inches (5.1 centimetres) are also considered acceptable in some jurisdictions but the use of monitoring wells smaller than 1-inch (2.5 centimetres) is not permitted unless approved by the Project Manager.

5.1.2 Screen Length and Placement

Well screens typically range in length from 1.5 to 3.0 metres. Well screens greater than 3.0 metres in length are not permitted in Ontario as per Ontario Regulation 903 and Ontario Regulation 153/04. Saturated well screen lengths beyond 1.8 metres, including sand pack, should be avoided in British Columbia, as per British Columbia Ministry of Environment Technical Guidance 8.

Wells screens must not straddle more than one hydrostratigraphic unit and should not be placed such that a preferential pathway for contaminant migration is created between two hydrostratigraphic units. In particular, a well screen must not straddle the overburden/bedrock interface, and the well screen, sand pack and seal must be situated entirely within either the overburden or the bedrock. An exception to this if the well is installed for assessing dense non-aqueous phase liquid (DNAPL), the penetration into the bedrock is minimal, and bedrock fractures are isolated from the sand pack.

This type of well installation must only be completed under the guidance of staff with the appropriate geological expertise to ensure it is done correctly.

When determining the well screen length and depth of screen placement for a project, the following should be considered by the Project Manager:

- When assessing for the presence of light non-aqueous phase liquid (LNAPL) at the water table, longer well screens are preferred due to seasonal fluctuations in the water table and the well screen should intersect the water table whenever possible.

- When assessing for the presence of DNAPL, the well screen should be positioned at the bottom of the aquifer immediately above the aquitard.
- When assessing geochemical parameters, shorter well screens may be preferable to reduce the potential for mixing of water from distinct vertical geochemical zones.
- The use of long well screens within the saturated zone may result in the mixing of impacted and unimpacted groundwater from different depths within the aquifer, with the resulting dilution effect biasing the groundwater concentrations low.
- Nested wells can be used to determine contaminant stratification within an aquifer or assess multiple aquifers, as long as the wells and individual aquifers are properly sealed off from each other within the borehole.

5.1.3 Well Screen/Casing Materials

Polyvinyl chloride (PVC) is the standard material used to construct groundwater monitoring wells. However, some organic compounds if present at excessive concentrations can degrade PVC, and stainless-steel or Teflon well materials may be considered for use by the Project Manager at such project sites.

A filter sock must not be placed over a well screen.

5.1.4 Well Screen Slot Size and Sand Pack

The slot size of the well screen will be determined by the size of the filter pack used. Pinchin typically uses No. 10 slot screen and #1 silica sand to form the sand pack around the well screen. When investigating a site with fine-grained soil, it may be appropriate to use a finer sand pack and smaller slot size to act as a “filter” to prevent as much fine-grained soil from entering the well as possible. The Project Manager should consult with the drilling contractor to determine the most appropriate screen slot size and sand pack size.

5.1.5 Bentonite Seal

The annular space above the sand pack in all wells is to be filled with bentonite. The purpose of placing the bentonite is create a seal above the sand pack that prevents a connection between other water bearing zones within the subsurface and/or water infiltration from the surface.

5.1.6 Surface Completions

A protective steel casing and lockable cap are to be installed at each well to protect the well and prevent tampering. Protective casings come in two varieties: aboveground casings (commonly known as monument casings) and flush-mount casings.

Aboveground casings have the advantage of having better visibility and can be located more easily, especially during winter, are less likely to need repair, and have fewer problems related to water intrusion and frost heave of the casing.

Flush-mount casings are usually the only available option for wells installed in areas of high vehicular or pedestrian traffic. Also, some clients prefer flush-mount casings for aesthetic reasons as they are less obtrusive.

When installing a well in a high vehicular traffic area such as a roadway, the flush-mount casing must have sufficient strength to avoid damage when run over by vehicles. Flush-mount casings with brass lids should not be installed in high vehicular traffic areas as they are easily damaged to the point where they can no longer be opened.

5.2 Well Installation Procedures

Note that Pinchin field staff are not trained, nor have the necessary licensing, to install monitoring wells. This task is to be performed by the drilling contractor in accordance with the applicable regulatory requirements (e.g., Ontario Regulation 903 (as amended) in Ontario). Pinchin field staff will assist the drilling contractor by specifying the general design of the monitoring well but will not perform the actual installation. The primary role of Pinchin field staff during well installation is to document the installation (e.g., measuring and/or recording the well length, screen length, depth to top of sand pack, etc.) as outlined below.

The following presents the general procedure for the completion of overburden and bedrock monitoring well installations:

1. Assemble the well by threading sufficient lengths of screen and riser materials together, and placing a threaded cap or slip-on cap at the bottom of the well. Well materials are to be kept in their plastic sleeves until immediately prior to well installation, and are not to be placed on the ground unless the ground surface is covered by clean plastic sheeting. Well materials should not be stored near potentially contaminated materials (e.g., soil cuttings).
2. Dedicated, disposable nitrile gloves are to be worn by all personnel handling the well materials and are to be replaced if they become contaminated during well installation. Confirm the length of the well screen, well riser and total length of well. This is especially important if the screen and/or riser are trimmed to fit the borehole depth or desired screen interval. Record the length of the well screen, the length of the well casing, the total length of the well (including the bottom cap), the type of bottom cap used, and the interior diameter of the well screen/well casing in the field notes.
3. Prior to placing the assembled well into the borehole, measure the depth from ground surface to the bottom of the borehole and record this depth in the field notes.

4. When possible, place a minimum of 0.15 metres of filter pack into the bottom of the borehole to provide a firm base for the well. Note that the placement of such a filter pack base may not be appropriate when investigating a site where DNAPLs are suspected as the filter pack base may act as a DNAPL "sump" beneath the well and the DNAPL may go undetected when monitoring the well.
5. Place the assembled well into the open borehole or within the interior of the hollow stem augers. If trimming of the well casing is required, measure the length of the trimmed piece and record this information in the field notes. Before installing the sand pack, place a J-plug or slip cap on the top of the well to prevent sand and seal materials from entering the well when backfilling the annular space between the well and the borehole walls.
6. Install the sand pack around the exterior of the well screen and extend it to between 0.3 and 0.6 metres above the top of the well screen. The sand pack should be installed slowly, and with a tremie pipe if possible, to minimize the potential for bridging of the sand pack. When installing a sand pack in a borehole that has been drilled with hollow stem augers, the sand pack should be installed in lifts of approximately 0.5 metres. After placement of each lift, the augers are withdrawn from the ground by approximately 0.5 metres and the process repeated until the sand pack is placed to the required depth. Measure the depth to the top of the sand pack and record this depth in the field notes.
7. Install a bentonite seal comprised of granular and/or powdered bentonite above the sand pack to within approximately 0.6 metres of the ground surface. The bentonite should be installed slowly, and with a tremie pipe if possible, to minimize the potential for bridging of the seal. For the portion of the seal located above the water table, distilled water is to be poured into the borehole for each lift placed above the water table (approximately 0.3 to 0.6 metres per lift) to hydrate the seal. Approximately 1 to 2 litres of distilled water per lift is considered sufficient to hydrate the seal. Measure the depth to the top of the bentonite seal and record this depth in the field notes.
8. Record whether the seal was hydrated during installation and over which depth interval. Note that in some jurisdictions very long bentonite seals can be broken up with sand intervals. This reduces the potential for ground heaving due to bentonite shrinking and swelling but the sand intervals must not connect hydraulically separated aquifers.
9. (Ontario only) If the well is to be installed with a flush-mount protective casing, an outer casing comprised of a short length (10 to 15 cm) of PVC riser, or PVC coupling, that is slightly larger in diameter than the well casing needs to be installed around the well casing into the top of the bentonite seal, with the gap between the two casings sealed with bentonite. The top of the outer casing needs to be flush with or slightly below the top

of the well casing. For example, if a 2-inch diameter well is installed, then a 10 to 15 cm length of 3-inch or 4-inch diameter riser or coupling placed around the 2-inch diameter well casing will suffice provided that bentonite is placed between the two casings. The flush-mount protective casing is then installed around the two casings. The outer casing does not need to be capped, and we only need to cap the well casing with a J-plug or slip cap.

10. If the well is to be installed with a stick up protected by a monument casing, the procedure for installing the outer casing is essentially the same, except that the outer casing will extend from 10 to 15 cm below ground to above the ground surface, preferably flush with or slightly below the top of the well casing if the design of the monument casing permits it.
11. Place a protective well casing (monument or flush-mount) around the well casing and cement it in place.
12. Measure the depth to groundwater in the well at the time of completion. Note the depth to water and time of measurement in the field notes.
13. Place a lockable J-plug on the well casing and ensure that the J-plug is tightened sufficiently to prevent surface water from infiltrating into the well if the well has a flush-mount completion. Place a lock on the J-plug for a flush-mount completion or on the lockable cap for an aboveground completion if required by the Project Manager. A PVC slip cap can also be used, especially for an aboveground completion.
14. Photograph the completed well installation. Close up photographs of the well are to be taken as well as more distant photographs that show the location of site landmarks relative to the well so that the photograph can be used to locate the well in the future.
15. Using a measuring tape or measuring wheel, measure the distance between the well and a nearby landmark (e.g., corner of the nearest building) and provide a well location sketch in the field notes. Measurements are to be made at right angles relative to the orientation of the landmark or to a fixed axis (e.g., relative to true north). If required by the Project Manager, measure the UTM coordinates of the well with a hand-held GPS device.

5.3 Additional Considerations for O. Reg. 153/04 Phase Two ESA Compliance

None. Following this SOP will be sufficient to comply with the Ontario Regulation 153/04 requirements for Phase Two Environmental Site Assessments.

Note that Ontario Regulation 153/04 mandates that well screens <u>must not exceed 3.1 metres</u> in length.

6.0 TRAINING

The Practice Leader is responsible for identifying the training needs of EDR staff and ensuring that staff are trained and competent before undertaking work assignments.

All trained personnel are responsible for identifying coaching or re-training needs (if they are uncomfortable with work assignments that have been assigned).

The careful application of *Health & Safety Training* by each employee is an integral part of all activities and is assumed as part of this SOP.

7.0 MAINTENANCE OF SOP

1 Year.

8.0 REFERENCES

Association of Professional Geoscientists of Ontario, "*Guidance for Environmental Site Assessments under Ontario Regulation 153/04 (as amended)",* April 2011.

British Columbia Ministry of the Environment, "*Technical Guidance 8: Groundwater Investigation and Characterization*", July 2010.

9.0 APPENDICES

None.

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Template: Master SOP Template – February 2014

SOP – EDR008 – REV003 – MONITORING WELL SAMPLING

Title:	Monitoring Well Sampling
Practice:	EDR
First Effective Date:	November 8, 2013
Version:	003
Version Date:	April 29, 2016
Author:	Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	2016.04.29 10:49:56 -04'00'

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1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	November 08, 2013	N/A	Robert MacKenzie
001	September 25, 2015	Incorporated procedures specific to Pinchin West into SOP	Robert MacKenzie
002	February 9, 2016	Revised overall procedure to be consistent with well development SOP/Added reference to revised well development field forms	Robert MacKenzie
003	April 29, 2016	Updated Section 4.0	Robert MacKenzie

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the standard procedures for groundwater monitoring well purging and sampling, and provides a description of the equipment required and field methods.

Note that this SOP pertains to monitoring well sampling using the “well volume” purging procedure. Groundwater monitoring well purging and sampling using low flow procedures is described in SOP-EDR023.

3.0 OVERVIEW

Groundwater sampling involves two main steps: well purging followed by sample collection. All groundwater monitoring wells must be purged prior to groundwater sampling to remove groundwater that may have been chemically altered while residing in the well so that groundwater samples representative of actual groundwater quality within the formation intersected by the well screen can be obtained.

Monitoring well sampling should not be completed until at least 24 hours have elapsed following monitoring well development to allow subsurface conditions to equilibrate. Any deviation from this procedure must be discussed with the Project Manager before proceeding.

4.0 DISTRIBUTION

This is an on-line document. Paper copies are valid only on the day they are printed. Refer to the author if you are in any doubt about the accuracy of this document.

This SOP will be distributed to all Pinchin staff and others as follows:

- Posted to the SOP section of the EDR Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at Pinchin West, Le Groupe Gesfor Poirier and Pinchin LeBlanc for distribution as appropriate.

5.0 PROCEDURE

5.1 Equipment and Supplies

5.1.1 Documents and Information Gathering

- A copy of the proposal or work plan;
- Monitoring well construction details (borehole logs, well construction summary table from a previous report or well installation field notes);
- A copy of this SOP;
- A site-specific Health and Safety Plan (as per the project requirements); and
- Client or site representative’s contact details.

5.1.2 Well Purging and Sampling Equipment

- Inertial pump (e.g., Waterra tubing and foot valve) (Optional depending on jurisdiction);
- Peristaltic pump (Optional depending on the parameters being sampled);
- Submersible or bladder pump (Optional depending on jurisdiction and well depth);
- Disposable bailer (Optional);
- Graduated pail (to contain purge water and permit the volume of groundwater purged to be tracked);
- Pails or drums for purge water storage prior to disposal;
- Well keys (if wells are locked);
- Tools to open monitoring well (T-bar, socket set, Allen keys, etc.);
- Interface probe;
- Equipment cleaning supplies (see SOP-EDR009);
- Disposable latex or nitrile gloves; and
- Field forms.

5.2 Purging Procedures

The well purging procedures employed will be determined by the hydraulic conductivity of the formation in which the groundwater monitoring well is installed. For this SOP, a high yield well is defined as a well that cannot be purged to dryness when pumping continuously at a rate of up to 2 litres per minute (L/min) and a low yield well is defined as a well that can be purged to dryness when pumping continuously at a rate of 2 L/min or less. This threshold represents a “normal” pumping rate when hand pumping with an inertial pump.

5.2.1 Purging of High Yield Wells

The procedures for purging a high yield monitoring well are as follows:

1. Decontaminate all non-dedicated monitoring and sampling equipment that will be used, including the interface probe and submersible or bladder pump (if used), in accordance with the procedures described in SOP-EDR009;
2. Review the well construction details provided in the borehole logs, previous field notes or well construction summary table from a previous report. Determine the well depth, screen length, depth to top of sand pack and diameter of the borehole annulus. If the well depth is unavailable, measure it with the interface probe;
3. Measure the initial water level (i.e., static water level) from the reference point on the well (which should be marked at the top of the well pipe) with an interface probe. If measurable free-phase product is present on the water table, record the depth to the free-phase product and discuss this with the Project Manager before proceeding further;
4. Calculate the well volume. **Note that for the purpose of this SOP, there are two definitions of well volume depending on the province in which the project is being conducted.** For Ontario and Manitoba, the well volume is defined as the volume of water within the wetted length of the well pipe (well pipe volume) plus the volume of water within the wetted length of the sand pack (sand pack volume). For British Columbia, Alberta and Saskatchewan, the well volume is defined as the volume of water within the wetted length of the well pipe (well pipe volume) only;

The volume of water in the well pipe is calculated as follows:

Well Pipe Volume (litres) = hw x π rw2 x 1,000 litres per cubic metre (L/m3)

Where π = 3.14

hw = the height of the water column in the monitoring well in metres (wetted length)

rw = the radius of the monitoring well in metres (i.e., half the interior diameter of the well)

The volume of the sand pack in the monitoring well is calculated as follows:

Sand Pack Volume (litres) = hw x [(0.3 π rb2 x 1,000 L/m3) – (0.3 π rw2 x 1,000 L/m3)]

Where 0.3 = the assumed porosity of the sand pack

hw = the height of the water column in the monitoring well in metres (wetted length)

π = 3.14

rb = the radius of the borehole annulus in metres

rw = the radius of the monitoring well in metres

For Ontario and Manitoba projects, the following table provides well volumes in litres/metre for typical well installations:

Borehole Annulus Diameter (Inches/Metres)	Well Interior Diameter (Inches)	Well Pipe Volume (Litres/Metre)*	Well Volume (Litres/Metre)*
4/0.1	1.25	0.8	2.9
	1.5	1.1	3.2
	2	2.0	3.8
6/0.15	1.25	0.8	5.9
	1.5	1.1	6.1
	2	2.0	6.7
8.25/0.21	1.5	1.1	11.2
	2	2.0	11.8
10.25/0.26	1.5	1.1	16.7
	2	2.0	17.3

* Litres to be removed per metre of standing water in the well (wetted length).

If the borehole annulus and well interior diameters match one of those listed above, to determine the volume of one well volume simply multiply the number in the last column of the table by the wetted length in the well. For example, if a 2-inch diameter well installed in a 8.25-inch diameter borehole has 2.2 metres of standing water, one well volume equals 26.0 litres (2.2 metres x 11.8 litres/metre).

Note that the above well volume calculations apply only to wells where the water level in the well is below the top of the sand pack. If the water level is above the top of the sand pack, then the well volume is the volume of water in the sand pack and well within the sand pack interval, plus the volume of water in the well pipe (i.e., well pipe volume) above the top of the sand pack. For example, assume a 2-inch diameter well has been installed in a 8.25-inch diameter borehole to a depth of 6.0 metres below ground surface (mbgs), with a 3.05 metre long screen.

The sand pack extends from 6.0 mbgs to 2.5 mbgs and the water level is at 1.85 mbgs. One well volume equals ([6.0 metres – 2.5 metres] x 11.8 litres/metre) + ([2.5 metres – 1.85 metres] x 2.0 litres/metre) or 42.6 litres.

For British Columbia, Alberta and Saskatchewan projects, the well volume is calculated using the conversion factor listed in the third column of the above table. For example, if there are 2.5 metres of standing water in a 1.5-inch diameter well, one well volume equals 2.75 litres (2.5 metres x 1.1 litres/metre).

1. Lower the pump intake into the well until it is approximately 0.3 metres above the bottom of the well. Remove half a well volume while pumping at a rate of approximately 1 to 2 L/min. Record the approximate purge volume, pump intake depth and pertinent visual/olfactory observations (e.g., sheen, odour, free-phase product, sediment content, clarity, colour, etc.);
2. Move the pump intake upward to the middle of the water column (or middle of the screened interval if the water level in the well is above the top of the screen). Remove half a well volume (for a cumulative total of 1 well volume) while pumping at a rate of approximately 1 to 2 L/min. Record the approximate purge volume, pump intake depth and any pertinent visual/olfactory observations;
3. Move the pump intake upward to near the top of the screened interval (or near the top of the water column if the water level is currently below the top of the screen). Remove half a well volume (for a cumulative total of 1.5 well volumes) while pumping at a rate of approximately 1 to 2 L/min. Record the approximate purge volume, pump intake depth and any pertinent visual/olfactory observations.

Note that if the wetted length is short within a well (e.g., 1.5 metres or less), there will not be enough separation between pump intake depths to warrant pumping from three depths (i.e., near the bottom, middle and top of the water column). In this case, pumping from two depths (i.e., near the bottom and top of the water column) is sufficient;

4. Repeat steps 5 through 7 until a minimum of 3 well volumes in total have been removed. If the purge water contains high sediment content after the removal of 3 well volumes, well purging should continue by removing additional well volumes until the sediment content visibly decreases. If the purge water continues to have high sediment content after the removal of 2 additional well volumes (i.e., 5 well volumes in total), contact the Project Manager to discuss whether well purging should continue; and
5. Proceed with groundwater sample collection (see below).

Note that the use of a bailer to purge a high yield well with a wetted interval greater than 2 metres is not recommended given that the depth from which groundwater is removed is difficult to control.

5.2.2 Purging of Low Yield Wells

The procedures for purging a low yield monitoring well are as follows:

1. Decontaminate all non-dedicated monitoring and sampling equipment that will be used, including the interface probe and submersible or bladder pump (if used), in accordance with the procedures described in SOP-EDR009;
2. Review the well construction details provided in the borehole logs, previous field notes or well construction summary table from a previous report. Determine the well depth, screen length, depth to top of sand pack and diameter of the borehole annulus. If the well depth is unavailable, measure it with the interface probe;
3. Measure the initial water level (i.e., static water level) from the reference point on the well (which should be marked at the top of the well pipe) with an interface probe. If measurable free-phase product on the water table, record the depth to the free-phase product and discuss this with the Project Manager before proceeding further;
4. Position the pump intake at the bottom of the well. Purge the well to dryness at a rate of between approximately 1 and 2 litres L/min. At the conclusion of purging, drain the pump tubing if possible. Record the approximate purge volume;
5. After allowing sufficient time for the well to recover, proceed with sample collection (see below). Note that wherever possible, the well should be allowed to recover to at least 90% recovery before proceeding with sample collection. However, if recovery to this level requires more than one hour to complete, it is better to sample the well as soon as it

recovers sufficiently to permit sampling, especially if samples are being collected for volatile parameters such as VOCs and PHCs (F1); and

6. Record the water levels, time of water level measurements and well status (e.g., well recovery incomplete, 90% recovery target met) on the field form to document the well recovery. Purging of wells at the end of a day and returning to the site the following day to collect samples is not permitted unless the well recovery is so poor that this amount of time is needed for there to be sufficient recovery to permit sample collection.

Note that bailers can be used in lieu of a pump to purge a well provided that the well yield is low enough to permit the draining of all of the groundwater in the well with the bailer.

5.3 Well Purging Record

Well purging prior to sampling is to be documented through the completion in full of the following field forms located in the Pinchin Orchard:

- EDR-GW-Well Sampling-Low Yield Well; or
- EDR-GW-Well Sampling-High Yield Well.

Any deviations from this SOP along with the rationale for these deviations must be recorded on the forms.

Pinchin West field staff may use these forms or alternate forms as designated by the Pinchin West Practice Leader.

5.4 Sample Collection

5.4.1 General Considerations

Inertial pumps are generally suitable for all sample collection for due diligence projects. However, the motion of the inertial pump in the water column of a well, even when pumping at a low rate, can create turbulence in the well that can suspend sediment already in the well or draw it in from the formation. Sediment captured in a sample can often result in positive bias to the analytical results, especially for the parameters PHCs (F3 and F4) and PAHs, resulting in “false positives” that are not representative of actual groundwater quality. Sampling for these parameters following low flow purging and sampling procedures (SOP-EDR023) is an acceptable option to minimize potential sediment bias but because it is more expensive and time consuming than “conventional” sampling, it is typically not completed for due diligence projects. In lieu of low flow purging and sampling, a peristaltic pump, submersible pump or bladder pump is to be used as a “grab sampler” when sampling for PHCs (F2-F4) and PAHs.

In Ontario and Manitoba, or where otherwise prohibited by provincial guidance documents, peristaltic pumps <u>must not</u> be used to collect samples for analysis of volatile parameters, namely VOCs and PHCs (F1). As such, if the suite of parameters to be sampled at a given well includes VOCs and/or PHCs (F1), a “hybrid” sampling procedure is to be followed, in which samples for VOCs, PHCs (F1), PCBs and/or metals analysis are to be collected using an inertial pump and samples for PHCs (F2-F4) and PAHs analysis are to be collected using a peristaltic pump. Alternatively, the entire suite of parameters can be collected using a submersible or bladder pump.

The following table summarizes the pump types, parameters that can be sampled using each pump and how the well volume is determined for each province:

Jurisdiction	**Pump Type**	**Parameters**	**Well Volume**
BC	Inertial Pump	All Parameters	Well Pipe Volume
	Peristaltic Pump	All Parameters	Well Pipe Volume
Alberta/Saskatchewan	Inertial Pump	All Parameters Except PHCs (F2) and PAHs	Well Pipe Volume
	Peristaltic Pump	PHCs (F2) and PAHs	Well Pipe Volume
Manitoba/Ontario	Inertial Pump	All Parameters Except PHCs (F2-F4) and PAHs	Well Pipe Volume + Casing Volume
	Peristaltic Pump	PHCs (F2-F4) and PAHs	
All Provinces	Submersible Pump	All Parameters	As Per Above
All Provinces	Bladder Pump	All Parameters	As Per Above

Bailers should not be used for sample collection unless there is no other option (e.g., when there is minimal groundwater in a well). They can be used as a substitute for an inertial pump but may bias concentrations of volatile parameters low and concentrations of PHCs (F2-F4) and PAHs high. The use of a bailer for groundwater sample collection must be approved by the Project Manager.

There is a common misconception that using a peristaltic pump, submersible pump or bladder pump and sampling at a low pumping rate is “low flow sampling”. Sampling in this manner is essentially “sampling at a reduced pumping rate” and should not be referred to as “low flow sampling”.

5.4.2 *Sampling of High and Low Yield Wells*

The procedures for collecting groundwater samples from a high and low yield monitoring well are as follows:

1. Label the sample containers with the sample identifier, project number and date and time of sample collection. The sample containers for each well are be filled in the following order:
   - Volatiles parameters (e.g., VOCs, PHCs (F1));
   - Semi-volatile parameters (e.g., PHCs (F2-F4), PAHs); and
   - Non-volatile parameters (e.g., inorganic parameters, metals).

   There is an exception to the above sample collection order when using the "hybrid" sampling method. In this case, the semi-volatile parameters (PHCs (F2-F4) and/or PAHs) are to be sampled first using the peristaltic pump, submersible pump or bladder pump, followed by sampling volatile parameters and then non-volatile parameters using the inertial pump;
2. Position the pump intake at the approximate middle of the screened interval (or middle of the water column if the water level is below the top of the screen). At the discretion of the Project Manager, the pump intake may be positioned near the top of the water column if LNAPLs are being investigated (e.g., gasoline) and at the bottom of the well when DNAPLs (e.g., chlorinated solvents) are being investigated. For a low yield well when the tubing was (or could) not be drained at the conclusion of purging, or when a high yield well is not sampled immediately after purging, pump sufficient water from the tubing before initiating sample collection at a rate of approximately 0.5 L/min to remove any water that was left over in the tubing following purging;
3. When sampling for volatile parameters (i.e., VOCs and PHCs (F1)), pump at a rate of approximately 0.5 L/min. When using an inertial pump, hold the pump vertical while pumping to minimize agitation and possible contaminant volatilization. During volatile parameter sampling, the tubing of the inertial pump must not contain air bubbles. If air bubbles are present, continue pumping until there are no air bubbles in the tubing. Once the tubing is full and free of air bubbles, carefully pour the groundwater from the tubing into the sample vials until they are filled to be headspace-free. When using a peristaltic pump (BC only), submersible pump or bladder pump for volatile parameter sampling, the samples can be collected by pumping directly into the sample containers until they are headspace-free. Once filled and capped, check each vial for air bubbles by turning it upside down. If bubbles are present in a vial, reopen it and add additional groundwater until there are no remaining bubbles;

4. When sampling for semi-volatile parameters, pump at a rate of between 0.5 and 1 L/min. The samples can be collected by pumping directly into the sample containers;
5. When sampling for non-volatile parameters, pump at a rate of between 0.5 and 1 L/min. The samples can be collected by pumping directly into the sample containers;
6. Samples collected for dissolved metals analysis are to be filtered in the field using dedicated, disposable 0.45 micron in-line filters or marked to be filtered by the laboratory, except for samples collected in Ontario for methyl mercury analysis which are not to be filtered.

   Field filtering must occur before samples for metals analysis are preserved. Prior to filling the first sample container using a new filter, the filter is to be “primed” by flushing a volume of water equal to twice the capacity of the filter through the filter. Samples for other parameters are not to be filtered in the field. In situations where field filtering cannot be completed, such as when sampling with a bailer, samples for metals analysis are to be collected in sample containers without preservatives and the analytical laboratory is to be instructed on the chain-of-custody to filter and preserve the samples upon receipt;
7. When collecting samples in containers that are pre-charged with preservatives, care must be taken not to overfill the containers as some of the preservative may be lost which will result in the sample not being properly preserved. Also, sample containers for metals analysis typically have a fill line marked on the container and the container must not be filled to above this line as this will cause dilution of the preservative and the sample may not be properly preserved;
8. Record the parameters sampled for, the purging and sampling equipment used, whether samples for metals analysis were field filtered, and the time and date of sample collection in the field forms; and
9. Immediately following collection, place each sample container in a cooler containing ice bags or ice packs.

5.5 Additional Considerations for O. Reg. 153/04 Phase Two ESA Compliance

Groundwater sampling conducted for a Phase Two ESA completed in accordance Ontario Regulation 153/04 must be completed using the low flow purging and sampling methods provided in SOP-EDR023 unless authorized by the Qualified Person responsible for the Phase Two ESA.

6.0 TRAINING

The Practice Leader is responsible for identifying the initial training needs of EDR staff and ensuring that staff are trained and competent before undertaking work assignments.

All trained personnel are responsible for identifying coaching or re-training needs (if they are uncomfortable with work assignments that have been assigned).

The careful application of *Health & Safety Training* by each employee is an integral part of all activities and is assumed as part of this SOP.

7.0 MAINTENANCE OF SOP

1 Year.

8.0 REFERENCES

Association of Professional Geoscientists of Ontario, "*Guidance for Environmental Site Assessments under Ontario Regulation 153/04 (as amended)",* April 2011.

9.0 APPENDICES

None.

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Template: Master SOP Template – February 2014

SOP – EDR009 – REV003 – FIELD DECONTAMINATION OF NON-DEDICATED MONITORING AND SAMPLING EQUIPMENT

Title:	Field Decontamination of Non-Dedicated Monitoring and Sampling Equipment
Practice:	EDR
First Effective Date:	August 03, 2009
Version:	003
Version Date:	April 29, 2016
Author:	Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	2016.04.29 10:55:58 -04'00'

TABLE OF CONTENTS

1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	August 02, 2009	N/A	MEM
001	November 26, 2010	Updated Approval Signature/Added reference to Ontario Regulation 511/09	FG
002	September 20, 2013	Revised majority of text to reflect current practices/Focused on equipment cleaning and removed reference to personnel decontamination/Added section on O. Reg. 153/04 requirements/Revised reference list	RLM
003	April 29, 2016	Updated Section 4.0/Removed methanol as optional cleaning reagent	RLM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) presents the general requirements for field decontamination of non-dedicated equipment used for monitoring of environmental media and the collection of environmental samples (i.e., equipment that is re-used between monitoring and sampling locations).

3.0 OVERVIEW

The main purpose of non-dedicated monitoring and sampling equipment decontamination is to minimize the potential for cross-contamination during monitoring/sampling activities completed for site investigations. Cross-contamination can occur when equipment used to monitor/sample contaminated soil, groundwater or sediment is reused at another monitoring/sampling location without cleaning. This can result in the transfer of contaminants from a “dirty” monitoring/sampling location to a “clean” monitoring/sampling location, causing possible positive bias of subsequent samples. Positive sample bias can result in reported analytical results that are not representative of actual site conditions and, if significant cross-contamination occurs, can result in reported exceedances of the applicable regulatory standards for samples that would have met the standards had cross-contamination not occurred.

Site investigations completed by Pinchin typically use the following non-dedicated monitoring/sampling equipment:

- Manually operated equipment (e.g., water level tapes/interface probes using during groundwater monitoring and sampling, knifes/spatulas used for soil sampling, hand augers);
- Pumps for groundwater monitoring well development, purging and/or sampling (e.g., bladder pumps, submersible pumps); and
- Downhole drilling/sampling equipment – (e.g., split-spoon samplers, augers).

The above list is not all inclusive and other non-dedicated monitoring/sampling equipment may be employed during a site investigation that requires decontamination. For example, it may be appropriate to decontaminate the bucket of a backhoe used for test pitting between test pit locations. The Project Manager will be responsible for identifying the additional monitoring/sampling equipment that requires decontamination and instructing field staff regarding the procedure to be followed for cleaning this equipment.

When conducting field monitoring and sampling work in the field, it is not always possible to judge whether a monitoring/sampling location is uncontaminated. Because of this, it is important that all non-dedicated monitoring/sampling equipment be properly cleaned before initial use and between uses to minimize the potential for cross-contamination to occur.

4.0 DISTRIBUTION

This is an on-line document. Paper copies are valid only on the day they are printed. Refer to the author if you are in any doubt about the accuracy of this document.

This SOP will be distributed to all Pinchin staff and others as follows:

- Posted to the SOP section of the EDR Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at Pinchin West, Le Groupe Gesfor Poirier and Pinchin LeBlanc for distribution as appropriate.

5.0 PROCEDURE

5.1 Equipment and Supplies

The following is a list of equipment needed to perform the decontamination of non-dedicated monitoring and sampling equipment in accordance with this SOP:

- Personal Protective Equipment (PPE);
- Potable tap water;
- Distilled water (store bought);
- Volatile organic compound (VOC)-free deionized distilled water (supplied by the analytical laboratory);
- Laboratory grade, phosphate-free soap;
- Wash buckets (minimum of three);
- Scrub brushes;
- Paper towels; and
- Buckets or drums with resealable lids for containing liquids generated by equipment cleaning.

Other equipment required to clean drilling equipment (e.g., steam cleaner, power washer, tub for containing wash water, etc.) is typically provided by the drilling contractor. The Project Manager is responsible for ensuring that the drilling contractor brings the required cleaning equipment to the project site. Prior to mobilization, the Project Manager should also assess the availability of a potable water supply for drilling equipment cleaning at the project site. When no accessible potable water supply is available at a project site, the drilling contractor will need to bring a potable water supply to the site in the drill rig water supply tank or separate support vehicle, or arrange to have a third-party supplier deliver potable water to the site.

5.2 Procedure

5.2.1 *General Procedures and Considerations*

The following general procedures and considerations apply to all decontamination of non-dedicated monitoring/sampling equipment activities:

- Personnel will dress in suitable PPE to reduce personal exposure during equipment decontamination activities;
- In addition to cleaning between monitoring/sampling locations, all non-dedicated monitoring/sampling equipment must be cleaned before initial use. Field staff should not assume that the equipment was properly cleaned by the last person to use it;
- Prior to starting a drilling program, the downhole drilling equipment (e.g., augers) must be inspected and any “dirty” equipment must not be used in the drilling program or it must be cleaned prior to use; and
- All liquids and solids generated by the cleaning of non-dedicated monitoring/sampling equipment are to be containerized and managed in accordance with the procedures outlined in SOP-EDR020 – Investigation Derived Wastes.

5.2.2 *Decontamination of Manually Operated Monitoring/Sampling Equipment*

The procedure for decontaminating manually operated monitoring/sampling equipment is as follows:

- Wash the equipment in a bucket filled with a mixture of phosphate-free soap/potable water, while using a brush to remove any obvious contamination and/or adhered soil;
- Rinse the equipment thoroughly in a bucket filled with potable water;
- Rinse the equipment thoroughly using a spray bottle filled with distilled water, capturing the rinsate in a bucket; and
- Allow the equipment to air dry. If there is insufficient time to allow the equipment to air dry before reusing, or the equipment cleaning is occurring during winter conditions, the equipment should be dried after the final rinse with a clean paper towel.

At the discretion of the Project Manager, it may be acceptable to use spray bottles, rather than buckets, for lightly contaminated equipment or if no obvious contaminants are present.

Should soil or obvious contaminants remain on the equipment after cleaning, the above procedure must be repeated until the soil or contaminants have been removed. The equipment should not be reused if repeated cleanings do not remove the soil or contaminants.

The above equipment cleaning procedure applies to, but is not limited to, the following non-dedicated monitoring/sampling equipment:

- Knives/spatulas used for soil sampling;
- Hand augers;
- Water level tapes and interface probes;
- The exterior of submersible pumps and interior/exterior of bladder pumps (including the portion of the electrical or retrieval cables that contact groundwater in a well); and
- Various pieces of drilling equipment, including split-spoon samplers, hollow stem auger centre plugs, continuous sampling tubes, and the reusable portions of dual-tube samplers.

At the discretion of the Project Manager, the distilled water used for the final equipment rinse will be VOC-free deionized distilled water supplied by the analytical laboratory. For example, the use of VOC-free distilled water would be appropriate for a project where trace VOCs are being investigated and it is important to minimize the potential for cross-contamination and positive bias of VOC sample results.

For tapes associated with water level tapes and interface probes, if they were submerged in monitoring well water free of non-aqueous phase liquids or obvious contamination, the tape can be cleaned at the discretion of the Project Manager by pulling the tape through a phosphate-free soap/potable water dampened towel as the tape is retrieved. The end probes should then be cleaned as described above.

5.2.3 Decontamination of Groundwater Sampling Pumps

The exterior of each bladder or submersible pump that is used for well development, well purging and/or groundwater sampling, and the portion of any electrical or retrieval cables that contact groundwater in the well, are to be cleaned following the procedure described above for decontaminating manually operated monitoring/sampling equipment.

Submersible pumps are not designed to be disassembled in the field and cleaning of the interior of this type of pump requires flushing of cleaning solutions through the pump. After cleaning the exterior of the pump, the minimum decontamination requirement for a submersible pump is the flushing of a phosphate-free soap/potable water mixture contained in a bucket through the pump (i.e., pumping the mixture through the pump and capturing the pump outflow in the same bucket or a separate bucket), followed by flushing distilled water contained in a separate bucket through the pump and capturing the pump outflow in the same bucket or separate bucket. Note that store bought distilled water is acceptable for this purpose.

At the discretion of the Project Manager and depending on the requirements of the project, the final step in the process is a final flush with laboratory-supplied VOC-free distilled water.

The following summarizes the flushing sequence for decontaminating the interior of a submersible pump:

- Soap/water mixture*;
- Distilled water (store bought)*; and
- Distilled water (either store bought or laboratory supplied VOC-free - to be confirmed by the Project Manager).

* Minimum requirement.

Bladder pumps are designed for disassembly in the field to facilitate the replacement of the bladders. The internal parts of a bladder pump are to be cleaned in accordance with the procedure described above for decontaminating manually operated monitoring/sampling equipment. Whenever possible, bladders are to be disposed of between well locations. However, if it is necessary to reuse a bladder, it must be cleaned in accordance with the procedure for cleaning manually operated monitoring/sampling equipment. It should be noted that bladders are difficult to clean and the decontamination procedure needs to be thorough.

Flushing of a bladder pump with distilled water after cleaning and reassembly is not required unless specified by the Project Manager.

5.2.4 Decontamination of Downhole Drilling Equipment

Hollow stem and solid stem augers used for borehole advancement are to be decontaminated by the drilling contractor using the following procedure:

- Wherever possible, all augers used for borehole drilling should be cleaned before initial use and between borehole locations by steam cleaning or power washing with potable water. However, the minimum requirements for auger cleaning are as follows:
    - Use a brush or shovel to remove excess soil from <u>all</u> used augers; and
    - Any augers that <u>may come into contact with groundwater</u> are to be decontaminated by steam cleaning or power washing with potable water. An auger must not be used for the balance of the drilling program if obvious contaminants or residual soil remain on the auger following decontamination, unless subsequent cleaning efforts remove these materials.

As noted previously, downhole drilling equipment used for soil sample retrieval (e.g., split-spoon samplers, continuous sampling tubes and the reusable portions of dual-tube samplers used with direct push rigs) and the hollow stem auger centre plug are to be decontaminated following the procedure outlined above for cleaning manually operated monitoring/sampling equipment.

5.3 Decontamination Records

Field personnel will be responsible for documenting the decontamination of non-dedicated monitoring/sampling equipment and drilling equipment in their field log book or field forms. The documentation should include the type of equipment cleaned and the frequency of cleaning, the methods and reagents used for equipment cleaning, and how fluids generated by the equipment cleaning were stored.

5.4 Additional Considerations for O. Reg. 153/04 Phase Two ESA Compliance

When completing a Phase Two Environmental Assessment (ESA) in accordance with Ontario Regulation 153/04, the following additional procedures must be undertaken:

- All augers must have excess soil removed by a brush or shovel and be steam cleaned or power washed before initial use and between borehole locations regardless of whether they contact the groundwater or not (i.e., the minimum requirements listed above for auger cleaning are not sufficient); and
- Thorough records of the frequency and cleaning materials used for the decontamination of non-dedicated monitoring/sampling equipment and downhole drilling must be kept. The Quality Assurance/Quality Control section of the Phase Two ESA report requires a summary of what steps were taken to minimize the potential for cross-contamination during the Phase Two ESA. The handling and disposal of fluids generated by equipment decontamination must also be well documented in the field for inclusion in the Phase Two ESA report.

6.0 TRAINING

The Practice Leader is responsible for identifying the training needs of Environmental Due Diligence and Remediation (EDR) staff and ensuring that staff are trained and competent before undertaking work assignments.

All trained personnel are responsible for identifying coaching or re-training needs (if they are uncomfortable with work assignments that have been assigned).

The careful application of *Health & Safety Training* by each employee is an integral part of all activities and is assumed as part of this SOP.

7.0 MAINTENANCE OF SOP

1 Year.

8.0 REFERENCES

Association of Professional Geoscientists of Ontario, "*Guidance for Environmental Site Assessments under Ontario Regulation 153/04 (as amended)",* April 2011.

9.0 APPENDICES

None.

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SOP – EDR013 – REV003 – SAMPLING HANDLING DOCUMENTATION

Title:	Sampling Handling Documentation
Practice:	EDR
First Effective Date:	August 03, 2009
Version:	003
Version Date:	April 29, 2016
Author:	Mark McCormack and Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	2016.04.29 16:39:46 -04'00'

TABLE OF CONTENTS

1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	August 03, 2009	N/A	MEM
001	November 26, 2010	Updated Approval Signature/Added reference to Ontario Regulation 511/09	FG
002	September 12, 2013	Updated text/Added tables from MOE lab protocol/Streamlined reference section/Added O. Reg. 153/04 compliance section	RLM
003	April 29, 2016	Updated Section 4.0/Aligned document retention with PEP	RLM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) presents the general requirements for sample handling and documentation practices.

3.0 OVERVIEW

Not applicable

4.0 DISTRIBUTION

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5.0 PROCEDURE

5.1 Equipment Required

- Laboratory-supplied sample containers;
- Field log book or field forms; and
- Laboratory-supplied Chain-of-Custody forms.

5.2 Procedures

5.2.1 *Sample Labelling*

Sample labels are to be filled out in the field at the time of sampling as completely as possible by field personnel. All sample labels shall be filled out using waterproof ink. At a minimum, each label shall contain the following information:

- Sample identifier, consisting of sample location (borehole number, monitoring well number, surface sample location, etc.) and sample number (if appropriate). For example, the second soil sample collected during borehole advancement at borehole BH3 would be labelled “BH3-2”;
- Pinchin project number;
- Date and time of sample collection;
- Company name (i.e., Pinchin); and
- Type of analysis.

5.2.2 *Sample Containers, Preservation and Holding Times*

The sample containers, sample preservation and holding times for projects in Ontario are to be those specified in Table A (for soil and sediment) and Table B (groundwater) from Ontario Ministry of the Environment Climate Change’s (MOECC, formerly the Ontario Ministry of the Environment) *Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act,* dated March 9, 2004, amended as of July 1, 2011. These tables are attached and form part of this SOP.

With reference to the attached Tables A and B, field personnel must use the sample containers appropriate for the parameters being sampled for, undertake any required field preservation or filtration and observe the sample holding times.

Each province has its own preservation and holding time regulations or guidance, which are generally similar. It is the Project Manager’s responsibility to ensure that field staff are aware of, and can meet, the requirements in the province they are working in.

5.2.3 *Sample Documentation*

The following sections describe documentation required in the field notes and on the Chain-of-Custody forms.

Field Notes

Documentation of observations and data from the field will provide information on sample collection and also provide a permanent record of field activities. The observations and data will be recorded using pens with permanent ink in the field log book or on field forms.

The information in the field book or field forms will, at a minimum, include the following:

- Site name;
- Name of field personnel;
- Sample location (borehole number, monitoring well number, surface sample location, etc.);
- Sample number;
- Date and time of sample collection;
- Sample containers used;
- Description of sample;
- Matrix sampled;
- Sample depth (if applicable).
- Method of field preservation (if applicable);
- Whether filtration was completed for water samples;
- Analysis requested;
- Field observations;
- Results of any field measurements (e.g., field screening measurements, depth to water, etc,); and
- Volumes purged (if applicable).

In addition to the above, other pertinent information is to be recorded in the field log book or field forms depending on the type of sampling being completed (e.g., field parameter measurements and pumping rates for low flow sampling) as required by the SOP for the particular sampling activity.

Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the sampler's memory.

All field notes are to be scanned and saved to the project folder on the server immediately upon returning from the field.

Sample Chain-of-Custody

Sample Chain-of-Custody maintains the traceability of the samples from the time they are collected until the analytical data are issued by the laboratory. Initial information concerning collection of the samples will be recorded in the field log book or field forms as described above. Information on the custody, transfer, handling and shipping of samples will be recorded on a Chain-of-Custody for each sample submission.

All signed Chain-of-Custody forms will be photocopied or copies retained prior to sample shipment. A Chain-of-Custody should be laboratory specific and will typically be supplied by the laboratory with the sample containers requested for the project. The sampler will be responsible for fully filling out the Chain-of-Custody for each sample submission.

The Chain-of-Custody will be signed by the sampler when the sampler relinquishes the samples to anyone else (i.e., courier or laboratory). Until samples are picked up by the courier or delivered to the laboratory, they will be stored in a secure area. The following information needs to be provided on the Chain-of-Custody at a minimum:

- Company name;
- Name, address, phone number, fax number and e-mail address of the main contact for the submission (typically the Project Manager);
- Project information (project number, site address, quotation number, rush turnaround number, etc.);
- Regulatory standards or criteria applicable to the samples (including whether the samples are for regulated drinking water or whether the samples are for a Record of Site Condition);
- Sample identifiers;
- Date and time of sample collection;
- Matrix (e.g., soil, groundwater, sediment, etc.);
- Field preservation information (e.g., whether groundwater samples for metals analysis were field filtered);
- Analyses required;
- Number of sample containers per sample;
- Analytical turnaround required (i.e., standard or rush turnaround);
- Sampler’s name and signature;
- Date and time that custody of the samples was transferred;

- Name and signature of person accepting custody of the samples from Pinchin, and date and time of custody transfer; and
- Method of shipment (if applicable).

The person responsible for delivery of the samples to the laboratory or transfer to a courier will sign the Chain-of-Custody, retain a copy or photocopy of the Chain-of-Custody so it can be scanned and saved to the project file, document the method of shipment, and send the original copy of the Chain-of Custody with the samples.

5.3 Additional Considerations for O. Reg. 153/04 Phase Two ESA Compliance

Custody seals must be placed on all coolers containing samples prior to transfer to a courier or delivery to the laboratory. The laboratory will comment on the presence/absence of custody seals in the Certificate-of-Analysis for each submission and this information must be discussed in the QA/QC section of the Phase Two Environmental Site Assessment report.

6.0 TRAINING

The Practice Leader is responsible for identifying the training needs of Environmental Due Diligence and Remediation (EDR) staff and ensuring that staff are trained and competent before undertaking work assignments.

All trained personnel are responsible for identifying coaching or re-training needs (if they are uncomfortable with work assignments that have been assigned).

The careful application of *Health & Safety Training* by each employee is an integral part of all activities and is assumed as part of this SOP.

7.0 MAINTENANCE OF SOP

1 Year.

8.0 REFERENCES

Ontario Ministry of the Environment and Climate Change, *Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act*, March 9, 2004, as amended as of July 1, 2011.

9.0 APPENDICES

Appendix I Tables A and B From Ontario MOECC Laboratory Protocol

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Template: Master SOP Template – February 2014

APPENDIX I

Tables A and B From Ontario MOECC Laboratory Protocol

TABLE A: SOIL AND SEDIMENT Sample Handling and Storage Requirements

SOIL Inorganic Parameters	**Container[1]**	**Field Preservation**	**Storage Temp.[2]**	**Preserved Holding Time[3]**	**Unpreserved Holding Time[3]**
Chloride, electrical conductivity	glass, HDPE or PET	none	5 ± 3 °C		30 days as received (without lab drying); indefinite when dried at the lab
Cyanide (CN^-)	glass wide-mouth jar, Teflon™ lined lid	protect from light	5 ± 3 °C		14 days
Fraction organic carbon (FOC)	glass jar, Teflon™ lined lid	none	5 ± 3 °C		28 days as received(without lab drying); indefinite storage time when dried
Hexavalent chromium	glass, HDPE	none	5 ± 3 °C		30 days as received
Metals (includes hydride-forming metals, SAR, HWS boron, calcium, magnesium, sodium)	glass, HDPE	none	5 ± 3 °C		180 days as received (without lab drying); indefinite when dried at the lab
Mercury, methyl mercury	glass, HDPE or PET	none	5 ± 3 °C		28 days
pH	glass, HDPE or PET	none	5 ± 3 °C		30 days as received
SOIL Organic Parameters	**Container [1,5,6,7,20]**	**Field Preservation**	**Storage Temp.[2]**	**Preserved Holding Time[3]**	**Unpreserved Holding Time[3]**
BTEX [8], PHCs (F1)[8], THMs, VOCs[7] **NB: SEE FOOTNOTE #20**	40–60 mL glass vial (charged with methanol preservative, pre-weighed)[6]AND glass jar (for moisture content) [hermetic samplers are an acceptable alternative [5, 18]]	methanol (aqueous $NaHSO_4$ is an acceptable alternative for bromomethane)[6, 7, 18,20]	5 ± 3 °C	14 days	hermetic samples: stabilize with methanol preservative within 48 hours of sampling[18]
1,4-Dioxane[9, 15]	when processed as a VOC sample: same as per VOCs above; when processed as an extractable: same as per ABNs below; (consult laboratory)[9,15,18]		5 ± 3 °C	14 days	when processed as a VOC sample: same as per VOCs above; when processed as an extractable: same as per ABNs below; (consult laboratory)[18]
PHCs (F2–F4)	glass wide-mouth jar, Teflon™ lined lid	none	5 ± 3 °C		14 days
ABNs, CPs, OCs, PAHs	glass wide-mouth jar, Teflon™ lined lid	none	5 ± 3 °C		60 days
Dioxins and furans, PCBs	glass wide-mouth jar Teflon™ lined lid	none	5 ± 3 °C		indefinite storage time

HDPE = high density polyethylene; PET = polyethylene terephthalate; HWS = hot water soluble boron; THM = trihalomethanes; VOC = volatile organic compounds; BTEX = benzene, toluene, ethylbenzene, xylenes; PHCs = petroleum hydrocarbons; CPs = chlorophenols; PCBs = polychlorinated biphenyls; OCs = organochlorine pesticides

[1–20] footnotes immediately follow Table B

TABLE B: GROUND WATER Sample Handling and Storage Requirement

GROUND WATER Inorganic Parameters	**Container[10]**	**Field Preservation**	**Storage Temperature[2]**	**Preserved Holding Time[3]**	**Unpreserved Holding Time[3]**
Chloride, electrical conductivity, pH	HDPE or glass	none	5 ± 3 °C		28 days
Cyanide (CN^-)	HDPE or glass	NaOH to a pH > 12	5 ± 3 °C	14 days	must be field preserved
Hexavalent chromium	HDPE or glass	field filter followed by buffer solution to a pH 9.3–9.7 [17]	5 ± 3 °C	28 days[17]	24 hours[17]
Metals (includes hydride-forming metals, calcium, magnesium, sodium)	HDPE or Teflon™ [10]	field filter followed by HNO_3 to pH < 2[11]	room temperature when preserved	60 days	must be field preserved
Mercury	glass or Teflon™ [10]	field filter followed by HCl to pH < 2[11]	room temperature when preserved	28 days	must be field preserved
Methyl mercury	glass or Teflon™	DO NOT FILTER HCl or H_2SO_4 to pH <2[12]	5 ± 3 °C	28 days	DO NOT FILTER must be field preserved[12]
GROUND WATER Organic Parameters[10, 13, 14]	**Container[10, 13, 14]**	**Field Preservation**	**Storage Temperature[2]**	**Preserved Holding Time[3]**	**Unpreserved Holding Time[3]**
BTEX, PHCs (F1),THMs, VOCs;	40–60 mL glass vials (minimum of 2)[14] (no headspace)	$NaHSO_4$ or HCl to a pH < 2[16]	5 ± 3 °C	14 days	7 days
1,4-Dioxane[9, 15]	when processed as a VOC sample: same as per VOCs above; when processed as an extractable: same as per ABNs below; (consult laboratory)[9, 15]		5 ± 3 °C	14 days	14 days
PHCs (F2–F4)	1L amber glass bottle, Teflon™ lined lid	$NaHSO_4$ or HCl to a pH < 2[16]	5 ± 3 °C	40 days	7 days
ABNs, CP, OCs, PAHs[19], PCBs	1L amber glass bottle, Teflon™ lined lid	none	5 ± 3 °C		14 days
Dioxins and furans	1L amber glass bottle, Teflon™ lined lid	None	5 ± 3 °C		indefinite storage time

HDPE = high density polyethylene;THM = trihalomethanes; VOC = volatile organic compounds; BTEX = benzene, toluene, ethylbenzene, xylenes; PHCs = petroleum hydrocarbons; CPs = chlorophenols; PCBs = polychlorinated biphenyls; OCs = organochlorine pesticides

[1] One soil container is generally sufficient for inorganic analysis and another for extractable organics. A separate container is required for BTEX, THM, VOC and PHC (F1) moisture analysis.

[2] Storage temperature refers to storage at the laboratory. Samples should be cooled and transported as soon as possible after collection.

[3] Holding time refers to the time delay between time of sample collection and time stabilization/analysis is initiated. For samples stabilized with methanol, the hold time for the recovered methanol extract is up to 40 days.

[4] PET can not be used for samples requiring antimony analysis.

[5] As an alternative, the USEPA has investigated hermetic sample devices that take and seal a single core sample. The sample is submitted as is to the laboratory where it is extruded into an extracting solvent. Samples must be received at the laboratory within 48 hours of sampling. (Note that replicate samples are necessary for bisulphate and methanol extraction for all samples plus laboratory duplicates and spikes.) Consult the laboratory for the number of samples required.

[6] The USEPA has approved field preservation. Pre-weighed vials containing known weights of methanol preservative (or aqueous sodium bisulphate if used for bromomethane) are sent to the field. Sample cores (approximately 5 g) are extruded directly into the vial. The vials are sealed, and submitted directly to the laboratory. In practice, this technique requires great care to prevent losses of methanol due to leaking vials or through splashing. Consult the laboratory for the number of containers required.

[7] Methanol-preserved samples may elevate the detection limit for bromomethane (VOC); a separate bisulphate-preserved sample or hermetically sealed sample may be submitted at the time of sampling if bromomethane is a chemical of concern – contact the laboratory to determine if a separate sample should be collected.

[8] For BTEX and PHC (F1) pre-charging the soil sampling container with methanol preservative is an accepted deviation from the CCME method.

[9] 1,4-Dioxane may be analyzed with the ABNs or VOCs; sample container requirements used for ABNs or VOCs are both acceptable. If 1,4-dioxane is to be analyzed with ABNs, follow the ABN sample container requirements; similarly if it is to be analyzed with VOCs, follow VOC sample container requirements. Consult the laboratory for the container type and the total number required (see also footnote #15).

[10] Samples containing visual sediment at the time of analysis should be documented and noted on the Certificate of Analysis or written report as results may be biased high due to the inclusion of sediment in the extraction.

[11] Field filter with 0.45µm immediately prior to adding preservative or filling pre-charged container.

[12] Sample directly into a HCl or H_2SO_4 preserved container, or add acid to an unfiltered sample immediately after sample collection in the field.

[13] Aqueous organic samples should be protected from light. If amber bottles are not available, glass should be wrapped in foil.

[14] Separate containers are required for each organic water analysis. Consult the laboratory for required volumes. Chloride and electrical conductivity can be taken from the same container.

[15] For 1,4-dioxane in soil and sediment, no preservative is required if processed as an ABN, however. Methanol is an acceptable alternative if processed as a VOC. For 1,4-dioxane in groundwater, no preservative is required, however, $NaHSO_4$ or HCl are acceptable alternatives.

[16] Preserved to reduce biodegradation, however effervescence/degassing may occur in some ground water samples. In this case, rinse preservative out three times with sample and submit to the laboratory as unpreserved.

[17] To achieve the 28-day holding time, use the ammonium sulfate buffer solution [i.e., $(NH_4)_2SO_4/NH_4OH$] or $(NH_4)_2SO_4/NH_4OH/NaOH$ + NaOH] as specified in EPA Method 218.6 (revision 3.3, 1994) or Standard Methods 3500-Cr Chromium (2009).Using only NaOH without the ammonium sulfate buffer to adjust the pH would require analysis within 24 hours of sampling.

[18] Alternatively, to achieve a longer hold time, hermetic samples may be frozen within 48 hours of sampling as per ASTM method D6418 – 09; however, storage stability must be validated by the laboratory with no more than 10% losses.

[19] For benzo(a)pyrene in ground water samples filtration prior to analysis on a duplicate sample is permitted.

[20] For VOC, BTEX, F1 PHCs, 1,4 dioxane soil samples collected before July 1, 2011, the following sampling and handling requirements are also permitted.

SOIL Organic Parameters	**Container**	**Preservative**	**Storage Temperature**	**Preserved Holding Time**	**Unpreserved Holding Time**
VOC, BTEX, F1 PHCs, 1,4-dioxane*	glass jar, Teflon lined lid, no headspace, separate container required Hermetic samplers are an acceptable alternative	none field preservation with aqueous sodium bisulphate and methanol is an acceptable alternative	5 ± 3C	See notations 1-3 below	Stabilize by extraction or freezing within 48 hrs of receipt at the laboratory (7days from sampling). Frozen or field preserved samples must be extracted within 14 days of sampling.

*Special care must be used when sampling for VOC, BTEX and F1 in soil and sediment. Studies have shown that substantial losses can occur through volatilization and bacterial degradation. There are several allowable options for field collection of samples. Each is discussed below. Consult SW846, Method 5035A for additional detail. The laboratory is required to stabilize the sample on the day of receipt, either by extraction or freezing.

1. Collection in soil containers: To minimize volatilization losses, minimize sample handling and mixing during the process of filling the sample container. The bottle should be filled with headspace and voids minimized. Care is required to ensure that no soil remains on the threads of the jar, preventing a tight seal and allowing volatilization losses. To minimize losses through bacterial degradation, commence cooling of the samples immediately and transport the samples to the lab as soon as possible, ideally on the day of sampling. Samples must be received at the laboratory within 48 hours of sampling. Freezing can be used to extend the hold time to 14 days, however the practice is difficult to implement in the field and can cause sample breakage.
2. As an alternative, the USEPA has investigated hermetic sample devices that take and seal a single core sample. The sampler is submitted as is to the laboratory where it is extruded into the extracting solvent. Samples must be received at the laboratory within 48 hours of sampling. This technique minimizes volatilization losses and is worth consideration for critical sites. (Note that replicate samplers are necessary for bisulphate and methanol extraction for all samples plus lab duplicates and spikes). Consult the laboratory for the number of samplers required.

3 The USEPA has also approved field preservation. Pre-weighed vials containing known weights of methanol and aqueous sodium bisulphate preservative are sent to the field. Sample cores (≈5 g) are extruded directly into the vial. The vials are sealed, and submitted directly to the laboratory. In practice, this technique requires great care to implement successfully. Losses due to leaking vials, through splashing and effervescence (aqueous bisulphate) can easily occur and make the sample unusable. Consult the laboratory for the number of containers required.

SOP – EDR016 – REV002 – FIELD MEASUREMENT OF WATER QUALITY PARAMETERS

Title:	Field Measurement of Water Quality Parameters
Practice:	EDR
First Effective Date:	November 24, 2010
Version:	002
Version Date:	April 29, 2016
Author:	Paresh Patel
Authorized by:	Robert MacKenzie
Signature:	2016.04.29 11:40:56 -04'00'

TABLE OF CONTENTS

1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	November 24, 2010	N/A	PDP
001	October 31, 2013	Cross-referenced low flow sampling SOP/Added section on O. Reg. 153/04 compliance	RLM
002	April 29, 2016	Updated Section 4.0	RLM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) defines the standard procedures for measuring water quality parameters during water sampling, and covers the calibration and use of multi-parameter and single-parameter probes for monitoring in situ water quality parameters in streams, down hole in monitoring wells and in flow-through cells. Water quality parameters may include temperature, pH, dissolved oxygen (DO), oxidation reduction potential (ORP), conductivity and turbidity.

Measurements of water quality parameters are typically made for two main purposes: to provide information on water geochemistry to assist in designing in situ remediation programs and to assess whether representative formation groundwater is being sampled during low flow purging and sampling. They can also be used to assess whether well development is complete in certain situations (see SOP-EDR018).

3.0 OVERVIEW

Not applicable.

4.0 DISTRIBUTION

This is an on-line document. Paper copies are valid only on the day they are printed. Refer to the author if you are in any doubt about the accuracy of this document

This SOP will be distributed to all Pinchin staff and others as follows:

- Posted to the SOP section of the EDR Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at Pinchin West, Le Groupe Gesfor Poirier and Pinchin LeBlanc for distribution as appropriate.

5.0 PROCEDURE

5.1 Equipment and Reagents Required

- Single or multi-parameter probes for monitoring water quality parameters;
- Calibration solutions for calibrating the probes to the standard values;

- Field book or field forms;
- Distilled water;
- Beaker or bucket;
- Stirrer for DO measurement (optional); and
- Flow-through cell (optional).

5.2 Probe Measurement Accuracy

The probes utilized for measuring water quality parameters shall be capable of producing measurement accuracy greater or equal to the following specifications:

Temperature:	± 0.5 degrees Celsius (°C)
Conductivity:	± 1 milliSiemens per centimetre (µS/cm)
pH:	±0.1 pH unit
Dissolved Oxygen:	±0.2 milligrams per litre (mg/L) ≤ 20 mg/L
	± 0.6 mg/L > 20 mg/L
Turbidity:	±1% up to 100 Nephelometric Turbidity Units (NTU)
	±3% up to 100-400 NTU
	±5% up to 400-3,000 NTU
ORP:	± 20 millivolts (mV)

5.3 Probe Calibration

Calibrate the water quality probes used for field parameter measurement in accordance with the manufacturer's specifications. Wherever possible, arrange for the equipment rental company to calibrate the water quality probes and provide a calibration sheet that contains information such as calibration date and calibration measurements for each parameter. If the water quality probes are used for more than one day, a calibration check shall be performed using standard calibration solutions at the start of each day at a minimum. If the calibration check shows deviations from the standard values that exceed the ranges provided below, the probe(s) that exceed the ranges shall be calibrated prior to further use:

pH	±0.1 pH units
Specific Conductance	±3%
Temperature	±3%
DO	±10% mg/L

ORP	±10 mV
Turbidity	±10%

A calibration check should also be performed if the parameter measurements suggest that calibration drift has occurred. Document all calibration activities in the field notes, including date and time of calibration/calibration check, calibration solutions used, probe readings, and make, model and serial number of the instrument(s). Note that if the water quality probe manufacturer recommends more frequent calibration/calibration checks than specified above, the manufacturer's recommendations are to be followed.

Extra care must be taken to calibrate a multi-parameter probe to prevent cross-contamination. Specifically, following immersion of the probes into each calibration standard, all probes should be thoroughly rinsed in distilled water and the excess water shaken off or blotted dry with a lint-free wipe. Conductivity standards are much more sensitive to cross contamination/dilution than other standards, and prior to immersion in a conductivity standard, all probes should be thoroughly rinsed and completely dried with lint-free wipes. Besides being easily diluted, conductivity also affects other parameters (specifically DO), and the conductivity probe should always be the first probe calibrated. The following order for calibration of a multi-parameter probe is to be followed:

1. Specific Conductance;
2. pH;
3. DO; and
4. Turbidity.

There is no recommended order for calibration of other parameters.

5.4 Single-Parameter Probes

Prior to conducting field measurements, probe sensors must be allowed to equilibrate to the temperature of the water being monitored. Probe sensors have equilibrated adequately when the temperature reading has stabilized. Deployment of single-parameter probes will follow the following procedures:

5.4.1 Temperature

Whenever possible the temperature shall be measured in situ (i.e., within a stream, direct deployment in a monitoring well). When temperature cannot be measured in situ, it can be measured in a beaker or bucket. The following conditions must be met when measuring temperature within a beaker or bucket:

- The beaker or bucket shall be large enough to allow full immersion of the temperature probe. The beaker or bucket is to be rinsed with water from the well or stream being measured prior to obtaining the measurement;

- The probe must be placed in the beaker or bucket immediately before the temperature changes due to ambient conditions;
- The beaker or bucket must be shaded from direct sunlight and strong breezes before and during temperature measurement; and
- The probe must be allowed to equilibrate for at least 1 minute before temperature is recorded.

5.4.2 pH

Preferably, pH is measured in situ at the centroid of flow and at the mid-depth of a stream, or the mid-point of the well screen in a well. The pH probe must be allowed to equilibrate according to the manufacturer's recommendations before the pH value is recorded without removing the probe from the water.

If the pH cannot be measured in situ, it should be measured in a bucket or beaker using the procedures outlined above for measuring temperature.

5.4.3 Dissolved Oxygen

As for pH, it is preferable to measure DO in situ at the centroid of flow and at the mid-depth of a stream, or the mid-point of the well screen in a well. The DO probe must be allowed to equilibrate according to manufacturer's recommendations before the DO value is recorded without removing the probe from the water.

If DO cannot be measured in situ, it should be measured in a bucket or beaker using the procedures outlined above for measuring temperature.

Some types of DO probes require a sufficient flow of fresh water across the membrane to maintain the accuracy and precision of the DO measurement. When taking DO measurements in a bucket or beaker, either employ a stirrer, or physically move the probe in a gentle motion. Moving the probe in a gentle motion should also be completed when measuring DO in situ down hole in a monitoring well.

5.4.4 ORP

ORP shall be measured using the procedures outlined above for measuring pH. Note that changes in temperature directly affect ORP values and ORP should be measured as soon as possible after the probe has stabilized.

5.4.5 Turbidity

In situ turbidity shall be measured using the procedures outlined above for measuring pH.

If turbidity cannot be measured in situ, it can be measured with a probe in a bucket or beaker using the procedures outlined above for measuring temperature. Note that some turbidity measuring instruments do not use a probe, and a sample of the water is collected in a small vial that is inserted into the instrument which then measures the turbidity of the water.

5.4.6 Multi-Parameter Probe Use With A Flow-Through Cell

A multi-parameter probe and a flow-through cell are typically employed when undertaking low flow purging and sampling of groundwater. SOP-EDR023 describes the procedures to be followed when using a multi-parameter probe and a flow-through cell.

5.5 Additional Considerations for O. Reg. 153/04 Phase Two ESA Compliance

When completing a Phase Two Environmental Assessment (ESA) in accordance with Ontario Regulation 153/04, the following additional procedures must be undertaken:

- Thorough records of the calibration and calibration checks of the probes/instruments used for water quality parameter measurement must be kept, including any calibration sheets provided by the equipment supplier. The Quality Assurance/Quality Control section of the Phase Two ESA report requires a discussion of field equipment calibration, and equipment calibration records must be appended to the Phase Two ESA report; and
- If groundwater samples collected for a Phase Two ESA are not collected using low flow purging and sampling, which mandates the measurement of water quality parameters, water quality parameters must be measured (pH, temperature and specific conductance at a minimum) and the measurements included in the Phase Two ESA report. Ontario Regulation 153/04 does not provide specifics as to when these water quality parameter measurements are to be made but one set of measurements made at the conclusion of purging prior to sampling is the minimum requirement.

6.0 TRAINING

The Practice Leader is responsible for identifying the training needs of Environmental Due Diligence and Remediation (EDR) staff and ensuring that staff are trained and competent before undertaking work assignments.

All trained personnel are responsible for identifying coaching or re-training needs (if they are uncomfortable with work assignments that have been assigned).

The careful application of *Health & Safety Training* by each employee is an integral part of all activities and is assumed as part of this SOP.

7.0 MAINTENANCE OF SOP

1 Year.

8.0 REFERENCES

New Jersey Department of Environmental Protection, “*Field Sampling Procedures Manual”,* August 2005.

Commonwealth of Kentucky – Department of Environmental Protection, “*Standard Operating Procedure – In Situ Water Quality Measurements and Meter Calibration”,* January 1, 2009.

U.S Environmental Protection Agency – Science and Ecosystem Support Division, Athens, Georgia, ”*In Situ Water Quality Monitoring”,* December 7, 2009.

U.S. Geological Survey, *“National Field Manual for the Collection of Water-Quality Data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps A1-A9”,* various dates.

9.0 APPENDICES

None.

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Template: Master SOP Template – February 2014

SOP – EDR017 – REV004 – MONITORING WELL DEVELOPMENT

Title:	Monitoring Well Development
Practice:	EDR
First Effective Date:	November 23, 2010
Version:	004
Version Date:	April 29, 2016
Author:	Paresh Patel and Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	2016.04.29 11:42:01 -04'00'

TABLE OF CONTENTS

1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	November 23, 2010	N/A	PDP
001	June 15, 2013	Streamlined background section/Focused procedure on tasks that can be completed by Pinchin personnel/Provided step-by-step summary of field procedure	RLM
002	January 22, 2015	Incorporated procedures specific to Pinchin West into SOP	RLM
003	February 9, 2016	Revised overall procedure to include initial determination of well yield/Added reference to revised well development field forms/Provided guidance on assessing field parameter stabilization when developing wells where water or air were used during drilling	RLM
004	April 29, 2016	Updated Section 4.0	RLM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the standard procedures for groundwater monitoring well development and provides a description of the equipment required and field methods.

All groundwater monitoring wells are to be developed following installation prior to groundwater sampling or the completion of hydraulic conductivity testing. In addition, previously installed groundwater monitoring wells that have not been purged in over one year should be redeveloped prior to additional sampling or hydraulic conductivity testing if there is evidence of sediment impacting the monitoring well (e.g., the depth to bottom of well measurement indicates sediment accumulation) or at the discretion of the Project Manager.

This SOP pertains to monitoring well development that can be undertaken by Pinchin personnel. Monitoring well development completed by drilling rigs is beyond the scope of this SOP.

3.0 OVERVIEW

The main objective of groundwater monitoring well development is to ensure that groundwater sampled from a well is representative of the groundwater in the formation adjacent to the well and that hydraulic conductivity testing provides data representative of the hydraulic characteristics of the adjacent formation.

The specific goals of well development include the following:

- Rectifying the clogging or smearing of formation materials that may have occurred during drilling of the borehole;
- Retrieving lost drilling fluids;
- Improving well efficiency (i.e., the hydraulic connection between the sand pack and the formation);
- Restoring groundwater properties that may have been altered during the drilling process (e.g., volatilization of volatile parameters due to frictional heating during auger advancement or use of air rotary drilling methods); and
- Grading the filter pack to effectively trap fine particles that may otherwise interfere with water quality analysis.

Monitoring well development should not be completed until at least 24 hours have elapsed following monitoring well installation to permit enough time for the well seal to set up and for the water level in the monitoring well to stabilize. Any deviation from this procedure must be approved by the Project Manager before proceeding.

4.0 DISTRIBUTION

This is an on-line document. Paper copies are valid only on the day they are printed. Refer to the author if you are in any doubt about the accuracy of this document.

This SOP will be distributed to all Pinchin staff and others as follows:

- Posted to the SOP section of the EDR Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at Pinchin West, Le Groupe Gesfor Poirier and Pinchin LeBlanc for distribution as appropriate.

5.0 PROCEDURE

5.1 Equipment and Supplies

- Inertial pump (e.g., Waterra tubing and foot valve);
- Surge block for use with an inertial pump (Optional);
- Submersible pump (including pump controller and power supply) (Optional);

- Disposable bailer (Optional);
- Graduated pail (to contain purge water and permit the volume of groundwater purged to be tracked);
- Pails or drums for purge water storage prior to disposal;
- Well keys (if wells are locked);
- Tools to open monitoring well (T-bar, socket set, Allen keys, etc.);
- Interface probe;
- Equipment cleaning supplies (see SOP-EDR009);
- Field parameter measurement equipment (see SOP-EDR016) (Optional);
- Disposable nitrile gloves; and
- Field forms.

Pinchin typically employs inertial pumps or bailers for well development because they can be dedicated to each well. However, the use of submersible pumps is a viable alternative for deep wells with high well volumes at the discretion of the Project Manager.

5.2 Procedures

The well development procedures employed will be determined by the hydraulic conductivity of the formation in which the groundwater monitoring well is installed. For this SOP, a high yield well is defined as a well that cannot be purged to dryness when pumping continuously at a rate of up to 2 litres per minute (L/min) and a low yield well is defined as a well that can be purged to dryness when pumping continuously at a rate of up to 2 L/min or less. This threshold represents a “normal” pumping rate when hand pumping with an inertial pump.

The initial stage of well development (Stage 1) will apply to all wells and will involve the removal of up to one well volume, followed by an evaluation of the well yield. The procedures followed for Stage 2 of well development will be contingent on whether the well is determined to be a low yield or high yield well.

5.2.1 Well Development for Low and High Yield Wells - Stage 1

The initial procedures for developing a low yield or high yield monitoring well are as follows:

1. Decontaminate all non-dedicated monitoring and sampling equipment that will be used, including the interface probe and submersible pump (if used), in accordance with the procedures described in SOP-EDR009;
2. Review the well construction details provided in the borehole log, previous field notes or well construction summary table from a previous report. Determine the well depth, screen length, depth to the top of the sand pack and diameter of the borehole annulus. If the well depth is unavailable, measure it with the interface probe;

3. Measure the initial water level (i.e., static water level) from the reference point on the well (which should be marked at the top of the well pipe) with an interface probe. If measurable free-phase product is present on the water table, record the depth to the free-phase product and discuss this with the Project Manager before proceeding further;
4. Calculate the well volume. **Note that for the purpose of this SOP, there are two definitions of well volume depending on the province in which the project is being conducted.** For Ontario and Manitoba, the well volume is defined as the volume of water within the wetted length of the well pipe (well pipe volume) plus the volume of water within the wetted length of the sand pack (sand pack volume). For British Columbia, Alberta and Saskatchewan, the well volume is defined as the volume of water within the wetted length of the well pipe (well pipe volume) only.

   The volume of water in the well pipe is calculated as follows:

   Well Pipe Volume (litres) = h_w x π r_w^2 x 1,000 litres per cubic metre (L/m^3)

   Where π = 3.14

   h_w = the height of the water column in the monitoring well in metres (wetted length)

   r_w = the radius of the monitoring well in metres (i.e., half the interior diameter of the well)

   The volume of the sand pack in the monitoring well is calculated as follows:

   Sand Pack Volume (litres) = h_w x [(0.3 π r_b^2 x 1,000 L/m^3) – (0.3 π r_w^2 x 1,000 L/m^3)]

   Where 0.3 = the assumed porosity of the sand pack

   h_w = the height of the water column in the monitoring well in metres (wetted length)

   π = 3.14

   r_b = the radius of the borehole annulus in metres

   r_w = the radius of the monitoring well in metres

   For Ontario and Manitoba projects, the following table provides well volumes in litres/metre for typical well installations:

Borehole Annulus Diameter (Inches/Metres)	Well Interior Diameter (Inches)	Well Pipe Volume (Litres/Metre)*	Well Volume (Litres/Metre)*
4/0.1	1.25	0.8	2.9
	1.5	1.1	3.2
	2	2.0	3.8
6/0.15	1.25	0.8	5.9
	1.5	1.1	6.1
	2	2.0	6.7
8.25/0.21	1.5	1.1	11.2
	2	2.0	11.8
10.25/0.26	1.5	1.1	16.7
	2	2.0	17.3

* Litres to be removed per metre of standing water in the well (wetted length).

If the borehole annulus and well interior diameters match one of those listed above, to determine the volume of one well volume simply multiply the number in the last column of the table by the wetted length in the well. For example, if a 2-inch diameter well installed in a 8.25-inch diameter borehole has 2.2 metres of standing water, one well volume equals 26.0 litres (2.2 metres x 11.8 litres/metre).

Note that the above well volume calculations apply only to wells where the water level in the well is below the top of the sand pack. If the water level is above the top of the sand pack, then the well volume is the volume of water in the sand pack and well within the sand pack interval, plus the volume of water in the well pipe (i.e., well pipe volume) above the top of the sand pack.

For example, assume a 2-inch diameter well has been installed in a 8.25-inch diameter borehole to a depth of 6.0 metres below ground surface (mbgs), with a 3.05 metre long screen. The sand pack extends from 6.0 mbgs to 2.5 mbgs and the water level is at 1.85 mbgs. One well volume equals ([6.0 metres – 2.5 metres] x 11.8 litres/metre) + ([2.5 metres – 1.85 metres] x 2.0 litres/metre) or 42.6 litres.

For British Columbia, Alberta and Saskatchewan projects, the well volume is calculated using the conversion factor listed in the third column of the above table. For example, if there are 2.5 metres of standing water in a 1.5-inch diameter well, one well volume equals 2.75 litres (2.5 metres x 1.1 litres/metre);

5. Lower the pump into the well until the pump intake is approximately 0.3 metres above the bottom of the well. Remove half a well volume while pumping at a rate of approximately 1 to 2 L/min. Measure the depth to water after the half a well volume is removed. Record the approximate purge volume, pump intake depth and any pertinent visual/olfactory observations (e.g., sheen, odour, free-phase product, sediment content, clarity, colour, etc.); and
6. Move the pump intake upward to the middle of the water column (or middle of the screened interval if the static water level in the well is above the top of the screen). Remove half a well volume (for a cumulative total of 1 well volume) or purge until dry while pumping at a rate of approximately 1 to 2 L/min, whichever occurs first. Measure the depth to water after the half a well volume is removed. Record the approximate purge volume, pump intake depth and any pertinent visual/olfactory observations. Note that if suction is broken (indicating that drawdown to the pump intake depth has occurred), move the pump intake to the bottom of the well and continue purging.

After completing Step 6, review the water level data to assess whether the well is a low yield or high yield well. If the well is purged dry or close to dryness, or significant drawdown has occurred, then the well is a low yield well. If little or no drawdown has occurred then the well is a high yield well. Some judgement will be required by field personnel when classifying the well yield if moderate drawdown has occurred during removal of the first well volume.

5.2.2 Well Development for High Yield Wells - Stage 2

The procedures for the second stage of developing a high yield monitoring well are as follows:

1. Move the pump intake upward to near the top of the screened interval (or near the top of the water column if the water level is currently below the top of the screen). Remove half a well volume (for a cumulative total of 1.5 well volumes) while pumping at the maximum practical rate that is greater than 2 L/min. Record the approximate purge volume, pump intake depth and any pertinent visual/olfactory observations (e.g., sheen, odour, free-phase product, sediment content, clarity, colour, etc.);
2. Note that if the wetted length is short within a well (e.g., 1.5 metres or less), there will not be enough separation between pump intake depths to warrant pumping from three depths (i.e., near the bottom, middle and top of the water column). In this case, pumping from two depths (i.e., near the bottom and top of the water column) is sufficient;

3. Lower the pump intake until it is approximately 0.3 metres above the bottom of the well. Remove half a well volume (for a cumulative total of 2 well volumes) while pumping at the maximum practical rate that is greater than 2 L/min. Record the approximate purge volume, pump intake depth and any pertinent visual/olfactory observations;
4. Move the pump intake upward to the middle of the water column (or middle of the screened interval if the water level in the well is above the top of the screen). Remove half a well volume (for a cumulative total of 2.5 well volumes) while pumping at the maximum practical rate that is greater than 2 L/min. Record the approximate purge volume, pump intake depth and any pertinent visual/olfactory observations;
5. Move the pump intake upward to near the top of the screened interval (or near the top of the water column if the water level is currently below the top of the screen). Remove half a well volume (for a cumulative total of 3 well volumes) while pumping at the maximum practical rate that is greater than 2 L/min. Record the approximate purge volume, pump intake depth and any pertinent visual/olfactory observations;
6. If the purge water contains high sediment content after the removal of 3 well volumes, well development should continue by removing additional well volumes until the sediment content visibly decreases. If the purge water continues to have high sediment content after the removal of 2 additional well volumes (i.e., 5 well volumes in total), contact the Project Manager to discuss whether well development should continue. A cap of 10 well volumes removed is considered sufficient for high yield well development regardless of sediment content; and
7. Record the water level at the conclusion of well development.

Note that at the discretion of the Project Manager, when developing a monitoring well using an inertial pump, a surge block can be attached to the foot valve before completing Step 1 (i.e., the first time groundwater is pumped from near the top of the screened interval or water column) and then leaving it on the foot valve for the remainder of well development. A surge block is used to increase the turbulence created by pumping and enhance the removal of fine-grained material from the sand pack.

Note that the use of a bailer to develop a high yield well with a wetted interval greater than 2 metres is not recommended given that the depth from which groundwater is removed is difficult to control. However, a bailer can be used as a substitute for a surge block by raising and lowering it through the screened interval for approximately 5 to 10 minutes before the start of Step 1.

5.2.3 Well Development for Low Yield Wells - Stage 2

The procedures for the second stage of developing a low yield monitoring well are as follows:

1. Position the pump intake at the bottom of the well and purge the well to dryness if it was not purged to dryness during completion of Stage 1 at the maximum practical rate that is greater than 2 L/min. Allow sufficient time for the well to recover to at least 90% of the initial static water level or allow the well to recover for a period of time designated by the Project Manager; and
2. Repeat Step 1 until the well has been purged to dryness a minimum of 3 times. An exception to this is that if recovery is slow, especially if sediment content is low, repeat purging (i.e., purging the well to dryness more than once) may not be necessary and the need for additional purging is to be discussed with the Project Manager. If the purge water contains high sediment content after purging to dryness 3 times, well development should continue by purging the well to dryness until the sediment content visibly decreases. If the purge water continues to have high sediment content after purging the well to dryness 2 additional times (i.e., purging the well to dryness 5 times in total), contact the Project Manager to discuss whether well development should continue. A cap of purging a well to dryness 10 times is considered sufficient for low yield well development regardless of sediment content.

As per the procedure for high yield well development, a surge block can be attached to the foot valve to increase the effectiveness of the pumping action. If a surge block is used, pumping should commence at the top of the water column in the well (instead of near the bottom of the well as described above) with the pump intake progressively lowered as the water level in the well decreases.

Note that bailers can be used in lieu of an inertial pump for well development. The turbulence created in a well by the act of dropping a bailer into it and then removing it full of groundwater can be effective in removing fine-grained material from the sand pack. If a bailer is left in a well, it should be “hung” above the water table to facilitate future water level monitoring.

5.2.4 Removal of Water Lost During Well Installation

When water has been used during well installation (e.g., for bedrock coring, to control heaving sands), the total volume of water required to be purged from a well during development will be equal to 3 times the estimated volume of water lost during drilling plus the volume of water that would normally be removed during well development.

For example, for a high yield well where 25 litres of water were lost during drilling and the well volume is 10 litres, the minimum amount of water to be purged during development is 105 litres (i.e., 3 times the volume of water lost during drilling [75 litres] plus a minimum of 3 well volumes [30 litres]).

For a low yield well, the well will need to be purged to dryness enough times to remove a volume equivalent to 3 times the volume of water lost during drilling plus the volume of water that would normally be removed during well development.

As an alternative to removing 3 times the volume of water lost during drilling, field parameter stabilization during well development can be used to assess whether sufficient water has been removed. For example, the conductivity of drill water (which is usually tap water) is typically much lower than groundwater, and conductivity measurements can act as a guide during development as to whether the water being removed is formation groundwater or drill water.

For assessing field parameter stability when developing a high yield well, field parameter measurements of pH, conductivity, temperature and oxidation-reduction potential are to be made after every half well volume is removed and stability is considered achieved if the field parameters are all within ±10% over 3 consecutive readings. Note that a minimum of 3 well volumes must be removed even if field parameter stabilization is achieved prior to the removal of 3 well volumes to comply with the minimum well purging requirements of this SOP (i.e., removal of a minimum of 3 well volumes from a high yield well).

For assessing field parameter stability when developing a low yield well, field parameter measurements of pH, conductivity, temperature and oxidation-reduction potential are to be made once each time a well is purged to dryness, approximately halfway through purging. For example, if based on the current water level it is estimated that 10 litres will be removed before a well is purged to dryness, the field parameters are to be measured after 5 litres have been removed. Stability is considered achieved if the field parameters are all within ±10% over 3 consecutive readings. After stabilization is achieved, continue to purge the well to dryness a final time at which point development is complete.

A second alternative would be to allow sufficient time for the drill water to dissipate into the formation. The appropriate amount of time will depend on the amount of water lost to the formation and the formation characteristics, but will be a minimum of one week. A Senior Project Manager or Senior Technical Reviewer will be responsible for determining the suitability of this approach and the required length of time. At the discretion of the Senior Project Manager or Senior Technical Reviewer, field parameter measurements may be made during pre-sampling purging to assess whether the drill water has dissipated by the time of sampling.

Note that it can be difficult to estimate the amount of water lost during drilling. If the driller's water tank is accessible, measure the water levels in the water tank before and after drilling the well and then estimate the volume of water used during drilling using the water tank dimensions and subtract this volume from the volume of water recovered at the end of drilling from this volume to estimate the volume of water lost. If this is not possible, ask the driller to estimate the approximate volume of water lost during drilling.

For some well installations, determining even an approximate volume of water lost during drilling is not possible. In this situation, field parameter stabilization should be used as a guide in deciding how much water to remove during well development.

5.2.5 Development of Monitoring Wells Installed Using Air Rotary Drilling Methods

When developing a monitoring well installed using an air rotary drilling procedure, field parameter stabilization must be used to assess whether sufficient water has been removed and the field parameters measured must include dissolved oxygen. This is particularly important when the contaminants of concern at a site include volatile organic compounds (VOCs) as the use of compressed air during the drilling process can result in sparging of VOCs from the groundwater, resulting in groundwater samples that are biased low with respect to VOC concentrations.

The well development procedure is the same as described in Section 5.2.4, except that the field parameters measured are to include pH, conductivity, temperature, oxidation-reduction potential and dissolved oxygen. The criterion for determining field parameter stabilization for dissolved oxygen is ±10% over 3 consecutive readings or 3 consecutive readings with concentrations less than 0.5 milligrams per litre.

5.2.6 Assessing Field Parameter Stabilization

When determining whether field parameter stabilization has occurred over 3 consecutive readings (except for dissolved oxygen), the following procedure is to be followed:

1. For each parameter, use the first of the 3 readings and calculate 10% of this reading; and
2. The range that the next 2 readings must be within is ± 10% of the first reading.

For example, if the temperature of the first of 3 consecutive readings is 10º C, the next 2 readings must fall between 9 and 11 º C for temperature to be considered stable.

5.3 Well Development Record

Well development is to be documented through the completion in full of the following field forms located in the Pinchin Orchard:

- EDR-GW-Well Development-S1-Low/High Yield Well (completed for Stage 1 for both low and high yield wells);
- EDR-GW-Well Development-S2-Low Yield Well (completed for Stage 2 for low yield wells); and/or
- EDR-GW-Well Development-S2-High Yield Well (completed for Stage 2 for high yield wells).

Any deviations from this SOP along with the rationale for these deviations must be recorded on the EDR-GW-Well Development-S1-Low/High Yield Well form.

Pinchin West field staff may use these forms or alternate forms as designated by the Pinchin West Practice Leader.

5.4 Additional Considerations for O. Reg. 153/04 Phase Two ESA Compliance

When developing a low yield well, the well must be purged to dryness a minimum of 3 times regardless of the recovery time unless reduced purging is authorized by the Qualified Person responsible for the Phase Two ESA.

6.0 TRAINING

The Practice Leader is responsible for identifying the training needs of Environmental Due Diligence and Remediation (EDR) staff and ensuring that staff are trained and competent before undertaking work assignments.

All trained personnel are responsible for identifying coaching or re-training needs (if they are uncomfortable with work assignments that have been assigned).

The careful application of *Health & Safety Training* by each employee is an integral part of all activities and is assumed as part of this SOP.

7.0 MAINTENANCE OF SOP

1 Year.

8.0 REFERENCES

Association of Professional Geoscientists of Ontario, "*Guidance for Environmental Site Assessments under Ontario Regulation 153/04 (as amended)",* April 2011.

9.0 APPENDICES

None.

I:\2016 SOP Updates\SOP - EDR017 - REV003 - Well Development.docx

Template: Master SOP Template – February 2014

PINCHIN

SOP – EDR023 – REV004 – LOW FLOW GROUNDWATER SAMPLING

Title:	Low Flow Groundwater Sampling
Practice:	EDR
First Effective Date:	July 08, 2011
Version:	004
Version Date:	April 29, 2016
Author:	Paresh Patel and Robert MacKenzie
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TABLE OF CONTENTS

1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	July 08, 2011	N/A	PDP
001	April 15, 2013	Streamlined background section/Provided step-by-step summary of field procedure/Added O. Reg. 153/04 compliance items	RLM
002	September 11, 2013	Added centrifugal submersible pump to list of pumps suitable for low flow sampling	RLM
003	January 26, 2015	Adjusted well development, sampling and field parameter measurement procedures to reflect Pinchin West practices.	RLM
004	April 29, 2016	Updated Section 4.0/Updated Section 5.3 to reflect current field documentation requirements and new document retention policy	RLM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the standard procedures for collecting groundwater samples from monitoring wells using low flow (low stress) sampling techniques and provides a description of the equipment required and field procedures.

Low flow sampling provides an alternative to the conventional groundwater purge and sampling technique using inertial pumps and/or bailers, and emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water level drawdown, and by using low pumping rates during purging and sampling. Rather than removing a specified number of well volumes or purging a well to dryness a specified number of times prior to sampling, purging is completed at a low pumping rate until field parameters such as pH, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), specific conductance and turbidity, which are monitored during purging, have stabilized indicating that representative formation groundwater is being purged. It is important that field parameter stabilization be achieved prior to groundwater sampling as this indicates that fresh formation water is being purged and not stagnant groundwater from within the well itself.

Low flow groundwater sampling methods work best for moderate to high yield wells (i.e., wells installed in permeable soils such as sand, silty sand and some silts). For low yield wells (e.g., wells installed in silty clay), low flow groundwater sampling may not be suitable and alternate purging and sampling procedures will be required (see SOP-EDR008 for low yield well sampling procedures).

Conventional sampling can result in sediment entrainment in samples which can result in “positive bias” (i.e., reported concentrations greater than actual groundwater concentrations). This is particularly an issue with petroleum hydrocarbons (PHCs) in the F3 and F4 Fraction ranges and polycyclic aromatic hydrocarbons (PAHs) and low flow sampling as per this SOP is strongly recommended when sampling for these parameters unless the hybrid sampling method described in SOP-EDR008 is employed.

This SOP is based primarily on the procedures described in the United States Environmental Protection Agency Region 1 document *“Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells”*, revised January 19, 2010.

3.0 OVERVIEW

The low flow sampling technique can be implemented for any size of monitoring well that can accommodate a positive lift pump or tubing assembly. Note that low flow sampling can be conducted for bedrock monitoring wells without well screens (i.e., with an open interval below the well casing) but for simplicity the screen interval or open interval will be referred to collectively in this SOP as the “screen interval”.

Advantages of the low flow sampling technique over conventional groundwater sampling techniques include:

- Minimal disturbance at the sampling point, reducing the potential for sediment to be entrained during the purging process which can result in positive bias (elevated and unrepresentative concentrations) of parameters such as heavy fraction range PHCs and PAHs;
- Reduced operator variability resulting in greater operator control;
- Reduced purge water volumes resulting in reduced investigation derived waste disposal costs; and
- Improved sample consistency resulting in more representative (unbiased) and reproducible sample results.

Disadvantages of the low flow sampling technique over conventional groundwater sampling techniques include:

- Purging and sampling typically requires more time than conventional sampling methods;
- Use of non-dedicated equipment (e.g., submersible pumps) that requires cleaning before initial use and between monitoring well locations; and
- Overall project costs for low flow groundwater sampling programs are typically higher than groundwater sampling programs completed using conventional sampling methods.

It is imperative that the monitoring wells to be sampled are properly developed prior to conducting low flow groundwater sampling. This often includes redevelopment of previously installed wells that have not been sampled for a prolonged period of time (i.e., more than one year). During well development or redevelopment, the hydraulic characteristics of each well should be assessed to provide guidance on the suitability of using the low flow groundwater sampling procedure. Well development procedures are provided in SOP-EDR017.

When groundwater conditions are known, sample the background monitoring wells (i.e., outside of the impacted groundwater area) and wells with low concentrations of contaminants of concern first prior to sampling wells with known impacts. Leave impacted wells to the last to minimize the potential for cross contamination.

In Ontario and Manitoba, or where otherwise specified by provincial guidance documents, a peristaltic pump is not to be used for the collection of groundwater samples for analysis of volatile parameters (i.e., volatile organic compounds (VOCs) and PHCs F1 Fraction). When sampling for volatile parameters using low flow groundwater sampling methods, a bladder pump or centrifugal submersible pump (collectively referred to herein as “submersible pumps”) must be used. A “hybrid” groundwater purging and sampling procedure using a peristaltic pump to undertake low flow groundwater sampling for non-volatile parameters as described in this SOP followed by conventional purging and sampling methods for volatile parameters is an acceptable alternative to using a bladder pump or centrifugal submersible pump.

Peristaltic pumps cannot be used where the suction lift (i.e., vertical distance between the pump and groundwater level) is more than 8.5 metres (28 feet).

It is very important to maintain consistency in applying low flow groundwater sampling procedures to purging and sampling for each monitoring well and for each sampling event. Any deviation from the field procedures described in this SOP can induce variability in the analytical results.

Our primary objective is to obtain unbiased groundwater samples whose analytical results are representative of actual groundwater quality at the property being investigated.

4.0 DISTRIBUTION

This is an on-line document. Paper copies are valid only on the day they are printed. Refer to the author if you are in any doubt about the accuracy of this document.

This SOP will be distributed to all Pinchin staff and others as follows:

- Posted to the SOP section of the EDR Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at Pinchin West, Le Groupe Gesfor Poirier and Pinchin LeBlanc for distribution as appropriate.

5.0 PROCEDURE

5.1 Equipment and Supplies

5.1.1 Documents and Information Gathering

The following documents and information are required to complete low flow groundwater sampling:

- A copy of the proposal or work plan;
- Monitoring well construction details;
- A copy of this SOP;
- Field data from the last sampling event (if available);
- Operation, maintenance and calibration manuals for the multi-parameter water quality meter;
- A site-specific Health and Safety Plan (as per the project requirements); and
- Client or site representative’s contact details.

5.1.2 Extraction Devices and Tubing

This SOP will not discuss in detail the various pumps and tubing options that are available for completing low flow groundwater sampling. The following section provides some general guidelines for the use of this equipment and it is recommended that the equipment supplier be consulted when selecting the appropriate pump and tubing, taking into account site-specific parameters (e.g., well depth, well diameter, site accessibility) and the parameters that will be sampled.

5.1.3 Extraction Devices

For purging and sampling using the low flow sampling procedure, submersible pumps (e.g., centrifugal, bladder) and peristaltic pumps are the most commonly used extraction devices. Regardless of the type of extraction device used, the low flow sampling procedure requires precise control over the flow rate during purging and sample collection. A battery-operated pump controller is required to operate submersible pumps and to control the extraction flow rate. Peristaltic pumps have built-in flow rate adjusters.

Submersible pumps with internal parts constructed of stainless-steel or Teflon are preferred. If the internal parts are constructed of other materials, adequate information must be provided by the equipment supplier to show that the substituted materials do not leach contaminants nor cause interference to the analytical procedures to be used. The use of any such substituted materials must be approved by the Project Manager prior to the field program.

If a bladder pump is selected for the collection of samples for volatile parameters analysis, it should be capable of delivering a water volume sufficient to fill a VOC sample vial in one pulse.

5.1.4 Tubing

Teflon, Teflon-lined polyethylene or polyethylene 1/4-inch interior diameter (ID) or 3/8-inch ID tubing is to be used to connect to the pump and the flow-through cell. In the winter time, the use of 3/8-inch ID tubing is recommended to avoid groundwater freezing in the tubing during severe cold weather conditions.

If the tubing is constructed of other materials (other than mentioned above), adequate information must be provided to show that the substitute materials do not leach contaminants nor cause interference with the analytical procedures. The use of any such substituted materials must be approved by the Project Manager prior to the field program.

Direct sunlight and hot ambient air temperatures may cause groundwater in the tubing to heat up and degas resulting into loss of volatile parameters. When sampling under these conditions, the length of the tubing between the top of the monitoring well and the flow-through cell should be kept as short as possible to minimize exposure to sunlight or ambient air and heating of the groundwater.

5.1.5 Groundwater Monitoring, Purging and Sampling

The following equipment is required to complete the low flow purging and sampling procedure described in this SOP:

- Well keys;
- Interface probe;
- Assorted tools (e.g., knife, screwdriver, etc.);
- Equipment cleaning reagents required as per SOP-EDR009 (e.g., distilled water, phosphate-free detergent, etc.);
- Multi-parameter water quality meter (including calibration solutions);
- Graduated cylinder, graduated measuring cup or graduated bucket;
- Stopwatch;
- Flow-through cell;
- Peristaltic pump, submersible centrifugal pump or bladder pump;
- Tubing;
- Pails or drums for storing purge water;
- Paper towels or wipes;
- Calculator;
- Field forms or field notebook (hereafter the “field notes”);
- Waterproof and permanent markers;

- Disposable gloves and appropriate personal protective equipment based on site-specific conditions;
- Cooler and ice packs;
- Sample bottles and labels. Several extra sample bottles should be available in case of breakage or other problems; and
- Laboratory Chain of Custody forms.

The following equipment may be used during well sampling, in addition to the above:

- Disposable field filtration units/filters (if appropriate).

5.2 Low Flow Groundwater Sampling Procedures

The following is the summary of the procedures to be followed for low flow groundwater sampling:

1. Develop the monitoring wells to be sampled (if required) prior to sampling by removing between three and five well volumes or by purging them to dryness between one and three times. Further details regarding well development are provided in SOP-EDR017. Well development is to be completed for all newly installed wells prior to low flow sampling and may be required for previously installed monitoring wells that have not been sampled in more than one year. Ideally, well development should occur at least one day prior to low flow sampling. At the discretion of the Project Manager, low flow sampling can occur on the same day as the well is developed but the well must be allowed to fully recover to its original static level prior to the start of purging;
2. Decontaminate all non-dedicated monitoring and sampling equipment that will be used, including the interface probe, submersible pump (if used), water quality meter probes and flow-through cell in accordance with the procedures described in SOP-EDR009;
3. Calibrate the water quality meter used for field parameter measurement in accordance with the manufacturer's specifications. Wherever possible, arrange for the equipment rental company to calibrate the water quality meter and provide a calibration sheet that contains information such as calibration date and calibration measurements for each parameter. If the water quality meter is to be used for more than a one day, a calibration check shall be performed using standard calibration solutions at the start of each day at a minimum. If the calibration check shows deviations from the standard values that exceed the ranges provided in bullet 10 below, the instrument shall be calibrated prior to further use. A calibration check should also be performed during the course of purging and sampling if the parameter measurements suggest that calibration drift has occurred. Document all calibration activities in the field notes, including date and time of

calibration/calibration check, calibration solutions used, probe readings and make, model and serial number of the water quality meter. Note that if the water quality meter manufacturer recommends more frequent calibration/calibration checks than specified above, the manufacturer's recommendations are to be followed. See SOP-EDR016 for additional procedures regarding water quality meter calibration.

Extra care must be taken to calibrate the multi-parameter probe to prevent cross-contamination. Specifically, following immersion of the probes into each calibration standard, all probes should be thoroughly rinsed in distilled or de-ionized water and the excess water shaken off or blotted dry with a lint-free wipe. Conductivity standards are much more sensitive to cross contamination/dilution than other standards, and prior to immersion in a conductivity standard, all probes should be thoroughly rinsed and completely dried with lint-free wipes. Besides being easily diluted, conductivity standards also affect other parameters (specifically DO), and the conductivity probe should always be the first probe calibrated. The following order for calibration of a multi-parameter probe is to be followed:

- Specific Conductance;
- pH;
- DO; and
- Turbidity.

There is no recommended order for calibration of other parameters;

4. Review the well construction details provided in the borehole logs or well construction summary table from a previous report. Determine the well depth, length of the screen interval, and depth to the top of the screen interval. If the well depth is unavailable, measure it with the interface probe;
5. Measure the initial water level (i.e., static water level) from the reference point on the well (which should be marked at the top of the well casing) with an interface probe. If measurable free-phase product is present in the well, discuss this with the Project Manager before proceeding further. Using the known well depth, confirm that at least 0.6 metres of water is present within the well. If less than 0.6 metres of water is present, low flow sampling may not be appropriate and the Project Manager is to be contacted before proceeding further;
6. Following decontamination, slowly install the pump or tubing (for peristaltic pumps) to the appropriate depth within the well. Do not connect the pump discharge tubing to the flow-through cell at this time. If the water level in the well is above the top of the screen

interval, the pump or tubing intake depth will be the mid-point of the screen interval. If the water level is below the top of the screen interval, the pump or tubing intake will be set at the mid-point of the wetted interval (i.e., the distance between the static water level and the bottom of the well) or 0.6 metres from the bottom of the well, whichever is a greater distance from the bottom of the well. Pumping from within 0.6 metres of the bottom of the well has a higher potential to entrain sediment from the bottom of the well and is not to be completed unless authorized by the Project Manager.

The pump intake depth may vary from that described above at the discretion of the Project Manager depending on the specific purpose of the groundwater sampling program. For example, if chlorinated solvents that are denser than water are being assessed, it may be desirable to position the pump intake as close to the bottom of the well as possible, or if PHC-related parameters which are lighter than water are being assessed, it may be preferable to position the pump intake as close to the water table as possible. Pump intake depth should be confirmed with the Project Manager prior to the field program;

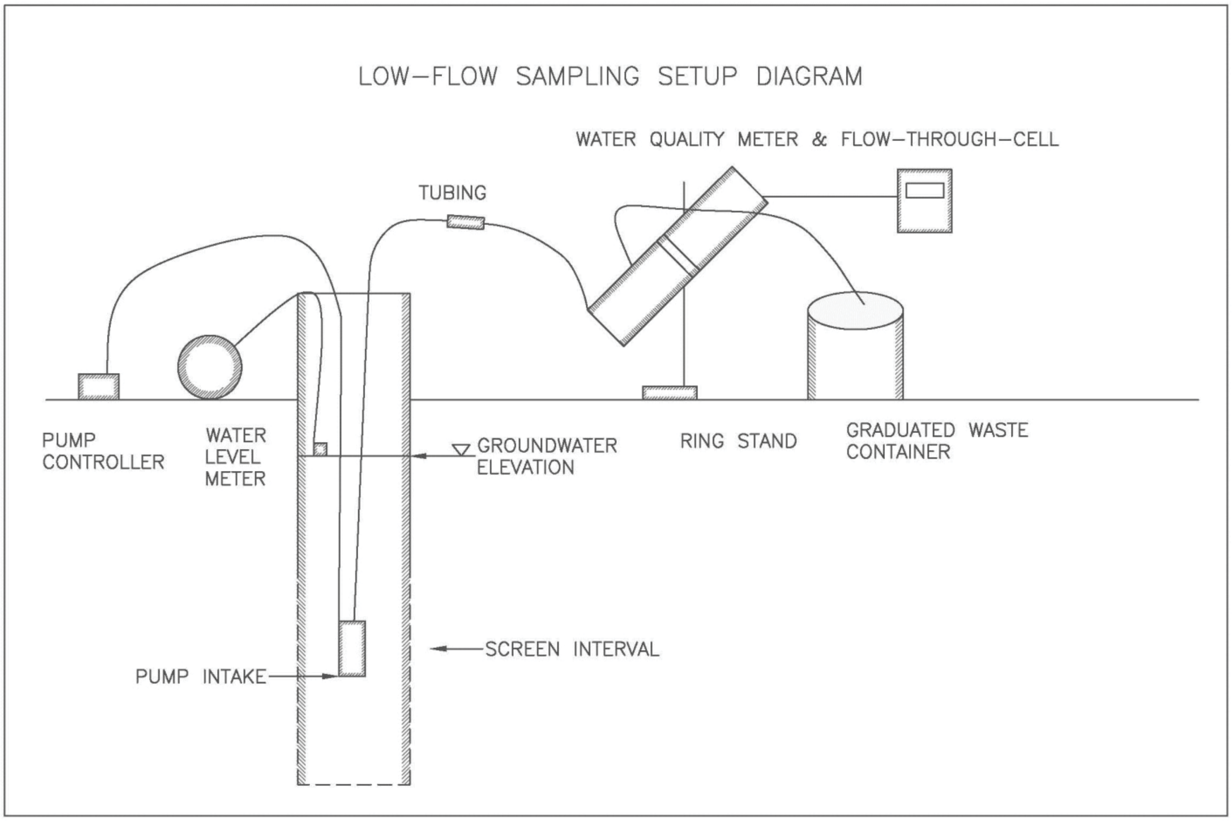
7. Turn on the pump and discharge groundwater into a purge bucket. Purge initially at a flow rate of approximately 250 millilitres/minute (mL/min). Increase or decrease the flow rate until the water level in the well reaches a steady state condition (i.e., a stabilized water level). The goal is to purge at as high a pumping rate as the well will sustain and still maintain a stabilized water level; however, purging rates should not exceed 500 mL/min during purging and sampling. Also, it is important that during the early phase of purging, emphasis should be put on minimizing pumping stress (i.e., rapid fluctuations in pumping rates).

   Whenever possible, purge at a pumping rate low enough to keep the total drawdown in the well to less than 10 centimetres although this may not be achievable for low to moderate yield wells. Once a steady state condition is achieved, the purge rate must be maintained constant and should not be changed. Determine the flow rate using a graduated bucket, graduated measuring cup or graduated cylinder and a stop watch. If the well is purged dry even after reducing the flow rate to the minimum practical purging rate of approximately 50 mL/min to 100 mL/min, then low flow sampling procedures will not work for the well and the sampling procedure described in SOP-EDR008 for sampling low yield wells is to be followed. During purging and sampling, it is important to keep the pump intake below the water level in the well at all times to avoid aeration of the groundwater;

8. If the visual appearance of the groundwater is highly turbid once a stabilized water level is achieved, continue to discharge purged water directly into the purge bucket until the groundwater clears, as highly turbid groundwater may foul the flow-through cell. Once the turbidity clears up, connect the flow-through cell to the pump discharge tubing. If the groundwater remains highly turbid after approximately 15 minutes of purging, contact the Project Manager to discuss whether sampling should occur. Further well development may be required to remove excess sediment from the monitoring well before sampling can proceed;
9. Confirm the volume of the flow-through cell excluding the volume of the water quality meter probes. If this information is not readily available, fill the cell with water and empty its contents into a graduated cylinder or measuring cup to determine the volume. After connecting the discharge tubing to the flow-through cell, continue purging until the flow-through cell is full and turn on the multi-parameter meter. Record the initial field parameter readings in the field notes. At a minimum, the field parameters that are to be monitored are pH, specific conductance, temperature, DO and ORP. The monitoring of turbidity is also a minimum requirement in Ontario and Manitoba. Field parameter readings are to be obtained at a frequency of a minimum of once every 5 minutes. Obtaining field parameter readings at a spacing of greater than 5 minutes apart may be required if the volume of the flow-through cell is large or pumping occurs at a low rate (e.g., 50 or 100 mL/min). For example, if the flow-through cell has a volume of 300 mL and the pumping rate is 50 mL/min, it will take 6 minutes for the volume of water equivalent to the flow-through cell volume to pass through the cell and field parameter readings should be taken 6 minutes apart.

Figure 1 shows a typical low flow groundwater sampling set up using a submersible pump. The set up when using a peristaltic pump is similar except that the only part of the extraction system in the well is tubing that is connected to the peristaltic pump at the ground surface (i.e., there is no pump mechanism within the well), and a second section of tubing connects the discharge of the peristaltic pump to the flow-through cell.

Figure 1: Low Flow Sampling Set Up Diagram



Reference: USEPA Region I EQASOP-GW 001, July 30, 1996, Revised January 19, 2010.

Air bubbles in the flow-through cell can result in inaccurate field parameter measurements, in particular for DO. If air bubbles appear in the flow-through cell, check that the discharge tubing is properly connected to the flow-through cell and check that the pump intake is located below the water table by confirming the pump intake depth and checking the water level in the well. If air bubbles persist in the flow-through cell, position the flow-through cell at a 45-degree angle with the ports facing upwards. This configuration should keep any gas bubbles entering the cell away from the multimeter probes and allow the air bubbles to exit the cell easily;

10. Regardless of the frequency of field parameter readings, purging is to be completed until field parameter stabilization is achieved, which occurs when the field parameter measurements for all of the parameters are within the following ranges for three consecutive sets of readings:

pH	±0.1 pH units

Specific Conductance	±3%
Temperature	±3%
DO	±10% for values greater than 0.5 milligrams per litres (mg/L), or three consecutive values less than 0.5 mg/L
ORP	±10 millivolts
Turbidity	±10% for values greater than 5 Nephelometric Turbidity Units (NTUs), or three consecutive values less than 5 NTU

11. Check the water level in the well during purging a minimum of once every 10 minutes to confirm that steady state conditions are being maintained. Although not mandatory, more frequent water level measurements can be made (e.g., at the time of each set of water quality parameters). Reduce the pumping rate if the water level measurements indicate that drawdown is occurring;
12. Record the time of all water level and field parameter measurements in the field notes;
13. Should field parameter stabilization not occur within one hour of the start of purging, contact the Project Manager to discuss whether to continue purging to attempt to achieve field parameter stabilization or whether to proceed with groundwater sample collection. The Project Manager will consider the total volume of water purged to this point and may deem it suitable to collect the groundwater sample if, for example, three or more well volumes in total have been purged despite the lack of field parameter stability. Note that achieving stabilization of some parameters is more important with respect to certain contaminant types. For example, the stabilization of DO readings is important for volatile parameter sampling because fluctuations in DO concentrations may indicate that the groundwater is being aerating during the purging process which could result in volatile loss from the groundwater samples;
14. Following field parameter stabilization, disconnect the tubing from the flow-through cell and collect the groundwater samples by filling the appropriate laboratory-supplied sample containers directly from the discharge tubing. Note that it is important not to sample groundwater that has passed through the flow-through cell. The order of sample collection should be most volatile parameters to least volatile parameters as follows:
    - VOCs and PHCs F1 Fraction;
    - PHCs F2-F4 Fraction;
    - PAHs and Base/Neutral/Acid Extractables;

- Metals and Inorganics; and
- Polychlorinated Biphenyls and Organochlorine Pesticides.

Special Notes for Volatile Parameter Sampling

When collecting samples for volatile parameter analysis (i.e., VOCs and PHCs F1 Fraction), the tubing must be filled completely and must not contain air bubbles prior to sample collection. If this is observed, increase the pumping rate slightly prior to sample collection until the tubing is filled and/or there are no longer any air bubbles, and then collect the sample. When collecting the groundwater samples for volatile parameter analysis, the sample vials should be tilted to avoid agitation and bubbling to minimize the potential for volatilization.

Special Notes for Metals Sampling

Groundwater samples collected for metals analysis will require filtering prior to preservation if dissolved metals concentrations are sought. Depending on the type and diameter of the discharge tubing used, in-line filters can be used for field filtering. Disposable filtration kits (e.g., Nalgene 0.45 micron filters) can also be used for field filtering. If field filtering cannot be completed, then the groundwater samples are to be collected in sample containers that do not contain preservatives, and the analytical laboratory is to be instructed to filter and preserve the samples immediately upon receipt. The procedure and necessary equipment required to filter and preserve metals samples using the low flow methods should be discussed with the Project Manager prior to mobilization to the field; and

15. Measure the water level in the well at the conclusion of sample collection and record the total purged volume. Remove the pump and/or tubing from the well and decontaminate the sampling equipment.

5.3 Fieldwork Records

The purging and sampling of a monitoring well using the low flow groundwater sampling procedure described in this SOP are to be documented through the completion in full of the following field forms located in the Pinchin Orchard:

- EDR-GW-Low Flow Sampling; and
- EDR-GW-Water Quality Parameters.

Any deviations from this SOP along with the rationale for these deviations must be recorded on the forms.

Pinchin West field staff may use these forms or alternate forms as designated by the Pinchin West Practice Leader.

Upon completion of the sampling event, the field notes must be submitted to the Project Manager for review. The field notes must also be scanned and a copy of the scan placed in the project folder on the server.

5.4 Additional Considerations for O. Reg. 153/04 Phase Two ESA Compliance

When completing a Phase Two Environmental Assessment (ESA) in accordance with Ontario Regulation 153/04, the following must be undertaken:

- Calibration checks must be made for the water quality meter used for field parameter measurements. Records of the calibration checks must be kept and appended to the Phase Two ESA report;
- At least one field duplicate groundwater sample must be collected for every ten samples submitted for analysis. The frequency is one for one to 10 samples, two for 11 to 20 samples, etc. for all parameters analyzed. For example, even if only one groundwater sample is collected for PAHs analysis, a duplicate of this sample must be collected; and
- When sampling for VOCs, one trip blank sample must be submitted to the laboratory for VOCs analysis for each submission to the laboratory. In other words, if a groundwater sampling program lasts three days and samples are submitted to the laboratory at the end of each day, there must be a total of three trip blanks submitted with the samples (i.e., one per day of sampling). Note that analysis of trip blank samples for other volatile parameters (e.g., PHCs (F1 Fraction)) is not mandatory but can be completed at the discretion of the Qualified Person.

In addition, low flow groundwater sampling using a bladder pump or centrifugal submersible pump should be completed whenever well yields are high enough permit it for all Phase Two ESAs undertaken to support the filing of a Record of Site Condition. This will minimize potential issues the Ministry of the Environment and Climate Change may have regarding the representativeness of the groundwater analytical data.

6.0 TRAINING

The Practice Leader is responsible for identifying the training needs of EDR staff and ensuring that staff are trained and competent before undertaking work assignments.

All trained personnel are responsible for identifying coaching or re-training needs (if they are uncomfortable with work assignments that have been assigned).

The careful application of *Health & Safety Training* by each employee is an integral part of all activities and is assumed as part of this SOP.

7.0 MAINTENANCE OF SOP

1 Year.

8.0 REFERENCES

U.S. Environmental Protection Agency Region I, "*Low Stress ('low flow') Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells",* EQASOP-GW 001, July 30, 1996, Revised January 19, 2010.

9.0 APPENDICES

None.

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Template: Master SOP Template – February 2014

SOP – EDR025 – REV002 – QA/QC SAMPLING

Title:	QA/QC Sampling
Practice:	EDR
First Effective Date:	January 17, 2014
Version:	002
Version Date:	April 29, 2016
Author:	Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	2016.04.29 14:03:42 -04'00'

TABLE OF CONTENTS

1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	January 17, 2014	N/A	RLM
001	June 26, 2014	Amended blind duplicate sampling requirements	RLM
002	April 29, 2016	Updated Section 4.0/Amended O.Reg. 153/04 trip blank requirements	RLM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the standard procedures for collecting soil, water and sediment samples for quality assurance/quality control (QA/QC) purposes.

A QA/QC program is essentially a management system that ensures that quality standards are met within a stated level of confidence. The QC component of the program comprises daily activities in the field and laboratory that are used to control the quality of both the samples collected and the sample analytical data. The QA component of the program is made up of measures used to determine whether the QC activities are effective.

When completing a site investigation, one of our primary goals is to obtain analytical data that are representative of actual soil, water and/or sediment conditions at the site. The completion of a QA/QC program, consisting of the collection and analysis of various QA/QC samples, provides information for use in evaluating the accuracy of the analytical data used to assess the environmental quality of the site.

The type and number of samples comprising the QA/QC program will be determined by the Project Manager on a site-by-site basis, but will typically include at a minimum a trip blank when collecting water samples for volatile parameter analysis and duplicate soil, sediment and/or groundwater samples. Other types of QA/QC samples may be collected (e.g., equipment or field blanks) to meet project-specific requirements at the discretion of the Project Manager.

The QA/QC sampling requirements and procedures for indoor air and soil vapour samples are described in SOP-EDR012 and SOP-EDR018, respectively.

3.0 OVERVIEW

The types of samples collected for the QA/QC program during site investigations include the following:

- Trip blanks;
- Field blanks;

- Equipment blanks; and
- Field duplicates.

Trip blanks are used to assess whether ambient air conditions may have resulted in positive bias of water samples collected for volatile parameter analysis during transportation of the sample containers to and from a project site. Note that the term “positive bias” means that reported sample concentrations are greater than actual in situ sample concentrations due to some form of “cross-contamination”.

Field blanks are collected to assess whether ambient air conditions may have resulted in positive bias of samples collected at a project site for volatile parameter analysis at the time of sampling.

Equipment blanks are collected to assess the efficiency of non-dedicated monitoring/sampling equipment cleaning procedures.

Duplicate samples are collected to assess whether field sampling and laboratory analytical methods are suitable and reproducible.

The analytical results of the QA/QC samples are reviewed by the Project Manager to assess whether any data quality issues are evident which may affect the interpretation of the soil, water and/or sediment sample analytical data.

4.0 DISTRIBUTION

This is an on-line document. Paper copies are valid only on the day they are printed. Refer to the author if you are in any doubt about the accuracy of this document.

This SOP will be distributed to all Pinchin staff and others as follows:

- Posted to the SOP section of the EDR Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at Pinchin West, Le Groupe Gesfor Poirier and Pinchin LeBlanc for distribution as appropriate.

5.0 PROCEDURE

5.1 Equipment and Supplies

The equipment/supplies required for QA/QC sample collection is the same as that used for regular investigative sampling, except for the following:

- Volatile organic compound (VOC)-free distilled water supplied by the analytical laboratory for use in the collection of field blanks and/or equipment blanks;
- Additional sample jars supplied by the analytical laboratory for the collection of field blanks, equipment blanks and field duplicates; and
- Trip blanks supplied by the analytical laboratory.

5.2 QA/QC Sampling Procedures

5.2.1 General Procedures for QA/QC Blank Sampling

The analytical laboratory that will be completing the analysis of the regular investigative samples and QA/QC samples for a project must supply the water used to collect field blanks and equipment blanks. Water provided by another analytical laboratory or store-bought distilled water must not be used.

5.2.2 Trip Blanks

A trip blank is a set of VOC sample vials filled by the analytical laboratory with VOC-free distilled water and shipped with the sample containers. A trip blank is to be stored with the sample containers provided by the analytical laboratory during travel to the project site, while on the project site, and during travel from the project site back to the analytical laboratory. The sample containers comprising a trip blank are not to be opened in the field.

For some projects, submissions of volatile parameter samples to the analytical laboratory over several days will be required. In this case, a trip blank sample should accompany each submission to the laboratory. If this situation is anticipated, the Project Manager must request that the analytical laboratory provide sufficient trip blanks so that a trip blank can accompany the submission of each set of samples to the laboratory.

Trip blanks are to be analyzed for the same volatile parameters (i.e., VOCs and/or petroleum hydrocarbons (PHCs) (F1 fraction)) as the regular investigative samples. For example, if the groundwater sampling program includes analysis of VOCs and PHCs (F1-F4 fractions), then the trip blank(s) require analysis of VOCs and PHCs (F1 fraction). If the groundwater sampling program only includes VOC analysis, then the trip blank(s) require analysis of VOCs only.

Unless specified by the Project Manager, trip blanks are not required for soil and sediment sampling, or for water sampling involving only non-volatile parameters. At the discretion of the Project Manager and to meet project-specific requirements, trip blanks for non-volatile parameters can be prepared and analyzed using the same principals as for volatile parameter trip blanks.

5.2.3 Field Blanks

A field blank is a set of VOC sample vials filled during a sampling event at a project site with VOC-free distilled water supplied by the analytical laboratory and submitted for analysis of volatile parameters (i.e., VOCs and/or PHCs (F1 fraction)).

Field blanks are to be collected at a sample location considered “worst case” with respect to ambient air conditions (e.g., when sampling adjacent to and downwind of the pump island of an active retail fuel outlet, when sampling inside an active on-the-premises dry cleaner, etc.). At project sites where there is no obvious “worst case” ambient air location, the field blank can be collected at a sampling location picked randomly. The field blank collection location and rationale for selecting it must be documented in the field notes.

If a groundwater sampling event at a project site occurs over more than one day, a field blank is to be collected for each day of sampling.

Some project sites may have an isolated area where the ambient air conditions are significantly poorer than the remainder of the site and a field blank collected from this area may not be representative of conditions elsewhere on the site. In this case, at the discretion of the Project Manager, the collection of two field blanks may be appropriate, with one field blank collected from the poor ambient air area and one field blank collected from a location outside of this area.

Unless specified by the Project Manager, field blanks are not required for soil and sediment sampling, or for water sampling involving only non-volatile parameters. At the discretion of the Project Manager and to meet project-specific requirements, field blanks for non-volatile parameters can be collected and analyzed using the same principals as for volatile parameter field blanks.

5.2.4 Equipment Blanks

An equipment blank is collected by pouring VOC-free distilled water supplied by the analytical laboratory either over or through non-dedicated sampling/monitoring equipment that has been cleaned following sampling/monitoring using the procedures outlined in SOP-EDR009. The resulting rinsate is then captured in sample containers appropriate for the intended analysis. Note that the surface over which the distilled water is poured must be the surface from which samples are collected from or that is in contact with the medium being monitored. For example, if an equipment blank is being collected from a split-spoon sampler, the distilled water must be poured through the interior of sampler, and not the exterior of the sampler.

The Project Manager will be responsible for determining the sampling/monitoring equipment from which equipment blanks will be obtained, the number of equipment blanks and the parameters to be analyzed. Regarding the latter, the parameters analyzed for equipment blanks are typically the parameters of concern for a given project site.

5.2.5 Evaluation of Blank Sample Results

The Project Manager will evaluate the results of the blank sample analysis to assess whether these results show that bias may have been introduced to investigative samples collected during the field sampling activities. Judgement by the Project Manager will be required to assess whether the blank sample results have any effect on the interpretation of the investigative sample results. This is judged on a case-by-case basis, but the following general principals can be applied:

- If all soil, groundwater and/or sediment samples collected for a site investigation meet the applicable environmental standards/criteria, the presence of detectable or elevated parameter concentrations in the blanks has no effect on the interpretation of the investigative sample results;
- If parameters have detectable or elevated concentrations in the blank samples but none of these parameters are present in the regular investigative samples at concentrations exceeding the applicable environmental standards/criteria, the blank sample results have no effect on the interpretation of the investigative sample results;
- If parameters have detectable or elevated parameter concentrations in the blank samples and one or more of these parameters are present in the regular investigative samples at concentrations exceeding the applicable environmental standards/criteria, then positive bias of the regular investigative samples may have occurred. The Project Manager will need to assess a number of variables, including the relative parameter concentrations in the blank and regular investigative samples, to determine whether the regular investigative sample data is considered representative and usable for assessing the environmental quality of the site. If the regular investigative sample data is questionable, then resampling may be required; and
- If the regular investigative samples have exceedances of the applicable environmental standards/criteria and the blank samples have non-detectable parameter concentrations, the blank sample results have no effect on the interpretation of the investigative sample results.

5.2.6 General Procedures for QA/QC Duplicate Sampling

Whenever possible, duplicate samples are to be collected from “worst case” sample locations. The reason for this is that Relative Percent Differences (RPDs) are calculated using the analytical results of the duplicate and regular investigative samples to evaluate the suitability and reproducibility of field sampling and laboratory analytical methods. However, RPDs for a given parameter can only be calculated if there are detectable concentrations in both samples, and “worst case” sample locations are the most likely to have detectable levels of parameters of concern. The calculation and evaluation of RPDs is discussed at the end of this section.

When filling sample containers, the order of collection is regular investigative sample first and duplicate sample second.

5.2.7 Field Duplicate Samples – Soil/Sediment

Soils/sediments are frequently heterogeneous because they are typically deposited in horizontal layers over time, causing both small scale and large scale grain size variations that can often result in significant variations in contaminant concentrations between layers. Because of this, it is important that duplicate soil/sediment samples be collected from the same vertical depths as the regular investigative samples in sample cores or at discrete sampling locations (e.g., grab samples).

When collecting a duplicate soil/sediment sample from a sampling device that provides a soil core (e.g., dual-tube sampler, split-spoon sampler), the soil core is to be split in half vertically (i.e., longitudinally). A portion of one half of the core is used for the regular investigative sample and a portion of the other half of the core is used for the duplicate sample. The portion of each core placed in sample jars for analysis must be obtained from the same depth interval within the cores.

When collecting a duplicate soil/sediment sample from a grab sample (e.g., excavation floor or sidewall), the field duplicate sample must be collected as close as possible to the regular investigative sample location at the sample depth and within the same soil layer.

There are no special procedures for collecting field duplicates of composite soil/sediment samples given that the soil/sediment is homogenized during the composite sample collection procedure.

A field duplicate soil/sediment sample must be collected at the same time as the regular investigative sample. Retroactively splitting a soil/sediment sample to obtain a field duplicate sample is not permitted.

5.2.8 Field Duplicate Samples – Surface Water/Potable Water/Groundwater

There are no special procedures for collecting surface water/potable water/groundwater field duplicate samples with the following exceptions:

- When collecting a duplicate water sample for metals analysis and field filtering is required, a new filter is to be used to collect the duplicate sample unless the groundwater has a low sediment content; and
- When collecting a duplicate surface water sample, the sample containers for the same parameter(s) should be immersed in the surface water body at the same location and at the same time whenever possible.

5.2.9 Duplicate Sample Labelling

The duplicate sample should have the term “DUP” in the sample identifier to distinguish it as a duplicate sample.

5.2.10 Evaluation of Duplicate Sample Results

Duplicate sample results are evaluated by calculating RPDs using the following equation:

$$\text{RPD} = \frac{\text{Absolute Value (Original Concentration} - \text{Duplicate Concentration)}}{\text{(Original Concentration} + \text{Duplicate Concentration)/2}} \times 100\%$$

RPDs are not calculated unless the parameter concentrations in both the regular investigative sample and duplicate sample are detectable concentrations above the corresponding practical quantitation limit (PQL) for the parameter, which is equal to five times the lowest laboratory reportable detection limit (RDL).

For example, if the RDL for a parameter is 0.1 parts per million (ppm), and the concentration in the regular investigative sample is 0.4 ppm and the concentration in the duplicate sample is 0.6 ppm, the RPD cannot be calculated because the concentration in the regular investigative sample (0.4 ppm) is less than PQL of 0.5 ppm (5 times the RDL of 0.1 ppm).

Also, if the regular investigative sample concentration is 2 ppm and the duplicate sample concentration is <1 ppm, then the RPD cannot be calculated regardless of the PQL since detectable concentrations were not reported for both samples.

Calculated RPDs for the regular investigative and field duplicate samples are compared to established performance standards to evaluate the suitability and reproducibility of field sampling and laboratory analytical methods. In Ontario, the Ontario Ministry of the Environment provides duplicate sample performance standards in the document *Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act,* dated March 9, 2004, amended as of July 1, 2011. Although these performance standards only strictly apply to laboratory duplicate samples, they are considered suitable for comparison to field duplicate samples. Other provinces provide their own similar guidance.

When calculated RPDs exceed the performance standards, the Project Manager will evaluate whether these results have any effect on the interpretation of the investigative sample results. This is judged on a case-by-case basis, but in many situations RPD values above the performance standards can be attributed to small scale heterogeneity inherent in soil samples or variations in the quantity of sediment in groundwater or surface water samples, and are not indicative of poor field sampling or laboratory procedures. The results of internal laboratory QA/QC sampling may provide additional information as to the precision of the data. Furthermore, if all soil, groundwater and/or sediment samples collected for a site investigation meet the applicable environmental standards/criteria, the apparent lack of precision shown by elevated RPD values should not affect the interpretation of the investigative sample results.

Sometimes a regular investigative sample will meet the applicable environmental standards/criteria and its corresponding duplicate sample will fail the applicable environmental standards/criteria (or vice versa).

In Ontario, it is permitted to average the parameter concentrations of two samples provided they are collected at the same time and from the same sample location and depth. The resulting average parameter concentrations are then compared with the applicable standards to determine whether the sample meets or fails the standards. This approach is not acceptable in all jurisdictions. In situations where averaging is not acceptable to the regulatory agency, the "worst case" sample result is to be used in assessing the environmental condition of the project site.

5.3 Fieldwork Records

The field notes must include the following information with respect to QA/QC samples:

- The date and time of sampling for all blank/duplicate samples;
- The sample location for field blanks and the rationale for selecting the field blank locations;
- The type of equipment from which a rinsate was collected for equipment blanks and the parameters to be analyzed; and
- The corresponding regular investigative sample location/sample interval for duplicate samples and the parameters to be analyzed.

5.4 Additional Considerations for O. Reg. 153/04 Phase Two ESA Compliance

When completing a Phase Two ESA in accordance with Ontario Regulation 153/04, the QA/QC sampling program must consist of the following as a minimum:

- At least one field duplicate soil, sediment or groundwater sample must be collected for every ten samples submitted for analysis. The frequency is one duplicate sample for one to 10 regular investigative samples, two duplicate samples for 11 to 20 samples, etc. for all parameters analyzed. For example, even if only one groundwater sample is collected for PAHs analysis, a duplicate of this sample must be collected.

When sampling for VOCs, one trip blank sample must be submitted to the laboratory for VOCs analysis for each submission to the laboratory. In other words, if a groundwater sampling program lasts three days and samples are submitted to the laboratory at the end of each day, there must be a total of three trip blanks submitted with the samples (i.e., one per day of sampling). Note that analysis of trip blank samples for other volatile parameters (e.g., PHCs (F1 Fraction)) is not mandatory but can be completed at the discretion of the Qualified Person.

6.0 TRAINING

The Practice Leader is responsible for identifying the training needs of Environmental Due Diligence and Remediation (EDR) staff and ensuring that staff are trained and competent before undertaking work assignments.

All trained personnel are responsible for identifying coaching or re-training needs (if they are uncomfortable with work assignments that have been assigned).

The careful application of *Health & Safety Training* by each employee is an integral part of all activities and is assumed as part of this SOP.

7.0 MAINTENANCE OF SOP

1 Year.

8.0 REFERENCES

Association of Professional Geoscientists of Ontario, "*Guidance for Environmental Site Assessments under Ontario Regulation 153/04 (as amended)",* April 2011.

Ontario Ministry of the Environment, *Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act*, March 9, 2004, as amended as of July 1, 2011.

Water, Air and Climate Change Branch, Ministry of Water, Land and Air Protection, Province of British Columbia, "*British Columbia Field Sampling Manual"*, 2003.

9.0 APPENDICES

None.

I:\2016 SOP Updates\SOP - EDR025 - REV002 - QA QC Sampling.docx

Template: Master SOP Template – February 2014

APPENDIX C

Borehole Logs

Log of Borehole: MW16-1

Project #: 103341.001 **Logged By:** KS

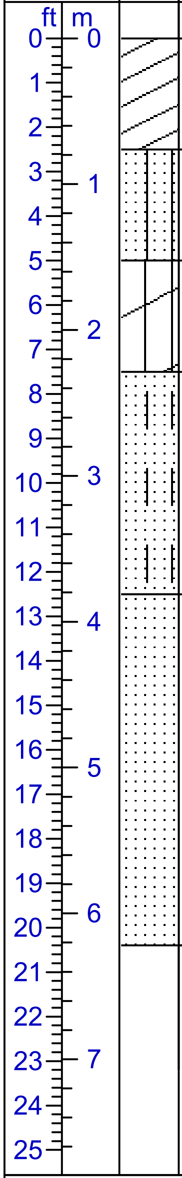
Project: Phase II Environmental Assessment

Client: R.B Morgan Construction

Location: 1294 Wharf Street, Pickering Ontario

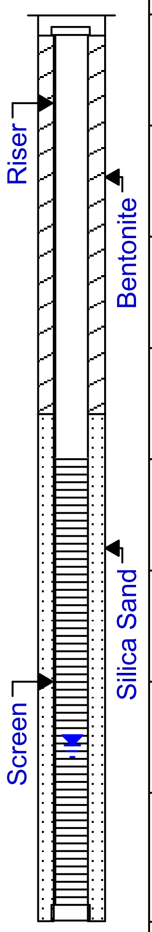
Drill Date: May 20, 2016 **Project Manager:** IM

SUBSURFACE PROFILE



Description	Measured Depth (m)
Ground Surface	0.00
Clay Fill Brown, trace silt & organics, moist	0.76
Sandy Silt Brown, trace gravel, moist	1.52
Clayey Silt Brown, trace gravel, moist	2.29
Silty Sand Till Brown, some gravel, moist Brown to grey, some gravel, no odour from 2.29 to 3.81 mbgs	3.81
Sand Grey, some silt, moist, some gravel to 4.57 mbgs Grey, some gravel from 4.57 to 5.33 mbgs Grey, wet from 5.33 to 6.10 mbgs	6.22
End of Borehole	

Monitoring Well Details



Water level measured at 5.01 mbgs on May 24, 2016.

SAMPLE

Sampler #	Recovery (%)	Sample ID	Soil Vapour Concentration CGI/PID	Laboratory Analysis
1	52/60	SA1	0/0	pH
2	52/60	SA2	0/0	
3	57/60	SA3	10/1	
4	57/60	SA4	10/1	Grain Size, VOCs, PHC F1-F4, PAHs
5	55/60	SA5	10/2	
6	55/60	SA6	0/0	
7	60/60	SA7	20/2	Grain Size, VOCs, PHC F1-F4, PAHs
8	60/60	SA8	15/2	

Contractor: Strata Drilling

Drilling Method: Direct Push

Well Casing Size: 5.08 cm

Pinchin Ltd.
2470 Milltower Court
Mississauga, ON L5N 7W5

Grade Elevation: NM

Top of Casing Elevation: NM

Sheet: 1 of 1

PINCHIN

Log of Borehole: MW16-2

Project #: 103341.001 **Logged By:** KS

Project: Phase II Environmental Assessment

Client: R.B Morgan Construction

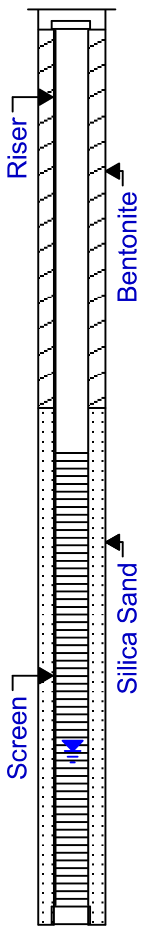
Location: 1294 Wharf Street, Pickering Ontario

Drill Date: May 20, 2016 **Project Manager:** IM

SUBSURFACE PROFILE

Depth (ft / m)	Description	Measured Depth (m)
0 / 0	Ground Surface	0.00
0 – 2.5 ft	***Clay Fill*** Brown, trace silt & organics, moist	0.76
2.5 – 17.5 ft	***Sandy Silt Till*** Brown, some gravel, moist Brown to grey, some gravel from 3.05 to 3.81 mbgs Grey, some gravel, moist from 3.81 to 5.33 mbgs.	5.33
17.5 – 20.6 ft	***Sand*** Grey, wet	6.28
	End of Borehole	

Depth scale: ft 0–25; m 0–7



Water level measured at 5.09 mbgs on May 24, 2016.

SAMPLE

Sampler #	Recovery (%)	Sample ID	Soil Vapour Concentration CGI/PID	Laboratory Analysis
1	52/60	SA1	0/0	
2	52/60	SA2	0/1	
3	55/60	SA3	0/0	
4	55/60	SA4	0/0	
5	57/60	SA5	35/0	Grain Size, VOCs, PHC F1-F4, PAHs
6	57/60	SA6	0/1	Grain Size, PHC F1-F4, PAHs, pH
7	55/60	SA7	0/0	
8	55/60	SA8	0/1	

Contractor: Strata Drilling

Drilling Method: Direct Push

Well Casing Size: 5.08 cm

Pinchin Ltd.
2470 Milltower Court
Mississauga, ON L5N 7W5

Grade Elevation: NM

Top of Casing Elevation: NM

Sheet: 1 of 1

Log of Borehole: MW16-3

Project #: 103341.001 **Logged By:** KS

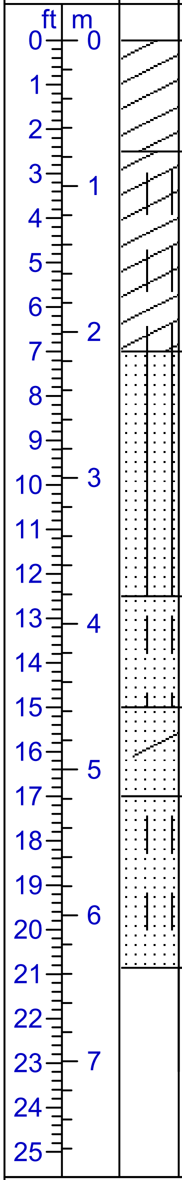
Project: Phase II Environmental Assessment

Client: R.B Morgan Construction

Location: 1294 Wharf Street, Pickering Ontario

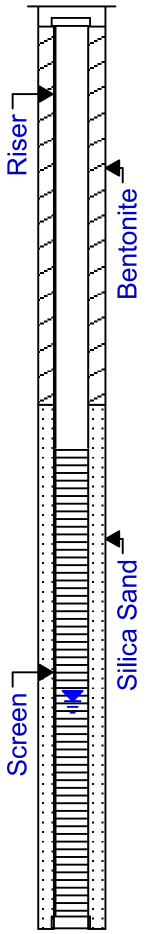
Drill Date: May 20, 2016 **Project Manager:** IM

SUBSURFACE PROFILE



Description	Measured Depth (m)
Ground Surface	0.00
Clay Fill Brown, trace silt & organics, moist	0.76
Silty Clay Brown, wet Trace sand from 1.52 to 2.13 mbgs	2.13
Sandy Silt Till Brown, trace gravel, wet Brown, trace clay & gravel, wet	3.81
Silty Sand Till Brown to grey, trace gravel	4.57
Sandy Clay Brown, trace gravel, wet	5.18
Silty Sand Till Brown to grey, some gravel, moist	6.36
End of Borehole	

Monitoring Well Details



Water level measured at 4.77 mbgs on May 24, 2016.

SAMPLE

Sampler #	Recovery (%)	Sample ID	Soil Vapour Concentration CGI/PID	Laboratory Analysis
1	40/60	SA1	0/0	
2	40/60	SA2	0/0	
3	42/60	SA3	0/0	
4	42/60	SA4	0/0	
5	60/60	SA5	0/0	Grain size, VOCs, PHCs, PAHs
6	60/60	SA6	0/0	
7	60/60	SA7	155/0	VOCs, PHCs, F1-F4, PAHs
8	60/60	SA8	0/0	

Contractor: Strata Drilling

Drilling Method: Direct Push

Well Casing Size: 5.08 cm

Pinchin Ltd.
2470 Milltower Court
Mississauga, ON L5N 7W5

Grade Elevation: NM

Top of Casing Elevation: NM

Sheet: 1 of 1

APPENDIX D

Field Instrument Calibration Records

MAXIM ENVIRONMENTAL AND SAFETY INC.
170 AMBASSADOR DRIVE, UNIT # 12
MISSISSAUGA, ONTARIO
L5T 2H9

Phone: **(905) 507-8412**

CERTIFICATE OF CALIBRATION

The RKI Instruments **Model EAGLE-2** as listed below has been inspected and calibrated following the Manufacturer's published specifications and methods.

Instrument Model: **EAGLE-2** Serial Number: **E2B633** Date of Calibration: **May 18, 2016**

SENSOR	CALIBRATION GAS STANDARD	CALIBRATION GAS CONCENTRATION	READING PRIOR TO ADJUSTMENT	INSTRUMENT SPAN SETTING	ALARM LEVEL SETTINGS
Combustible	Hexane lot # 260699	15% LEL	15% LEL	15% LEL **"Methane Elimination" Mode**	10 & 50% LEL
Combustible	Methane lot # 156545	50% LEL	<500 PPM	Verification Only **"Methane Elimination" Mode**	
Combustible	Hexane lot # 260699	15% LEL	15% LEL	15% LEL **"Methane Response Enabled" Mode**	10 & 50% LEL
VOC	Isobutylene lot # 27156	100 PPM	100 PPM	100 PPM	400 & 1000 PPM

The calibration gas standard used is considered to be a certified standard and is traceable to the National Institute of Standards and Technology (NIST). Certificate of Analysis is available upon request.

The instrument indicated above is now certified to be operating within the Manufacturer's specifications. **This does not preclude the requirement for regular maintenance and pre-use sensor response checks in order to ensure continued complete and accurate operating condition.**

Certified: ____________________

RENTALS, SALES, SUPPORT
Maxim
1-888-285-2324
ENVIRONMENTAL AND SAFETY INC.
"Exceptional Customer Service!"

Certificate of Calibration

This certifies that YSI 556 Serial Number 10D101649
has been calibrated following the Manufacturer's published specifications and methods.

3-Point pH	**Spec. Cond.**	**ORP**	**DO**
4.00, 7.00, 10.00	1413uS/cm	240mV	100.0% @ 20 Deg. C
pH 4.00 lot # 5AD772 exp.04/ 2017	lot # 6GA526 exp.01/2017	lot # 8114 exp.10/2019	
pH 7.00 lot # 5GL825 exp.12/2017	@ 25 deg C		
pH 10.00 lot # 4AJ846	- Exp.10/2016		

MAY 24,
2016

Calibrated

RENTALS, SALES, SERVICE, SUPPORT

APPENDIX E
Well Records

Ontario Ministry of the Environment and Climate Change

Measurements recorded in: ☐ Metric ☑ Imperial

Well Tag No. *(Place Sticker and/or Print Below)*
A185134

S-18632
Well Record
Regulation 903 Ontario Water Resources Act

Page ______ of ______

Well Owner's Information

First Name Mr. Ralph Morgan	Last Name / Organization R.B. Morgan Construction	E-mail Address	☐ Well Constructed by Well Owner

Mailing Address (Street Number/Name) 289 Wharf Street	Municipality Pickering	Province ON	Postal Code L1W 1A2	Telephone No. *(inc. area code)*

Well Location

Address of Well Location (Street Number/Name) 1280 Wharf Street	Township	Lot	Concession
County/District/Municipality	City/Town/Village Pickering	Province **Ontario**	Postal Code
UTM Coordinates NAD 83 · Zone 17 · Easting 654186 · Northing 4853240	Municipal Plan and Sublot Number	Other WKQ-009013 A0-A02	

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth *(m/ft)* From	To
BRN	Sand	Grove		0	2'
BRN	Silt	Sand/clay		2'	12'
GRY	Silt	Sand/clay		12'	20'

Annular Space

Depth Set at *(m/ft)* From	To	Type of Sealant Used *(Material and Type)*	Volume Placed *(m^3/ft^3)*
20'	9'	Sand	
9'	0	Holeplug	
		& Monument	

Method of Construction

☐ Cable Tool
☐ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☒ Other, *specify* Direct Push
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging

Well Use

☐ Public
☐ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, *specify*
☐ Commercial
☐ Municipal
☒ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☒ Monitoring

Construction Record - Casing

Inside Diameter *(cm/in)*	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness *(cm/in)*	Depth *(m/ft)* From	To
2"	PVC	.25	0	10'

Construction Record - Screen

Outside Diameter *(cm/in)*	Material (Plastic, Galvanized, Steel)	Slot No.	Depth *(m/ft)* From	To
2.25	PVC	.10	10'	20'

Status of Well

☐ Water Supply
☐ Replacement Well
☒ Test Hole
☐ Recharge Well
☐ Dewatering Well
☒ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify* ______
☐ Other, *specify* ______

Water Details

Water found at Depth *(m/ft)* ☐ Gas · Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify* ______
Water found at Depth *(m/ft)* ☐ Gas · Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify* ______
Water found at Depth *(m/ft)* ☐ Gas · Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify* ______

Hole Diameter

Depth *(m/ft)* From	To	Diameter *(cm/in)*
0	20'	6"

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify* ______

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping ______ hrs + ______ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

Draw Down Time *(min)*	Water Level *(m/ft)*	Recovery Time *(min)*	Water Level *(m/ft)*
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Map of Well Location

Please provide a map below following instructions on the back.

MW3

Comments: General contractor: Pinchin Environmental

Well Contractor and Well Technician Information

Business Name of Well Contractor Strata Soil Sampling Inc.	Well Contractor's Licence No. 7241
Business Address (Street Number/Name) 165 Shields Court	Municipality Markham

Province Ontario	Postal Code L3R 8V2	Business E-mail Address wrecords@stratasoil.com

Bus.Telephone No. *(inc. area code)* 905-764-9304	Name of Well Technician (Last Name, First Name) Keven Mike	
Well Technician's Licence No. T3216	Signature of Technician and/or Contractor	Date Submitted 20162530

Well owner's information package delivered ☐ Yes ☒ No	Date Package Delivered Y Y Y Y M M D D	**Ministry Use Only** Audit No. Z233278
	Date Work Completed 20162530	Received

0506E (2014/11)

Contractor's Copy

Ontario
Ministry of the Environment and Climate Change

Measurements recorded in: ☐ Metric ☑ Imperial

Well Tag No. *(Place Sticker and/or Print Below)*
A18490

S-18632

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Well Owner's Information

First Name Mr. Ralph Morgan	Last Name / Organization R.B. Morgan Construction	E-mail Address	☐ Well Constructed by Well Owner
Mailing Address (Street Number/Name) 1289 Wharf Street	Municipality Pickering	Province ON	Postal Code L1W1A2
Telephone No. *(inc. area code)*			

Well Location

Address of Well Location (Street Number/Name) 1280 Wharf Street	Township	Lot	Concession
County/District/Municipality	City/Town/Village Pickering	Province Ontario	Postal Code
UTM Coordinates NAD 83 · Zone 17 · Easting 654202 · Northing 4853232	Municipal Plan and Sublot Number	Other WKQ-009013 A 0 - A 02	

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth *(m/ft)* From	Depth *(m/ft)* To
BRN	Sand	Gravel		0	2'
BRN	Clay	Silt	Till	2'	11'
GRY	Silt	Sand/Clay	Till	11'	20'

Annular Space

Depth Set at *(m/ft)* From	To	Type of Sealant Used *(Material and Type)*	Volume Placed *(m³/ft³)*
20'	9'	Sand	
9'	0	Holeplug	
		flushmount	

Method of Construction

☐ Cable Tool
☐ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☒ Other, *specify* Direct Push
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging

Well Use

☐ Public
☐ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, *specify*
☐ Commercial
☐ Municipal
☒ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☒ Monitoring

Construction Record - Casing

Inside Diameter *(cm/in)*	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness *(cm/in)*	Depth *(m/ft)* From	To
2"	PVC	.25	0	10'

Construction Record - Screen

Outside Diameter *(cm/in)*	Material (Plastic, Galvanized, Steel)	Slot No.	Depth *(m/ft)* From	To
2.25	PVC	.10	10'	20'

Status of Well

☐ Water Supply
☐ Replacement Well
☒ Test Hole
☐ Recharge Well
☐ Dewatering Well
☒ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify*
☐ Other, *specify*

Water Details

Water found at Depth *(m/ft)* ☐ Gas · Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*
Water found at Depth *(m/ft)* ☐ Gas · Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*
Water found at Depth *(m/ft)* ☐ Gas · Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*

Hole Diameter

Depth *(m/ft)* From	To	Diameter *(cm/in)*
0	20	6"

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify*

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping ____ hrs + ____ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

Draw Down Time *(min)*	Water Level *(m/ft)*	Recovery Time *(min)*	Water Level *(m/ft)*
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Map of Well Location

Please provide a map below following instructions on the back.

MW 2

Well Contractor and Well Technician Information

Business Name of Well Contractor Strata Soil Sampling Inc.	Well Contractor's Licence No. 7241
Business Address (Street Number/Name) 165 Shields Court	Municipality Markham
Province Ontario	Postal Code L3R 8V2
Business E-mail Address wrecords@stratasoil.com	
Bus.Telephone No. *(inc. area code)* 905-764-9304	Name of Well Technician (Last Name, First Name) Leccese Mike
Well Technician's Licence No. T3816	Signature of Technician and/or Contractor
Date Submitted 20160523	

Comments: General contractor: Pinchin Environmental

Well owner's information package delivered ☐ Yes ☒ No

Date Package Delivered Y Y Y Y M M D D

Date Work Completed 20160523

Ministry Use Only
Audit No. Z233279
Received

0506E (2014/11)

Contractor's Copy

Ontario Ministry of the Environment and Climate Change

Measurements recorded in: ☐ Metric ☑ Imperial

Well Tag No. *(Place Sticker and/or Print Below)* A184874

S-18632

Well Record

Regulation 903 Ontario Water Resources Act

Page ______ of ______

Well Owner's Information

First Name: Mr. Ralph Morgan	Last Name / Organization: R.B. Morgan Construction	E-mail Address:	☐ Well Constructed by Well Owner
Mailing Address (Street Number/Name): 1289 Wharf Street	Municipality: Pickering	Province: ON	Postal Code: L1W1A2
Telephone No. *(inc. area code)*:			

Well Location

Address of Well Location (Street Number/Name): 1280 Wharf Street	Township:	Lot:	Concession:
County/District/Municipality:	City/Town/Village: Pickering	Province: **Ontario**	Postal Code:
UTM Coordinates NAD 8 3 Zone 17 Easting 654200 Northing 4853234	Municipal Plan and Sublot Number:	Other: WKQ-009013 A 0 - A 02	

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth *(m/ft)* From	Depth *(m/ft)* To
BRN	Sand	Gravel		0	2'
BRN	Clay	Silt	Till	2'	11'
GRY	Silt	Sand/Clay	Till	11'	20'

Annular Space

Depth Set at *(m/ft)* From	To	Type of Sealant Used *(Material and Type)*	Volume Placed *(m³/ft³)*
20'	9	Sand	
9'	0	Holeplug	
		flushmount	

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify* ______

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping ____ hrs + ____ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

Draw Down Time *(min)*	Water Level *(m/ft)*	Recovery Time *(min)*	Water Level *(m/ft)*
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Method of Construction

☐ Cable Tool
☐ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☒ Other, *specify* Direct Push
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging

Well Use

☐ Public
☐ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, *specify*
☐ Commercial
☐ Municipal
☒ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☒ Monitoring

Construction Record - Casing

Inside Diameter *(cm/in)*	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness *(cm/in)*	Depth *(m/ft)* From	To
2"	PVC	.25	0	10'

Construction Record - Screen

Outside Diameter *(cm/in)*	Material (Plastic, Galvanized, Steel)	Slot No.	Depth *(m/ft)* From	To
2.25	PVC	.10	10'	20'

Status of Well

☐ Water Supply
☐ Replacement Well
☒ Test Hole
☐ Recharge Well
☐ Dewatering Well
☒ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify*
☐ Other, *specify*

Map of Well Location

Please provide a map below following instructions on the back.

MW1

Water Details

Water found at Depth *(m/ft)* ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*
Water found at Depth *(m/ft)* ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*
Water found at Depth *(m/ft)* ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*

Hole Diameter

Depth *(m/ft)* From	To	Diameter *(cm/in)*
0	20'	6"

Well Contractor and Well Technician Information

Business Name of Well Contractor: Strata Soil Sampling Inc.	Well Contractor's Licence No.: 7 2 4 1
Business Address (Street Number/Name): 165 Shields Court	Municipality: Markham
Province: Ontario	Postal Code: L3R 8V2
Business E-mail Address: wrecords@stratasoil.com	
Bus.Telephone No. *(inc. area code)*: 905-764-9304	Name of Well Technician (Last Name, First Name): Leccese Mik
Well Technician's Licence No.: T3816	Signature of Technician and/or Contractor:
Date Submitted: 2016 05 20	

Comments: General contractor: Pinchin Environmental

Well owner's information package delivered ☐ Yes ☒ No

Date Package Delivered: Y Y Y Y M M D D

Date Work Completed: 2016 05 20

Ministry Use Only

Audit No. Z233277

Received

0506E (2014/11)

Contractor's Copy

APPENDIX F

Field Measured Parameters

PINCHIN

MONITORING WELL DEVELOPMENT - LOW/HIGH YIELD WELL

Well ID MW16-1

Project No. 103341.001
Field Technician C Griffith
Project Manager K Shearer

Site Location 1280 Wharf St, Pickering ON
Date May 24, 2016
Weather 18°C, Sunny

Well Depth (From BH Log) mbgs
Well Depth (Measured) 6.220 mbgs (If measured, use instead of depth from BH log)
Well Interior Diameter 2 inches

Borehole Annulus 6 inches / metres
Screen Length 3.05 metres
Depth to Top of Sand Pack mbgs

Initial (Static) Water Level 4.905 mbtoc
Depth to LNAPL NA mbtoc
Well Stick Up/Down metres
Initial (Static) Water Level 5.010 mbgs

Volume of Drill Water Lost to Formation litres
Water Level Above Top of Sand Pack? Yes / No
One Well Volume 8.107 litres
Target Purge Volume 24.321 litres

(If well is within a basement or other below grade structure, replace mbgs with mbfs)

(Three Well Volumes + Three Times Volume Lost To Formation)

Cumulative Well Volume Removed	**Water Level** (mbtoc)	**Time**	**Cumulative Purge Volume** (litres)	**Pump Intake Depth** (mbgs)	**Comments** (e.g., sheen, odour, free-phase product, sediment content, clarity, colour, etc.)
0	4.905	11:40	0		
0.5	4.905	11:40	2L-dry	6m	~~grey~~ no sh/od, no product, substantial sediment, opaque, grey
1 / Dry	6.00	11:52	4L-dry	6m	Same as above

Based on observed drawdown, is well a low or high yield well? ____________ (Use appropriate field form for low yield well or high yield well to complete development)

Borehole Annulus Diameter (inches/metres)	Well ID (inches)	Well Pipe Volume (litres/metre)	Well Volume (litres/metre)
4/0.1	1.25	0.8	2.9
	1.5	1.1	3.2
	2	2	3.8
6/0.15	1.25	0.8	5.9
	1.5	1.1	6.1
	2	2	6.7
8.25/0.21	1.5	1.1	11.2
	2	2	11.8
10.25/0.26	1.5	1.1	16.7
	2	2	17.3

Well Volume Calculation - Water Level Within Sand Pack*

One Well Volume = (Well Depth - Static Water Level) x Well Volume Conversion Factor

Well Volume Calculation - Water Level Above Sand Pack*

One Well Volume = ([Well Depth - Depth to Top of Sand Pack] x Well Volume Conversion Factor) + ([Depth to Top of Sand Pack - Static Water Level] x Well Pipe Volume Conversion Factor)

* All levels/depths used in the calculation are in mbgs

(1.2) × 6.7 × 3 =~30L

PINCHIN

MONITORING WELL SAMPLING - LOW YIELD WELL

Well ID MW16-1

Project No. 103341.001

Field Technician Cayli Griffith

Project Manager Kyle Shearer

Site Location 1280 ~~1251~~ Wharf St, Pickering ON

Date May 26, 2016

Weather Cloudy 15°C

Well Interior Diameter 2 inches

Screen Length 3.05 metres

Initial (Static) Water Level 4.94 mbtoc

Depth to LNAPL ______ mbtoc

Well Stick Up/Down ______ metres

Initial (Static) Water Level 5.065 mbgs

(If well is within a basement or other below grade structure, replace mbgs with mbfs)

Interface Probe / Water Level Tape (Make & Model) Solinst model 122

Purging Equipment Used (Check All Applicable)

Inertial Pump ✓ Peristaltic Pump ______ Centrifugal Pump ______ Bladder Pump ______

Bailer ______ Other ______

90% of Static Water Level (Initial Water Level + [{Total Depth - Initial Water Level} x 0.1])
(Minimum % recovery before sampling) ______ mbtoc

PINCHIN

MONITORING WELL SAMPLING - LOW YIELD WELL

Well ID MW16-1

Project No. 103341.001

Field Technician Gayle Griffith

Site Location 1250 Wharf St, Pickering, ON

Date May 26, 2016

Time	Water Level[1] (mbtoc)	Purge Volume (litres)	Well Status[2]	Comments (e.g., sheen, odour, free-phase product, sediment content, clarity, colour, etc.)
0	4.94	0		
0:30		32.5	well recovery incomplete	~~brown~~ no sh/od, no product, some sediment, opaque, brown
1.00		4		

[1] Water level does not need to be measured if well was just purged dry.

[2] Comment on current status of the well (e.g., Purged dry, 90% recovery target met, Well recovery incomplete, etc.)

Sample Collection Time 10:15 **Metals Field Filtered?** Yes / [✓ No] / NA **If Yes, Type of Filter** ______

Parameters Sampled (Check All Applicable)

VOCs	✓	BTEX		PHCs (F1)	✓	PHCs (F2-F4)	✓	PAHs	✓
Metals		Hg		Cr (VI)		Inorganics (List)			
PCBs		ABNs		OCPs		Other			

If Hybrid Sampling Completed, List Parameters Sampled With Peristaltic Pump PHCs F2-F4, PAHs

PINCHIN

MONITORING WELL SAMPLING - LOW YIELD WELL

Well ID M4V16-1

Project No. [illegible]

Field Technician [illegible]

Site Location [illegible]

Date [illegible] 26, [illegible]

Describe Any Deviations From Well Sampling SOP With Rationale

Additional Notes

① 7.49°C	② ~~7.8~~ 7.95°C
1.529 mS/cm	1.530 mS/cm
6.20 mg/L DO	6.97 mg/L DO
5.91 pH	6.43 pH
166.3 ORP	134.1 ORP

PINCHIN

MONITORING WELL DEVELOPMENT - LOW/HIGH YIELD WELL

Well ID MW16-2

Project No. 103341.001
Field Technician Cayli G
Project Manager Kyle Shearer
Well Depth (From BH Log) mbgs
Well Depth (Measured) 6.280 mbgs (If measured, use instead of depth from BH log)
Well Interior Diameter 2 inches

Initial (Static) Water Level 4.935 mbtoc
Depth to LNAPL NA mbtoc
Well Stick Up/Down metres
Initial (Static) Water Level 5.090 mbgs
(If well is within a basement or other below grade structure, replace mbgs with mbfs)

Site Location 1280 wharf st, Pickering ON
Date May 24, 2016
Weather Sunny, 18°C

Borehole Annulus 6 inches / metres
Screen Length 3.05 metres
Depth to Top of Sand Pack mbgs

Volume of Drill Water Lost to Formation litres
Water Level Above Top of Sand Pack? Yes / No
One Well Volume 7.973 litres
Target Purge Volume 23.919 litres
(Three Well Volumes + Three Times Volume Lost To Formation)

Cumulative Well Volume Removed	**Water Level** (mbtoc)	**Time**	**Cumulative Purge Volume** (litres)	**Pump Intake Depth** (mbgs)	**Comments** (e.g., sheen, odour, free-phase product, sediment content, clarity, colour, etc.)
0			0		
0.5		11:53	3L-dry	6.00m	No sh/od, No product, substantial sediment, opaque, grey
1 / Dry					

Based on observed drawdown, is well a low or high yield well? ________ (Use appropriate field form for low yield well or high yield well to complete development)

Borehole Annulus Diameter (inches/metres)	Well ID (inches)	Well Pipe Volume (litres/metre)	Well Volume (litres/metre)
4/0.1	1.25	0.8	2.9
	1.5	1.1	3.2
	2	2	3.8
6/0.15	1.25	0.8	5.9
	1.5	1.1	6.1
	2	2	6.7
8.25/0.21	1.5	1.1	11.2
	2	2	11.8
10.25/0.26	1.5	1.1	16.7
	2	2	17.3

Well Volume Calculation - Water Level Within Sand Pack*

One Well Volume = (Well Depth - Static Water Level) x Well Volume Conversion Factor

Well Volume Calculation - Water Level Above Sand Pack*

One Well Volume = ([Well Depth - Depth to Top of Sand Pack] x Well Volume Conversion Factor) + ([Depth to Top of Sand Pack - Static Water Level] x Well Pipe Volume Conversion Factor)

* All levels/depths used in the calculation are in mbgs

PINCHIN

MONITORING WELL SAMPLING - LOW YIELD WELL

Well ID MW16-2

Project No. [illegible]

Field Technician [illegible]

Project Manager [illegible]

Site Location [illegible]

Date [illegible] 6 [illegible]

Weather [illegible]

Well Interior Diameter 2 inches

Screen Length 5 metres

Initial (Static) Water Level 5.015 mbtoc

Depth to LNAPL mbtoc

Well Stick Up/Down metres

Initial (Static) Water Level 5.10 mbgs

(If well is within a basement or other below grade structure, replace mbgs with mbfs)

Interface Probe / Water Level Tape (Make & Model) Solinst model 122

Purging Equipment Used (Check All Applicable)

Inertial Pump ____ Peristaltic Pump ✓ Centrifugal Pump ____ Bladder Pump ____

Bailer ____ Other ____

90% of Static Water Level (Initial Water Level + [{Total Depth - Initial Water Level} x 0.1])
(Minimum % recovery before sampling) mbtoc

PINCHIN

MONITORING WELL SAMPLING - LOW YIELD WELL

Well ID MW16-2

Project No. 103341.001
Field Technician Cayli Griffith
Site Location 1250 Wharf St, Pickering, ON
Date May 26, 2016

Time	Water Level[1] (mbtoc)	Purge Volume (litres)	Well Status[2]	Comments (e.g., sheen, odour, free-phase product, sediment content, clarity, colour, etc.)
0	5.015	0	—	
5:00		2.5L	well recovery incomplete	no sh/od, no product, little sediment, translucent grey/brown
7:00		4.5L	purged dry	no sh/od, no product, little sediment, translucent grey/brown

[1] Water level does not need to be measured if well was just purged dry.

[2] Comment on current status of the well (e.g., Purged dry, 90% recovery target met, Well recovery incomplete, etc.)

Sample Collection Time 12:00 **Metals Field Filtered?** Yes / ~~No~~ / [✓ NA] **If Yes, Type of Filter** ______

Parameters Sampled (Check All Applicable)

VOCs	✓	BTEX		PHCs (F1)	✓	PHCs (F2-F4)	✓
Metals		Hg		Cr (VI)		Inorganics (List)	
PCBs		ABNs		OCPs		Other	
PAHs	✓						

If Hybrid Sampling Completed, List Parameters Sampled With Peristaltic Pump PHCs F2-F4, PAHs

PINCHIN

MONITORING WELL SAMPLING - LOW YIELD WELL

Well ID Mw16-2

Project No. 103341.001

Field Technician [illegible] li Griffith

Site Location 128 Wh[illegible] st Pickering

Date [illegible] 26 2016

Describe Any Deviations From Well Sampling SOP With Rationale

Additional Notes

① 6.92°C	⑥ 6.74°C
1.249 mS/cm	1.257 mS/cm
4.93 mg/L DO	5.07 mg/L DO
6.08 pH	6.69 pH
22.6 ORP	9.1 ORP

PINCHIN

MONITORING WELL DEVELOPMENT - LOW/HIGH YIELD WELL

Well ID MW16-3

Project No. 103341.001

Field Technician C Griffith

Project Manager K Shearer

Site Location 1280 Wharf St, Pickering ON

Date May 24, 2016

Weather 18°C, sunny

Well Depth (From BH Log) mbgs

Well Depth (Measured) ~~[illegible]~~ 6.36 mbgs (If measured, use instead of depth from BH log)

Well Interior Diameter 2 inches

Borehole Annulus 6 inches / metres

Screen Length 3.05 metres

Depth to Top of Sand Pack mbgs

Initial (Static) Water Level 4.730 mbtoc

Depth to LNAPL mbtoc

Well Stick Up/Down +0.96m metres

Initial (Static) Water Level ~~3.770~~ mbgs 4.770 ✓ KS

(If well is within a basement or other below grade structure, replace mbgs with mbfs)

Volume of Drill Water Lost to Formation litres

Water Level Above Top of Sand Pack? Yes / No

One Well Volume ~~5.18~~ 17.353 litres

Target Purge Volume 52.059 litres

(Three Well Volumes + Three Times Volume Lost To Formation)

Cumulative Well Volume Removed	**Water Level** (mbtoc)	**Time**	**Cumulative Purge Volume** (litres)	**Pump Intake Depth** (mbgs)	**Comments** (e.g., sheen, odour, free-phase product, sediment content, clarity, colour, etc.)
0	4.730		0		
0.5	4.730	12:00	4L - dry	6 m	no sh/od, no product, substantial sediment, opaque, brown
1 / Dry					

Based on observed drawdown, is well a low or high yield well? Low (Use appropriate field form for low yield well or high yield well to complete development)

Borehole Annulus Diameter (inches/metres)	Well ID (inches)	Well Pipe Volume (litres/metre)	Well Volume (litres/metre)
4/0.1	1.25	0.8	2.9
	1.5	1.1	3.2
	2	2	3.8
6/0.15	1.25	0.8	5.9
	1.5	1.1	6.1
	2	2	6.7
8.25/0.21	1.5	1.1	11.2
	2	2	11.8
10.25/0.26	1.5	1.1	16.7
	2	2	17.3

Well Volume Calculation - Water Level Within Sand Pack*

One Well Volume = (Well Depth - Static Water Level) x Well Volume Conversion Factor

Well Volume Calculation - Water Level Above Sand Pack*

One Well Volume = ([Well Depth - Depth to Top of Sand Pack] x Well Volume Conversion Factor) + ([Depth to Top of Sand Pack - Static Water Level] x Well Pipe Volume Conversion Factor)

* All levels/depths used in the calculation are in mbgs

PINCHIN

MONITORING WELL SAMPLING - LOW YIELD WELL

Well ID MW16-3

Project No. 103341.001
Field Technician Cayli Griffith
Project Manager Kyle Shearer

Site Location 1280 ~~1289~~ Wharf St, Pickering ON
Date May 26, 2016
Weather Cloudy, 15°C

Well Interior Diameter 2 inches
Screen Length 3.05 metres

Initial (Static) Water Level 5.65 mbtoc
Depth to LNAPL mbtoc

Well Stick Up/Down metres
Initial (Static) Water Level 4.71 ~~3.71~~ mbgs
(If well is within a basement or other below grade structure, replace mbgs with mbfs)

Interface Probe / Water Level Tape (Make & Model) solinst model 122

Purging Equipment Used (Check All Applicable)

Inertial Pump
Peristaltic Pump ✓
Centrifugal Pump
Bladder Pump
Bailer
Other

90% of Static Water Level (Initial Water Level + [{Total Depth - Initial Water Level} x 0.1]) mbtoc
(Minimum % recovery before sampling)

PINCHIN

MONITORING WELL SAMPLING - LOW YIELD WELL

Well ID MW16-3

Project No. 103341.001

Site Location 1280 Wharf St, Pickering ON

Field Technician Cayli Griffith

Date May 26, 2016

Time	Water Level[1] (mbtoc)	Purge Volume (litres)	Well Status[2]	Comments (e.g., sheen, odour, free-phase product, sediment content, clarity, colour, etc.)
0		0	—	
5:00		1~~2~~L	well recovery incomplete	no sh/od, no product, substantial sediment, opaque, brown
8:00		4L	purged dry	no sh/od, no product, some sediment, ~~opaque~~ translucent, brown

[1] Water level does not need to be measured if well was just purged dry.

[2] Comment on current status of the well (e.g., Purged dry, 90% recovery target met, Well recovery incomplete, etc.)

Sample Collection Time ______

Metals Field Filtered? Yes / No [✓ NA]

If Yes, Type of Filter ______

Parameters Sampled (Check All Applicable)

VOCs	✓	BTEX		PHCs (F1)	✓	PHCs (F2-F4)	✓
Metals		Hg		Cr (VI)		Inorganics (List)	
PCBs		ABNs		OCPs		Other	

PAHs ✓

If Hybrid Sampling Completed, List Parameters Sampled With Peristaltic Pump ______

PINCHIN

MONITORING WELL SAMPLING - LOW YIELD WELL

Well ID Mw16-3

Project No. 103341.001

Field Technician Cayli Griffith

Site Location 1280 Wharf st, Pickering ON

Date May 26, 2016

Describe Any Deviations From Well Sampling SOP With Rationale

Additional Notes

① 8.75°c Temp
0.938 ms/cm EC
9.99 mg/L DO
7.22 pH
102.4 ORP

A started to rain while sampling

May 27, 2016
too much sediment in water after purging. Returned to site to sample on May 27, 2016 at 8:00 am - still too much sediment.

May 30, 2016
Sampled water on May 30, 2016 at 9:30 am.
20°C, Sunny

APPENDIX G

Laboratory Certificates of Analysis

Your Project #: 103341.001
Your C.O.C. #: 562310-01-01

Attention:Kyle Shearer
Pinchin Ltd.
2470 Milltower Crt
Mississauga, ON
L5N 7W5

Report Date: 2016/07/22
Report #: R4076699
Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B6A5189
Received: 2016/05/25, 13:50

Sample Matrix: Soil
Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Methylnaphthalene Sum	7	N/A	2016/05/31	CAM SOP-00301	EPA 8270D m
1,3-Dichloropropene Sum	7	N/A	2016/05/30		EPA 8260C m
Petroleum Hydro. CCME F1 & BTEX in Soil (1)	7	N/A	2016/05/31	CAM SOP-00315	CCME PHC-CWS m
Petroleum Hydrocarbons F2-F4 in Soil (2)	7	2016/05/28	2016/05/30	CAM SOP-00316	CCME CWS m
F4G (CCME Hydrocarbons Gravimetric)	3	2016/06/01	2016/06/01	CAM SOP-00316	CCME PHC-CWS m
Moisture	7	N/A	2016/05/27	CAM SOP-00445	Carter 2nd ed 51.2 m
PAH Compounds in Soil by GC/MS (SIM)	7	2016/05/28	2016/05/28	CAM SOP-00318	EPA 8270D m
pH CaCl2 EXTRACT	2	2016/05/27	2016/05/27	CAM SOP-00413	EPA 9045 D m
pH CaCl2 EXTRACT	1	2016/07/05	2016/07/05	CAM SOP-00413	EPA 9045 D m
pH CaCl2 EXTRACT	1	2016/07/20	2016/07/20	CAM SOP-00413	EPA 9045 D m
Sieve, 75um	4	N/A	2016/05/30	CAM SOP-00467	Carter 2nd ed m
Volatile Organic Compounds in Soil	6	N/A	2016/05/27	CAM SOP-00228	EPA 8260C m
Volatile Organic Compounds in Soil	1	N/A	2016/05/28	CAM SOP-00228	EPA 8260C m

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.

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

(1) No lab extraction date is given for F1BTEX & VOC samples that are field preserved with methanol. Extraction date is the date sampled unless otherwise stated.

(2) All CCME PHC results met required criteria unless otherwise stated in the report. The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following “Alberta Environment’s Interpretation of the Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil Validation of Performance-Based Alternative Methods September 2003”. Documentation is available upon request. Modifications from Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil-Tier 1 Method: F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction.

Your Project #: 103341.001
Your C.O.C. #: 562310-01-01

Attention:Kyle Shearer
Pinchin Ltd.
2470 Milltower Crt
Mississauga, ON
L5N 7W5

Report Date: 2016/07/22
Report #: R4076699
Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B6A5189
Received: 2016/05/25, 13:50

Encryption Key

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.

Total Cover Pages : 2

O.REG 153 PAHS (SOIL)

Maxxam ID		CKK076	CKK077		CKK078	CKK078	CKK079		
Sampling Date		2016/05/20 08:00	2016/05/20 09:00		2016/05/20 08:40	2016/05/20 08:40	2016/05/20 09:30		
COC Number		562310-01-01	562310-01-01		562310-01-01	562310-01-01	562310-01-01		
	UNITS	**MW16-1 SA4**	**MW16-2 SA5**	**RDL**	**MW16-1 SA7**	**MW16-1 SA7 Lab-Dup**	**MW16-2 SA6**	**RDL**	**QC Batch**
Inorganics									
Moisture	%	12	8.4	1.0	9.7	9.8	7.8	1.0	4514675
Calculated Parameters									
Methylnaphthalene, 2-(1-)	ug/g	<0.0071	0.016	0.0071	0.016		<0.0071	0.0071	4511214
Polyaromatic Hydrocarbons									
Acenaphthene	ug/g	<0.0050	0.0092	0.0050	<0.0050		<0.0050	0.0050	4516040
Acenaphthylene	ug/g	<0.0050	0.025	0.0050	<0.0050		<0.0050	0.0050	4516040
Anthracene	ug/g	<0.0050	0.048	0.0050	<0.0050		<0.0050	0.0050	4516040
Benzo(a)anthracene	ug/g	<0.0050	0.28	0.0050	<0.0050		<0.0050	0.0050	4516040
Benzo(a)pyrene	ug/g	<0.0050	0.21	0.0050	<0.0050		<0.0050	0.0050	4516040
Benzo(b/j)fluoranthene	ug/g	<0.0050	0.20	0.0050	<0.010 (1)		<0.010 (1)	0.010	4516040
Benzo(g,h,i)perylene	ug/g	<0.0050	0.078	0.0050	<0.0050		<0.0050	0.0050	4516040
Benzo(k)fluoranthene	ug/g	<0.0050	0.079	0.0050	<0.0050		<0.0050	0.0050	4516040
Chrysene	ug/g	<0.0050	0.20	0.0050	0.014		0.016	0.0050	4516040
Dibenz(a,h)anthracene	ug/g	<0.0050	0.025	0.0050	<0.0050		<0.0050	0.0050	4516040
Fluoranthene	ug/g	<0.0050	0.42	0.0050	0.0069		0.0066	0.0050	4516040
Fluorene	ug/g	<0.0050	0.0078	0.0050	<0.0050		<0.0050	0.0050	4516040
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	0.11	0.0050	<0.0050		<0.0050	0.0050	4516040
1-Methylnaphthalene	ug/g	<0.0050	0.0079	0.0050	0.0078		<0.0050	0.0050	4516040
2-Methylnaphthalene	ug/g	<0.0050	0.0081	0.0050	0.0078		<0.0050	0.0050	4516040
Naphthalene	ug/g	<0.0050	<0.0050	0.0050	<0.0050		<0.0050	0.0050	4516040
Phenanthrene	ug/g	<0.0050	0.13	0.0050	0.0072		<0.0050	0.0050	4516040
Pyrene	ug/g	<0.0050	0.39	0.0050	0.0065		0.0053	0.0050	4516040
Surrogate Recovery (%)									
D10-Anthracene	%	102	102		105		106		4516040
D14-Terphenyl (FS)	%	104	100		106		106		4516040
D8-Acenaphthylene	%	105	100		104		108		4516040

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
(1) DL was raised due to matrix interference.

O.REG 153 PAHS (SOIL)

Maxxam ID		CKK081	CKK082	CKK082		CKK083		
Sampling Date		2016/05/20 11:00	2016/05/20 11:40	2016/05/20 11:40		2016/05/20 11:00		
COC Number		562310-01-01	562310-01-01	562310-01-01		562310-01-01		
	UNITS	**MW16-3 SA5**	**MW16-3 SA7**	**MW16-3 SA7 Lab-Dup**	**RDL**	**DUP-1**	**RDL**	**QC Batch**
Inorganics								
Moisture	%	18	15		1.0	7.3	1.0	4514675
Calculated Parameters								
Methylnaphthalene, 2-(1-)	ug/g	<0.0071	<0.0071		0.0071	<0.0071	0.0071	4511214
Polyaromatic Hydrocarbons								
Acenaphthene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	0.0096	0.0050	4516040
Acenaphthylene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
Anthracene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	0.015	0.0050	4516040
Benzo(a)anthracene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
Benzo(a)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
Benzo(b/j)fluoranthene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.010 (1)	0.010	4516040
Benzo(g,h,i)perylene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
Benzo(k)fluoranthene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
Chrysene	ug/g	<0.0050	0.0056	<0.0050	0.0050	0.012	0.0050	4516040
Dibenz(a,h)anthracene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
Fluoranthene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.010 (1)	0.010	4516040
Fluorene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	0.022	0.0050	4516040
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
1-Methylnaphthalene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
2-Methylnaphthalene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
Naphthalene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
Phenanthrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
Pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	<0.0050	0.0050	4516040
Surrogate Recovery (%)								
D10-Anthracene	%	101	99	100		102		4516040
D14-Terphenyl (FS)	%	105	101	101		104		4516040
D8-Acenaphthylene	%	100	95	98		104		4516040

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
(1) DL was raised due to matrix interference.

O.REG 153 PETROLEUM HYDROCARBONS (SOIL)

Maxxam ID		CKK076	CKK077	CKK078	CKK079	CKK081	CKK082		
Sampling Date		2016/05/20 08:00	2016/05/20 09:00	2016/05/20 08:40	2016/05/20 09:30	2016/05/20 11:00	2016/05/20 11:40		
COC Number		562310-01-01	562310-01-01	562310-01-01	562310-01-01	562310-01-01	562310-01-01		
	UNITS	**MW16-1 SA4**	**MW16-2 SA5**	**MW16-1 SA7**	**MW16-2 SA6**	**MW16-3 SA5**	**MW16-3 SA7**	**RDL**	**QC Batch**
BTEX & F1 Hydrocarbons									
F1 (C6-C10)	ug/g	<10	<10	<10	<10	<10	<10	10	4514804
F1 (C6-C10) - BTEX	ug/g	<10	<10	<10	<10	<10	<10	10	4514804
F2-F4 Hydrocarbons									
F2 (C10-C16 Hydrocarbons)	ug/g	17	33	41	34	11	19	10	4516127
F3 (C16-C34 Hydrocarbons)	ug/g	58	130	170	150	<50	61	50	4516127
F4 (C34-C50 Hydrocarbons)	ug/g	<50	<50	64	56	<50	<50	50	4516127
Reached Baseline at C50	ug/g	Yes	Yes	No	No	Yes	Yes		4516127
Surrogate Recovery (%)									
1,4-Difluorobenzene	%	102	100	101	101	102	100		4514804
4-Bromofluorobenzene	%	92	100	91	92	90	90		4514804
D10-Ethylbenzene	%	100	89	89	90	97	120		4514804
D4-1,2-Dichloroethane	%	123	122	120	118	118	118		4514804
o-Terphenyl	%	97	98	97	99	97	98		4516127

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		CKK083		
Sampling Date		2016/05/20 11:00		
COC Number		562310-01-01		
	UNITS	**DUP-1**	**RDL**	**QC Batch**
BTEX & F1 Hydrocarbons				
F1 (C6-C10)	ug/g	<10	10	4514804
F1 (C6-C10) - BTEX	ug/g	<10	10	4514804
F2-F4 Hydrocarbons				
F2 (C10-C16 Hydrocarbons)	ug/g	53	10	4516127
F3 (C16-C34 Hydrocarbons)	ug/g	180	50	4516127
F4 (C34-C50 Hydrocarbons)	ug/g	64	50	4516127
Reached Baseline at C50	ug/g	No		4516127
Surrogate Recovery (%)				
1,4-Difluorobenzene	%	101		4514804
4-Bromofluorobenzene	%	92		4514804
D10-Ethylbenzene	%	96		4514804
D4-1,2-Dichloroethane	%	116		4514804
o-Terphenyl	%	98		4516127

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 153 VOLATILE ORGANICS (SOIL)

Maxxam ID		CKK076	CKK077	CKK078	CKK079	CKK081		
Sampling Date		2016/05/20 08:00	2016/05/20 09:00	2016/05/20 08:40	2016/05/20 09:30	2016/05/20 11:00		
COC Number		562310-01-01	562310-01-01	562310-01-01	562310-01-01	562310-01-01		
	UNITS	**MW16-1 SA4**	**MW16-2 SA5**	**MW16-1 SA7**	**MW16-2 SA6**	**MW16-3 SA5**	**RDL**	**QC Batch**
Calculated Parameters								
1,3-Dichloropropene (cis+trans)	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4511215
Volatile Organics								
Acetone (2-Propanone)	ug/g	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4512840
Benzene	ug/g	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	4512840
Bromodichloromethane	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Bromoform	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Bromomethane	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Carbon Tetrachloride	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Chlorobenzene	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Chloroform	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Dibromochloromethane	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
1,2-Dichlorobenzene	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
1,3-Dichlorobenzene	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
1,4-Dichlorobenzene	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Dichlorodifluoromethane (FREON 12)	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
1,1-Dichloroethane	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
1,2-Dichloroethane	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
1,1-Dichloroethylene	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
cis-1,2-Dichloroethylene	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
trans-1,2-Dichloroethylene	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
1,2-Dichloropropane	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
cis-1,3-Dichloropropene	ug/g	<0.030	<0.030	<0.030	<0.030	<0.030	0.030	4512840
trans-1,3-Dichloropropene	ug/g	<0.040	<0.040	<0.040	<0.040	<0.040	0.040	4512840
Ethylbenzene	ug/g	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	4512840
Ethylene Dibromide	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Hexane	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Methylene Chloride(Dichloromethane)	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Methyl Ethyl Ketone (2-Butanone)	ug/g	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4512840
Methyl Isobutyl Ketone	ug/g	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4512840
Methyl t-butyl ether (MTBE)	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Styrene	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
1,1,1,2-Tetrachloroethane	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
1,1,2,2-Tetrachloroethane	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Tetrachloroethylene	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Toluene	ug/g	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	4512840

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 153 VOLATILE ORGANICS (SOIL)

Maxxam ID		CKK076	CKK077	CKK078	CKK079	CKK081		
Sampling Date		2016/05/20 08:00	2016/05/20 09:00	2016/05/20 08:40	2016/05/20 09:30	2016/05/20 11:00		
COC Number		562310-01-01	562310-01-01	562310-01-01	562310-01-01	562310-01-01		
	UNITS	**MW16-1 SA4**	**MW16-2 SA5**	**MW16-1 SA7**	**MW16-2 SA6**	**MW16-3 SA5**	**RDL**	**QC Batch**
1,1,1-Trichloroethane	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
1,1,2-Trichloroethane	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Trichloroethylene	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Trichlorofluoromethane (FREON 11)	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	4512840
Vinyl Chloride	ug/g	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	4512840
p+m-Xylene	ug/g	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	4512840
o-Xylene	ug/g	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	4512840
Total Xylenes	ug/g	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	4512840
Surrogate Recovery (%)								
4-Bromofluorobenzene	%	101	90	91	93	88		4512840
D10-o-Xylene	%	84	86	109	90	91		4512840
D4-1,2-Dichloroethane	%	93	91	99	91	99		4512840
D8-Toluene	%	98	102	102	104	99		4512840

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 153 VOLATILE ORGANICS (SOIL)

Maxxam ID		CKK082	CKK083		
Sampling Date		2016/05/20 11:40	2016/05/20 11:00		
COC Number		562310-01-01	562310-01-01		
	UNITS	**MW16-3 SA7**	**DUP-1**	**RDL**	**QC Batch**
Calculated Parameters					
1,3-Dichloropropene (cis+trans)	ug/g	<0.050	<0.050	0.050	4511215
Volatile Organics					
Acetone (2-Propanone)	ug/g	<0.50	<0.50	0.50	4512840
Benzene	ug/g	<0.020	<0.020	0.020	4512840
Bromodichloromethane	ug/g	<0.050	<0.050	0.050	4512840
Bromoform	ug/g	<0.050	<0.050	0.050	4512840
Bromomethane	ug/g	<0.050	<0.050	0.050	4512840
Carbon Tetrachloride	ug/g	<0.050	<0.050	0.050	4512840
Chlorobenzene	ug/g	<0.050	<0.050	0.050	4512840
Chloroform	ug/g	<0.050	<0.050	0.050	4512840
Dibromochloromethane	ug/g	<0.050	<0.050	0.050	4512840
1,2-Dichlorobenzene	ug/g	<0.050	<0.050	0.050	4512840
1,3-Dichlorobenzene	ug/g	<0.050	<0.050	0.050	4512840
1,4-Dichlorobenzene	ug/g	<0.050	<0.050	0.050	4512840
Dichlorodifluoromethane (FREON 12)	ug/g	<0.050	<0.050	0.050	4512840
1,1-Dichloroethane	ug/g	<0.050	<0.050	0.050	4512840
1,2-Dichloroethane	ug/g	<0.050	<0.050	0.050	4512840
1,1-Dichloroethylene	ug/g	<0.050	<0.050	0.050	4512840
cis-1,2-Dichloroethylene	ug/g	<0.050	<0.050	0.050	4512840
trans-1,2-Dichloroethylene	ug/g	<0.050	<0.050	0.050	4512840
1,2-Dichloropropane	ug/g	<0.050	<0.050	0.050	4512840
cis-1,3-Dichloropropene	ug/g	<0.030	<0.030	0.030	4512840
trans-1,3-Dichloropropene	ug/g	<0.040	<0.040	0.040	4512840
Ethylbenzene	ug/g	<0.020	<0.020	0.020	4512840
Ethylene Dibromide	ug/g	<0.050	<0.050	0.050	4512840
Hexane	ug/g	<0.050	<0.050	0.050	4512840
Methylene Chloride(Dichloromethane)	ug/g	<0.050	<0.050	0.050	4512840
Methyl Ethyl Ketone (2-Butanone)	ug/g	<0.50	<0.50	0.50	4512840
Methyl Isobutyl Ketone	ug/g	<0.50	<0.50	0.50	4512840
Methyl t-butyl ether (MTBE)	ug/g	<0.050	<0.050	0.050	4512840
Styrene	ug/g	<0.050	<0.050	0.050	4512840
1,1,1,2-Tetrachloroethane	ug/g	<0.050	<0.050	0.050	4512840
1,1,2,2-Tetrachloroethane	ug/g	<0.050	<0.050	0.050	4512840
Tetrachloroethylene	ug/g	<0.050	<0.050	0.050	4512840
Toluene	ug/g	<0.020	<0.020	0.020	4512840

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 153 VOLATILE ORGANICS (SOIL)

Maxxam ID		CKK082	CKK083		
Sampling Date		2016/05/20 11:40	2016/05/20 11:00		
COC Number		562310-01-01	562310-01-01		
	UNITS	**MW16-3 SA7**	**DUP-1**	**RDL**	**QC Batch**
1,1,1-Trichloroethane	ug/g	<0.050	<0.050	0.050	4512840
1,1,2-Trichloroethane	ug/g	<0.050	<0.050	0.050	4512840
Trichloroethylene	ug/g	<0.050	<0.050	0.050	4512840
Trichlorofluoromethane (FREON 11)	ug/g	<0.050	<0.050	0.050	4512840
Vinyl Chloride	ug/g	<0.020	<0.020	0.020	4512840
p+m-Xylene	ug/g	<0.020	<0.020	0.020	4512840
o-Xylene	ug/g	<0.020	<0.020	0.020	4512840
Total Xylenes	ug/g	<0.020	<0.020	0.020	4512840
Surrogate Recovery (%)					
4-Bromofluorobenzene	%	97	96		4512840
D10-o-Xylene	%	125	83		4512840
D4-1,2-Dichloroethane	%	86	86		4512840
D8-Toluene	%	97	96		4512840

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

RESULTS OF ANALYSES OF SOIL

Maxxam ID		CKK076	CKK077	CKK078		CKK079	CKK080	
Sampling Date		2016/05/20 08:00	2016/05/20 09:00	2016/05/20 08:40		2016/05/20 09:30	2016/05/20 07:30	
COC Number		562310-01-01	562310-01-01	562310-01-01		562310-01-01	562310-01-01	
	UNITS	**MW16-1 SA4**	**MW16-2 SA5**	**MW16-1 SA7**	**RDL**	**MW16-2 SA6**	**MW16-1 SA1**	**QC Batch**
Inorganics								
Available (CaCl2) pH	pH					7.78	7.37	4514509
Miscellaneous Parameters								
Grain Size	%	COARSE	FINE	COARSE	N/A			4516351
Sieve - #200 (<0.075mm)	%	48	54	48	1			4516351
Sieve - #200 (>0.075mm)	%	52	46	52	1			4516351

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam ID		CKK081			CKK083	
Sampling Date		2016/05/20 11:00			2016/05/20 11:00	
COC Number		562310-01-01			562310-01-01	
	UNITS	**MW16-3 SA5**	**RDL**	**QC Batch**	**DUP-1**	**QC Batch**
Inorganics						
Available (CaCl2) pH	pH	7.80		4586139	7.91	4565177
Miscellaneous Parameters						
Grain Size	%	FINE	N/A	4516351		
Sieve - #200 (<0.075mm)	%	64	1	4516351		
Sieve - #200 (>0.075mm)	%	36	1	4516351		

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		CKK078	CKK079	CKK083		
Sampling Date		2016/05/20 08:40	2016/05/20 09:30	2016/05/20 11:00		
COC Number		562310-01-01	562310-01-01	562310-01-01		
	UNITS	**MW16-1 SA7**	**MW16-2 SA6**	**DUP-1**	**RDL**	**QC Batch**
F2-F4 Hydrocarbons						
F4G-sg (Grav. Heavy Hydrocarbons)	ug/g	1100	390	440	100	4520286

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Maxxam ID: CKK076
Sample ID: MW16-1 SA4
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4511214	N/A	2016/05/31	Automated Statchk
1,3-Dichloropropene Sum	CALC	4511215	N/A	2016/05/30	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4514804	N/A	2016/05/31	Abdikarim Ali
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4516127	2016/05/28	2016/05/30	Margaret Kulczyk-Stanko
Moisture	BAL	4514675	N/A	2016/05/27	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4516040	2016/05/28	2016/05/28	Lingyun Feng
Sieve, 75um	SIEV	4516351	N/A	2016/05/30	Nimarta Singh
Volatile Organic Compounds in Soil	GC/MS	4512840	N/A	2016/05/27	Karen Hughes

Maxxam ID: CKK077
Sample ID: MW16-2 SA5
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4511214	N/A	2016/05/31	Automated Statchk
1,3-Dichloropropene Sum	CALC	4511215	N/A	2016/05/30	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4514804	N/A	2016/05/31	Abdikarim Ali
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4516127	2016/05/28	2016/05/30	Margaret Kulczyk-Stanko
Moisture	BAL	4514675	N/A	2016/05/27	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4516040	2016/05/28	2016/05/28	Lingyun Feng
Sieve, 75um	SIEV	4516351	N/A	2016/05/30	Nimarta Singh
Volatile Organic Compounds in Soil	GC/MS	4512840	N/A	2016/05/27	Karen Hughes

Maxxam ID: CKK078
Sample ID: MW16-1 SA7
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4511214	N/A	2016/05/31	Automated Statchk
1,3-Dichloropropene Sum	CALC	4511215	N/A	2016/05/30	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4514804	N/A	2016/05/31	Abdikarim Ali
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4516127	2016/05/28	2016/05/30	Margaret Kulczyk-Stanko
F4G (CCME Hydrocarbons Gravimetric)	BAL	4520286	2016/06/01	2016/06/01	Raheela Usmani
Moisture	BAL	4514675	N/A	2016/05/27	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4516040	2016/05/28	2016/05/28	Lingyun Feng
Sieve, 75um	SIEV	4516351	N/A	2016/05/30	Nimarta Singh
Volatile Organic Compounds in Soil	GC/MS	4512840	N/A	2016/05/28	Karen Hughes

Maxxam ID: CKK078 Dup
Sample ID: MW16-1 SA7
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL	4514675	N/A	2016/05/27	Valentina Kaftani

TEST SUMMARY

Maxxam ID: CKK079
Sample ID: MW16-2 SA6
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4511214	N/A	2016/05/31	Automated Statchk
1,3-Dichloropropene Sum	CALC	4511215	N/A	2016/05/30	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4514804	N/A	2016/05/31	Abdikarim Ali
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4516127	2016/05/28	2016/05/30	Margaret Kulczyk-Stanko
F4G (CCME Hydrocarbons Gravimetric)	BAL	4520286	2016/06/01	2016/06/01	Raheela Usmani
Moisture	BAL	4514675	N/A	2016/05/27	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4516040	2016/05/28	2016/05/28	Lingyun Feng
pH CaCl2 EXTRACT	AT	4514509	2016/05/27	2016/05/27	Neil Dassanayake
Volatile Organic Compounds in Soil	GC/MS	4512840	N/A	2016/05/27	Karen Hughes

Maxxam ID: CKK080
Sample ID: MW16-1 SA1
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	4514509	2016/05/27	2016/05/27	Neil Dassanayake

Maxxam ID: CKK081
Sample ID: MW16-3 SA5
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4511214	N/A	2016/05/31	Automated Statchk
1,3-Dichloropropene Sum	CALC	4511215	N/A	2016/05/30	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4514804	N/A	2016/05/31	Abdikarim Ali
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4516127	2016/05/28	2016/05/30	Margaret Kulczyk-Stanko
Moisture	BAL	4514675	N/A	2016/05/27	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4516040	2016/05/28	2016/05/28	Lingyun Feng
pH CaCl2 EXTRACT	AT	4586139	2016/07/20	2016/07/20	Neil Dassanayake
Sieve, 75um	SIEV	4516351	N/A	2016/05/30	Nimarta Singh
Volatile Organic Compounds in Soil	GC/MS	4512840	N/A	2016/05/27	Karen Hughes

Maxxam ID: CKK082
Sample ID: MW16-3 SA7
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4511214	N/A	2016/05/31	Automated Statchk
1,3-Dichloropropene Sum	CALC	4511215	N/A	2016/05/30	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4514804	N/A	2016/05/31	Abdikarim Ali
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4516127	2016/05/28	2016/05/30	Margaret Kulczyk-Stanko
Moisture	BAL	4514675	N/A	2016/05/27	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4516040	2016/05/28	2016/05/28	Lingyun Feng
Volatile Organic Compounds in Soil	GC/MS	4512840	N/A	2016/05/27	Karen Hughes

TEST SUMMARY

Maxxam ID: CKK082 Dup
Sample ID: MW16-3 SA7
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4516040	2016/05/28	2016/05/28	Lingyun Feng

Maxxam ID: CKK083
Sample ID: DUP-1
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4511214	N/A	2016/05/31	Automated Statchk
1,3-Dichloropropene Sum	CALC	4511215	N/A	2016/05/30	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4514804	N/A	2016/05/31	Abdikarim Ali
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4516127	2016/05/28	2016/05/30	Margaret Kulczyk-Stanko
F4G (CCME Hydrocarbons Gravimetric)	BAL	4520286	2016/06/01	2016/06/01	Raheela Usmani
Moisture	BAL	4514675	N/A	2016/05/27	Valentina Kaftani
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4516040	2016/05/28	2016/05/28	Lingyun Feng
pH CaCl2 EXTRACT	AT	4565177	2016/07/05	2016/07/05	Neil Dassanayake
Volatile Organic Compounds in Soil	GC/MS	4512840	N/A	2016/05/27	Karen Hughes

GENERAL COMMENTS

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

Package 1	6.3°C

Cooler custody seal was not present and intact.

Revised Report (2016/07/06): Additional analysis included as per client request.

Revised Report (2016/07/22): pH analysis included as per client request.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**	**% Recovery**	**QC Limits**
4512840	4-Bromofluorobenzene	2016/05/27	95	60 - 140	94	60 - 140	92	%				
4512840	D10-o-Xylene	2016/05/27	98	60 - 130	90	60 - 130	83	%				
4512840	D4-1,2-Dichloroethane	2016/05/27	95	60 - 140	101	60 - 140	102	%				
4512840	D8-Toluene	2016/05/27	107	60 - 140	104	60 - 140	100	%				
4514804	1,4-Difluorobenzene	2016/05/30	100	60 - 140	100	60 - 140	99	%				
4514804	4-Bromofluorobenzene	2016/05/30	94	60 - 140	102	60 - 140	101	%				
4514804	D10-Ethylbenzene	2016/05/30	91	60 - 140	101	60 - 140	98	%				
4514804	D4-1,2-Dichloroethane	2016/05/30	115	60 - 140	103	60 - 140	103	%				
4516040	D10-Anthracene	2016/05/28	100	50 - 130	99	50 - 130	100	%				
4516040	D14-Terphenyl (FS)	2016/05/28	103	50 - 130	101	50 - 130	104	%				
4516040	D8-Acenaphthylene	2016/05/28	98	50 - 130	98	50 - 130	97	%				
4516127	o-Terphenyl	2016/05/30	96	60 - 130	94	60 - 130	101	%				
4512840	1,1,1,2-Tetrachloroethane	2016/05/27	92	60 - 140	89	60 - 130	<0.050	ug/g	NC	50		
4512840	1,1,1-Trichloroethane	2016/05/27	92	60 - 140	89	60 - 130	<0.050	ug/g	NC	50		
4512840	1,1,2,2-Tetrachloroethane	2016/05/27	90	60 - 140	96	60 - 130	<0.050	ug/g	NC	50		
4512840	1,1,2-Trichloroethane	2016/05/27	93	60 - 140	94	60 - 130	<0.050	ug/g	NC	50		
4512840	1,1-Dichloroethane	2016/05/27	102	60 - 140	98	60 - 130	<0.050	ug/g	NC	50		
4512840	1,1-Dichloroethylene	2016/05/27	108	60 - 140	100	60 - 130	<0.050	ug/g	NC	50		
4512840	1,2-Dichlorobenzene	2016/05/27	87	60 - 140	88	60 - 130	<0.050	ug/g	NC	50		
4512840	1,2-Dichloroethane	2016/05/27	93	60 - 140	95	60 - 130	<0.050	ug/g	NC	50		
4512840	1,2-Dichloropropane	2016/05/27	98	60 - 140	96	60 - 130	<0.050	ug/g	NC	50		
4512840	1,3-Dichlorobenzene	2016/05/27	91	60 - 140	88	60 - 130	<0.050	ug/g	NC	50		
4512840	1,4-Dichlorobenzene	2016/05/27	92	60 - 140	88	60 - 130	<0.050	ug/g	NC	50		
4512840	Acetone (2-Propanone)	2016/05/27	91	60 - 140	103	60 - 140	<0.50	ug/g	NC	50		
4512840	Benzene	2016/05/27	100	60 - 140	97	60 - 130	<0.020	ug/g	NC	50		
4512840	Bromodichloromethane	2016/05/27	93	60 - 140	93	60 - 130	<0.050	ug/g	NC	50		
4512840	Bromoform	2016/05/27	83	60 - 140	87	60 - 130	<0.050	ug/g	NC	50		
4512840	Bromomethane	2016/05/27	83	60 - 140	86	60 - 140	<0.050	ug/g	NC	50		
4512840	Carbon Tetrachloride	2016/05/27	95	60 - 140	90	60 - 130	<0.050	ug/g	NC	50		
4512840	Chlorobenzene	2016/05/27	98	60 - 140	94	60 - 130	<0.050	ug/g	NC	50		
4512840	Chloroform	2016/05/27	96	60 - 140	93	60 - 130	<0.050	ug/g	NC	50		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
4512840	cis-1,2-Dichloroethylene	2016/05/27	96	60 - 140	94	60 - 130	<0.050	ug/g	NC	50		
4512840	cis-1,3-Dichloropropene	2016/05/27	87	60 - 140	92	60 - 130	<0.030	ug/g	NC	50		
4512840	Dibromochloromethane	2016/05/27	90	60 - 140	91	60 - 130	<0.050	ug/g	NC	50		
4512840	Dichlorodifluoromethane (FREON 12)	2016/05/27	93	60 - 140	89	60 - 140	<0.050	ug/g	NC	50		
4512840	Ethylbenzene	2016/05/27	102	60 - 140	95	60 - 130	<0.020	ug/g	NC	50		
4512840	Ethylene Dibromide	2016/05/27	90	60 - 140	93	60 - 130	<0.050	ug/g	NC	50		
4512840	Hexane	2016/05/27	108	60 - 140	112	60 - 130	<0.050	ug/g	NC	50		
4512840	Methyl Ethyl Ketone (2-Butanone)	2016/05/27	86	60 - 140	101	60 - 140	<0.50	ug/g	NC	50		
4512840	Methyl Isobutyl Ketone	2016/05/27	78	60 - 140	88	60 - 130	<0.50	ug/g	NC	50		
4512840	Methyl t-butyl ether (MTBE)	2016/05/27	94	60 - 140	93	60 - 130	<0.050	ug/g	NC	50		
4512840	Methylene Chloride(Dichloromethane)	2016/05/27	95	60 - 140	92	60 - 130	<0.050	ug/g	NC	50		
4512840	o-Xylene	2016/05/27	99	60 - 140	93	60 - 130	<0.020	ug/g	NC	50		
4512840	p+m-Xylene	2016/05/27	101	60 - 140	94	60 - 130	<0.020	ug/g	NC	50		
4512840	Styrene	2016/05/27	95	60 - 140	92	60 - 130	<0.050	ug/g	NC	50		
4512840	Tetrachloroethylene	2016/05/27	96	60 - 140	88	60 - 130	<0.050	ug/g	0.11	50		
4512840	Toluene	2016/05/27	103	60 - 140	97	60 - 130	<0.020	ug/g	NC	50		
4512840	Total Xylenes	2016/05/27					<0.020	ug/g	NC	50		
4512840	trans-1,2-Dichloroethylene	2016/05/27	101	60 - 140	95	60 - 130	<0.050	ug/g	NC	50		
4512840	trans-1,3-Dichloropropene	2016/05/27	81	60 - 140	91	60 - 130	<0.040	ug/g	NC	50		
4512840	Trichloroethylene	2016/05/27	90	60 - 140	85	60 - 130	<0.050	ug/g	NC	50		
4512840	Trichlorofluoromethane (FREON 11)	2016/05/27	95	60 - 140	92	60 - 130	<0.050	ug/g	NC	50		
4512840	Vinyl Chloride	2016/05/27	103	60 - 140	100	60 - 130	<0.020	ug/g	NC	50		
4514509	Available (CaCl2) pH	2016/05/27			99	97 - 103			0.44	N/A		
4514675	Moisture	2016/05/27							1.0	20		
4514804	F1 (C6-C10) - BTEX	2016/05/31					<10	ug/g	NC	30		
4514804	F1 (C6-C10)	2016/05/31	68	60 - 140	88	80 - 120	<10	ug/g	NC	30		
4516040	1-Methylnaphthalene	2016/05/28	80	50 - 130	84	50 - 130	<0.0050	ug/g	NC	40		
4516040	2-Methylnaphthalene	2016/05/28	78	50 - 130	81	50 - 130	<0.0050	ug/g	NC	40		
4516040	Acenaphthene	2016/05/28	86	50 - 130	86	50 - 130	<0.0050	ug/g	NC	40		
4516040	Acenaphthylene	2016/05/28	87	50 - 130	84	50 - 130	<0.0050	ug/g	NC	40		
4516040	Anthracene	2016/05/28	85	50 - 130	90	50 - 130	<0.0050	ug/g	NC	40		

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
4516040	Benzo(a)anthracene	2016/05/28	94	50 - 130	96	50 - 130	<0.0050	ug/g	NC	40		
4516040	Benzo(a)pyrene	2016/05/28	92	50 - 130	92	50 - 130	<0.0050	ug/g	NC	40		
4516040	Benzo(b/j)fluoranthene	2016/05/28	83	50 - 130	93	50 - 130	<0.0050	ug/g	NC	40		
4516040	Benzo(g,h,i)perylene	2016/05/28	70	50 - 130	69	50 - 130	<0.0050	ug/g	NC	40		
4516040	Benzo(k)fluoranthene	2016/05/28	84	50 - 130	75	50 - 130	<0.0050	ug/g	NC	40		
4516040	Chrysene	2016/05/28	95	50 - 130	92	50 - 130	<0.0050	ug/g	NC	40		
4516040	Dibenz(a,h)anthracene	2016/05/28	82	50 - 130	71	50 - 130	<0.0050	ug/g	NC	40		
4516040	Fluoranthene	2016/05/28	87	50 - 130	89	50 - 130	<0.0050	ug/g	NC	40		
4516040	Fluorene	2016/05/28	85	50 - 130	83	50 - 130	<0.0050	ug/g	NC	40		
4516040	Indeno(1,2,3-cd)pyrene	2016/05/28	91	50 - 130	83	50 - 130	<0.0050	ug/g	NC	40		
4516040	Naphthalene	2016/05/28	75	50 - 130	80	50 - 130	<0.0050	ug/g	NC	40		
4516040	Phenanthrene	2016/05/28	82	50 - 130	81	50 - 130	<0.0050	ug/g	NC	40		
4516040	Pyrene	2016/05/28	92	50 - 130	91	50 - 130	<0.0050	ug/g	NC	40		
4516127	F2 (C10-C16 Hydrocarbons)	2016/05/30	95	50 - 130	95	80 - 120	<10	ug/g	NC	30		
4516127	F3 (C16-C34 Hydrocarbons)	2016/05/30	95	50 - 130	90	80 - 120	<50	ug/g	NC	30		
4516127	F4 (C34-C50 Hydrocarbons)	2016/05/30	96	50 - 130	93	80 - 120	<50	ug/g	NC	30		
4516351	Sieve - #200 (<0.075mm)	2016/05/30							1.5	20	89	53 - 58
4516351	Sieve - #200 (>0.075mm)	2016/05/30							1.6	20	11	42 - 47
4520286	F4G-sg (Grav. Heavy Hydrocarbons)	2016/06/01	114	65 - 135	102	65 - 135	<100	ug/g	NC	50		
4565177	Available (CaCl2) pH	2016/07/05			98	97 - 103			0.22	N/A		
4586139	Available (CaCl2) pH	2016/07/20			99	97 - 103			0.14	N/A		

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.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

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).

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
A Bureau Veritas Group Company

Maxxam Analytics International Corporation o/a Maxxam Analytics
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel:(905) 817-5700 Toll-Free (800) 563-6266 Fax:(905) 817-5777 www.maxxam.ca

IMMEDIATE TEST

CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE TO:

Company Name: #3103 Pinchin Ltd.
Attention: Maria Espinosa
Address: 2470 Milltower Crt
Mississauga ON L5N 7W5
Tel: (905) 363-0678 Fax: (905) 363-0681
Email: mespinosa@pinchin.com,ihutchison@pinchin.com,dball

REPORT TO:

Company Name:
Attention: Kyle Shearer
Address:
Tel: Fax:
Email: Kshearer@pinchin.com

PROJECT INFORMATION:

Quotation #: ~~A70927~~
P.O. #:
Project: 103341.001
Project Name:
Site #:
Sampled By: K. Shearer

Laboratory Use Only:

Maxxam Job #:	Bottle Order #:
	562310
COC #:	Project Manager:
C#562310-01-01	Antonella Brasil

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)

☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☒ Ind/Comm ☒ Coarse
☒ Table 3 ☐ Agri/Other ☒ For RSC
☐ Table ___

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558 ☐ Storm Sewer Bylaw
☐ MISA Municipality ________
☐ PWQO
☐ Other ________

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ________

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:

Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified).
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ________ Time Required: ________ ☐
Rush Confirmation Number: ________ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	O.Reg 153 Volatile Organics for RSC (Water)	O.Reg 153 Petroleum Hydrocarbons (Water)	O.Reg 153 PAHs (Water)	VOCs	PHCs F1-F4	PAHs	+/- 75 Grain size	pH			# of Bottles	Comments
1		MW16-1 SA4	May 20/16	0800	~~GW~~ Soil	NA				X	X	X	X				4	
2		MW16-2 SA5	↓	0900	GW	↓				X	X	X	X				4	25-May-16 13:50 Antonella Brasil B6A5189 SEL ENV-783
3		MW16-1 SA7		0840	GW					X	X	X	X				4	
4		MW16-2 SA6		0930	GW					X	X	X		X			4	
5		MW16-1 SA1		0730	GW									X			1	
6		MW16-3 SA5		1100	↓					X	X	X	X				4	
7		MW16-3 SA7		1140						X	X	X					4	
8		DUP-1	↓	1100	↓	↓				X	X	X					3	
9																		
10																		

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
/ Kyle Shearer	16/05/20	1135	JOSEPH UMAY	2016/05/25	13:50	

Laboratory Use Only				
Time Sensitive	Temperature (°C) on Receipt	Custody Seal	Yes	No
	6/7/6°C	Present		✓
		Intact		✓

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

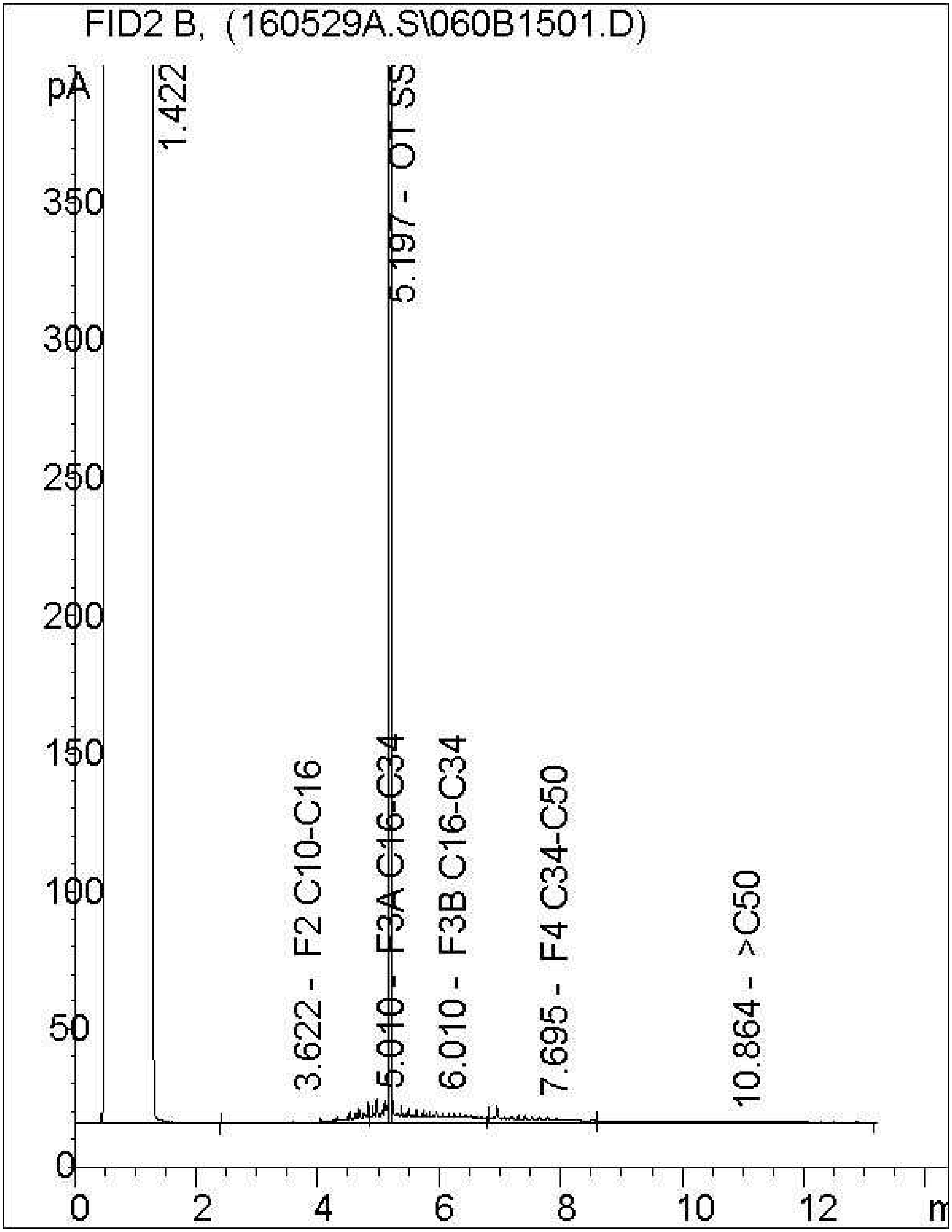
White: Maxxam Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

Maxxam Job #: B6A5189
Report Date: 2016/07/22
Maxxam Sample: CKK076

Pinchin Ltd.
Client Project #: 103341.001
Client ID: MW16-1 SA4

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram

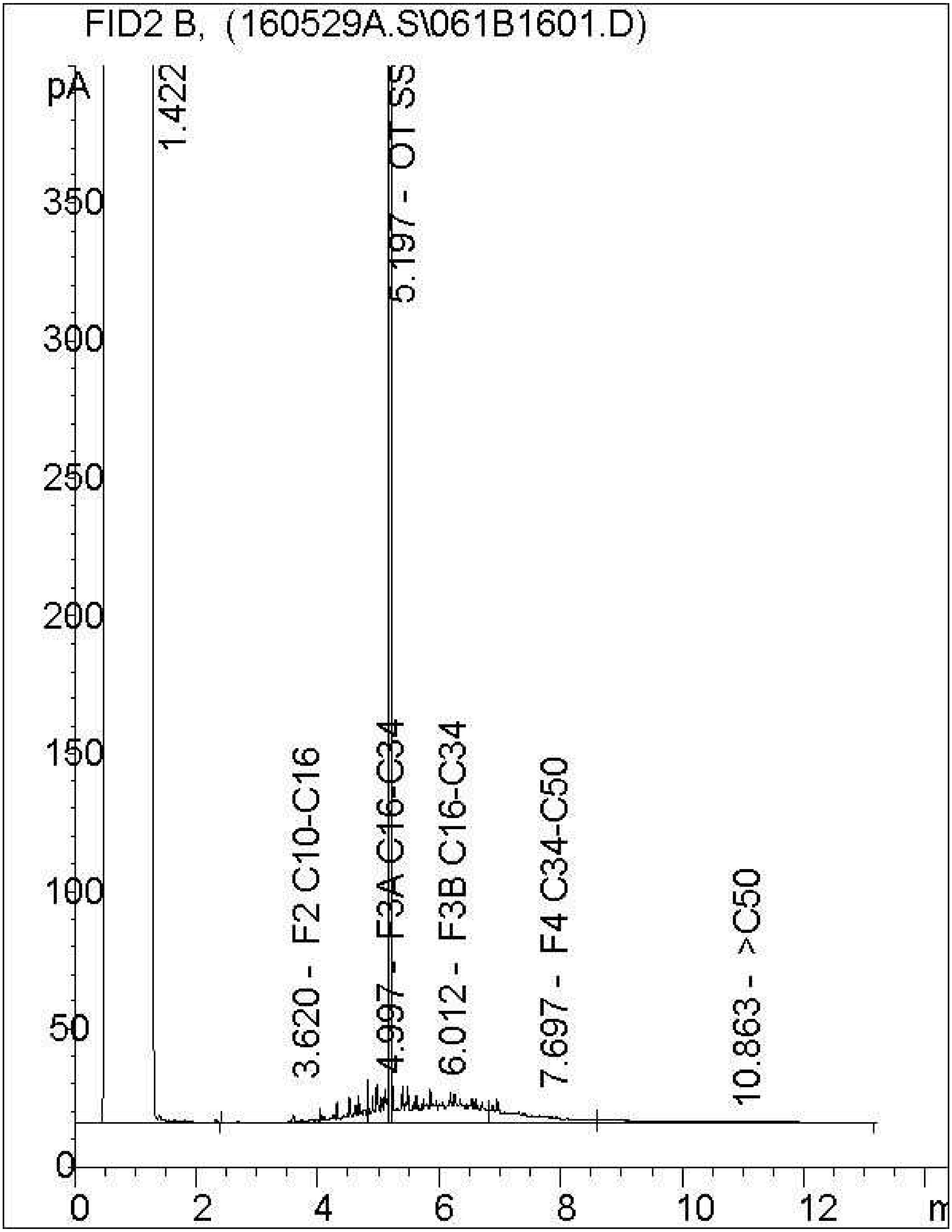


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B6A5189
Report Date: 2016/07/22
Maxxam Sample: CKK077

Pinchin Ltd.
Client Project #: 103341.001
Client ID: MW16-2 SA5

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram

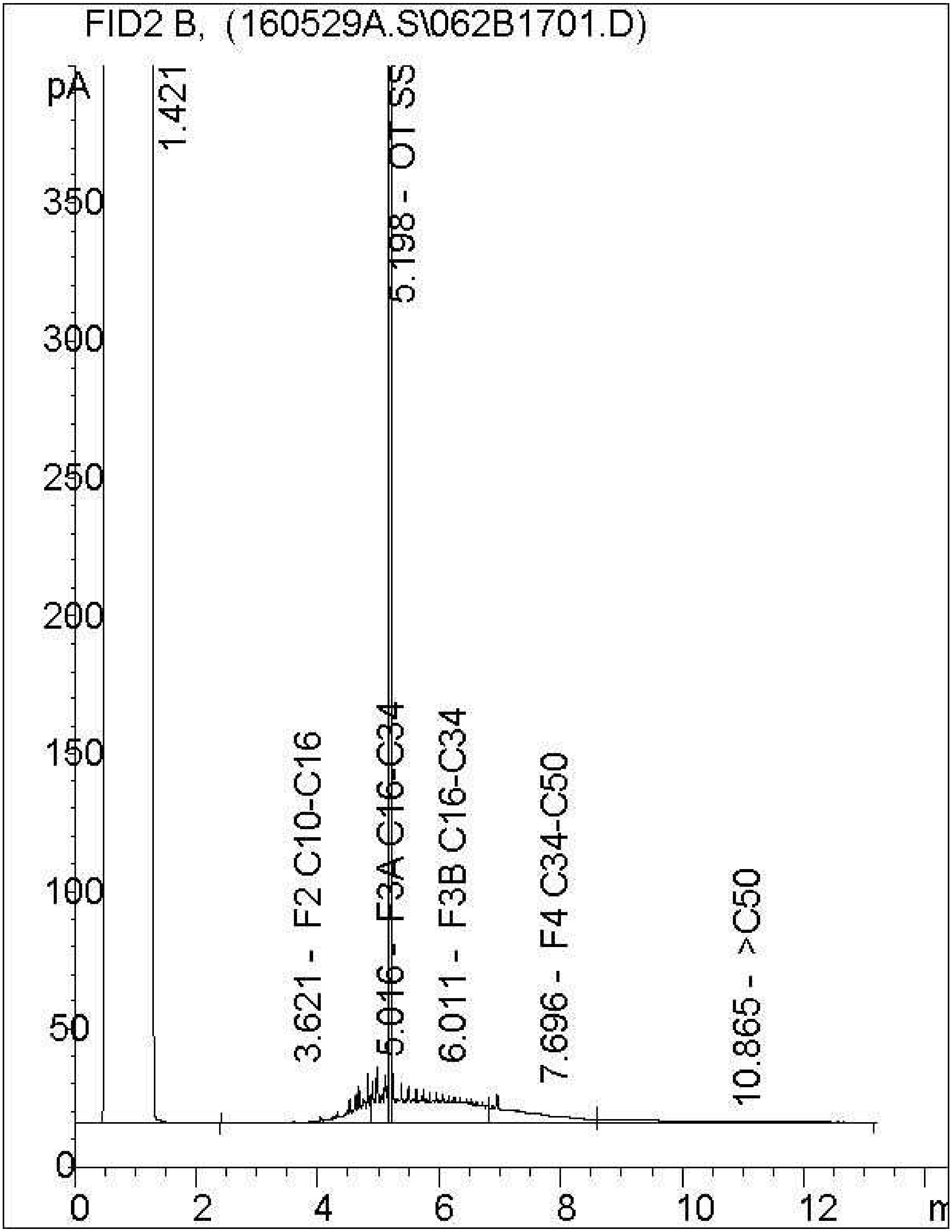


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B6A5189
Report Date: 2016/07/22
Maxxam Sample: CKK078

Pinchin Ltd.
Client Project #: 103341.001
Client ID: MW16-1 SA7

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram

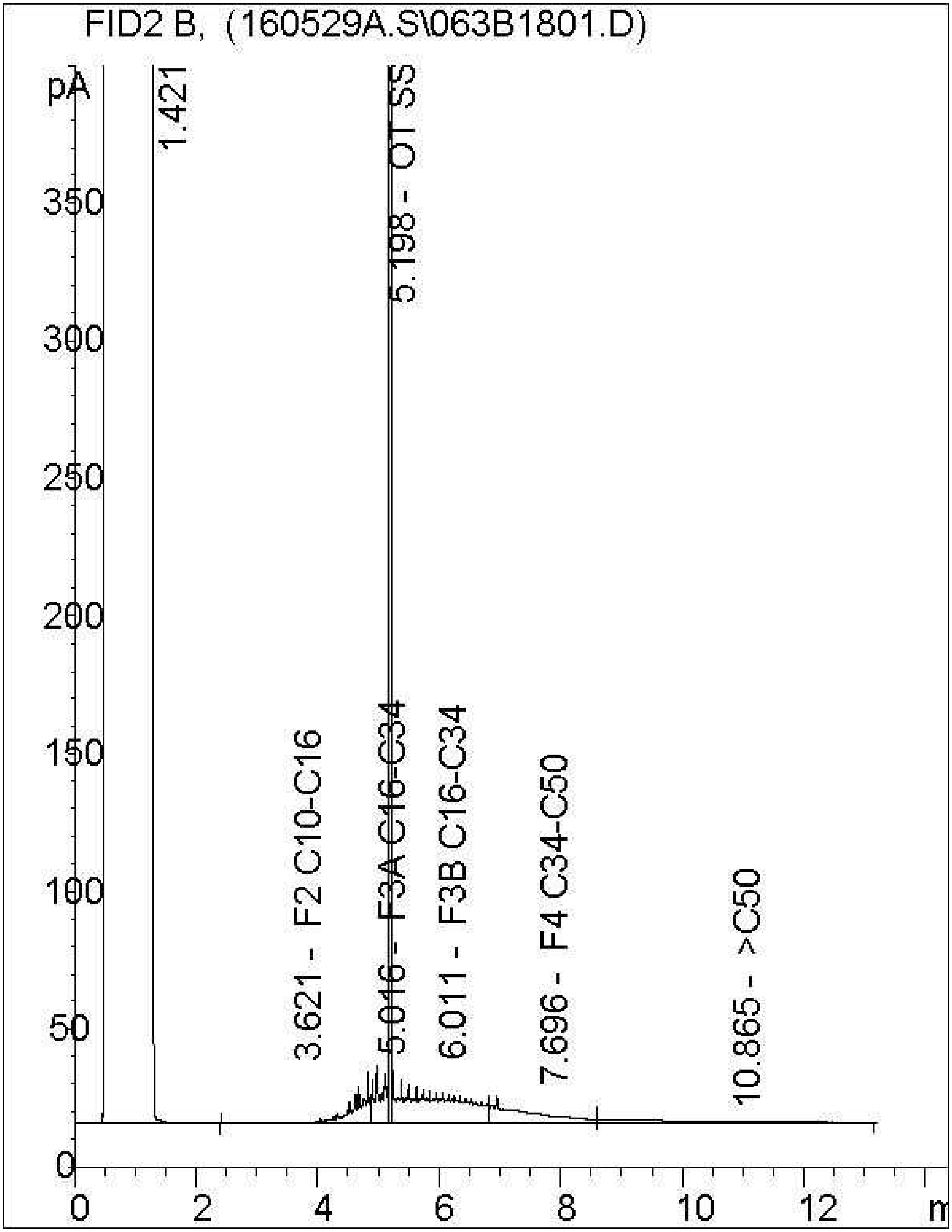


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B6A5189
Report Date: 2016/07/22
Maxxam Sample: CKK079

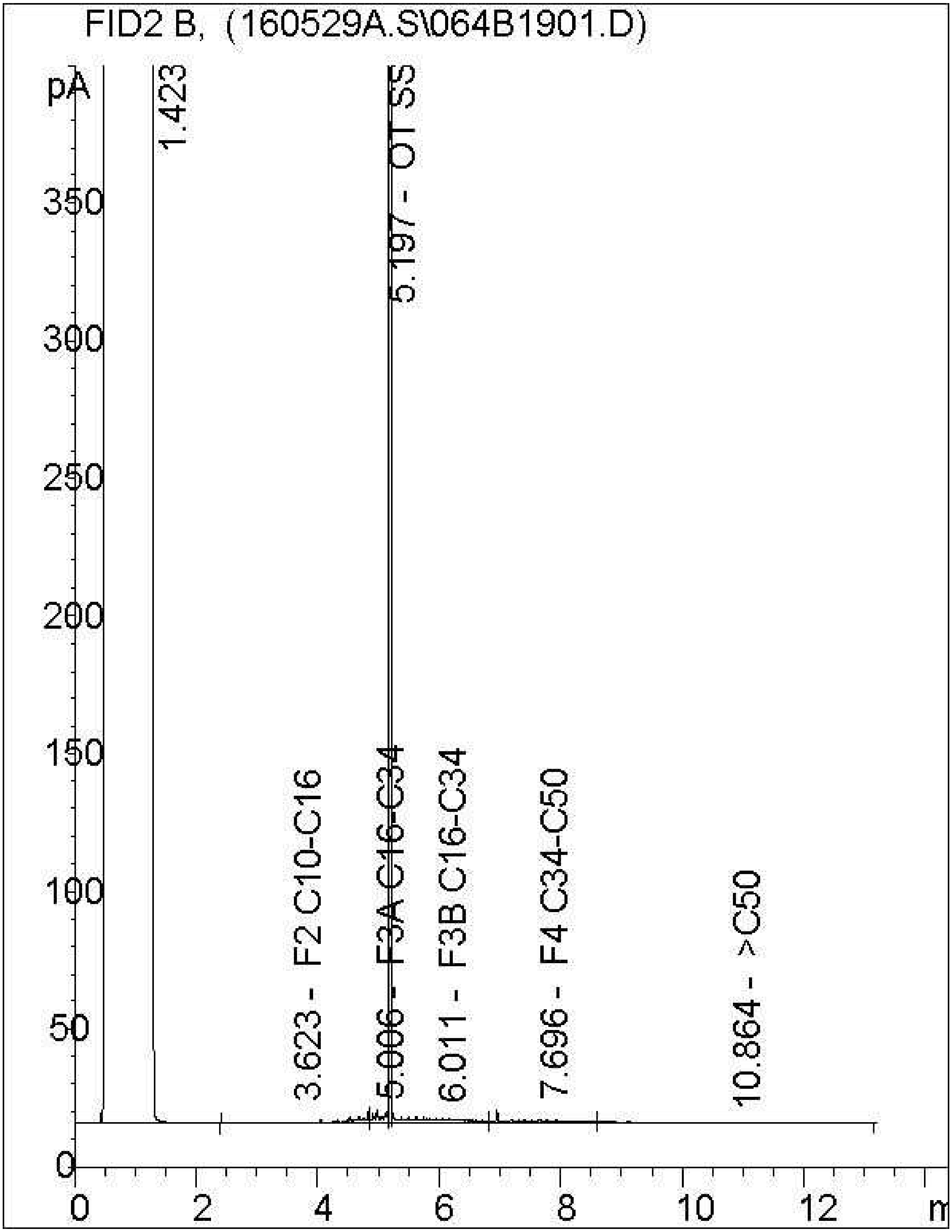
Pinchin Ltd.
Client Project #: 103341.001
Client ID: MW16-2 SA6

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



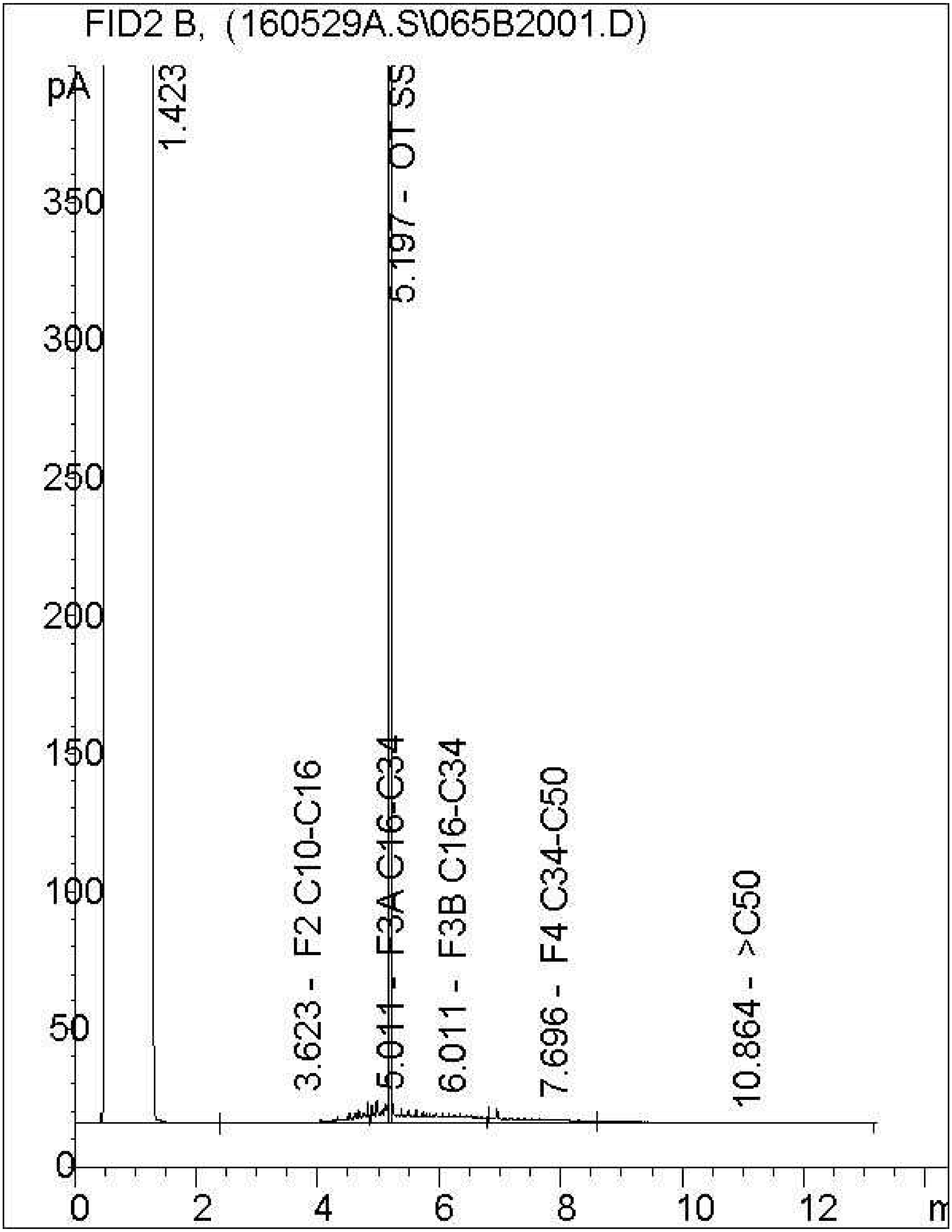
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



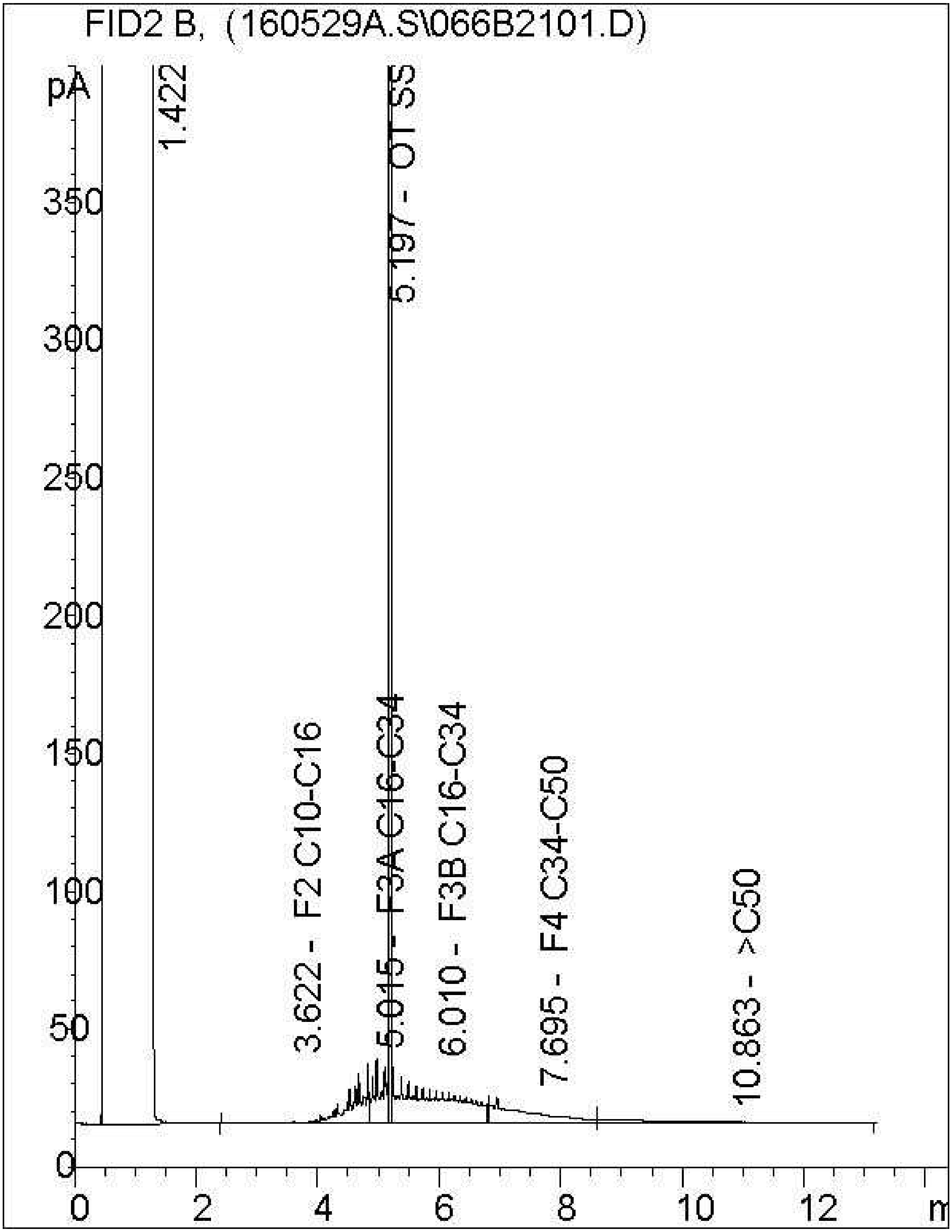
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



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

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



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

Your Project #: 103341.001
Site Location: WHARF ST
Your C.O.C. #: 557519-04-01

Attention:Kyle Shearer
Pinchin Ltd.
2470 Milltower Crt
Mississauga, ON
L5N 7W5

Report Date: 2016/07/11
Report #: R4059100
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B6B0019
Received: 2016/05/31, 12:55

Sample Matrix: Water
Samples Received: 5

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Methylnaphthalene Sum	4	N/A	2016/06/03	CAM SOP-00301	EPA 8270D m
1,3-Dichloropropene Sum	5	N/A	2016/06/06		EPA 8260C m
Petroleum Hydro. CCME F1 & BTEX in Water	5	N/A	2016/06/03	CAM SOP-00315	CCME PHC-CWS m
Petroleum Hydrocarbons F2-F4 in Water (1)	4	2016/06/03	2016/06/04	CAM SOP-00316	CCME PHC-CWS m
PAH Compounds in Water by GC/MS (SIM)	4	2016/06/01	2016/06/02	CAM SOP-00318	EPA 8270D m
Volatile Organic Compounds in Water	5	N/A	2016/06/03	CAM SOP-00228	EPA 8260C m

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.

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

(1) All CCME PHC results met required criteria unless otherwise stated in the report. The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following “Alberta Environment’s Interpretation of the Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil Validation of Performance-Based Alternative Methods September 2003”. Documentation is available upon request. Modifications from Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil-Tier 1 Method: F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction.

Encryption Key

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
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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.

Total Cover Pages : 1

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		CLH890		
Sampling Date				
COC Number		557519-04-01		
	UNITS	**TRIP BLANK**	**RDL**	**QC Batch**
BTEX & F1 Hydrocarbons				
F1 (C6-C10)	ug/L	<25	25	4524541
F1 (C6-C10) - BTEX	ug/L	<25	25	4524541
Surrogate Recovery (%)				
1,4-Difluorobenzene	%	98		4524541
4-Bromofluorobenzene	%	101		4524541
D10-Ethylbenzene	%	103		4524541
D4-1,2-Dichloroethane	%	94		4524541

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 153 PAHS (WATER)

Maxxam ID		CLH886	CLH887	CLH888	CLH889		
Sampling Date		2016/05/26 10:15	2016/05/26 12:00	2016/05/30 09:30	2016/05/26 10:45		
COC Number		557519-04-01	557519-04-01	557519-04-01	557519-04-01		
	UNITS	**MW16-1**	**MW16-2**	**MW16-3**	**DUP-1**	**RDL**	**QC Batch**
Calculated Parameters							
Methylnaphthalene, 2-(1-)	ug/L	<0.071	<0.071	<0.071	<0.071	0.071	4519265
Polyaromatic Hydrocarbons							
Acenaphthene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Acenaphthylene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Anthracene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Benzo(a)anthracene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Benzo(a)pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	4521779
Benzo(b/j)fluoranthene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Benzo(g,h,i)perylene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Benzo(k)fluoranthene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Chrysene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Dibenz(a,h)anthracene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Fluoranthene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Fluorene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Indeno(1,2,3-cd)pyrene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
1-Methylnaphthalene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
2-Methylnaphthalene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Naphthalene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Phenanthrene	ug/L	<0.030	<0.030	<0.030	<0.030	0.030	4521779
Pyrene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	4521779
Surrogate Recovery (%)							
D10-Anthracene	%	102	94	102	100		4521779
D14-Terphenyl (FS)	%	101	81	100	96		4521779
D8-Acenaphthylene	%	96	95	98	94		4521779

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 153 PETROLEUM HYDROCARBONS (WATER)

Maxxam ID		CLH886	CLH887	CLH887	CLH888	CLH889		
Sampling Date		2016/05/26 10:15	2016/05/26 12:00	2016/05/26 12:00	2016/05/30 09:30	2016/05/26 10:45		
COC Number		557519-04-01	557519-04-01	557519-04-01	557519-04-01	557519-04-01		
	UNITS	**MW16-1**	**MW16-2**	**MW16-2 Lab-Dup**	**MW16-3**	**DUP-1**	**RDL**	**QC Batch**
BTEX & F1 Hydrocarbons								
F1 (C6-C10)	ug/L	<25	<25		<25	<25	25	4524541
F1 (C6-C10) - BTEX	ug/L	<25	<25		<25	<25	25	4524541
F2-F4 Hydrocarbons								
F2 (C10-C16 Hydrocarbons)	ug/L	<100	<100	<100	<100	<100	100	4524746
F3 (C16-C34 Hydrocarbons)	ug/L	<200	<200	<200	<200	<200	200	4524746
F4 (C34-C50 Hydrocarbons)	ug/L	<200	<200	<200	<200	<200	200	4524746
Reached Baseline at C50	ug/L	Yes	Yes	Yes	Yes	Yes		4524746
Surrogate Recovery (%)								
1,4-Difluorobenzene	%	100	104		95	99		4524541
4-Bromofluorobenzene	%	102	101		101	101		4524541
D10-Ethylbenzene	%	101	105		98	98		4524541
D4-1,2-Dichloroethane	%	96	94		95	97		4524541
o-Terphenyl	%	91	89	90	88	89		4524746

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

O.REG 153 VOLATILE ORGANICS (WATER)

Maxxam ID		CLH886	CLH887	CLH887	CLH888	CLH889		
Sampling Date		2016/05/26 10:15	2016/05/26 12:00	2016/05/26 12:00	2016/05/30 09:30	2016/05/26 10:45		
COC Number		557519-04-01	557519-04-01	557519-04-01	557519-04-01	557519-04-01		
	UNITS	**MW16-1**	**MW16-2**	**MW16-2 Lab-Dup**	**MW16-3**	**DUP-1**	**RDL**	**QC Batch**
Calculated Parameters								
1,3-Dichloropropene (cis+trans)	ug/L	<0.50	<0.50		<0.50	<0.50	0.50	4519159
Volatile Organics								
Acetone (2-Propanone)	ug/L	<10	<10	<10	<10	<10	10	4520765
Benzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
Bromodichloromethane	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
Bromoform	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	4520765
Bromomethane	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
Carbon Tetrachloride	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
Chlorobenzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
Chloroform	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
Dibromochloromethane	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
1,2-Dichlorobenzene	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
1,3-Dichlorobenzene	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
1,4-Dichlorobenzene	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
Dichlorodifluoromethane (FREON 12)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	4520765
1,1-Dichloroethane	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
1,2-Dichloroethane	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
1,1-Dichloroethylene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
cis-1,2-Dichloroethylene	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
trans-1,2-Dichloroethylene	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
1,2-Dichloropropane	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
cis-1,3-Dichloropropene	ug/L	<0.30	<0.30	<0.30	<0.30	<0.30	0.30	4520765
trans-1,3-Dichloropropene	ug/L	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	4520765
Ethylbenzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
Ethylene Dibromide	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
Hexane	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	4520765
Methylene Chloride(Dichloromethane)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	2.0	4520765
Methyl Ethyl Ketone (2-Butanone)	ug/L	<10	<10	<10	<10	<10	10	4520765
Methyl Isobutyl Ketone	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	4520765
Methyl t-butyl ether (MTBE)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
Styrene	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
1,1,1,2-Tetrachloroethane	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

O.REG 153 VOLATILE ORGANICS (WATER)

Maxxam ID		CLH886	CLH887	CLH887	CLH888	CLH889		
Sampling Date		2016/05/26 10:15	2016/05/26 12:00	2016/05/26 12:00	2016/05/30 09:30	2016/05/26 10:45		
COC Number		557519-04-01	557519-04-01	557519-04-01	557519-04-01	557519-04-01		
	UNITS	**MW16-1**	**MW16-2**	**MW16-2 Lab-Dup**	**MW16-3**	**DUP-1**	**RDL**	**QC Batch**
1,1,2,2-Tetrachloroethane	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
Tetrachloroethylene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
Toluene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
1,1,1-Trichloroethane	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
1,1,2-Trichloroethane	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
Trichloroethylene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
Trichlorofluoromethane (FREON 11)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	4520765
Vinyl Chloride	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
p+m-Xylene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
o-Xylene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
Total Xylenes	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	4520765
Surrogate Recovery (%)								
4-Bromofluorobenzene	%	95	96	95	97	96		4520765
D4-1,2-Dichloroethane	%	102	102	103	103	103		4520765
D8-Toluene	%	95	95	95	94	95		4520765

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

O.REG 153 VOLATILE ORGANICS (WATER)

Maxxam ID		CLH890		
Sampling Date				
COC Number		557519-04-01		
	UNITS	**TRIP BLANK**	**RDL**	**QC Batch**
Calculated Parameters				
1,3-Dichloropropene (cis+trans)	ug/L	<0.50	0.50	4522493
Volatile Organics				
Acetone (2-Propanone)	ug/L	<10	10	4520765
Benzene	ug/L	<0.20	0.20	4520765
Bromodichloromethane	ug/L	<0.50	0.50	4520765
Bromoform	ug/L	<1.0	1.0	4520765
Bromomethane	ug/L	<0.50	0.50	4520765
Carbon Tetrachloride	ug/L	<0.20	0.20	4520765
Chlorobenzene	ug/L	<0.20	0.20	4520765
Chloroform	ug/L	<0.20	0.20	4520765
Dibromochloromethane	ug/L	<0.50	0.50	4520765
1,2-Dichlorobenzene	ug/L	<0.50	0.50	4520765
1,3-Dichlorobenzene	ug/L	<0.50	0.50	4520765
1,4-Dichlorobenzene	ug/L	<0.50	0.50	4520765
Dichlorodifluoromethane (FREON 12)	ug/L	<1.0	1.0	4520765
1,1-Dichloroethane	ug/L	<0.20	0.20	4520765
1,2-Dichloroethane	ug/L	<0.50	0.50	4520765
1,1-Dichloroethylene	ug/L	<0.20	0.20	4520765
cis-1,2-Dichloroethylene	ug/L	<0.50	0.50	4520765
trans-1,2-Dichloroethylene	ug/L	<0.50	0.50	4520765
1,2-Dichloropropane	ug/L	<0.20	0.20	4520765
cis-1,3-Dichloropropene	ug/L	<0.30	0.30	4520765
trans-1,3-Dichloropropene	ug/L	<0.40	0.40	4520765
Ethylbenzene	ug/L	<0.20	0.20	4520765
Ethylene Dibromide	ug/L	<0.20	0.20	4520765
Hexane	ug/L	<1.0	1.0	4520765
Methylene Chloride(Dichloromethane)	ug/L	<2.0	2.0	4520765
Methyl Ethyl Ketone (2-Butanone)	ug/L	<10	10	4520765
Methyl Isobutyl Ketone	ug/L	<5.0	5.0	4520765
Methyl t-butyl ether (MTBE)	ug/L	<0.50	0.50	4520765
Styrene	ug/L	<0.50	0.50	4520765
1,1,1,2-Tetrachloroethane	ug/L	<0.50	0.50	4520765
1,1,2,2-Tetrachloroethane	ug/L	<0.50	0.50	4520765

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 153 VOLATILE ORGANICS (WATER)

Maxxam ID		CLH890		
Sampling Date				
COC Number		557519-04-01		
	UNITS	**TRIP BLANK**	**RDL**	**QC Batch**
Tetrachloroethylene	ug/L	<0.20	0.20	4520765
Toluene	ug/L	<0.20	0.20	4520765
1,1,1-Trichloroethane	ug/L	<0.20	0.20	4520765
1,1,2-Trichloroethane	ug/L	<0.50	0.50	4520765
Trichloroethylene	ug/L	<0.20	0.20	4520765
Trichlorofluoromethane (FREON 11)	ug/L	<0.50	0.50	4520765
Vinyl Chloride	ug/L	<0.20	0.20	4520765
p+m-Xylene	ug/L	<0.20	0.20	4520765
o-Xylene	ug/L	<0.20	0.20	4520765
Total Xylenes	ug/L	<0.20	0.20	4520765
Surrogate Recovery (%)				
4-Bromofluorobenzene	%	95		4520765
D4-1,2-Dichloroethane	%	103		4520765
D8-Toluene	%	95		4520765

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Maxxam ID: CLH886
Sample ID: MW16-1
Matrix: Water

Collected: 2016/05/26
Shipped:
Received: 2016/05/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4519265	N/A	2016/06/03	Automated Statchk
1,3-Dichloropropene Sum	CALC	4519159	N/A	2016/06/06	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	4524541	N/A	2016/06/03	Lincoln Ramdahin
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	4524746	2016/06/03	2016/06/04	Barbara Wowk
PAH Compounds in Water by GC/MS (SIM)	GC/MS	4521779	2016/06/01	2016/06/02	Jett Wu
Volatile Organic Compounds in Water	GC/MS	4520765	N/A	2016/06/03	Xueming Jiang

Maxxam ID: CLH887
Sample ID: MW16-2
Matrix: Water

Collected: 2016/05/26
Shipped:
Received: 2016/05/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4519265	N/A	2016/06/03	Automated Statchk
1,3-Dichloropropene Sum	CALC	4519159	N/A	2016/06/06	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	4524541	N/A	2016/06/03	Lincoln Ramdahin
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	4524746	2016/06/03	2016/06/04	Barbara Wowk
PAH Compounds in Water by GC/MS (SIM)	GC/MS	4521779	2016/06/01	2016/06/02	Jett Wu
Volatile Organic Compounds in Water	GC/MS	4520765	N/A	2016/06/03	Xueming Jiang

Maxxam ID: CLH887 Dup
Sample ID: MW16-2
Matrix: Water

Collected: 2016/05/26
Shipped:
Received: 2016/05/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	4524746	2016/06/03	2016/06/04	Barbara Wowk
Volatile Organic Compounds in Water	GC/MS	4520765	N/A	2016/06/03	Xueming Jiang

Maxxam ID: CLH888
Sample ID: MW16-3
Matrix: Water

Collected: 2016/05/30
Shipped:
Received: 2016/05/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4519265	N/A	2016/06/03	Automated Statchk
1,3-Dichloropropene Sum	CALC	4519159	N/A	2016/06/06	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	4524541	N/A	2016/06/03	Lincoln Ramdahin
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	4524746	2016/06/03	2016/06/04	Barbara Wowk
PAH Compounds in Water by GC/MS (SIM)	GC/MS	4521779	2016/06/01	2016/06/02	Jett Wu
Volatile Organic Compounds in Water	GC/MS	4520765	N/A	2016/06/03	Xueming Jiang

Maxxam ID: CLH889
Sample ID: DUP-1
Matrix: Water

Collected: 2016/05/26
Shipped:
Received: 2016/05/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4519265	N/A	2016/06/03	Automated Statchk

TEST SUMMARY

Maxxam ID: CLH889
Sample ID: DUP-1
Matrix: Water

Collected: 2016/05/26
Shipped:
Received: 2016/05/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
1,3-Dichloropropene Sum	CALC	4519159	N/A	2016/06/06	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	4524541	N/A	2016/06/03	Lincoln Ramdahin
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	4524746	2016/06/03	2016/06/04	Barbara Wowk
PAH Compounds in Water by GC/MS (SIM)	GC/MS	4521779	2016/06/01	2016/06/02	Jett Wu
Volatile Organic Compounds in Water	GC/MS	4520765	N/A	2016/06/03	Xueming Jiang

Maxxam ID: CLH890
Sample ID: TRIP BLANK
Matrix: Water

Collected:
Shipped:
Received: 2016/05/31

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
1,3-Dichloropropene Sum	CALC	4522493	N/A	2016/06/06	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	4524541	N/A	2016/06/03	Lincoln Ramdahin
Volatile Organic Compounds in Water	GC/MS	4520765	N/A	2016/06/03	Xueming Jiang

GENERAL COMMENTS

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

Package 1	7.3°C

Cooler custody seal was present and intact.

For samples BH16-1, BH16-2, BH16-3, and DUP-1, all 40mL vials for F1BTEX and VOC analyses contained visible sediment. All 250mL amber glass bottles for F2-F4 and PAH analyses contained visible sediment, which was included in the extraction.

Revised Report(2016/07/11): IDs changed as per client request.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
4520765	4-Bromofluorobenzene	2016/06/03	100	70 - 130	101	70 - 130	98	%		
4520765	D4-1,2-Dichloroethane	2016/06/03	101	70 - 130	100	70 - 130	102	%		
4520765	D8-Toluene	2016/06/03	101	70 - 130	101	70 - 130	94	%		
4521779	D10-Anthracene	2016/06/02	108	50 - 130	102	50 - 130	103	%		
4521779	D14-Terphenyl (FS)	2016/06/02	108	50 - 130	102	50 - 130	103	%		
4521779	D8-Acenaphthylene	2016/06/02	101	50 - 130	94	50 - 130	95	%		
4524541	1,4-Difluorobenzene	2016/06/03	95	70 - 130	100	70 - 130	98	%		
4524541	4-Bromofluorobenzene	2016/06/03	103	70 - 130	106	70 - 130	103	%		
4524541	D10-Ethylbenzene	2016/06/03	101	70 - 130	98	70 - 130	104	%		
4524541	D4-1,2-Dichloroethane	2016/06/03	96	70 - 130	95	70 - 130	94	%		
4524746	o-Terphenyl	2016/06/03	92	60 - 130	92	60 - 130	88	%		
4520765	1,1,1,2-Tetrachloroethane	2016/06/03	92	70 - 130	97	70 - 130	<0.50	ug/L	NC	30
4520765	1,1,1-Trichloroethane	2016/06/03	90	70 - 130	95	70 - 130	<0.20	ug/L	NC	30
4520765	1,1,2,2-Tetrachloroethane	2016/06/03	97	70 - 130	99	70 - 130	<0.50	ug/L	NC	30
4520765	1,1,2-Trichloroethane	2016/06/03	94	70 - 130	97	70 - 130	<0.50	ug/L	NC	30
4520765	1,1-Dichloroethane	2016/06/03	90	70 - 130	95	70 - 130	<0.20	ug/L	NC	30
4520765	1,1-Dichloroethylene	2016/06/03	93	70 - 130	98	70 - 130	<0.20	ug/L	NC	30
4520765	1,2-Dichlorobenzene	2016/06/03	93	70 - 130	97	70 - 130	<0.50	ug/L	NC	30
4520765	1,2-Dichloroethane	2016/06/03	94	70 - 130	97	70 - 130	<0.50	ug/L	NC	30
4520765	1,2-Dichloropropane	2016/06/03	91	70 - 130	95	70 - 130	<0.20	ug/L	NC	30
4520765	1,3-Dichlorobenzene	2016/06/03	92	70 - 130	96	70 - 130	<0.50	ug/L	NC	30
4520765	1,4-Dichlorobenzene	2016/06/03	94	70 - 130	98	70 - 130	<0.50	ug/L	NC	30
4520765	Acetone (2-Propanone)	2016/06/03	106	60 - 140	108	60 - 140	<10	ug/L	NC	30
4520765	Benzene	2016/06/03	91	70 - 130	95	70 - 130	<0.20	ug/L	NC	30
4520765	Bromodichloromethane	2016/06/03	92	70 - 130	96	70 - 130	<0.50	ug/L	NC	30
4520765	Bromoform	2016/06/03	94	70 - 130	97	70 - 130	<1.0	ug/L	NC	30
4520765	Bromomethane	2016/06/03	80	60 - 140	83	60 - 140	<0.50	ug/L	NC	30
4520765	Carbon Tetrachloride	2016/06/03	92	70 - 130	97	70 - 130	<0.20	ug/L	NC	30
4520765	Chlorobenzene	2016/06/03	94	70 - 130	99	70 - 130	<0.20	ug/L	NC	30
4520765	Chloroform	2016/06/03	92	70 - 130	96	70 - 130	<0.20	ug/L	NC	30
4520765	cis-1,2-Dichloroethylene	2016/06/03	93	70 - 130	97	70 - 130	<0.50	ug/L	NC	30

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
4520765	cis-1,3-Dichloropropene	2016/06/03	95	70 - 130	97	70 - 130	<0.30	ug/L	NC	30
4520765	Dibromochloromethane	2016/06/03	94	70 - 130	98	70 - 130	<0.50	ug/L	NC	30
4520765	Dichlorodifluoromethane (FREON 12)	2016/06/03	83	60 - 140	89	60 - 140	<1.0	ug/L	NC	30
4520765	Ethylbenzene	2016/06/03	93	70 - 130	98	70 - 130	<0.20	ug/L	NC	30
4520765	Ethylene Dibromide	2016/06/03	95	70 - 130	98	70 - 130	<0.20	ug/L	NC	30
4520765	Hexane	2016/06/03	93	70 - 130	105	70 - 130	<1.0	ug/L	NC	30
4520765	Methyl Ethyl Ketone (2-Butanone)	2016/06/03	109	60 - 140	111	60 - 140	<10	ug/L	NC	30
4520765	Methyl Isobutyl Ketone	2016/06/03	101	70 - 130	104	70 - 130	<5.0	ug/L	NC	30
4520765	Methyl t-butyl ether (MTBE)	2016/06/03	94	70 - 130	98	70 - 130	<0.50	ug/L	NC	30
4520765	Methylene Chloride(Dichloromethane)	2016/06/03	96	70 - 130	100	70 - 130	<2.0	ug/L	NC	30
4520765	o-Xylene	2016/06/03	91	70 - 130	98	70 - 130	<0.20	ug/L	NC	30
4520765	p+m-Xylene	2016/06/03	92	70 - 130	97	70 - 130	<0.20	ug/L	NC	30
4520765	Styrene	2016/06/03	94	70 - 130	100	70 - 130	<0.50	ug/L	NC	30
4520765	Tetrachloroethylene	2016/06/03	90	70 - 130	95	70 - 130	<0.20	ug/L	NC	30
4520765	Toluene	2016/06/03	92	70 - 130	97	70 - 130	<0.20	ug/L	NC	30
4520765	Total Xylenes	2016/06/03					<0.20	ug/L	NC	30
4520765	trans-1,2-Dichloroethylene	2016/06/03	91	70 - 130	95	70 - 130	<0.50	ug/L	NC	30
4520765	trans-1,3-Dichloropropene	2016/06/03	94	70 - 130	96	70 - 130	<0.40	ug/L	NC	30
4520765	Trichloroethylene	2016/06/03	89	70 - 130	93	70 - 130	<0.20	ug/L	NC	30
4520765	Trichlorofluoromethane (FREON 11)	2016/06/03	91	70 - 130	96	70 - 130	<0.50	ug/L	NC	30
4520765	Vinyl Chloride	2016/06/03	89	70 - 130	94	70 - 130	<0.20	ug/L	NC	30
4521779	1-Methylnaphthalene	2016/06/02	88	50 - 130	86	50 - 130	<0.050	ug/L	34 (1)	30
4521779	2-Methylnaphthalene	2016/06/02	85	50 - 130	83	50 - 130	<0.050	ug/L	35 (1)	30
4521779	Acenaphthene	2016/06/02	91	50 - 130	90	50 - 130	<0.050	ug/L	29	30
4521779	Acenaphthylene	2016/06/02	92	50 - 130	90	50 - 130	<0.050	ug/L	NC	30
4521779	Anthracene	2016/06/02	92	50 - 130	92	50 - 130	<0.050	ug/L	NC	30
4521779	Benzo(a)anthracene	2016/06/02	93	50 - 130	92	50 - 130	<0.050	ug/L	NC	30
4521779	Benzo(a)pyrene	2016/06/02	91	50 - 130	90	50 - 130	<0.010	ug/L	NC	30
4521779	Benzo(b/j)fluoranthene	2016/06/02	89	50 - 130	92	50 - 130	<0.050	ug/L	NC	30
4521779	Benzo(g,h,i)perylene	2016/06/02	92	50 - 130	93	50 - 130	<0.050	ug/L	NC	30
4521779	Benzo(k)fluoranthene	2016/06/02	91	50 - 130	85	50 - 130	<0.050	ug/L	NC	30

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
4521779	Chrysene	2016/06/02	92	50 - 130	92	50 - 130	<0.050	ug/L	NC	30
4521779	Dibenz(a,h)anthracene	2016/06/02	90	50 - 130	91	50 - 130	<0.050	ug/L	NC	30
4521779	Fluoranthene	2016/06/02	100	50 - 130	100	50 - 130	<0.050	ug/L	NC	30
4521779	Fluorene	2016/06/02	88	50 - 130	87	50 - 130	<0.050	ug/L	34 (1)	30
4521779	Indeno(1,2,3-cd)pyrene	2016/06/02	100	50 - 130	101	50 - 130	<0.050	ug/L	NC	30
4521779	Naphthalene	2016/06/02	88	50 - 130	87	50 - 130	<0.050	ug/L	NC (2)	30
4521779	Phenanthrene	2016/06/02	91	50 - 130	91	50 - 130	<0.030	ug/L	32 (1)	30
4521779	Pyrene	2016/06/02	102	50 - 130	101	50 - 130	<0.050	ug/L	NC	30
4524541	F1 (C6-C10) - BTEX	2016/06/03					<25	ug/L	NC	30
4524541	F1 (C6-C10)	2016/06/03	96	70 - 130	92	70 - 130	<25	ug/L	NC	30
4524746	F2 (C10-C16 Hydrocarbons)	2016/06/04	89	50 - 130	92	60 - 130	<100	ug/L	NC	30
4524746	F3 (C16-C34 Hydrocarbons)	2016/06/04	NC	50 - 130	100	60 - 130	<200	ug/L	NC	30
4524746	F4 (C34-C50 Hydrocarbons)	2016/06/04	103	50 - 130	99	60 - 130	<200	ug/L	NC	30

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) Duplicate results exceeded RPD acceptance criteria. The variability in the results for this analyte may be more pronounced.

(2) DL was raised due to matrix interference.

VALIDATION SIGNATURE PAGE

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

Eva P

Eva Pranjic

Ewa Pranjic, M.Sc., C.Chem, 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
A Bureau Veritas Group Company

Maxxam Analytics International Corporation o/a Maxxam Analytics
6740 Campobello Road Mississauga, Ontario Canada L5N 2L8 Tel (905) 817-5700 Toll-Free (800) 563-6266 Fax (905) 817-5777 www.maxxam.ca

CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE TO:

Company Name: #3103 Pinchin Ltd.
Attention: Maria Espinosa
Address: 2470 Milltower Crt
Mississauga ON L5N 7W5
Tel: (905) 363-0678 Fax: (905) 363-0681
Email: mespinosa@pinchin.com,ihutchison@pinchin.com,dball

REPORT TO:

Company Name:
Attention: Kyle Shearer
Address:
Tel: Fax:
Email: Kshearer@pinchin.com

PROJECT INFORMATION:

Quotation #: ~~A70827~~
P.O. #:
Project: ~~141021.002~~ 103341.001
Project Name: Wharf St
Site #:
Sampled By: ~~K Shearer~~ C. Griffith

Laboratory Use Only:

Maxxam Job #:	Bottle Order #:
	557519
COC #:	Project Manager:
C#557519-04-01	Antonella Brasil

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☒ Ind/Comm ☒ Coarse
☒ Table 3 ☐ Agri/Other ☒ For RSC
☐ Table ___

Other Regulations
☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558 ☐ Storm Sewer Bylaw
☐ MISA Municipality ______
☐ PWQO
☐ Other ______

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ______

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required
Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ______ Time Required: ______ ☐
Rush Confirmation Number: ______ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Petroleum Hydrocarbons F2-F4 in Soil	O Reg 153 Metals & Inorganics Pkg (Soil)	PHCs F1-F4	VOCs	PAH	F1 / VOCs					# of Bottles	Comments
1		BH16-1	May 26/16	1015	GW	N/A			X	X	X						9	
2		BH16-2	May 26/16	1200	↓	↓			X	X	X						9	
3		BH16-3	May 30/16	0930 ~~1000~~					X	X	X						7	
4		DUP-1	May 26/16	1045	↓	↓			X	X	X						9	
5		Trip Blank	NA	NA	NA	↓						X					1	
6																		
7																		
8																		
9																		
10																		

31-May-16 12:55
Antonella Brasil
B6B0019
ABH ENV-1146

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
/ Kyle Shearer	16/05/31	1040	RACHEL DEVLIN	2016/05/31	12:55	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Receipt	Custody Seal	Yes	No
	7/7/8	Present	—	
		Intact	—	

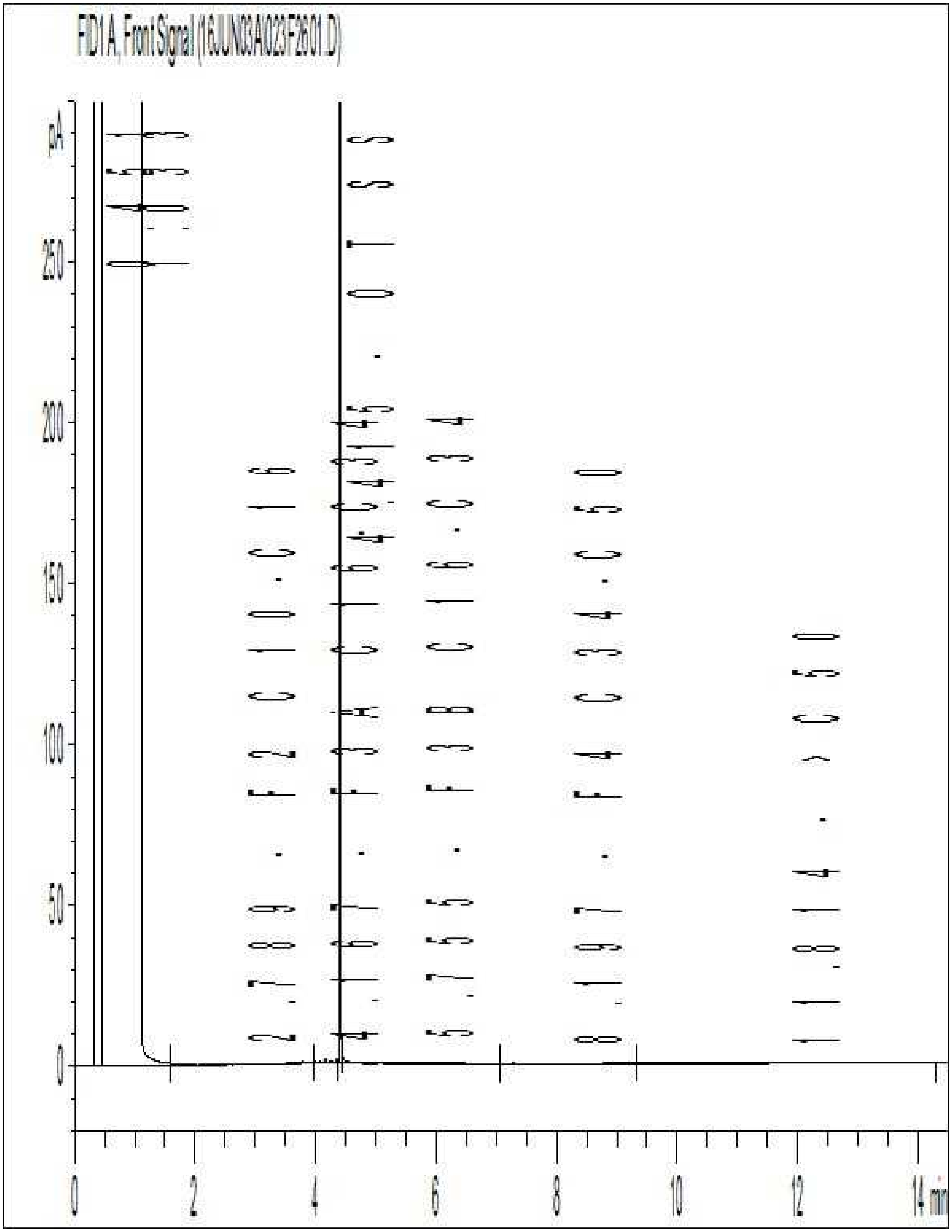
* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: [✓ Maxxam] Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics #344364

Petroleum Hydrocarbons F2-F4 in Water Chromatogram

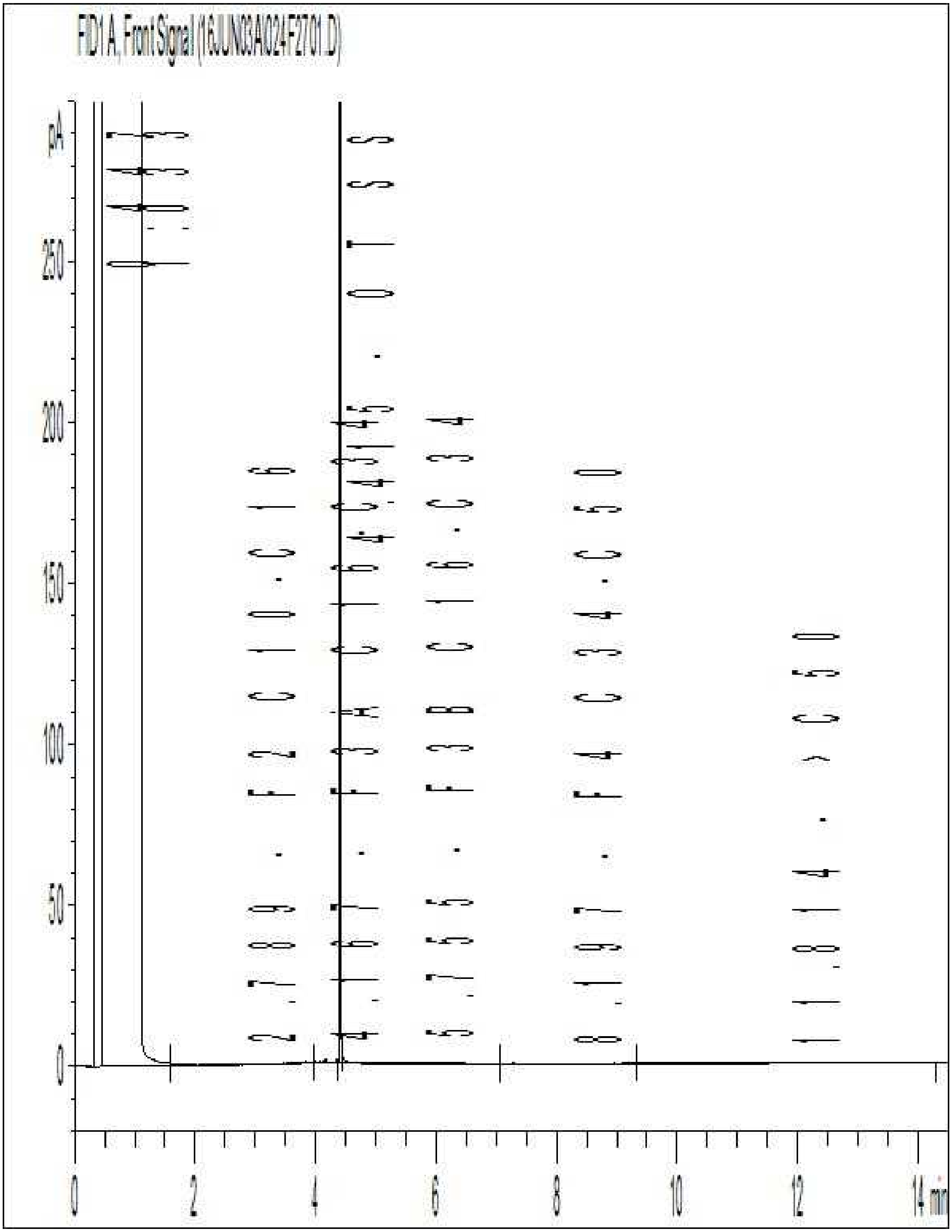


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B6B0019
Report Date: 2016/07/11
Maxxam Sample: CLH887

Pinchin Ltd.
Client Project #: 103341.001
Project name: WHARF ST
Client ID: MW16-2

Petroleum Hydrocarbons F2-F4 in Water Chromatogram

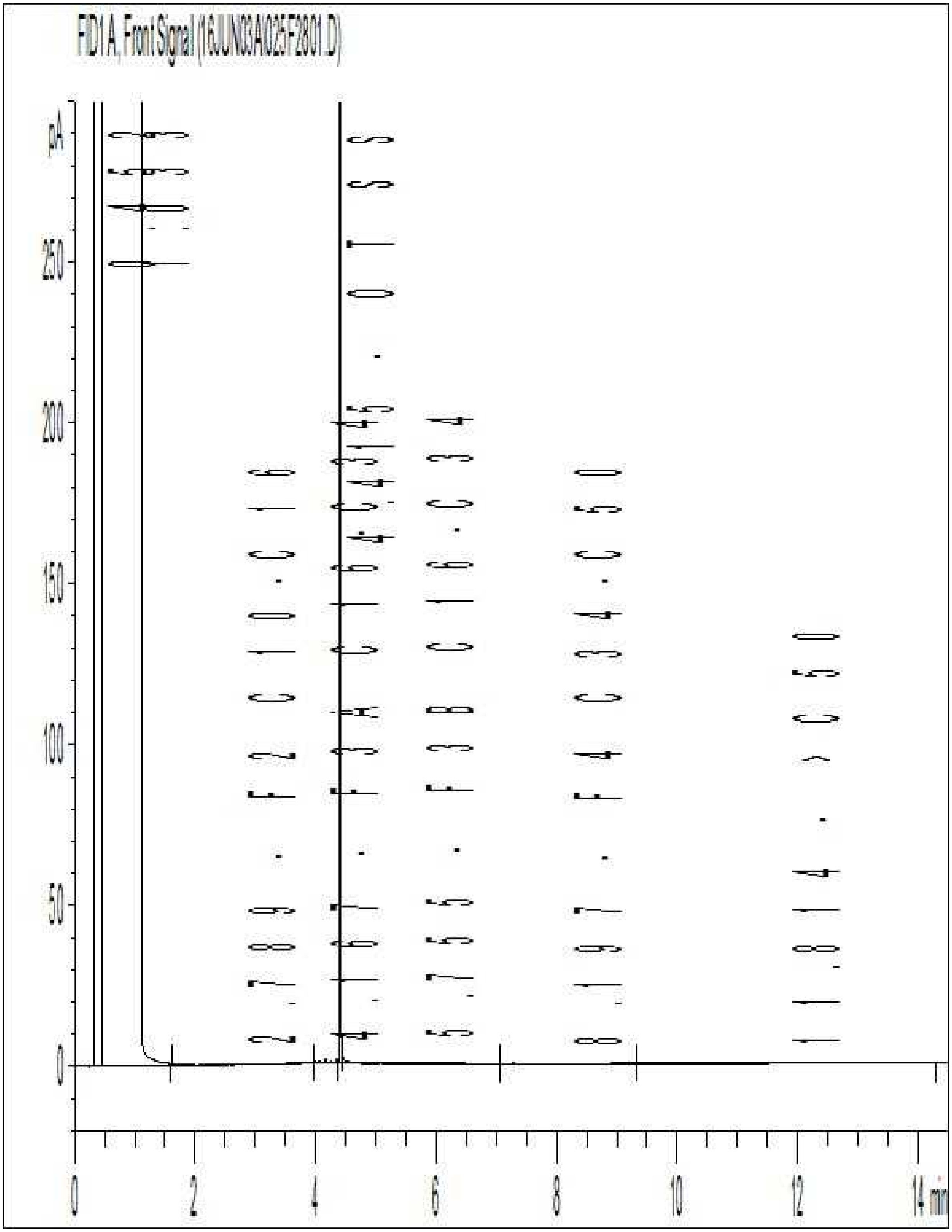


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B6B0019
Report Date: 2016/07/11
Maxxam Sample: CLH887 Lab-Dup

Pinchin Ltd.
Client Project #: 103341.001
Project name: WHARF ST
Client ID: MW16-2

Petroleum Hydrocarbons F2-F4 in Water Chromatogram

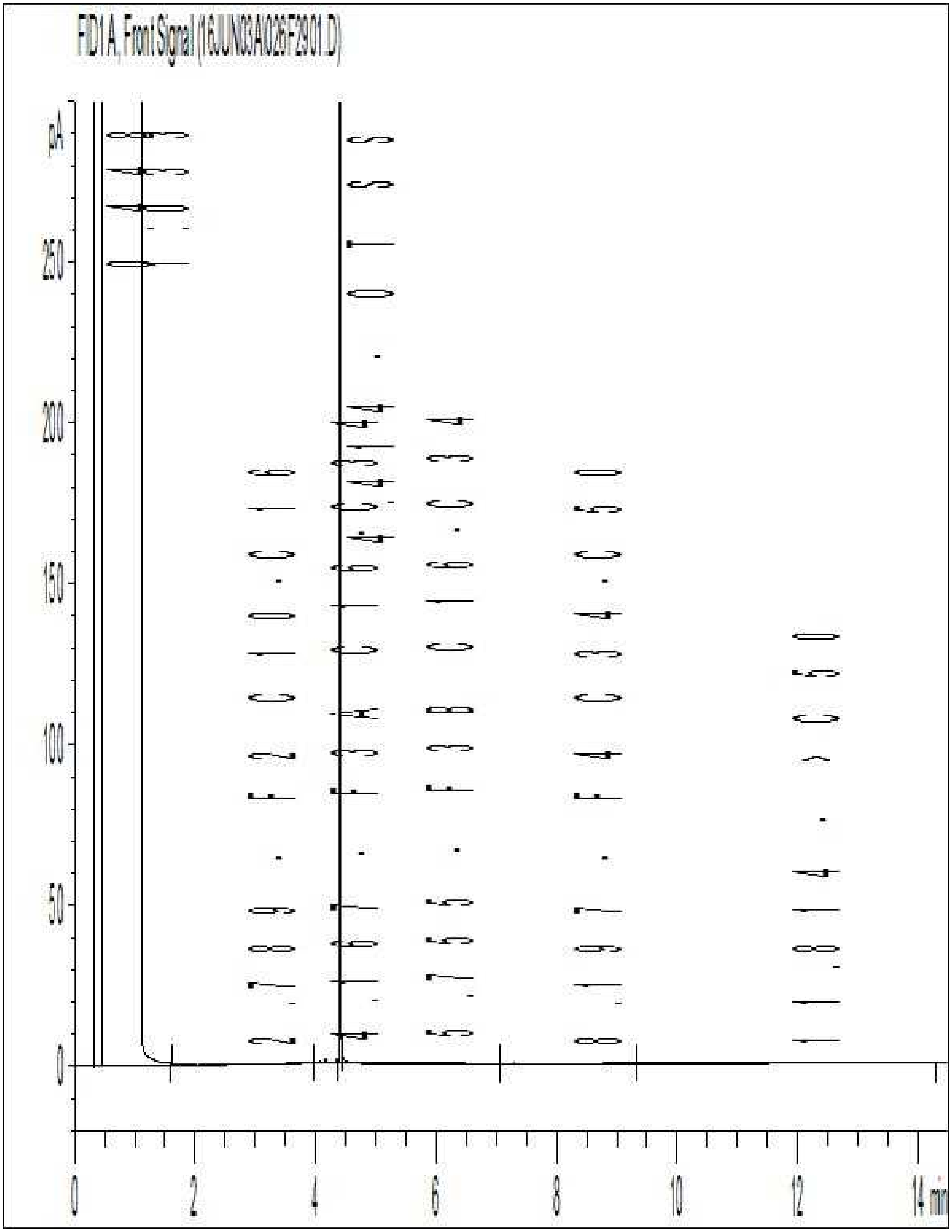


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B6B0019
Report Date: 2016/07/11
Maxxam Sample: CLH888

Pinchin Ltd.
Client Project #: 103341.001
Project name: WHARF ST
Client ID: MW16-3

Petroleum Hydrocarbons F2-F4 in Water Chromatogram

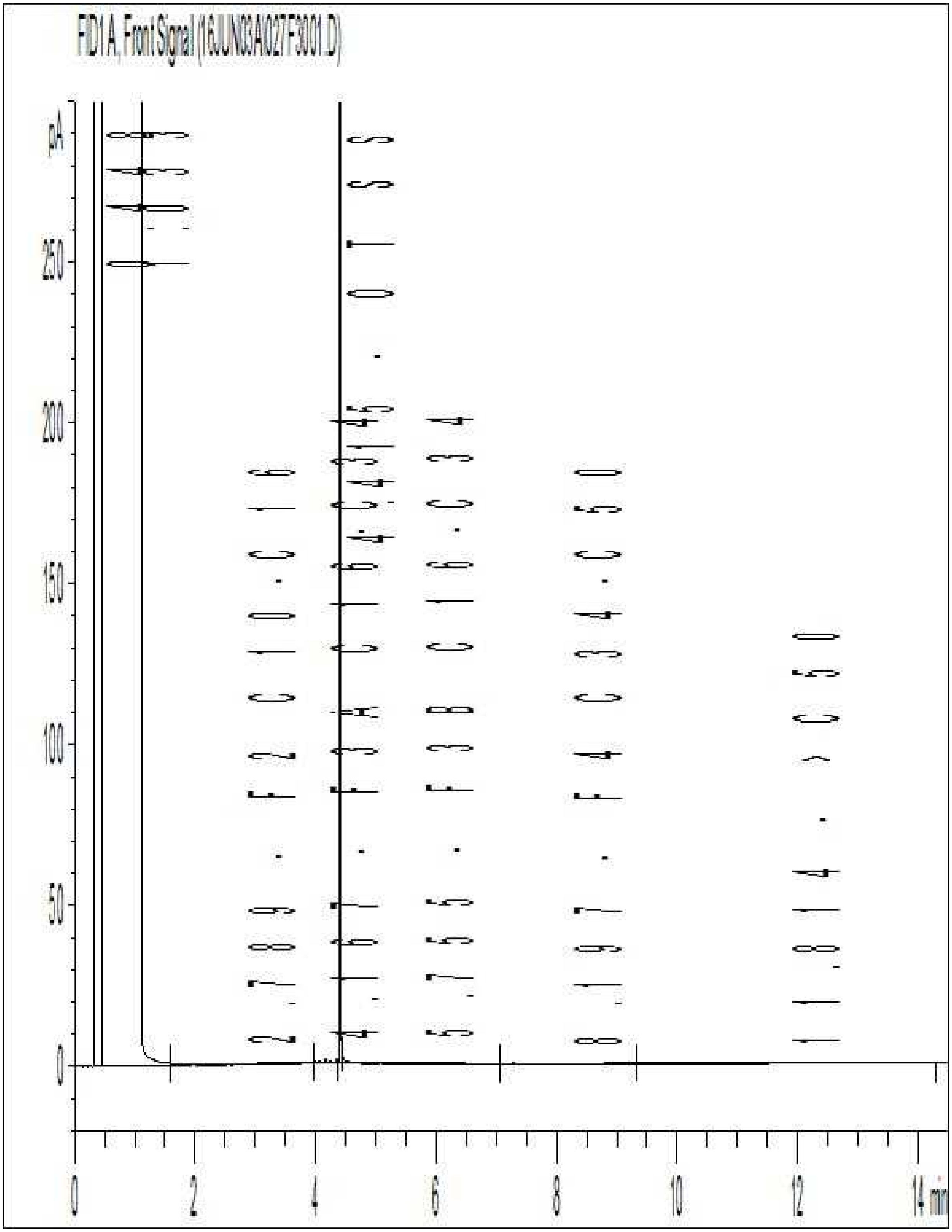


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B6B0019
Report Date: 2016/07/11
Maxxam Sample: CLH889

Pinchin Ltd.
Client Project #: 103341.001
Project name: WHARF ST
Client ID: DUP-1

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



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

Maxxam
A Bureau Veritas Group Company

Your Project #: 103341.001
Your C.O.C. #: 70692

Attention:Kyle Shearer

Pinchin Ltd.
2470 Milltower Crt
Mississauga, ON
L5N 7W5

Report Date: 2016/06/02
Report #: R4013074
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B6A6367
Received: 2016/05/26, 13:55

Sample Matrix: Soil
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Cyanide (WAD) in Leachates	1	N/A	2016/06/01	CAM SOP-00457	OMOE 3015 m
Fluoride by ISE in Leachates	1	2016/05/31	2016/06/01	CAM SOP-00449	SM 22 4500-F- C m
Mercury (TCLP Leachable) (mg/L)	1	N/A	2016/06/01	CAM SOP-00453	EPA 7470A m
Total Metals in TCLP Leachate by ICPMS	1	2016/05/31	2016/05/31	CAM SOP-00447	EPA 6020A m
Nitrate(NO3) + Nitrite(NO2) in Leachate	1	N/A	2016/06/01	CAM SOP-00440	SM 22 4500-NO3I/NO2B
PAH Compounds in Leachate by GC/MS (SIM)	1	2016/05/31	2016/06/01	CAM SOP-00318	EPA 8270D m
Polychlorinated Biphenyl in Leachate	1	2016/05/31	2016/05/31	CAM SOP-00309	EPA 8082A m
TCLP - % Solids	1	2016/05/30	2016/05/31	CAM SOP-00401	EPA 1311 Update I m
TCLP - Extraction Fluid	1	N/A	2016/05/31	CAM SOP-00401	EPA 1311 Update I m
TCLP - Initial and final pH	1	N/A	2016/05/31	CAM SOP-00401	EPA 1311 Update I m
TCLP Zero Headspace Extraction	1	2016/05/30	2016/05/31	CAM SOP-00430	EPA 1311 m
VOCs in ZHE Leachates	1	2016/05/31	2016/06/01	CAM SOP-00226	EPA 8260C m

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.

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

Your Project #: 103341.001
Your C.O.C. #: 70692

Attention:Kyle Shearer

Pinchin Ltd.
2470 Milltower Crt
Mississauga, ON
L5N 7W5

Report Date: 2016/06/02
Report #: R4013074
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B6A6367
Received: 2016/05/26, 13:55

Encryption Key

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 #: B6A6367
Report Date: 2016/06/02

Pinchin Ltd.
Client Project #: 103341.001
Sampler Initials: KS

O.REG 558 TCLP VOLATILE ORGANICS (SOIL)

Maxxam ID			CKQ261		
Sampling Date			2016/05/20 12:00		
COC Number			70692		
	UNITS	**Criteria**	**TCLP-1**	**RDL**	**QC Batch**
Charge/Prep Analysis					
Amount Extracted (Wet Weight) (g)	N/A	-	23	N/A	4516812
Volatile Organics					
Leachable Benzene	mg/L	**0.5**	<0.020	0.020	4518275
Leachable Carbon Tetrachloride	mg/L	**0.5**	<0.020	0.020	4518275
Leachable Chlorobenzene	mg/L	**8**	<0.020	0.020	4518275
Leachable Chloroform	mg/L	**10**	<0.020	0.020	4518275
Leachable 1,2-Dichlorobenzene	mg/L	**20**	<0.050	0.050	4518275
Leachable 1,4-Dichlorobenzene	mg/L	**0.5**	<0.050	0.050	4518275
Leachable 1,2-Dichloroethane	mg/L	**0.5**	<0.050	0.050	4518275
Leachable 1,1-Dichloroethylene	mg/L	**1.4**	<0.020	0.020	4518275
Leachable Methylene Chloride(Dichloromethane)	mg/L	**5**	<0.20	0.20	4518275
Leachable Methyl Ethyl Ketone (2-Butanone)	mg/L	**200**	<1.0	1.0	4518275
Leachable Tetrachloroethylene	mg/L	**3**	<0.020	0.020	4518275
Leachable Trichloroethylene	mg/L	**5**	<0.020	0.020	4518275
Leachable Vinyl Chloride	mg/L	**0.2**	<0.020	0.020	4518275
Surrogate Recovery (%)					
Leachable 4-Bromofluorobenzene	%	-	97		4518275
Leachable D4-1,2-Dichloroethane	%	-	95		4518275
Leachable D8-Toluene	%	-	97		4518275

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: Ontario Reg. 347/90 Schedule 4 Leachate Quality Criteria (as amended by Reg 558/00)

N/A = Not Applicable

O.REG 558 TCLP BENZO(A)PYRENE

Maxxam ID			CKQ261	CKQ261		
Sampling Date			2016/05/20 12:00	2016/05/20 12:00		
COC Number			70692	70692		
	UNITS	**Criteria**	**TCLP-1**	**TCLP-1 Lab-Dup**	**RDL**	**QC Batch**
Polyaromatic Hydrocarbons						
Leachable Benzo(a)pyrene	ug/L	**1**	<0.10	<0.10	0.10	4519869
Surrogate Recovery (%)						
Leachable D10-Anthracene	%	-	88	90		4519869
Leachable D14-Terphenyl (FS)	%	-	95	97		4519869
Leachable D8-Acenaphthylene	%	-	94	97		4519869

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

Criteria: Ontario Reg. 347/90 Schedule 4 Leachate Quality Criteria (as amended by Reg 558/00)

O.REG 558 TCLP INORGANICS PACKAGE (SOIL)

Maxxam ID			CKQ261		
Sampling Date			2016/05/20 12:00		
COC Number			70692		
	UNITS	**Criteria**	**TCLP-1**	**RDL**	**QC Batch**
Inorganics					
Leachable Fluoride (F-)	mg/L	**150**	0.21	0.10	4519648
Leachable Free Cyanide	mg/L	**20**	<0.010	0.010	4519657
Leachable Nitrite (N)	mg/L	-	<0.10	0.10	4519659
Leachable Nitrate (N)	mg/L	-	<1.0	1.0	4519659
Leachable Nitrate + Nitrite (N)	mg/L	**1000**	<1.0	1.0	4519659
Metals					
Leachable Mercury (Hg)	mg/L	**0.1**	<0.0010	0.0010	4518541
Leachable Arsenic (As)	mg/L	**2.5**	<0.2	0.2	4518724
Leachable Barium (Ba)	mg/L	**100**	0.5	0.2	4518724
Leachable Boron (B)	mg/L	**500**	<0.1	0.1	4518724
Leachable Cadmium (Cd)	mg/L	**0.5**	<0.05	0.05	4518724
Leachable Chromium (Cr)	mg/L	**5**	<0.1	0.1	4518724
Leachable Lead (Pb)	mg/L	**5**	<0.1	0.1	4518724
Leachable Selenium (Se)	mg/L	**1**	<0.1	0.1	4518724
Leachable Silver (Ag)	mg/L	**5**	<0.01	0.01	4518724
Leachable Uranium (U)	mg/L	**10**	<0.01	0.01	4518724

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Criteria: Ontario Reg. 347/90 Schedule 4 Leachate Quality Criteria (as amended by Reg 558/00)

O.REG 558 TCLP LEACHATE PREPARATION (SOIL)

Maxxam ID		CKQ261		
Sampling Date		2016/05/20 12:00		
COC Number		70692		
	UNITS	**TCLP-1**	**RDL**	**QC Batch**
Inorganics				
Final pH	pH	6.33		4518531
Initial pH	pH	9.71		4518531
TCLP - % Solids	%	100	0.2	4518517
TCLP Extraction Fluid	N/A	FLUID 1		4518524

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 558 TCLP PCBS (SOIL)

Maxxam ID			CKQ261	CKQ261		
Sampling Date			2016/05/20 12:00	2016/05/20 12:00		
COC Number			70692	70692		
	UNITS	**Criteria**	**TCLP-1**	**TCLP-1 Lab-Dup**	**RDL**	**QC Batch**
PCBs						
Leachable Aroclor 1016	ug/L	-	<3.0	<3.0	3.0	4519072
Leachable Aroclor 1221	ug/L	-	<3.0	<3.0	3.0	4519072
Leachable Aroclor 1242	ug/L	-	<3.0	<3.0	3.0	4519072
Leachable Aroclor 1248	ug/L	-	<3.0	<3.0	3.0	4519072
Leachable Aroclor 1254	ug/L	-	<3.0	<3.0	3.0	4519072
Leachable Aroclor 1260	ug/L	-	<3.0	<3.0	3.0	4519072
Leachable Total PCB	ug/L	**300**	<3.0	<3.0	3.0	4519072
Surrogate Recovery (%)						
Leachable Decachlorobiphenyl	%	-	108	110		4519072

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

Criteria: Ontario Reg. 347/90 Schedule 4 Leachate Quality Criteria (as amended by Reg 558/00)

TEST SUMMARY

Maxxam ID: CKQ261
Sample ID: TCLP-1
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/26

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Cyanide (WAD) in Leachates	SKAL/CN	4519657	N/A	2016/06/01	Christine Pham
Fluoride by ISE in Leachates	ISE	4519648	2016/05/31	2016/06/01	Surinder Rai
Mercury (TCLP Leachable) (mg/L)	CV/AA	4518541	N/A	2016/06/01	Magdalena Carlos
Total Metals in TCLP Leachate by ICPMS	ICP1/MS	4518724	2016/05/31	2016/05/31	Cristina Petran
Nitrate(NO3) + Nitrite(NO2) in Leachate	LACH	4519659	N/A	2016/06/01	Chandra Nandlal
PAH Compounds in Leachate by GC/MS (SIM)	GC/MS	4519869	2016/05/31	2016/06/01	Lingyun Feng
Polychlorinated Biphenyl in Leachate	GC/ECD	4519072	2016/05/31	2016/05/31	Sarah Huang
TCLP - % Solids	BAL	4518517	2016/05/30	2016/05/31	Jian (Ken) Wang
TCLP - Extraction Fluid		4518524	N/A	2016/05/31	Jian (Ken) Wang
TCLP - Initial and final pH	PH	4518531	N/A	2016/05/31	Jian (Ken) Wang
TCLP Zero Headspace Extraction		4516812	2016/05/30	2016/05/31	Walt Wang
VOCs in ZHE Leachates	GC/MS	4518275	2016/05/31	2016/06/01	John Wu

Maxxam ID: CKQ261 Dup
Sample ID: TCLP-1
Matrix: Soil

Collected: 2016/05/20
Shipped:
Received: 2016/05/26

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
PAH Compounds in Leachate by GC/MS (SIM)	GC/MS	4519869	2016/05/31	2016/06/01	Lingyun Feng
Polychlorinated Biphenyl in Leachate	GC/ECD	4519072	2016/05/31	2016/05/31	Sarah Huang

GENERAL COMMENTS

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

Package 1	5.7°C

Cooler custody seal was not present and intact.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	Value	UNITS
4518275	Leachable 4-Bromofluorobenzene	2016/06/01	103	70 - 130	102	70 - 130	98	%				
4518275	Leachable D4-1,2-Dichloroethane	2016/06/01	92	70 - 130	94	70 - 130	95	%				
4518275	Leachable D8-Toluene	2016/06/01	99	70 - 130	99	70 - 130	98	%				
4519072	Leachable Decachlorobiphenyl	2016/05/31	109	30 - 130	107	30 - 130	108	%				
4519869	Leachable D10-Anthracene	2016/06/01	110	50 - 130	96	50 - 130	96	%				
4519869	Leachable D14-Terphenyl (FS)	2016/06/01	117	50 - 130	105	50 - 130	105	%				
4519869	Leachable D8-Acenaphthylene	2016/06/01	116	50 - 130	101	50 - 130	103	%				
4518275	Leachable 1,1-Dichloroethylene	2016/06/01	104	70 - 130	107	70 - 130	<0.020	mg/L	NC	30		
4518275	Leachable 1,2-Dichlorobenzene	2016/06/01	93	70 - 130	94	70 - 130	<0.050	mg/L	NC	30		
4518275	Leachable 1,2-Dichloroethane	2016/06/01	97	70 - 130	99	70 - 130	<0.050	mg/L	NC	30		
4518275	Leachable 1,4-Dichlorobenzene	2016/06/01	96	70 - 130	97	70 - 130	<0.050	mg/L	NC	30		
4518275	Leachable Benzene	2016/06/01	105	70 - 130	107	70 - 130	<0.020	mg/L	NC	30		
4518275	Leachable Carbon Tetrachloride	2016/06/01	108	70 - 130	111	70 - 130	<0.020	mg/L	NC	30		
4518275	Leachable Chlorobenzene	2016/06/01	99	70 - 130	99	70 - 130	<0.020	mg/L	NC	30		
4518275	Leachable Chloroform	2016/06/01	100	70 - 130	102	70 - 130	<0.020	mg/L	NC	30		
4518275	Leachable Methyl Ethyl Ketone (2-Butanone)	2016/06/01	89	60 - 140	90	60 - 140	<1.0	mg/L	NC	30		
4518275	Leachable Methylene Chloride(Dichloromethane)	2016/06/01	101	70 - 130	103	70 - 130	<0.20	mg/L	NC	30		
4518275	Leachable Tetrachloroethylene	2016/06/01	104	70 - 130	104	70 - 130	<0.020	mg/L	NC	30		
4518275	Leachable Trichloroethylene	2016/06/01	105	70 - 130	107	70 - 130	<0.020	mg/L	NC	30		
4518275	Leachable Vinyl Chloride	2016/06/01	98	70 - 130	101	70 - 130	<0.020	mg/L	NC	30		
4518541	Leachable Mercury (Hg)	2016/06/01	123	75 - 125	100	80 - 120	<0.0010	mg/L	NC	25	<0.0010	mg/L
4518724	Leachable Arsenic (As)	2016/05/31	108	80 - 120	97	80 - 120			NC	35	<0.2	mg/L
4518724	Leachable Barium (Ba)	2016/05/31	NC	80 - 120	96	80 - 120			NC	35	<0.2	mg/L
4518724	Leachable Boron (B)	2016/05/31	NC	80 - 120	100	80 - 120			3.1	35	<0.1	mg/L
4518724	Leachable Cadmium (Cd)	2016/05/31	109	80 - 120	100	80 - 120			NC	35	<0.05	mg/L
4518724	Leachable Chromium (Cr)	2016/05/31	105	80 - 120	97	80 - 120			NC	35	<0.1	mg/L
4518724	Leachable Lead (Pb)	2016/05/31	101	80 - 120	96	80 - 120			NC	35	<0.1	mg/L
4518724	Leachable Selenium (Se)	2016/05/31	100	80 - 120	97	80 - 120			NC	35	<0.1	mg/L
4518724	Leachable Silver (Ag)	2016/05/31	103	80 - 120	98	80 - 120			NC	35	<0.01	mg/L
4518724	Leachable Uranium (U)	2016/05/31	107	80 - 120	99	80 - 120			NC	35	<0.01	mg/L

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		Leachate Blank	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**	**Value**	**UNITS**
4519072	Leachable Aroclor 1016	2016/05/31					<3.0	ug/L	NC	40		
4519072	Leachable Aroclor 1221	2016/05/31					<3.0	ug/L	NC	40		
4519072	Leachable Aroclor 1242	2016/05/31					<3.0	ug/L	NC	40		
4519072	Leachable Aroclor 1248	2016/05/31					<3.0	ug/L	NC	40		
4519072	Leachable Aroclor 1254	2016/05/31					<3.0	ug/L	NC	40		
4519072	Leachable Aroclor 1260	2016/05/31	108	30 - 130	107	30 - 130	<3.0	ug/L	NC	40		
4519072	Leachable Total PCB	2016/05/31	108	30 - 130	107	30 - 130	<3.0	ug/L	NC	40		
4519648	Leachable Fluoride (F-)	2016/06/01	97	80 - 120	102	80 - 120	<0.10	mg/L	NC	25	<0.10	mg/L
4519657	Leachable Free Cyanide	2016/06/01	96	80 - 120	108	80 - 120	<0.0020	mg/L	NC	20	<0.010	mg/L
4519659	Leachable Nitrate (N)	2016/06/01	98	80 - 120	98	80 - 120	<1.0	mg/L	NC	25	<1.0	mg/L
4519659	Leachable Nitrate + Nitrite (N)	2016/06/01	99	80 - 120	100	80 - 120	<1.0	mg/L	NC	25	<1.0	mg/L
4519659	Leachable Nitrite (N)	2016/06/01	NC	80 - 120	107	80 - 120	<0.10	mg/L	NC	25	<0.10	mg/L
4519869	Leachable Benzo(a)pyrene	2016/06/01	122	50 - 130	115	50 - 130	<0.10	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.

Leachate Blank: A blank matrix containing all reagents used in the leaching procedure. Used to determine any process contamination.

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).

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
A Bureau Veritas Group Company

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
CAM FCD-01191/2

CHAIN OF CUSTODY RECORD 70692

Page ____ of ____

Invoice Information		Report Information (if differs from invoice)		Project Information (where applicable)	
Company Name:	#3103 Pinchin Ltd.	Company Name:		Quotation #:	
Contact Name:	Maria Espinosa	Contact Name:	Kyle Shearer	P.O. #/ AFE#:	
Address:	2470 Milltower Crt Mississauga ON L5N 7W5	Address:		Project #:	103341.001
				Site Location:	
Phone:	905-363-0678 Fax: 905-363-0681	Phone:	Fax:	Site #:	
Email:	mespinosa@pinchin.com, ihutchison@pinchin.com	Email:	kshearer@pinchin.com	Sampled By:	K. Shearer

Turnaround Time (TAT) Required

☒ Regular TAT (5-7 days) Most analyses

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS

Rush TAT (Surcharges will be applied)

☐ 1 Day ☐ 2 Days ☐ 3-4 Days

Date Required:

Rush Confirmation #:

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153

☐ Table 1 ☐ Res/Park ☐ Med/ Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/ Other
☐ Table ____
FOR RSC (PLEASE CIRCLE) [✓ Y] / N

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ MISA ☐ Storm Sewer Bylaw
☐ PWQO Region
☐ Other (Specify)
☒ REG 558 (MIN. 3 DAY TAT REQUIRED)

Include Criteria on Certificate of Analysis: [✓ Y] / N

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

LABORATORY USE ONLY

CUSTODY SEAL Y / N		COOLER TEMPERATURES
Present	Intact	
N	N	7/5/5

COOLING MEDIA PRESENT: [✓ Y] / N

Analysis Requested

	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / CrVI	BTEX/ PHC F1	PHCs F2 - F4	VOCs	REFER TO BACK OF COC REG 153 METALS & INORGANICS	REG 153 ICPMS METALS	REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B)	TCLP - benzo(a)pyrene, Inorganics, VOC, PCBs								HOLD- DO NOT ANALYZE	COMMENTS
1	TCLP-1	2016/05/20	1200	Soil	3	NA							X									
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						

26-May-16 13:55
Antonella Brasil
B6A6367
HGR ENV-728

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	MAXXAM JOB #
			BHASOU	2016/05/26	13:55	