FINAL

Phase Two Environmental Site Assessment

1887 St. Joseph Boulevard
Ottawa, Ontario

Prepared for:

Sobeys Inc.
1-535 Portland Street
Dartmouth, NS B2Y 4B1

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1.0 EXECUTIVE SUMMARY

Pinchin Ltd. (Pinchin) was retained by Sobeys Inc. (Client), to complete a Phase Two Environmental Site Assessment (Phase Two ESA) of the property located at 1887 St. Joseph Boulevard in Ottawa, Ontario (hereafter referred to as the Site or Phase Two Property). The Phase Two Property is presently developed with a single-storey multi-tenant commercial building (Site Building).

The Phase Two ESA was conducted at the request of the Client as a condition for a future rezoning application with the City of Ottawa.

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 214/21 on March 19, 2021 (O. Reg. 153/04).

The objectives of this Phase Two ESA were to assess the soil and groundwater quality in relation to an area of potential environmental concern (APEC) 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 Phase Two ESA was completed by Pinchin between May 19, 2023, and May 30, 2023, and included the advancement of seven 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 of approximately 6.1 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), polycyclic aromatic hydrocarbons (PAHs) and/or metals. In addition, groundwater samples were collected from select newly-installed monitoring wells and submitted for laboratory analysis of VOCs, PHCs and/or PAHs.

Based on Site-specific information, the applicable regulatory standards for the Phase Two Property were determined to be the *"Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition",* provided in the MECP document entitled, *"Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act"* dated April 15, 2011 *(Table 3 Standards)* for medium and fine-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 3 Standards*.

It is the opinion of the Qualified Person (QP) who supervised the Phase Two ESA that the applicable *Table 3 Standards* for soil and groundwater at the Phase Two Property have been met as of the Certification Date of May 30, 2023, 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 as a condition for a potential future rezoning application with the City of Ottawa. The Phase Two ESA was conducted in accordance with O. Reg. 153/04 even though the Client does not intend to submit an RSC to MECP given that there is no regulatory requirement to file one at this time.

The overall objectives of this Phase Two ESA were to assess the soil and groundwater quality in relation to an APEC and related COPCs identified in a Phase One ESA completed by Pinchin, the findings of which were summarized in the report entitled “*Phase One Environmental Site Assessment*, *1887 St. Joseph Boulevard, Ottawa, Ontario*”, completed by Pinchin for the Client and dated April 14, 2023. The property assessed by the Pinchin Phase One ESA is referred to herein as the Phase One Property. The Phase Two ESA was conducted on the whole Phase One Property, at specific APECs identified during the Phase One ESA, and the Phase One Property and Phase Two Property have the same boundaries.

2.1 Site Description

This Phase Two ESA was completed for the property located at the municipal address of 1887 St. Joseph Boulevard, in Ottawa, Ontario. The Phase Two Property is 5.65 acres (2.29 hectares) in size and is located immediately north of St. Joseph Boulevard, approximately 65 metres (m) west of the intersection of St. Joseph Boulevard and Marenger Street. The Phase Two Property is bounded by light industrial and community buildings to the north and west, commercial and light industrial buildings to the east, and St. Joseph Boulevard followed by residential dwellings to the south. 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 Site Building was occupied by Farm Boy as commercial storage space, and Jeanne D'Arc Medical Centre as a medical office.

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 the Client	N/A
Municipal Address	Client	1887 St. Joseph Boulevard, Ottawa, ON K1C 7J2
Parcel Identification Number (PIN)	Legal Survey Drawing provided by the Client	N/A
Current Owner	Client	Sobeys Capital
Current Occupants	Client	Commercial building
Client	Authorization to Proceed, Limitation of Liability & Terms of Engagement Form	Sobeys Capital
Client Contact Information	Authorization to Proceed, Limitation of Liability & Terms of Engagement Form	Brandy Dorken c/o Sobeys Capital 1-535 Portland Street, Dartmouth, NS B2Y 4B1
Site Area	Site Representative	2.29 hectares (5.65 acres)

2.2 Property Ownership

The entirety of the Phase Two Property is currently owned by the Client (Sobeys Capital) located at 1-535 Portland Street, Dartmouth, Nova Scotia.

Pinchin was retained by Ms. Brandy Dorken of the Client to conduct the Phase Two ESA of the Site. Contact information for Ms. Dorken is provided in the preceding section.

2.3 Current and Proposed Future Uses

The Phase Two Property is presently utilized for commercial purposes and it is Pinchin's understanding that the Client may divest the Phase Two Property for potential residential redevelopment. The potential change of land will eventually require that an RSC be filed as per Section 168.3.1 of the Province of Ontario's *Environmental Protection Act*. Based on this information, Pinchin recommended that all work be completed in accordance with O. Reg. 153/04, although additional investigations may be required for the purposes of filing an RSC.

2.4 Applicable Site Condition Standards

The Phase Two Property is currently a commercial property located within the City of Ottawa and the proposed future land use may be residential. It is Pinchin's understanding that drinking water for the Phase Two Property and surrounding properties within 250 metres of the Phase Two Property is supplied by the City of Ottawa, and there are no known drinking water supply wells within 250 metres of the Phase Two Property. Source water is obtained by the City of Ottawa from the Ottawa River.

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 of approximately 50.9 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 or equal to 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 two representative soil samples collected from the boreholes advanced at the Phase Two Property were submitted for pH analysis. The pH analytical results are summarized in Table 1. 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 completed on 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 two-thirds of the overburden at the Phase Two Property is medium and fine-textured as defined by O. Reg. 153/04.

Therefore, the soil at the Phase Two Property has been considered medium and fine-textured for the purpose of establishing the applicable MECP Site Condition Standards.

Based on the above, the referenced Site Condition Standards for the Phase Two Property are the Table 3 Standards for:

- Medium and fine-textured soils; and
- Residential/parkland/institutional property use.

As such, all analytical results have been compared to these *Table 3 Standards*.

3.0 BACKGROUND INFORMATION

3.1 Physical Setting

The elevation of the Phase One Property, based on information obtained from the Ontario Base Map series, is approximately 61 m above mean sea level (mamsl). The general topography in the local and surrounding area is generally flat and the Phase One Property is at a similar elevation to the adjacent/surrounding properties. No bedrock outcrops were observed on-Site or in the surrounding area. 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.

There are no open water bodies or areas of natural significance located on-Site or within the area assessed by the Pinchin Phase One ESA (the Phase One Study Area). A plan showing the Phase One Study Area is presented on Figure 3. The nearest surface water body to the Phase Two Property is an unnamed creek located approximately 105 m west of the Phase One Property at an elevation of approximately 61 mamsl.

A review of the municipal plan for the City of Ottawa indicated that the Phase One Study Area is not located in whole or in part within a well head protection area or other designation identified by the City of Ottawa for the protection of groundwater.

Based on information provided in Phase One ESA, the Phase One Property and all other properties within the Phase One Study Area are serviced by a municipal drinking water system.

The records review did not identify the presence of wells within the Phase One Property or within the Phase One Study Area that supply water for human consumption or for agricultural purposes.

3.2 Past Investigations

3.2.1 Summary of Previous Environmental Investigations by Others

No previous environmental investigation reports by others were available for review.

3.2.2 Pinchin Phase One ESA Summary

From March 30, 2023, through April 14, 2023, Pinchin conducted a Phase One ESA in support of the future rezoning 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, two 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.

Identified on-Site and off-Site PCAs are shown on Figure 3.

3.2.3 Use of Previous Analytical Data

No previous soil and groundwater data were available for use in the Phase Two ESA.

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, 1887 St. Joseph Boulevard, Ottawa, Ontario*", dated April 14, 2023, which is provided in Appendix A.

Based on Pinchin's knowledge of the surrounding properties and known hydrogeological conditions, boreholes were advanced at the Phase Two Property to a maximum depth of approximately 6.1 mbgs for the purposes of soil and/or groundwater quality assessment. Pinchin notes that the Phase Two ESA was conducted in conjunction with a geotechnical investigation which required select boreholes to be advanced deeper than 6.1 mbgs.

- Retained Strata Drilling Group Inc. (Strata) to advance boreholes and complete monitoring well installations using a Massenza MI3 and a Geoprobe 7822 DT^{TM} drill rig. Strata is licensed by the MECP in accordance with Ontario Regulation 903 (as amended) (O. Reg. 903) to undertake borehole drilling/well installation activities. Strata advanced seven boreholes at the Phase Two Property to investigate the potential for soil contaminants associated with the APECs identified in the Phase One ESA. All 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 visual/olfactory evidence of impacts as well as for petroleum-derived vapours in soil headspace using a combustible gas indicator (CGI) calibrated to hexane and VOC-derived vapours in soil headspace using a photoionization detector (PID).
- Submitted a minimum of one "worst case" soil sample from each borehole for chemical analysis of:
    - PHCs F1-F4;
    - VOCs;
    - PAHs;
    - Metals; and/or
    - Inorganics.
- Developed each of the newly-installed monitoring wells prior to the collection of groundwater samples.
- Submitted one representative groundwater sample from select newly-installed monitoring wells and for the chemical analysis of the following parameters:
    - PHCs F1-F4;
    - VOCs; and/or

- PAHs. Submitted four representative soil samples for the laboratory analysis of grain size and two representative soil samples for the laboratory analysis of pH in order to confirm the appropriate MECP Site Condition Standards.
- Conducted groundwater monitoring at each of the newly-installed groundwater monitoring wells by measuring depth to groundwater from both 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.
- Completed an elevation survey to establish the elevations of the boreholes and newly-installed monitoring wells relative to a benchmark with an assumed elevation.
- Obtained UTM coordinates for the boreholes and newly-installed monitoring wells using a portable Global Positioning System (GPS) device.
- Compared the soil and groundwater analytical results to the applicable criteria stipulated in the *Table 3 Standards*.
- 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 APEC 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 and groundwater. Pinchin included the assessment of groundwater as part of the Phase Two ESA to investigate groundwater quality in relation to former on-Site USTs. Note that due to the historical on-Site retail fuel outlet (RFO) at the Phase Two Property, the Phase Two Property is 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 four boreholes were advanced at the Phase Two Property for the purpose of collecting soil samples. 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 selected boreholes completed at the Phase Two Property to permit the collection of groundwater samples. Groundwater samples, comprising samples collected from each of the newly installed monitoring wells (i.e., MW1, MW101, MW102 and MW103) were submitted to the analytical laboratory for analysis of the COPCs.

4.3 Phase One Conceptual Site Model

A conceptual site model (CSM) has been created to provide a summary of the findings of the Phase One ESA. The Phase One CSM is summarized in Figures 1 through Figure 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 consists of one legal lot situated at the municipal address of 1887 St. Joseph Boulevard, Ottawa, Ontario, which is currently owned by Sobeys Capital. The Phase One Property is located immediately north of St. Joseph Boulevard, approximately 65 m west of the intersection of St. Joseph Boulevard and Marenger Street. The Phase One Property is presently developed with a single-storey multi-tenant commercial building (Site Building);
- The nearest surface water body is an unnamed creek located approximately 105 m west of the Phase One Property at an elevation of approximately 61 mamsl;
- No areas of natural significance were identified within the Phase One Study Area;
- No drinking water wells were located on the Phase One Property;
- The adjacent and surrounding properties in the vicinity of the Site consist of commercial, light industrial, community, residential and vacant land uses. The properties located north and west of the Phase One Property consist of light industrial buildings, community

buildings and associated roadways to beyond 200 m from the Phase One Property; the properties located south of the Phase One Property consist of residential buildings, vacant undeveloped land and associated roadways to beyond 200 m from the Phase One Property; and the properties located east of the Phase One Property consist of residential buildings, light industrial buildings, commercial buildings and associated roadways to beyond 200 m from the Phase One Property;

- A total of 18 PCAs were identified within the Phase One Study Area, consisting of four PCAs at the Phase One Property and 14 PCAs within the Phase One Study Area, outside of the Phase One Property. The on-Site PCAs consist of a historical RFO with several associated USTs, potential poor quality fill underlying the parking lot area, the Phase One Property being listed within the O. Reg. 347 Waste Generators database, and a pad-mounted oil-cooled transformer is located on the north portion of the Phase One Property. However, no evidence of spills or historical spills (i.e., staining) was observed in the vicinity of the transformers and no issues of potential environmental concern (i.e., spills) were noted for the transformers within the ERIS report and any maintenance/environmental issues associated with the transformers would be the responsibility of Hydro One. Based on the above-noted information and the limited annual quantities of hazardous wastes generated on-Site, the on-Site transformer and waste generation do not represent APECs for the Phase One Property. The off-Site PCAs were not considered to result in APECs at the Phase One Property given the distance from the PCAs to the Phase One Property, their downgradient or transgradient locations relative to the inferred groundwater flow direction in the Phase One Study Area and/or the nature of operations and potential contaminants related to these operations;
- Underground utilities at the Phase One Property provide natural gas, electrical, telephone and cable services to the Site Building. These services enter the Site Building through subsurface conduits, with the exception of a pressurized natural gas line, which connects to meters located along the exterior of the Site Building;
- The Phase One Property and the surrounding properties located within the Phase One Study Area are located within alluvial deposits consisting of stratified gravel, sand, silt and clay. Based on geological data published by the Ontario Geological Survey, bedrock is expected to consist of limestone, dolostone, shale, arkose, and sandstone of the Shadow Lake Formation; and
- The Phase One Property slopes downwards to the north; the difference in elevation from the north and south ends of the Phase One Property is approximately 4 m. Local groundwater flow was calculated to be towards the north/northwest.

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

No 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 A.

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 MECP 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.

In addition, Pinchin's SOP for groundwater sampling using low-flow purging and sampling procedures follows the United States Environmental Protection Agency Region I document entitled *"Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells"* dated January 19, 2010 (Low Flow Sampling Protocol).

5.2 Drilling

Pinchin retained Strata to advance a total of seven boreholes (MW1, MW2, MW3, MW4, MW101, MW102 and MW103) at the Phase Two Property between May 19 and May 25, 2023, to investigate the potential presence of COPCs associated with the APECs identified in the Phase One ESA. All of the advanced boreholes were completed as monitoring wells in accordance with O. Reg. 903 for the purpose of monitoring hydrogeological conditions and/or groundwater quality on-Site. For the purposes of soil and/or groundwater quality assessment, the boreholes were drilled to a maximum depth of 6.1 mbgs using a Massenza MI3 or a Geoprobe 7822 DT^{TM} drill rig. Pinchin notes that the Phase Two ESA was conducted in conjunction with a geotechnical investigation which required select boreholes to be advanced deeper than 6.1 mbgs, as illustrated in the borehole logs provided in Appendix B. Upon completion of the drilling and monitoring well installations, Strata completed and filed a Water Well Record with the MECP for the well cluster in accordance with O. Reg. 903.

The locations of the boreholes and monitoring wells are provided on Figure 4. Section 6.10.2 includes a table summarizing the boreholes and monitoring wells completed to investigate each of the APECs. A description of the subsurface stratigraphy encountered during the drilling program is documented in the borehole logs included in Appendix B. Well completion details and elevation data are provided in Table 2 and on the borehole logs provided in Appendix B.

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., split-spoon sampler, auger flights, spatulas used for sample collection) before initial use and between sample and borehole locations.
- 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 continuous intervals using 5.71 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 using a stainless-steel spatula. 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 Paracel Laboratories Ltd. (Paracel) in Ottawa, Ontario. Formal chain of custody records was maintained between Pinchin and the staff at Paracel.

Subsurface soil conditions were logged on-Site by Pinchin personnel at the time of borehole drilling and test pitting. Based on the soil samples recovered during the borehole drilling program, the soil stratigraphy at the drilling locations generally consists of brown sand fill to a maximum depth of approximately 3.1 mbgs, followed by sandy silt and clayey silt that extended to the maximum investigation depth of 6.1 mbgs. During the Phase Two ESA drilling work, moist to wet soil conditions were generally observed between 1.5 and 6.1 mbgs.

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

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

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 VOC-derived vapour concentrations in soil headspace with a MiniRae 2000™ PID and for petroleum-derived vapour concentrations in soil headspace with an RKI Eagle™ 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 MiniRae 2000™ 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. In addition, the PID calibration was tested at the beginning of each day of drilling activities (beginning on the second day of drilling) against a Maxim-provided isobutylene gas standard with a concentration of 100 ppm. The gas standard was stored in a gas cylinder and delivered to the PID via a regulator valve. An in-field re-calibration of the PID was conducted (using the gas standard in accordance with the operator's manual instructions) if the calibration check indicated that the PID's calibration had drifted by more than +/- 10%.

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. In addition, the CGI calibration was tested at the beginning of each day of drilling activities (beginning on the second day of drilling) against a Maxim-provided hexane gas standard with a concentration of 400 ppm. The gas standard was stored in a gas cylinder and delivered to the CGI via a regulator valve. An in-field re-calibration of the CGI was conducted (using the gas standard in accordance with the operator's manual instructions) if the calibration check indicated that the CGI's calibration had drifted by more than +/- 10%.

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.

5.5 Groundwater Monitoring Well Installation

Following soil sampling, Strata installed a groundwater monitoring well in boreholes MW1, MW2, MW3, MW4, MW101, MW102, MW103, under the full-time monitoring of a Pinchin field representative. To accommodate the well installations, each borehole was overdrilled using 15 cm (6-inch) diameter hollow stem augers to a maximum depth of 6.1 mbgs using the Massenza MI3 or a Geoprobe 7822 DT^{TM} drill rig.

The monitoring wells were constructed with 38-millimetre (1.5-inch) inner diameter (ID) flush-threaded schedule 40 polyvinyl chloride (PVC) risers followed by a 3.1 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 10 cm ID Schedule 40 PVC outer casing, approximately 15 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 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 B. Upon completion of the monitoring well installations, Strata completed and filed a Water Well Record with the MECP for the well cluster.

No additional soil sampling or groundwater sampling was completed during the well installations.

The monitoring wells were developed on May 29, 2023, in accordance with Pinchin's SOP for well development by removing a minimum of three standing water column volumes using a dedicated inertial pump comprised of 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.
- The use of dedicated inertial pumps for each well.

5.6 Groundwater Field Measurements of Water Quality Parameters

Low flow purging and sampling methods could not be employed due to the low yield of the formation in which the wells were installed.

As such, measurements of the water quality parameters were not collected during pre-sampling purging.

5.7 Groundwater Sampling

All monitoring wells installed by Pinchin as part of the Phase Two ESA were sampled. The monitoring wells were sampled a minimum of 24 hours after the completion of well development activities (see Section 5.5).

The on-Site monitoring wells could not be sampled using 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 parameters (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 a peristaltic pump and dedicated 0.64-cm (1/4-inch) ID polyethylene tubing.

As appropriate, laboratory sample bottles were pre-filled by Paracel with preservatives intended to preserve the collected groundwater samples prior to analysis.

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

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 Paracel for analysis. Paracel is an independent laboratory accredited by the Canadian Association for Laboratory Accreditation. Formal chain of custody records of the sample submissions was maintained between Pinchin and the staff at Paracel. Paracel conducted the laboratory analysis in accordance with the MECP 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

Given that the laboratory results for the submitted soil and groundwater samples indicated that all reported concentrations for the parameters analyzed met the corresponding *Table 3 Standards*, and no evidence of NAPL, odours or sheens was observed during sampling and monitoring activities, the excess soil and purge water were deposited on the ground surface at the Phase Two Property.

5.11 Elevation Surveying

On June 2, 2023, Pinchin completed a vertical elevation survey of all borehole and monitoring well locations (MW1, MW2, MW3, MW4, MW101, MW102 and MW103) using a Topcon RL-H5A Self-Leveling Laser Level and receiver. The elevations of the monitoring wells were tied to a temporary benchmark, the top of northwest corner of concrete base of the on-Site transformer, which was assigned an arbitrary elevation of 100.00 m. The benchmark location is shown on Figure 4.

The UTM coordinates of each monitoring well and borehole were determined by Pinchin using a hand-held GPS device.

A summary of the well elevation survey data is provided in Table 2. The UTM coordinates for each monitoring well and borehole are provided on the borehole logs in Appendix B.

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.
- PHCs F2-F4, PAHs, metals, inorganics, 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: 250 mL amber glass bottles with Teflon^{TM}–lined lids, pre-charged with sodium bisulphate preservative.
- PAHs: 250 mL unpreserved amber glass bottles with Teflon^{TM}–lined lids.

Each soil and groundwater 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 Paracel for analysis. Formal chain of custody records of the sample submissions was maintained between Pinchin and the staff at Paracel.

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 followed by a distilled water rinse prior to initial use and between samples.

During groundwater monitoring activities, the oil/water interface probe used to measure water levels was cleaned with a solution of Alconox™ detergent and potable water followed by a distilled water rinse prior to initial use and between well locations.

5.12.3 Field Quality Control Measures

No field duplicate soil samples were collected by Pinchin during the Phase Two ESA since the field work was completed for due diligence purposes at this time, and no visual or olfactory evidence of contamination was observed during the field work.

Maxim completed the calibration checks in accordance with the equipment manufacturers’ specifications and/or Maxim’s SOPs. As described in Section 5.4, calibration checks and recalibration (if required) were completed daily for the MiniRae 2000™ PID and RKI Eagle™ CGI during the drilling program.

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 exceptions:

- No field duplicate soil or groundwater samples were collected by Pinchin during the Phase Two ESA, since the field work was completed for due diligence purposes at this time, and no visual or olfactory evidence of contamination was observed during the field work; and
- No trip blank was included as part of the May 30, 2023, groundwater sampling event.

The lack of soil and groundwater field duplicates collected during the field work between May 19 and May 30, 2023, is not considered significant given that the concentrations of the COPCs were either not detected (i.e., for the PHC, VOC and PAH parameters) or well below the *Table 3 Standards* (i.e., the metal and/or inorganic parameters). The quality of the analytical results is typically evaluated by calculating relative percent differences (RPDs) for the parameters analyzed for the original and field duplicate samples. An RPD is not calculated unless the parameter concentration in both the original and duplicate sample had 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). Given that the RPD would not be calculated for the majority of the COPCs since the concentrations were below the PQL, the lack of field duplicates is not considered significant.

The lack of a trip blank for the groundwater samples collected on May 30, 2023, is not considered significant given that the concentrations of VOCs were not detected. 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 dry brown sand fill to a maximum depth of approximately 3.05 mbgs. The native soil underlying the sand fill is generally comprised of sandy silt containing some clay, followed by clayey silt to a maximum depth of 6.10 mbgs. The water table is located within the sandy silt unit at a depth of approximately 1 to 2 mbgs and this uppermost water bearing unit represents an unconfined aquifer.

The overburden/bedrock interface was not encountered during the Phase Two ESA drilling activities. However, based on Pinchin's geotechnical investigation conducted at the Site, bedrock was encountered at depths ranging between approximately 47.9 and 50.9 mbgs. Based on geological data published by the Ontario Geological Survey, bedrock is expected to consist of limestone, dolostone, shale, arkose, and sandstone of the Shadow Lake Formation.

The APEC investigated by the Phase Two ESA related to PHCs associated with the former on-Site RFO (APEC-1). Impacts on groundwater quality, if any, from PHCs contaminants in APEC-1 would be expected in the shallow groundwater zone and, as such, the water table groundwater quality within the unconfined aquifer in APEC-1 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 shallow groundwater zone 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 such that the well screens intersected the water table.

The following summarizes the findings of a groundwater monitoring event completed on May 29, 2023:

- The depths to groundwater measured within the on-Site monitoring wells installed within the unconfined aquifer ranged from 1.18mbgs at monitoring well MW101 to 3.09 mbgs at monitoring well MW6.
- The calculated groundwater elevations within the groundwater monitoring wells installed within the unconfined aquifer ranged between 91.8 mREL at MW5 and 97.84 mREL at MW1.
- No NAPL thicknesses were measured with the oil/water interface probe in any of the groundwater monitoring wells.

The surveyed top of well riser pipe elevations 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 29, 2023, are shown on Figure 9. The groundwater elevation contours were created using Golden Software Incorporated’s ‘Surfer’ contouring software by applying a 'triangulation with linear interpolation' gridding method with 0.2 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. The calculated groundwater surface elevation indicates that groundwater flow across the Phase Two Property is generally to the north/northwest.

The groundwater depth data collected indicate that the temporal fluctuations in the unconfined water table appear to be minimal.

Interaction of the groundwater at the Phase Two Property with buried utilities is possible given that the water table in some areas of the Phase Two Property is located at approximate depths of between 1 and 3 mbgs and the utilities are known to be located at depths ranging from approximately 2 to 3 mbgs. However, given that no groundwater impacts were identified at the Phase Two Property, preferential migration of contaminants along utilities is not considered to be a concern.

6.3 Groundwater Hydraulic Gradients

6.3.1 Groundwater Horizontal Hydraulic Gradients

The plotted groundwater surface elevation contours (as shown on Figure 9) 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 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 June 2, 2023, 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 Fine-Medium 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 primary stratigraphic units observed at the borehole locations. Sandy silt containing some clay was encountered underlying the sand fill in borehole MW1. The result of one particle size distribution analysis performed on a sample of the material indicates that the sample contains 32% sand, 51% silt and 17% clay. Clayey silt was found to be underlying the sandy silt in all boreholes. The material was noted to typically contain trace sand and was grey in colour. The result of three particle size distribution analyses performed on samples of the material indicates that the samples contain 1% sand, 29 to 34% silt and 65 to 71% clay.

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 two-thirds of the overburden at the Phase Two Property is medium and fine-textured as defined by O. Reg. 153/04. Therefore, the soil at the Phase Two Property was interpreted to be medium and fine-textured for the purpose of determining the MECP 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 80 ppm$_v$ in soil sample SS2 collected from borehole MW101 at a depth of approximately 0.8 to 1.5 mbgs. Soil vapour headspace values measured with the PID were non-detect (0 ppm) in all collected soil samples.

One most apparent “worst case” soil sample, based on vapour concentrations as well as visual and/or olfactory considerations, recovered from each borehole was submitted for laboratory analysis of VOCs, PHCs, PAHs and/or metals and inorganics.

6.6 Soil Quality

A total of four boreholes were advanced at the Phase Two Property at the locations shown on Figure 7 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 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 3 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 3 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 3 Standards*.

6.6.2 PHCs F1-F4

The soil sample analytical results for PHCs F1-F4, along with the corresponding *Table 3 Standards*, are presented in Table 3. As indicated in Table 1, all reported concentrations of PHCs F1- F4 in the soil samples submitted for analysis were below the *Table 3 Standards*.

6.6.3 PAHs

The soil sample analytical results for PAHs, along with the corresponding *Table 3 Standards*, are presented in Table 3. As indicated in Table 1, all reported concentrations of PAHs in the soil samples submitted for analysis were below the *Table 3 Standards*.

6.6.4 Metals and Inorganics

The soil sample analytical results for metals and inorganics parameters, along with the corresponding *Table 3 Standards*, are presented in Table 3. As indicated in Table 1, all reported concentrations of metals and inorganics in the soil samples submitted for analysis were below the *Table 3 Standards*.

6.6.5 General Comments on Soil Quality

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

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 MW1, MW101, MW102 and MW103 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 4. The groundwater sample collection depths and laboratory analysis are summarized in Table 5.

The groundwater sample analytical results were compared to the *Table 3 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 3 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 3 Standards.*

6.7.2 PHCs F1-F4

The groundwater analytical results for PHCs F1-F4, along with the corresponding *Table 3 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 3 Standards.*

6.7.3 PAHs

The groundwater analytical results for PAHs, along with the corresponding *Table 3 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 3 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.

As discussed in Section 6.6.5, soil sampling at the Phase Two Property did not identify any impacts related to VOCs, PHCs F1-F4, PAHs, and metals and inorganics parameters. As such, there is no evidence that the soil at the Phase Two Property is acting as a contaminant source for the groundwater.

The groundwater sample analytical results also show no evidence of NAPLs in the subsurface at the Site. In addition, no evidence of NAPL was observed during groundwater monitoring and sampling.

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.

Laboratory quality control activities and sample checks employed by Paracel 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.
- 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 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.

6.9.2 Laboratory Certificates of Analysis

Pinchin has reviewed the laboratory Certificates of Analysis provided by Paracel 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 C.
- All of the analytical data reported in the Certificates of Analysis have been summarized, in full, in Tables 1 and 5.

6.9.3 Laboratory Comments Regarding Sample Analysis

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

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

- The custody seal was present and intact on all submissions.
- The temperatures of the submitted soil and groundwater samples upon receipt ranged from 2 to 8 ºC, with the exception of soil samples BH1-SS2 and BH1-SS6 (>25ºC). These samples were collected at the end of May 2023 when high ambient air and ground temperatures were present. The soil samples were placed in coolers with ice immediately after sample collection and were delivered to Paracel immediately after sampling. As such, it is possible that there was insufficient time between sample collection and delivery to the laboratory for the soil samples to be cooled to temperatures below 8 ºC. Given these factors, it is the QP's opinion that the elevated sample temperatures reported by Paracel for these samples did not bias the analytical results.

6.9.4 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 MECP Site Condition Standards.

6.10 Phase Two Conceptual Site Model

This Phase Two ESA was completed for the property located at the municipal address of 1887 St. Joseph Boulevard, in Ottawa, Ontario. The Phase Two Property is 5.65 acres (2.29 hectares) in size and is located immediately north of St. Joseph Boulevard, approximately 65 metres (m) west of the intersection of St. Joseph Boulevard and Marenger Street. The Phase Two Property is bounded by light industrial and community buildings to the north and west, commercial and light industrial buildings to the east, and

St. Joseph Boulevard followed by residential dwellings to the south. 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 6, 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.
- 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 18 PCAs within the Phase One Study Area, consisting of four PCAs at the Phase One Property and 14 PCAs within the Phase One Study Area, outside of the Phase One Property. The on-Site PCAs consisted of a historical RFO with several associated USTs, potential poor quality fill underlying the parking lot area, the Phase One Property being listed within the O. Reg. 347 Waste Generators database, and a pad-mounted oil-cooled transformer is located on the north portion of the Phase One Property. However, no evidence of spills or historical spills (i.e., staining) was observed in the vicinity of the transformers and no issues of potential environmental concern (i.e., spills) were noted for the transformers within the ERIS report and any maintenance/environmental issues associated with the transformers would be the responsibility of Hydro One. Based on the above-noted information and the limited annual quantities of hazardous wastes generated on-Site, the on-Site transformer and waste generation do not represent APECs for the Phase One Property. The off-Site PCAs were not considered to result in APECs at the Phase One Property given the distance from the PCAs to the Phase One Property, their downgradient or transgradient locations relative to the inferred groundwater flow direction in the Phase One Study Area and/or the nature of operations and potential contaminants related to these operations.

6.10.2 Areas of Potential Environmental Concern

Table 1 summarizes the APECs identified at the Phase Two Property, as well as their respective PCAs, COPCs and the media that could potentially be impacted. APECs at the Phase Two Property are illustrated on Figure 6. The Phase Two ESA included an assessment of soil and groundwater quality within each of the APECs.

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

APEC	Investigation Location
APEC-1	MW1, MW101, MW102 and MW103
APEC-2	MW2*, MW3* and MW4*

* Soil sampling only.

A summary of the findings for each of the APECs is provided below.

APEC-1

The Fuel Storage Tank database indicated that seven 22,700-Litre (L) gasoline USTs were registered to the Phase Two Property in 1988. Based on the above-noted information, as well as a review of aerial photographs for the Phase One Property, an RFO was formerly located on the south portion of the Phase One Property. The former RFO equipped with seven gasoline USTs represented a PCA that required investigation as part of the Phase Two ESA. The subsurface investigation of APEC-1 completed by Pinchin as part of the Phase Two ESA included new boreholes/monitoring wells MW1, MW101, MW102 and MW103. Soil and groundwater samples collected from the boreholes and monitoring wells located within APEC-1 were submitted for laboratory analysis of PHCs, VOCs, PAHs, metals and/or inorganics. Soil and groundwater concentrations of the above-noted COPCs met the *Table 3 Standards*.

APEC-2

An asphalt-paved parking lot occupies the majority of the south portion of the Phase Two Property. The presence of potential fill material underlying the parking lot area represented a PCA that required further investigation as part of the Phase Two ESA. Soil samples collected from new borehole locations MW2, MW3 and MW4 assessed potential impacts from the fill material. The soil samples submitted from the boreholes completed within APEC-2 were analyzed for metals, PAHs and inorganics. The laboratory results met the *Table 3 Standards*.

6.10.3 Subsurface Structures and Utilities

Underground utilities which are known or inferred to be present at the Phase Two Property include natural gas lines, municipal water main and sanitary and storm sewers, which extend northwards from the northwest portion of the Phase Two Property towards Youville Drive, buried telecommunications lines located along the west central portion of the Phase Two Property, and electrical lines which extend south from the transformer to the Site Building, and across the parking lot area to provide lighting. The approximate locations of these underground utilities are illustrated on Figure 7.

Interaction of the groundwater at the Phase Two Property with buried utilities is possible given that the water table in some areas of the Phase Two Property is located at approximate depths of between 1 and 2 mbgs and the utilities are known to be located at depths ranging from approximately 2 to 3 mbgs. However, given that no groundwater impacts were identified at the Phase Two Property, preferential migration of contaminants along utilities is not considered to be a concern.

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.

Stratigraphy

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 dry brown sand fill to a maximum depth of approximately 3.05 mbgs. The native soil underlying the sand fill is generally comprised of sandy silt containing some clay, followed by clayey silt to a maximum depth of 6.10 mbgs. The water table is located within the sandy silt unit at a depth of approximately 1 to 2 mbgs and this uppermost water bearing unit represents an unconfined aquifer.

Based on geological data published by the Ontario Geological Survey, bedrock is expected to consist of limestone, dolostone, shale, arkose, and sandstone of the Shadow Lake Formation. The borehole locations are shown on Figure 7.

Hydrogeological Characteristics

The groundwater flow direction in the unconfined aquifer at the Phase Two Property was calculated to be towards the north/northwest.

The hydraulic conductivity of the shallow aquifer at the Phase Two Property (i.e., sandy silt) ranges from 10^{-6} metres/second to 10^{-7} metres/second, and groundwater flow velocity is estimated to be approximately 1.8 to 17 metres/year.

The horizontal hydraulic gradient within the unconfined aquifer at the Phase Two Property was estimated to be 0.025, and the porosity was estimated to be 0.45.

Depth to Bedrock

The overburden/bedrock interface was not encountered during the Phase Two ESA drilling activities. However, based on Pinchin's geotechnical investigation conducted at the Site, bedrock was encountered at depths ranging between approximately 47.9 and 50.9 mbgs.

Depth to Water Table

The water table at the Phase Two Property is located primarily within the shallow sandy silt aquifer. The depth to the water table across the Phase Two Property ranges from approximately 1.07 mbgs at monitoring well MW1 to 2.49 mbgs at monitoring well MW103.

Applicability of Section 35 of O. Reg 153/04 – Non-Potable Site Condition Standards

Site Condition Standards for non-potable groundwater use have been applied to the Phase Two Property given that the following conditions specified in Section 35 of O. Reg. 153/04 have been met:

- The Phase Two Property and all properties within 250 metres of the Phase Two Property are supplied by a municipal drinking water system.
- The Phase Two Property is not located within a well head protection area or other designation identified by the City of Ottawa for the protection of groundwater.
- There are no wells located at the Phase Two Property or within the Phase One Study Area that are used or intended for use as a water source for human consumption or agriculture.
- The City of Ottawa has been advised in writing of the intention to use non-potable Site Condition Standards at the Phase Two Property; a response has not been received.

Applicability of Section 41 of O. Reg 153/04 – Environmentally Sensitive Area

Section 41 of O. Reg. 153/04 states that a property is classified as an "environmentally sensitive area" if the property is within an area of natural significance, the property includes or is adjacent to an area of natural significance or part of such an area, the property includes land that is within 30 m of an area of natural significance or part of such an area, the soil at the property has a pH value for surface soil less than 5 or greater than 9 or the soil at the property has a pH value for subsurface soil less than 5 or greater than 11.

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

Applicability of Section 43.1 of O. Reg 153/04 – Shallow Soil Property and Proximity to a Water Body

Section 43.1 of O. Reg. 153/04 states that a property is classified as a "shallow soil property" if one-third or more of the area consists of soil less than 2 m in depth.

Bedrock was encountered at all borehole locations at depths greater than 2.0 mbgs. As such, the Phase Two Property is not a shallow soil property as defined by Section 43.1 of O. Reg. 153/04.

As per Section 43.1 of O. Reg. 153/04, the proximity of the Phase Two Property to a water body must be considered when selecting the appropriate Site Condition Standards.

The Phase Two Property does not include all or part of a water body, it is not adjacent to a water body and it does not include land within 30 m of a water body. As such, Site Condition Standards for use within 30 m of a water body were not applied.

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 may include 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 two-thirds of the overburden at the Phase Two Property is medium and fine-textured as defined by O. Reg. 153/04 and Site Condition Standards for coarse-textured soil were not 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 3: Full Depth Generic Site Condition Standards for Use in a Non-Potable Ground Water Condition", provided in the Ontario Ministry of the Environment, Conservation and Parks (MECP) document entitled, "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" dated April 15, 2011 (*Table 3 Standards*) for:
  - Medium/fine-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 3 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 3 Standards* for the parameters analyzed.

6.10.8 Meteorological and Climatic Conditions

The Phase Two Property is either covered by pavement or by the Site Building, which is expected to have limited the influence of meteorological and climatic conditions on contaminant distribution and migration in the subsurface. 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 3 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 3 Standards*, Pinchin considered that an evaluation of potential exposure pathways and receptors was unnecessary.

6.10.11 Applicability of Section 49.1 Exemptions

The Phase Two Property has a paved parking area located south of the Site Building. According to the Site Representative, salt has historically been applied to the parking area for safety reasons during winter conditions to remove snow and ice. It is the opinion of the $\mathrm{QP_{ESA}}$ supervising the Phase Two ESA that, although salt-related parameters such as sodium adsorption ratio and electrical conductivity in soil and sodium and chloride in groundwater may be present at concentrations exceeding the applicable Site Condition Standards (i.e., *Table 3 Standards*), the exemption provided in Section 49.1 of O. Reg. 153/04 can be applied. As such, these parameters would be deemed to meet the Site Condition Standards and were not assessed as part of this Phase Two ESA.

7.0 CONCLUSIONS

Pinchin completed a Phase Two ESA at the Phase Two Property in general accordance with the requirements stipulated in O. Reg. 153/04 as a condition for a future rezoning application with the City of Ottawa.

The Phase Two ESA completed by Pinchin included the advancement of seven boreholes at the Phase Two Property, all of which were completed as groundwater monitoring wells to facilitate the sampling of groundwater and/or for the purpose of monitoring hydrogeological conditions.

Based on Site-specific information, the applicable regulatory standards for the Phase Two Property were determined to be the *Table 3 Standards* for residential land use and medium and fine-textured soils. Soil samples were collected from each of the borehole locations and submitted for laboratory analysis of VOCs, PHCs, PAHs, metals and/or inorganic parameters. In addition, groundwater samples were collected from the four 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 3 Standards*. The maximum reported soil and groundwater concentrations for the parameters analyzed are summarized in Tables 8 and 9, respectively.

It is the opinion of the QP who supervised the Phase Two ESA that the applicable *Table 3 Standards* for soil and groundwater at the Phase Two Property have been met as of the Certification Date of May 30, 2023, 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 Scott Mather, 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 Terms and Limitations

This Phase Two ESA was performed for Sobeys Inc. (Client) in order to investigate potential environmental impacts at 1887 St. Joseph Boulevard in Ottawa, 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 terms, conditions and limitations contained within the duly authorized proposal for this project. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, is the sole responsibility of such third parties. Pinchin accepts no responsibility for damages suffered by any third party as a result of decisions made or actions conducted.

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 provide results or information to any party unless disclosure by Pinchin is required by law.

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, 1887 St. Joseph Boulevard, Ottawa, Ontario. Prepared for Sobeys Inc., April 14, 2023.
- 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 274/20 on July 1, 2020.
- 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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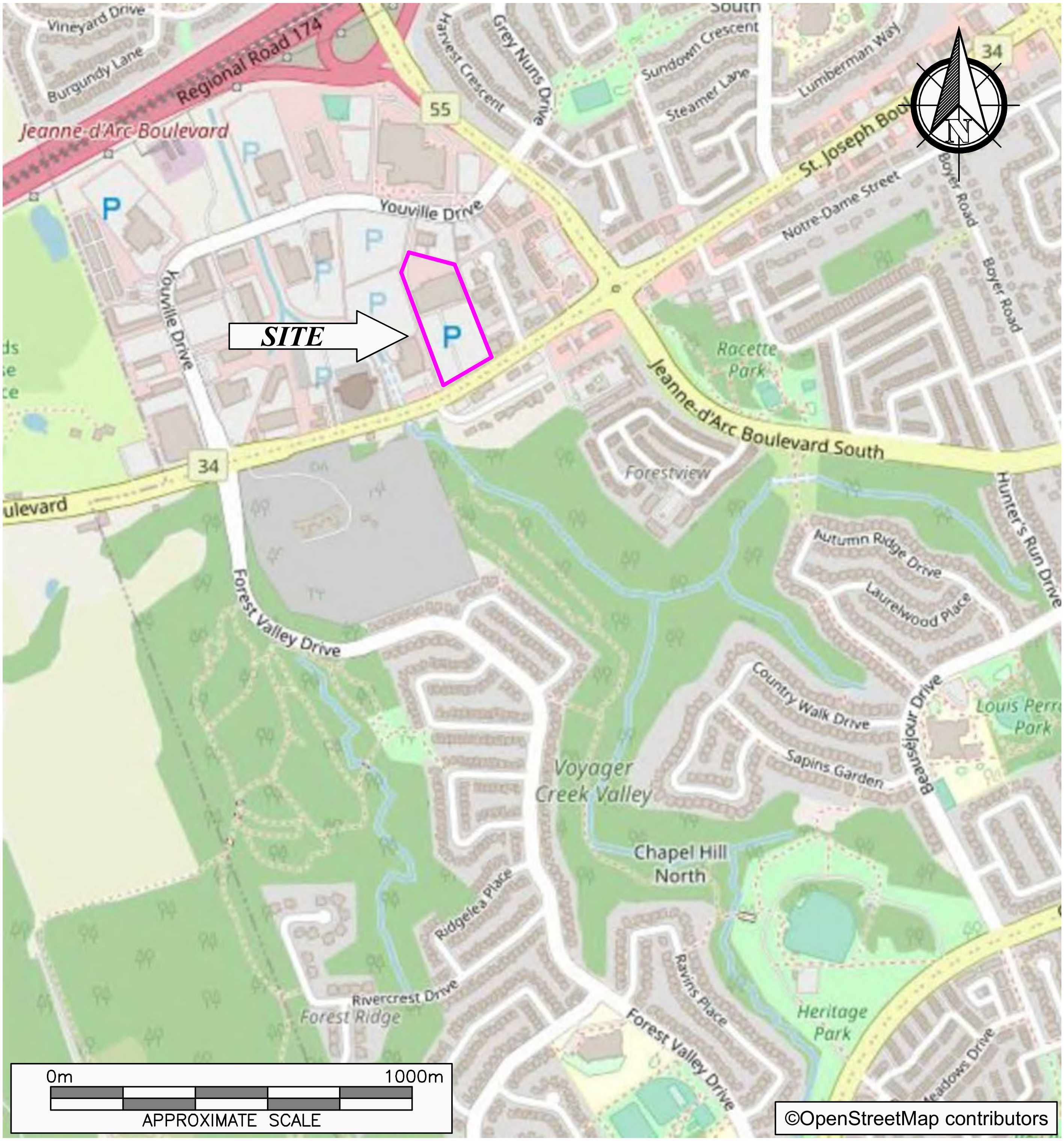
Template: Master Report for RSC Phase Two ESA Report – Unimpacted Site, EDR, October 16, 2020

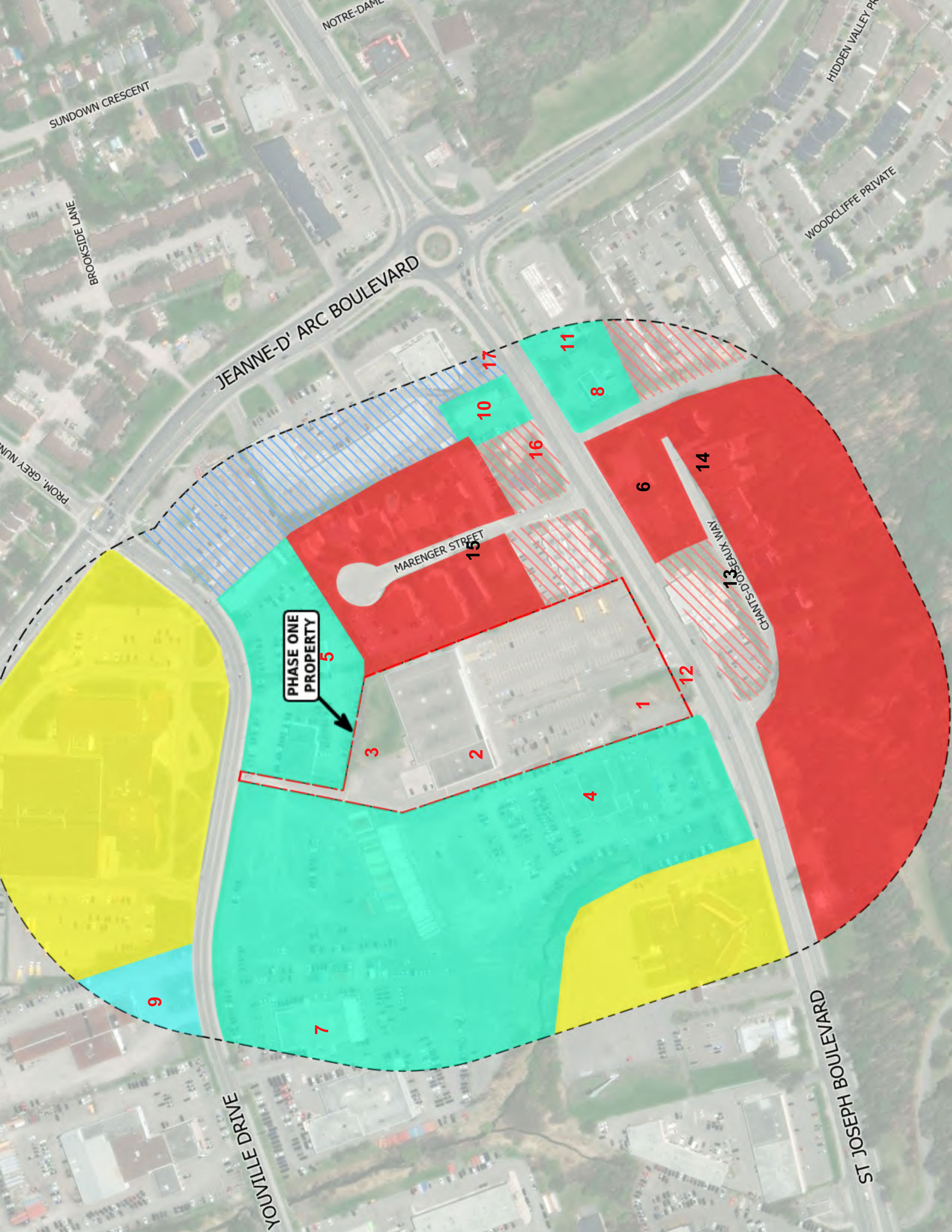
9.0 FIGURES AND TABLES



PINCHIN

PROJECT NAME	PHASE TWO ENVIRONMENTAL SITE ASSESSMENT
CLIENT NAME	SOBEYS INC.
PROJECT LOCATION	1887 ST JOSEPH BOULEVARD, OTTAWA, ONTARIO
FIGURE NAME	KEY MAP
FIGURE NO.	1
APPROXIMATE SCALE	AS SHOWN
PROJECT NO.	324269.002
DATE	JUNE 2023


JEANNE-D' ARC BOULEVARD
RFO
MTC
MTC
MTC
AUTO REPAIR FACILITY
AUTO REPAIR FACILITY
AUTO REPAIR FACILITY
COM
RES
RES
RES
MARENGER STREET
MTR
MTR
X WAY
AUTO REPAIR FACILITY
RES
AUTO REPAIR FACILITY
PHASE TWO PROPERTY
ST. JOSEPH BOULEVARD
AUTO REPAIR FACILITY
AUTO REPAIR FACILITY
YOUVILLE DRIVE
INST


NOTRE-DAME
SUNDOWN CRESCENT
HIDDEN VALLEY PR
BROOKSIDE LANE
WOODCLIFFE PRIVATE
JEANNE-D' ARC BOULEVARD
PROM. GREY NUN
MARENGER STREET
CHANTS-D'OISEAUX WAY
YOUVILLE DRIVE
ST JOSEPH BOULEVARD
PHASE ONE PROPERTY
1
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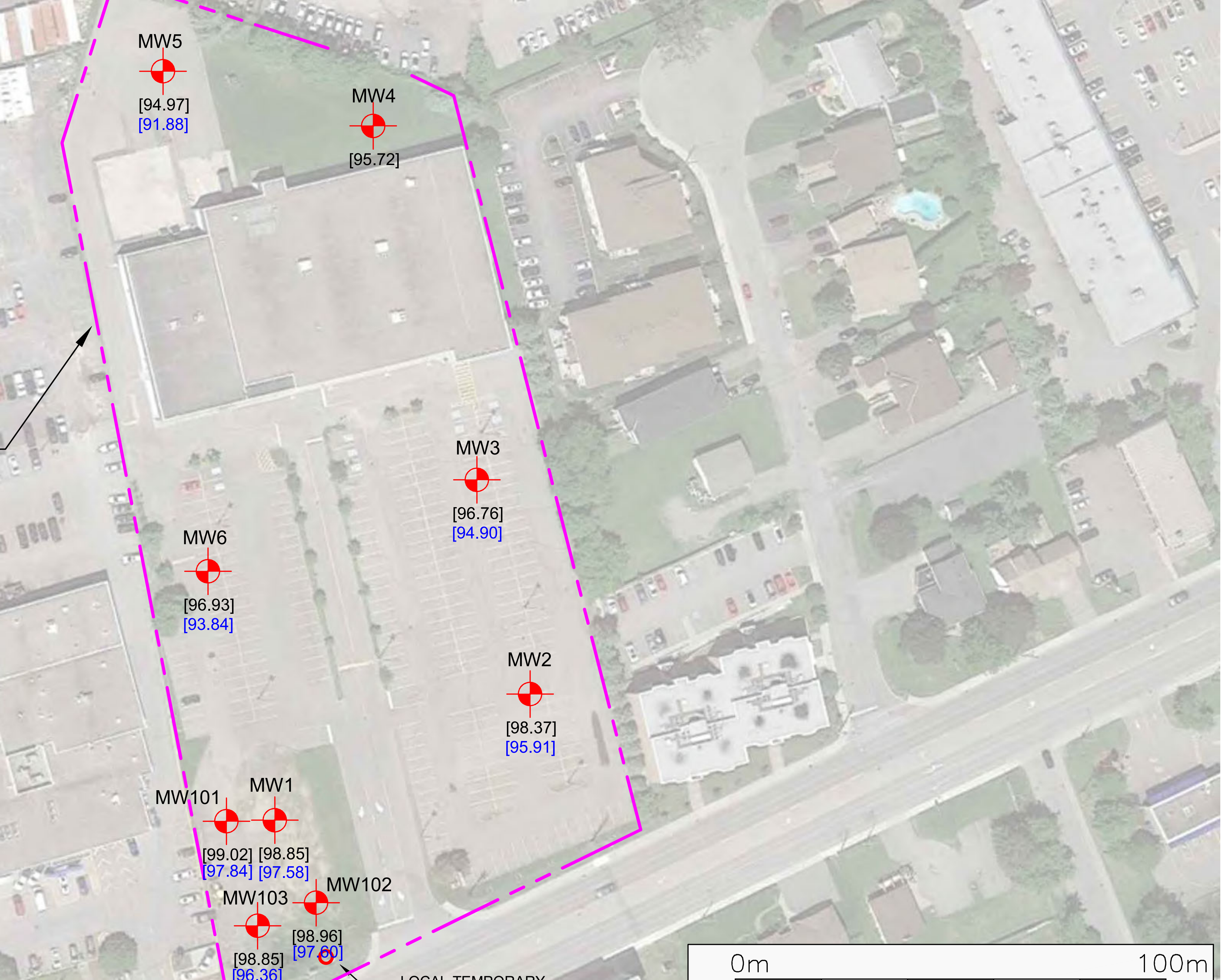

LEG
[XX.X
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PROJ
P

CLIEN

PROJ
18

FIGUR
E

APPR

0.26	-	<0.05	-	-	-	-	<0.05
0.05	-	<0.05	-	-	-	-	<0.05
0.12	-	<0.05	-	-	-	-	<0.05
2.7	-	<0.05	-	-	-	-	<0.05
0.18	-	<0.05	-	-	-	-	<0.05
9.4	-	<0.05	-	-	-	-	<0.05
4.3	-	<0.05	-	-	-	-	<0.05
6	-	<0.05	-	-	-	-	<0.05
0.097	-	<0.05	-	-	-	-	<0.05
25	-	<0.05	-	-	-	-	<0.05
11	-	<0.05	-	-	-	-	<0.05
0.05	-	<0.05	-	-	-	-	<0.05
0.05	-	<0.05	-	-	-	-	<0.05
30	-	<0.05	-	-	-	-	<0.05
0.75	-	<0.05	-	-	-	-	<0.05
0.085	-	<0.05	-	-	-	-	<0.05
0.083	-	<0.05	-	-	-	-	<0.05
15	-	<0.05	-	-	-	-	<0.05
0.05	-	<0.05	-	-	-	-	<0.05
34	-	<0.05	-	-	-	-	<0.05
44	-	<0.50	-	-	-	-	<0.50
4.3	-	<0.50	-	-	-	-	<0.50
1.4	-	<0.05	-	-	-	-	<0.05
0.96	-	<0.05	-	-	-	-	<0.05
2.2	-	<0.05	-	-	-	-	<0.05
0.05	-	<0.05	-	-	-	-	<0.05
0.05	-	<0.05	-	-	-	-	<0.05
2.3	-	<0.05	-	-	-	-	<0.05
6	-	<0.05	-	-	-	-	<0.05
3.4	-	<0.05	-	-	-	-	<0.05
0.05	-	<0.05	-	-	-	-	<0.05
0.52	-	<0.05	-	-	-	-	<0.05
5.8	-	<0.05	-	-	-	-	<0.05
0.022	-	<0.02	-	-	-	-	<0.02
25	-	<0.05	-	-	-	-	<0.05
58	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
0.17	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
0.74	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
0.63	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
0.3	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
0.78	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
7.8	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
0.78	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
7.8	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
0.1	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
0.69	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
69	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
0.48	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
3.4	<0.04	<0.04	<0.04	<0.04	<0.04	-	-
0.75	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
7.8	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
78	<0.02	<0.02	<0.02	<0.02	<0.02	-	-
7.5	<1.0	-	<1.0	<1.0	<1.0	-	-
18	1.0	-	1.1	<1.0	<1.0	-	-
390	30.0	-	23.9	18.8	20.7	-	-
5	<0.5	-	<0.5	<0.5	<0.5	-	-
120	<5.0	-	<5.0	<5.0	<5.0	-	-
1.2	<0.5	-	<0.5	<0.5	<0.5	-	-
160	10.2	-	14	11	9.9	-	-
22	3.6	-	3.1	2.6	2.9	-	-
180	<5.0	-	6.1	<5.0	<5.0	-	-
120	1.7	-	1.8	1.5	1.3	-	-

ABLE 2

ROUNDWATER MONITORING WELL ELEVATIONS AND CONSTRUCTION DETAILS

beys Inc.
87 St. Joseph Boulevard, Ottawa, Ontario

onitoring Well	Top of Pipe Elevation (mREL)	Ground Surface Elevation (mREL)	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 thicknes (metres)
MW1	99.64	98.85	6.1	0.79	3.8	010	3.1-6.1	3.1	2.7
MW2	98.23	98.37	6.1	-0.14	3.8	010	3.1-6.1	3.1	2.7
MW3	96.71	96.76	6.1	-0.05	3.8	010	3.1-6.1	3.1	2.7
MW4	96.65	95.72	6.1	0.93	3.8	010	3.1-6.1	3.1	2.7
MW5	94.86	94.97	6.1	-0.11	3.8	010	3.1-6.1	3.1	2.7
MW6	96.81	96.93	6.1	-0.12	3.8	010	3.1-6.1	3.1	2.7
MW101	98.94	99.02	6.1	-0.08	3.8	010	3.1-6.1	3.1	2.7
MW102	98.77	98.96	6.1	-0.19	3.8	010	3.1-6.1	3.1	2.7
MW103	98.72	98.85	6.1	-0.13	3.8	010	3.1-6.1	3.1	2.7

tes:

mamsl	metres above mean sea level
mbgs	metres below ground surface

TER MONITORING DATA

ph Boulevard, Ottawa, Ontario

l	Monitoring Well Screen Interval (mbgs)	Top of Pipe Elevation (mREL)	Ground Surface Elevation (mREL)	Stick-Up Height (metres)	Date of Monitoring (dd/mm/yyyy)	Measured Depth to Groundwater from Top of Pipe (mbtop)	Calculated Depth to Groundwater from Surface (mbgs)	Groundwater Elevation (mREL)	Visual / Olfa Observati
	3.1-6.1	99.64	98.85	0.80	02/06/2023	2.07	1.27	97.58	No sheen or
	3.1-6.1	98.23	98.37	-0.14	02/06/2023	2.32	2.46	95.91	No sheen or
	3.1-6.1	96.71	96.76	-0.05	02/06/2023	1.81	1.86	94.90	No sheen or
	3.1-6.1	96.65	95.72	0.93	02/06/2023	3.47	2.54	93.18	No sheen or
	3.1-6.1	94.86	94.97	-0.11	02/06/2023	2.98	3.09	91.88	No sheen or
	3.1-6.1	96.81	96.93	-0.12	02/06/2023	2.97	3.09	93.84	No sheen or
	3.1-6.1	98.94	99.02	-0.08	29/05/2023	1.10	1.18	97.84	No sheen or
	3.1-6.1	98.77	98.96	-0.19	29/05/2023	1.17	1.36	97.60	No sheen or
	3.1-6.1	98.72	98.85	-0.13	29/05/2023	2.36	2.49	96.36	No sheen or

Minimum =	1.18	91.88
Maximum =	3.09	97.84

sl metres above mean sea level
gs metres below ground surface
op metres below top of pipe
M Not Measured

- NON-AQUEOUS PHASE LIQUIDS

wa, Ontario

Date of Monitoring (dd/mm/yyyy)	LNAPL					DNAPL			
	Measured Depth to Bottom of LNAPL from Top of Pipe (metres)	Measured Depth to Top of LNAPL from Top of Pipe (metres)	LNAPL Thickness (metres)	Top of LNAPL Elevation (mamsl)	Bottom of LNAPL Elevation (mamsl)	Measured Depth to Bottom of DNAPL from Top of Pipe (metres)	Measured Depth to Top of DNAPL from Top of Pipe (metres)	DNAPL Thickness (metres)	To
02/06/2023	ND	ND	ND	ND	ND	ND	ND	ND	
29/05/2023	ND	ND	ND	ND	ND	ND	ND	ND	
29/05/2023	ND	ND	ND	ND	ND	ND	ND	ND	
29/05/2023	ND	ND	ND	ND	ND	ND	ND	ND	

Phase Liquid
hase Liquid
Sea Level
Surface

(dd/mm/yyyy)		02/06/2023	02/06/2023	02/06/2023	02/06/2023
Laboratory Sample No.		2322204-01	2322204-02	2322204-03	2322204-04
ell Screen Depth Interval (mbgs)		3.1-6.1	3.1-6.1	3.1-6.1	3.1-6.1
m Hydrocarbons (PHCs)					
(C_6 - C_{10})	750	<25	<25	<25	<25
(>C_{10} - C_{16})	150	<100	<100	<100	<100
(>C_{16} - C_{34})	500	<100	<100	<100	<100
(>C_{34} - C_{50})	500	<100	<100	<100	<100
rganic Compounds					
	130000	<5.0	<5.0	<5.0	<5.0
	430	<0.5	<0.5	<0.5	<0.5
hloromethane	85000	<0.5	<0.5	<0.5	<0.5
m	770	<0.5	<0.5	<0.5	<0.5
thane	56	<0.5	<0.5	<0.5	<0.5
etrachloride	8.4	<0.2	<0.2	<0.2	<0.2
nzene	630	<0.5	<0.5	<0.5	<0.5
m	22	<0.5	<0.5	<0.5	<0.5
hloromethane	82000	<0.5	<0.5	<0.5	<0.5
robenzene	9600	<0.5	<0.5	<0.5	<0.5
robenzene	9600	<0.5	<0.5	<0.5	<0.5
robenzene	67	<0.5	<0.5	<0.5	<0.5
ifluoromethane	4400	<1.0	<1.0	<1.0	<1.0
roethane	3100	<0.5	<0.5	<0.5	<0.5
roethane	12	<0.5	<0.5	<0.5	<0.5
roethylene	17	<0.5	<0.5	<0.5	<0.5
chloroethylene	17	<0.5	<0.5	<0.5	<0.5
Dichloroethylene	17	<0.5	<0.5	<0.5	<0.5
ropropane	140	<0.5	<0.5	<0.5	<0.5
ropropene (Total)	45	<0.5	<0.5	<0.5	<0.5
ene	2300	<0.5	<0.5	<0.5	<0.5
Dibromide	0.83	<0.2	<0.2	<0.2	<0.2
	520	<1.0	<1.0	<1.0	<1.0
yl Ketone	1500000	<5.0	<5.0	<5.0	<5.0
butyl Ketone	580000	<5.0	<5.0	<5.0	<5.0
utyl Ether (MTBE)	1400	13.5	<2.0	125	15.0
e Chloride	5500	<5.0	<5.0	<5.0	<5.0
	9100	<0.5	<0.5	<0.5	<0.5
etrachloroethane	28	<0.5	<0.5	<0.5	<0.5
etrachloroethane	15	<0.5	<0.5	<0.5	<0.5
roethylene	17	<0.5	<0.5	<0.5	<0.5
	18000	<0.5	<0.5	<0.5	<0.5
hloroethane	6700	<0.5	<0.5	<0.5	<0.5
hloroethane	30	<0.5	<0.5	<0.5	<0.5
thylene	17	<0.5	<0.5	<0.5	<0.5
uoromethane	2500	<1.0	<1.0	<1.0	<1.0
ride	1.7	<0.5	<0.5	<0.5	<0.5
Total)	4200	<0.5	<0.5	<0.5	<0.5
c Aromatic Hydrocarbons					
hene	1700	<0.05	<0.05	<0.05	<0.05
hylene	1.8	<0.05	<0.05	<0.05	<0.05
ne	2.4	<0.01	<0.01	<0.01	<0.01
anthracene	4.7	<0.01	<0.01	<0.01	<0.01
pyrene	0.81	<0.01	<0.01	<0.01	<0.01
luoranthene	0.75	<0.05	<0.05	<0.05	<0.05
i)perylene	0.2	<0.05	<0.05	<0.05	<0.05
luoranthene	0.4	<0.05	<0.05	<0.05	<0.05
	1	<0.05	<0.05	<0.05	<0.05
,h)anthracene	0.52	<0.05	<0.05	<0.05	<0.05
ene	130	<0.01	<0.01	<0.01	<0.01
	400	<0.05	<0.05	<0.05	<0.05
2,3-cd)pyrene	0.2	<0.05	<0.05	<0.05	<0.05
thylnaphthalene	1800	<0.10	<0.10	<0.10	<0.10
ene	6400	0.06	<0.05	<0.05	<0.05
rene	580	<0.05	<0.05	<0.05	<0.05
	68	0.02	<0.01	<0.01	<0.01

ble 3 SCS (F):
und Water and Sediment Standards for Use Under
of the Environmental Protection Act, April 15, 2011,
Full Depth Generic Site Condition Standards in a Non-
Ground Water Condition, for All Types of Property Use
um/Fine-Textured Soils

D	Exceeds SCS
D	Reportable Detection Limit Exceeds SCS

Organic Compounds					
	<0.5	28	Multiple Samples	Multiple Samples	Multiple Samples
	<0.02	0.17	Multiple Samples	Multiple Samples	Multiple Samples
chloromethane	<0.05	13	Multiple Samples	Multiple Samples	Multiple Samples
m	<0.05	0.26	Multiple Samples	Multiple Samples	Multiple Samples
ethane	<0.05	0.05	Multiple Samples	Multiple Samples	Multiple Samples
Tetrachloride	<0.05	0.12	Multiple Samples	Multiple Samples	Multiple Samples
nzene	<0.05	2.7	Multiple Samples	Multiple Samples	Multiple Samples
m	<0.05	0.18	Multiple Samples	Multiple Samples	Multiple Samples
chloromethane	<0.05	9.4	Multiple Samples	Multiple Samples	Multiple Samples
orobenzene	<0.05	4.3	Multiple Samples	Multiple Samples	Multiple Samples
orobenzene	<0.05	6	Multiple Samples	Multiple Samples	Multiple Samples
orobenzene	<0.05	0.097	Multiple Samples	Multiple Samples	Multiple Samples
ifluoromethane	<0.05	25	Multiple Samples	Multiple Samples	Multiple Samples
oroethane	<0.05	11	Multiple Samples	Multiple Samples	Multiple Samples
oroethane	<0.05	0.05	Multiple Samples	Multiple Samples	Multiple Samples
oroethylene	<0.05	0.05	Multiple Samples	Multiple Samples	Multiple Samples
ichloroethylene	<0.05	30	Multiple Samples	Multiple Samples	Multiple Samples
-Dichloroethylene	<0.05	0.75	Multiple Samples	Multiple Samples	Multiple Samples
oropropane	<0.05	0.085	Multiple Samples	Multiple Samples	Multiple Samples
oropropene (Total)	<0.05	0.083	Multiple Samples	Multiple Samples	Multiple Samples
zene	<0.05	15	Multiple Samples	Multiple Samples	Multiple Samples
Dibromide	<0.05	0.05	Multiple Samples	Multiple Samples	Multiple Samples
	<0.05	34	Multiple Samples	Multiple Samples	Multiple Samples
hyl Ketone	<0.5	44	Multiple Samples	Multiple Samples	Multiple Samples
obutyl Ketone	<0.5	4.3	Multiple Samples	Multiple Samples	Multiple Samples
Butyl Ether (MTBE)	<0.05	1.4	Multiple Samples	Multiple Samples	Multiple Samples
e Chloride	<0.05	0.96	Multiple Samples	Multiple Samples	Multiple Samples
	<0.05	2.2	Multiple Samples	Multiple Samples	Multiple Samples
etrachloroethane	<0.05	0.05	Multiple Samples	Multiple Samples	Multiple Samples
etrachloroethane	<0.05	0.05	Multiple Samples	Multiple Samples	Multiple Samples
oroethylene	<0.05	2.3	Multiple Samples	Multiple Samples	Multiple Samples
	<0.05	6	Multiple Samples	Multiple Samples	Multiple Samples
chloroethane	<0.05	3.4	Multiple Samples	Multiple Samples	Multiple Samples
chloroethane	<0.05	0.05	Multiple Samples	Multiple Samples	Multiple Samples
ethylene	<0.05	0.52	Multiple Samples	Multiple Samples	Multiple Samples
fluoromethane	<0.05	5.8	Multiple Samples	Multiple Samples	Multiple Samples
oride	<0.02	0.022	Multiple Samples	Multiple Samples	Multiple Samples
Total)	<0.05	25	Multiple Samples	Multiple Samples	Multiple Samples
ic Aromatic Hydrocarbons					
thene	<0.02	58	Multiple Samples	Multiple Samples	Multiple Samples
thylene	<0.02	0.17	Multiple Samples	Multiple Samples	Multiple Samples
ne	<0.02	0.74	Multiple Samples	Multiple Samples	Multiple Samples
anthracene	<0.02	0.63	Multiple Samples	Multiple Samples	Multiple Samples
pyrene	<0.02	0.3	Multiple Samples	Multiple Samples	Multiple Samples
fluoranthene	<0.02	0.78	Multiple Samples	Multiple Samples	Multiple Samples
i)perylene	<0.02	7.8	Multiple Samples	Multiple Samples	Multiple Samples
fluoranthene	<0.02	0.78	Multiple Samples	Multiple Samples	Multiple Samples
e	<0.02	7.8	Multiple Samples	Multiple Samples	Multiple Samples
a,h)anthracene	<0.02	0.1	Multiple Samples	Multiple Samples	Multiple Samples
ene	<0.02	0.69	Multiple Samples	Multiple Samples	Multiple Samples
	<0.02	69	Multiple Samples	Multiple Samples	Multiple Samples
2,3-cd)pyrene	<0.02	0.48	Multiple Samples	Multiple Samples	Multiple Samples
ethylnaphthalene	<0.04	3.4	Multiple Samples	Multiple Samples	Multiple Samples
ene	<0.01	0.75	Multiple Samples	Multiple Samples	Multiple Samples
rene	<0.02	7.8	Multiple Samples	Multiple Samples	Multiple Samples
	<0.02	78	Multiple Samples	Multiple Samples	Multiple Samples
	<1	7.5	Multiple Samples	Multiple Samples	Multiple Samples
	1.1	18	BH-2 SS2	MW2	0.76 - 1.52
	30	390	BH-1 SS2	MW1	0.76 - 1.52
	<0.5	5	Multiple Samples	Multiple Samples	Multiple Samples
otal)	<5	120	Multiple Samples	Multiple Samples	Multiple Samples
ot Water Soluble)	0	1.5	2, BH-2 SS2, BH-3 SS2, E	MW1, MW2, MW3, MW4	, 0.76 - 1.52, 0.76 - 1
n	<0.5	1.2	Multiple Samples	Multiple Samples	Multiple Samples
m (Total)	14	160	BH-2 SS2	MW2	0.76 - 1.52
m (Hexavalent)	0	10	2, BH-2 SS2, BH-3 SS2, E	MW1, MW2, MW3, MW4	, 0.76 - 1.52, 0.76 - 1
	3.6	22	BH-1 SS2	MW1	0.76 - 1.52
	6.1	180	BH-2 SS2	MW2	0.76 - 1.52
	1.8	120	BH-2 SS2	MW2	0.76 - 1.52
	0	1.8	2, BH-2 SS2, BH-3 SS2, E	MW1, MW2, MW3, MW4	, 0.76 - 1.52, 0.76 - 1
num	<1	6.9	Multiple Samples	Multiple Samples	Multiple Samples
	9.1	130	BH-1 SS2	MW1	0.76 - 1.52
	<1	2.4	Multiple Samples	Multiple Samples	Multiple Samples
	<0.3	25	Multiple Samples	Multiple Samples	Multiple Samples
	<1	1	Multiple Samples	Multiple Samples	Multiple Samples
	<1	23	Multiple Samples	Multiple Samples	Multiple Samples
n	16.9	86	BH-2 SS2	MW2	0.76 - 1.52

Organic Compounds					
	<5	130000	Multiple Samples	Multiple Samples	Multiple Sam
	<0.5	430	Multiple Samples	Multiple Samples	Multiple Sam
chloromethane	<0.5	85000	Multiple Samples	Multiple Samples	Multiple Sam
rm	<0.5	770	Multiple Samples	Multiple Samples	Multiple Sam
ethane	<0.5	56	Multiple Samples	Multiple Samples	Multiple Sam
Tetrachloride	<0.2	8.4	Multiple Samples	Multiple Samples	Multiple Sam
enzene	<0.5	630	Multiple Samples	Multiple Samples	Multiple Sam
rm	<0.5	22	Multiple Samples	Multiple Samples	Multiple Sam
chloromethane	<0.5	82000	Multiple Samples	Multiple Samples	Multiple Sam
orobenzene	<0.5	9600	Multiple Samples	Multiple Samples	Multiple Sam
orobenzene	<0.5	9600	Multiple Samples	Multiple Samples	Multiple Sam
orobenzene	<0.5	67	Multiple Samples	Multiple Samples	Multiple Sam
difluoromethane	<1	4400	Multiple Samples	Multiple Samples	Multiple Sam
oroethane	<0.5	3100	Multiple Samples	Multiple Samples	Multiple Sam
oroethane	<0.5	12	Multiple Samples	Multiple Samples	Multiple Sam
oroethylene	<0.5	17	Multiple Samples	Multiple Samples	Multiple Sam
Dichloroethylene	<0.5	17	Multiple Samples	Multiple Samples	Multiple Sam
-Dichloroethylene	<0.5	17	Multiple Samples	Multiple Samples	Multiple Sam
oropropane	<0.5	140	Multiple Samples	Multiple Samples	Multiple Sam
oropropene (Total)	<0.5	45	Multiple Samples	Multiple Samples	Multiple Sam
zene	<0.5	2300	Multiple Samples	Multiple Samples	Multiple Sam
Dibromide	<0.2	0.83	Multiple Samples	Multiple Samples	Multiple Sam
	<1	520	Multiple Samples	Multiple Samples	Multiple Sam
thyl Ketone	<5	1500000	Multiple Samples	Multiple Samples	Multiple Sam
obutyl Ketone	<5	580000	Multiple Samples	Multiple Samples	Multiple Sam
Butyl Ether (MTBE)	125	1400	MW102	MW102	3.1-6.1
ne Chloride	<5	5500	Multiple Samples	Multiple Samples	Multiple Sam
	<0.5	9100	Multiple Samples	Multiple Samples	Multiple Sam
Tetrachloroethane	<0.5	28	Multiple Samples	Multiple Samples	Multiple Sam
Tetrachloroethane	<0.5	15	Multiple Samples	Multiple Samples	Multiple Sam
roethylene	<0.5	17	Multiple Samples	Multiple Samples	Multiple Sam
	<0.5	18000	Multiple Samples	Multiple Samples	Multiple Sam
chloroethane	<0.5	6700	Multiple Samples	Multiple Samples	Multiple Sam
chloroethane	<0.5	30	Multiple Samples	Multiple Samples	Multiple Sam
ethylene	<0.5	17	Multiple Samples	Multiple Samples	Multiple Sam
fluoromethane	<1	2500	Multiple Samples	Multiple Samples	Multiple Sam
oride	<0.5	1.7	Multiple Samples	Multiple Samples	Multiple Sam
(Total)	<0.5	4200	Multiple Samples	Multiple Samples	Multiple Sam
lic Aromatic Hydrocarbons					
thene	<0.05	1700	Multiple Samples	Multiple Samples	Multiple Sam
thylene	<0.05	1.8	Multiple Samples	Multiple Samples	Multiple Sam
ene	<0.01	2.4	Multiple Samples	Multiple Samples	Multiple Sam
)anthracene	<0.01	4.7	Multiple Samples	Multiple Samples	Multiple Sam
)pyrene	<0.01	0.81	Multiple Samples	Multiple Samples	Multiple Sam
)fluoranthene	<0.05	0.75	Multiple Samples	Multiple Samples	Multiple Sam
hi)perylene	<0.05	0.2	Multiple Samples	Multiple Samples	Multiple Sam
)fluoranthene	<0.05	0.4	Multiple Samples	Multiple Samples	Multiple Sam
e	<0.05	1	Multiple Samples	Multiple Samples	Multiple Sam
(a,h)anthracene	<0.05	0.52	Multiple Samples	Multiple Samples	Multiple Sam
hene	<0.01	130	Multiple Samples	Multiple Samples	Multiple Sam
	<0.05	400	Multiple Samples	Multiple Samples	Multiple Sam
,2,3-cd)pyrene	<0.05	0.2	Multiple Samples	Multiple Samples	Multiple Sam
aphthalene 2-(1-)	<0.1	1800	Multiple Samples	Multiple Samples	Multiple Sam
lene	0.06	6400	MW1	MW1	3.1-6.1
hrene	<0.05	580	Multiple Samples	Multiple Samples	Multiple Sam
	0.02	68	MW1	MW1	3.1-6.1

Units	All units in micrograms per litre, unless otherwise noted
mbgs	metres below ground surface

10.0 APPENDICES

APPENDIX A

Sampling and Analysis Plan

DRAFT

Sampling and Analysis Plan for Phase Two Environmental Site Assessment

1887 St. Joseph Boulevard
Ottawa, Ontario

Prepared for:

Sobeys Inc.
1-535 Portland Street
Dartmouth, NS B2Y 4B1

April 14, 2023

Pinchin File: 324269.002

Issued To:	**Sobeys Inc.**
Issued On:	
Pinchin File:	**April 14, 2023**
Issuing Office:	**324269.002**
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TABLES

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 1887 St. Joseph Boulevard in Ottawa, Ontario (hereafter referred to as the Site or Phase Two Property). The Phase Two Property is presently developed with developed with a single-storey multi-tenant commercial building (Site Building). 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 Sobeys Inc. (Client) as a condition for a potential future rezoning application with the City of Ottawa. 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 214/21 on March 19, 2021 (O. Reg. 153/04) even though the Client does not intend to submit a Record of Site Condition (RSC) to Ontario Ministry of the Environment, Conservation and Parks (MECP) given that there is no regulatory requirement to file one at this time.

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, 187 St. Joseph Boulevard, Ottawa, Ontario"*, prepared for the Client, dated April 20, 2023.

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, 1887 St. Joseph Boulevard, Ottawa, Ontario",* prepared for the Client. The APECs and corresponding PCAs and COPCs are summarized in Table 1 (all Tables are located in Appendix II) and shown on Figure 3.

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 up to seven boreholes, all of which will be completed as groundwater monitoring wells. The proposed borehole and groundwater monitoring well locations are provided on Figure 2.

Table 2 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 3 to 4 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 two surface soil samples (0 to 1.5 mbgs) and up to two subsurface soil samples (deeper than 1.5 mbgs) for pH analysis.
- Submission of up to four soil samples for grain size analysis.
- Elevation surveying of the ground surface elevations of all monitoring well locations, and the top of pipe elevations for all groundwater monitoring wells.
- Depth to water measurements of all newly-installed groundwater 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 MECP'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.
- 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. 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 retained in Pinchin's project file.

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 retained in Pinchin's project file.

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).
- Vertical elevation surveying (SOP-EDR026).

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 in the vicinity of the former gasoline underground storage tanks and pump island (APEC-1).
- Boreholes will be completed across the parking lot area to assess the shallow fill material underlying the asphalt paved areas (APEC-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 2.

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.

9.0 TERMS AND 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 Sobey Inc. (Client) in order to investigate potential environmental impacts at 1887 St. Joseph Boulevard in Ottawa, 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 terms, conditions and limitations contained within the duly authorized proposal for this project. Any use which a third party makes of this SAP, or any reliance on or decisions to be made based on it, is the sole responsibility of such third parties. Pinchin accepts no responsibility for damages suffered by any third party as a result of decisions made or actions conducted.

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 provide results or information to any party unless disclosure by Pinchin is required by law.

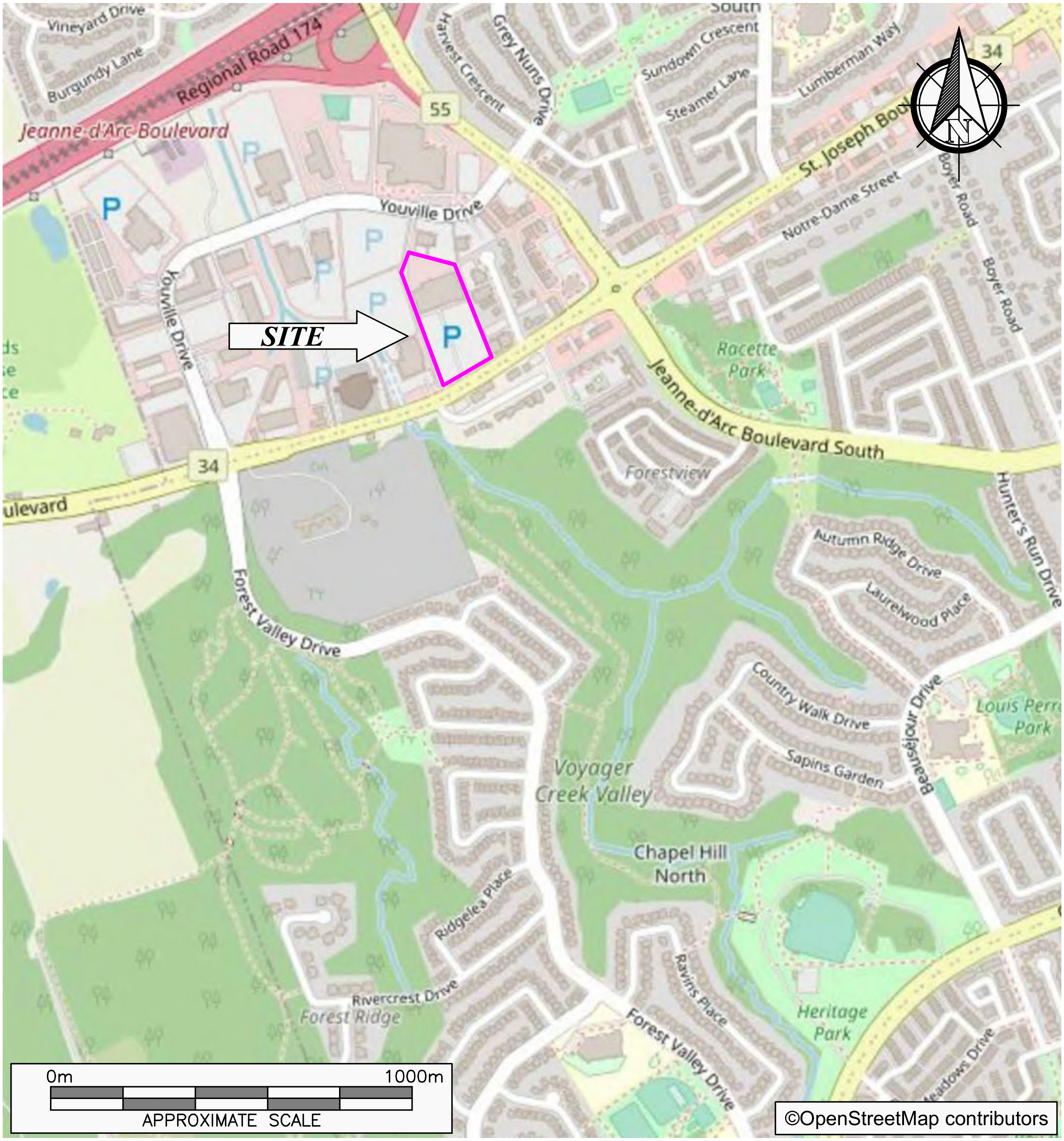
Pinchin makes no other representations whatsoever, including those concerning the legal significance of its findings, or as to other legal matters touched on in this SAP, including, but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect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

\\PIN-OTT-FS01\job\324000s\0324269.000 Sobeys,1887StJosephBlvd,EDR,SAONE\0324269.002 Sobeys,1887StJosephBlvd,EDR,PhaseTwo\Deliverables\SAP\RSC Phase Two ESA Sampling and Analysis Plan.docx

Template: RSC Sampling and Analysis Plan, EDR, January 17, 2020

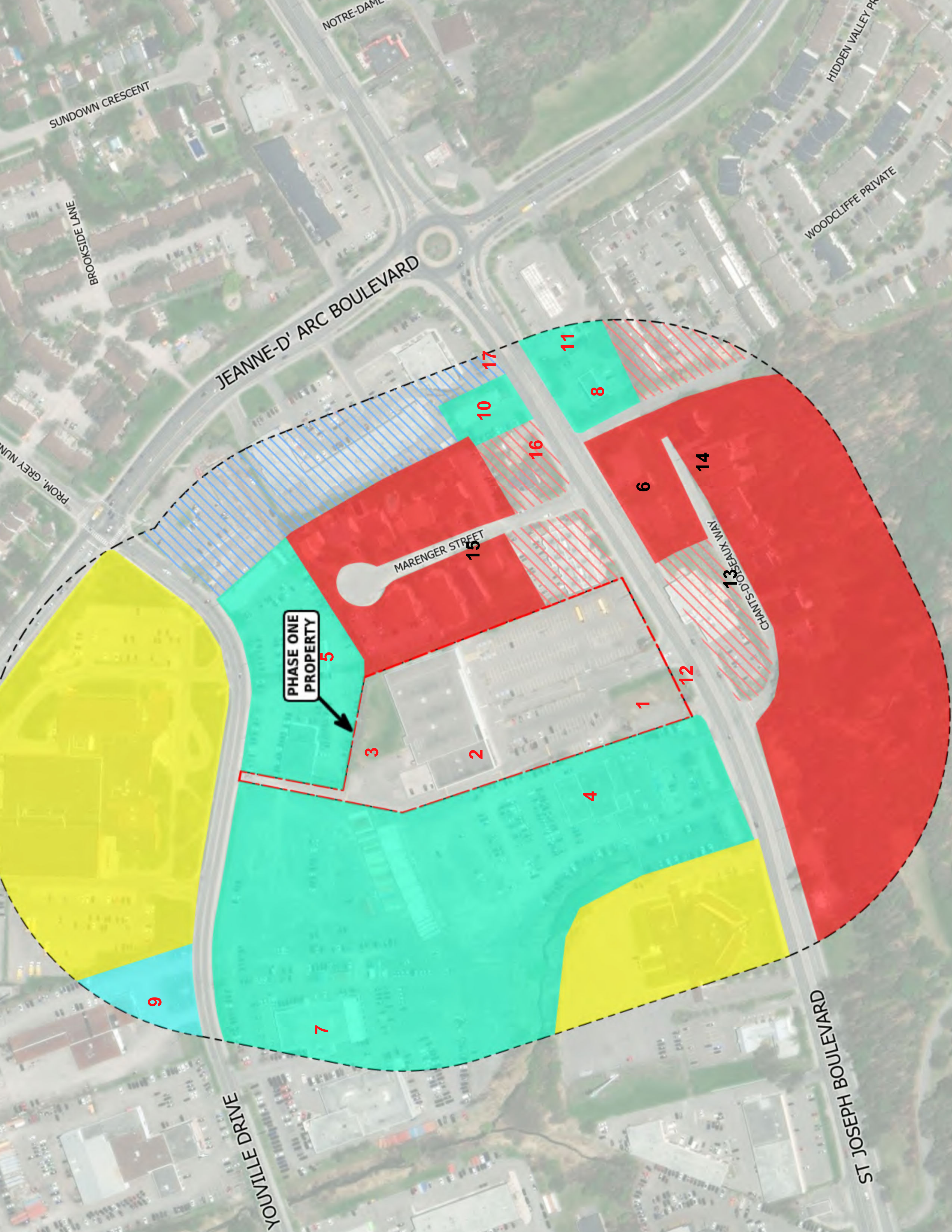
APPENDIX I

Figures



PINCHIN

PROJECT NAME SAMPLING AND ANALYSIS PLAN		
CLIENT NAME SOBEYS INC.		
PROJECT LOCATION 1887 ST JOSEPH BOULEVARD, OTTAWA, ONTARIO		
FIGURE NAME KEY MAP		FIGURE NO. 1
APPROXIMATE SCALE AS SHOWN	PROJECT NO. 324269.002	DATE APRIL 2023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HIDDEN VALLEY PR
WOODCLIFFE PRIVATE
BROOKSIDE LANE
JEANNE-D' ARC BOULEVARD
PROM. GREY NUN
MARENGER STREET
CHANTS-D'OISEAUX WAY
PHASE ONE PROPERTY
YOUVILLE DRIVE
ST JOSEPH BOULEVARD
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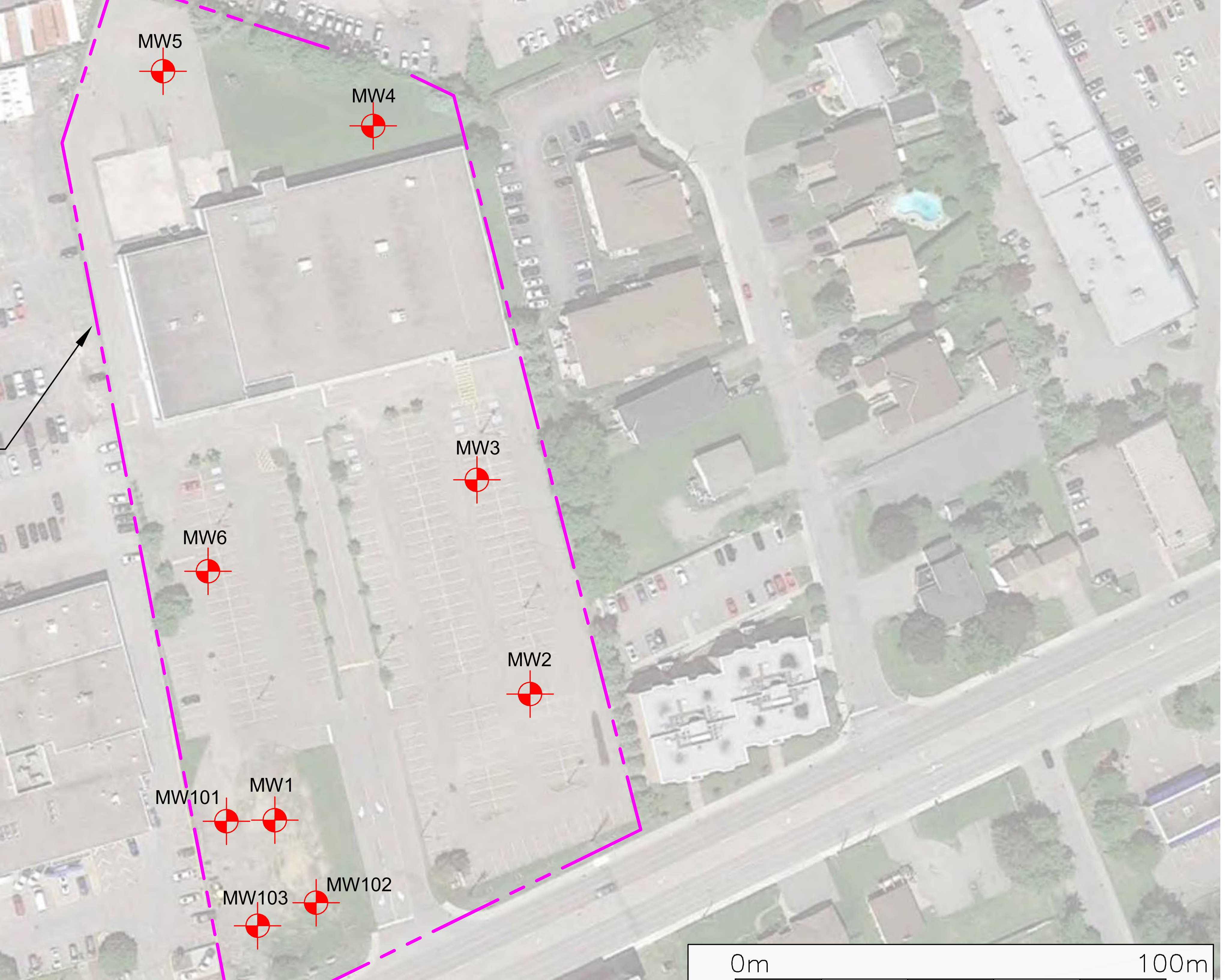

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APPENDIX II

Tables

Table 1 - Phase Two Scope of Work Summary

Sampling Location	APEC	Media Sampled	COPCs																			Number of Samples Submitted for Analysis	Soil Sampling Depth Interval (mbgs)	Screen Interval (mbgs)	Sampling Frequency	Sampling System	Rationale/Notes
			PHCs	BTEX	VOCs	PAHs	PCBs	Metals	Hydrides (As, Sb, Se)	Boron (HWS)	Chromium VI	Mercury	Methyl Mercury	ABNs	Dioxins/Furans	OCPs	Sodium	Chloride	Cyanide	EC	SAR						
MW101	1	Soil	●	●	●	●		●	●													1	0 - 6.1	NA	Continous/Soil cores every 0.75 m	Judgemental	Assess soil and groundwater quality in relation to a former on-Site RFO (PCA-1)
		Groundwater	●	●	●	●																1	NA	3.1 - 6.1	NA	Judgemental	
MW102	1	Soil	●	●	●	●		●	●													1	0 - 6.1	NA	Continous/Soil cores every 0.75 m	Judgemental	
		Groundwater	●	●	●	●																1	NA	3.1 - 6.1	NA	Judgemental	
MW103	1	Soil	●	●	●	●		●	●													1	0 - 6.1	NA	Continous/Soil cores every 0.75 m	Judgemental	
		Groundwater	●	●	●	●																1	NA	3.1 - 6.1	NA	Judgemental	
MW1	1	Soil	●	●	●	●		●	●													1	0 - 6.1	NA	Continous/Soil cores every 0.75 m	Judgemental	
		Groundwater	●	●	●	●																1	NA	3.1 - 6.1	NA	Judgemental	
BH2	2	Soil				●		●	●	●	●	●								●	●	1	0 - 3.0	NA	Continous/Soil cores every 0.75 m	Judgemental	Assess the soil quality of fill material of unknown origin underlying the parking lot areas at the Phase Two Property (PCA-2)
BH3	2	Soil				●		●	●	●	●	●								●	●	1	0 - 3.0	NA	Continous/Soil cores every 0.75 m	Judgemental	
BH4	2	Soil				●		●	●	●	●	●								●	●	1	0 - 3.0	NA	Continous/Soil cores every 0.75 m	Judgemental	

PHCs	Petroleum Hydrocarbons (Fraction 1 to Fraction 4)
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
VOCs	Volatile Organic Compounds
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
As, Sb, Se	Arsenic, Antimony, Selenium
Boron (HWS)	Hot Water Soluble Boron
Chromium VI	Hexavalent Chromium
ABNs	Acid/Base/Neutral Compounds
OCPs	Organochlorine Pesticides
EC	Electrical Conductivity
SAR	Sodium Adsorption Ratio

APEC	Area of Potential Environmental Concern
COPCs	Contaminants of Potential Concern
m	Metres
mbgs	Metres Below Ground Surface
NA	Not Applicable
PCA	Potentially Contaminating Activity
SOP	Standard Operating Procedure

APPENDIX III

Pinchin Standard Operating Procedures

SOP – EDR006 – REV005 – BOREHOLE DRILLING

Title:	Borehole Drilling
Practice:	EDR
First Effective Date:	November 25, 2010
Version:	004
Version Date:	November 19, 2020
Author:	Francesco Gagliardi and Robert MacKenzie
Authorized by:	Terry Duffy

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	RM
002	April 29, 2016	Updated Section 4.0	RM
003	April 28, 2017	Removed reference to Pinchin West	RM
004	January 30, 2020	Annual Review	TJD
005	November 19, 2020	Formatting updates	RM

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 hydrogeological 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

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 Environmental Due Diligence and Remediation (EDR) Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at Le Groupe Gesfor Poirier 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.

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 competent 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 the 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., 17-MW101 or MW101-17).

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 used 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 kilogram) 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 (e.g., BC, Manitoba) 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

The following describes the methods for logging and collection of samples from a split-spoon or direct-push sampler but can be adapted for sample collection from augers:

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 dual-tube or macro-core sampler with direct-push drilling, 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 (0.75 metres), 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;

   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;

7. 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;
8. Collect soil samples for the remaining parameters to be analyzed;
9. Soil samples are to be labelled and handled in accordance with SOP-EDR013;
10. 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;
11. Determine the soil texture in accordance with SOP-EDR019 and record this information in the field notes;
12. 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;
13. Immediately following collection, place each sample container in a cooler containing ice bags or ice packs; and
14. 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.

5.11 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.

5.12 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.

5.13 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.

5.14 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.

5.15 Health and Safety

All work activities under this SOP will be completed in a safe manner following the requirements of Pinchin's Occupational Health and Safety Program, client site requirements and current legislation.

Pinchin Employees conducting work under this SOP must meet the job competency requirements as outlined in Section 2.3 Job Competency of the Pinchin Health and Safety Program.

Where technical occupational health and safety assistance is required in evaluating hazards and determining controls, a Qualified Person should be engaged following Pinchin Health and Safety Program Section 3.2 Project Hazard Assessments.

If, while working on a site and following this SOP, there is an incident resulting in loss (personal injury, property damage) or a near miss (potential loss), fill in and submit the appropriate incident form (3.3.1.) or near miss form (3.3.2).

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

Canadian Standards Association, *Phase II Environmental Site Assessment, CSA Standard Z769-00 (R2018)*, dated 2000 and reaffirmed in 2018.

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 – EDR007 – REV006 – MONITORING WELL DESIGN AND CONSTRUCTION

Title:	Monitoring Well Design and Construction
Practice:	EDR
First Effective Date:	August 03, 2009
Version:	006
Version Date:	November 19, 2020
Author:	Robert MacKenzie
Authorized by:	Terry Duffy

TABLE OF CONTENTS

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
004	April 28, 2017	Remove reference to Pinchin West/Added note to Section 5.2 about placing a reference mark at the top of the well pipe/Added note to Section 5.3 that O.Reg.153/04 requires well screens to intersect the water table when assessing groundwater for petroleum hydrocarbon impacts during a Phase Two ESA	RLM
005	January 30, 2020	Yearly Review	TJD
006	November 19, 2020	Formatting updates	RM

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

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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 (3.8 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. 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; and
- 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 after the borehole has been advanced to the appropriate depth:

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;

   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;
2. 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;

3. 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;
4. 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;
5. 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;
6. 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;
7. 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;
8. (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;

9. (Ontario only) 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;
10. Place a protective well casing (monument or flush-mount) around the well casing and cement it in place;
11. Using a permanent marker, mark a point on the top of the well casing that will serve as a reference point for all future depth to water and elevation survey measurements. 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;
12. 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;
13. 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; and
14. 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

Ontario Regulation 153/04 mandates that well screens must not exceed 3.1 metres in length. In addition, whenever the Phase Two ESA includes the assessment of petroleum hydrocarbon impacts in groundwater, the well screen in each well must intersect the water table.

5.4 Health and Safety

All work activities under this SOP will be completed in a safe manner following the requirements of Pinchin's Occupational Health and Safety Program, client site requirements and current legislation.

Pinchin Employees conducting work under this SOP must meet the job competency requirements as outlined in Section 2.3 Job Competency of the Pinchin Health and Safety Program.

Where technical occupational health and safety assistance is required in evaluating hazards and determining controls, a Qualified Person should be engaged following Pinchin Health and Safety Program Section 3.2 Project Hazard Assessments.

If, while working on a site and following this SOP, there is an incident resulting in loss (personal injury, property damage) or a near miss (potential loss), fill in and submit the appropriate incident form (3.3.1.) or near miss form (3.3.2).

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 – REV005 – MONITORING WELL SAMPLING

Title:	Monitoring Well Sampling
Practice:	EDR
First Effective Date:	November 8, 2013
Version:	005
Version Date:	January 3, 2018
Author:	Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	

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1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	November 08, 2013	N/A	RM
001	September 25, 2015	Incorporated procedures specific to Pinchin West into SOP	RM
002	February 9, 2016	Revised overall procedure to be consistent with well development SOP/Added reference to revised well development field forms	RM
003	April 29, 2016	Updated Section 4.0	RM
004	April 28, 2017	Removed reference to Pinchin West	RM
005	January 3, 2018	Changed “submersible” to “centrifugal” throughout	RM

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 Environmental Due Diligence and Remediation (EDR) Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at 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);
- Centrifugal 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 procedure 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 procedure for purging a high yield monitoring well is as follows:

1. Decontaminate all non-dedicated monitoring and sampling equipment that will be used, including the interface probe and centrifugal 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, well stick up, 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 top of the free-phase product and the depth to the free-phase product/water boundary (i.e., water level), 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) = $h_w \times \pi r_w^2 \times 1{,}000$ litres per cubic metre (L/m^3)

   Where $\pi = 3.14$

   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 pipe 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 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.);
6. 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;
7. 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;
8. 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

9. 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 procedure for purging a low yield monitoring well is as follows:

1. Decontaminate all non-dedicated monitoring and sampling equipment that will be used, including the interface probe and centrifugal 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, well stick up, 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 top of the free-phase product and the depth to the free-phase product/water boundary (i.e., water level), 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 volatile organic compounds (VOCs) and petroleum hydrocarbons (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 low yield 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.

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 polycyclic aromatic hydrocarbons (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, centrifugal 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 must not 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 centrifugal 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

Jurisdiction	Pump Type	Parameters	Well 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	Centrifugal 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, centrifugal pump or bladder pump and sampling at a low pumping rate is “low flow sampling”. Sampling in this manner is essentially “grab sampling” using a device other than an inertial pump and is not “low flow sampling”. Only if groundwater sampling was completed in accordance with SOP-EDR023 can the sampling be referred to as “low flow sampling”.

5.4.2 Sampling of High and Low Yield Wells

The procedure for collecting groundwater samples from a high or low yield monitoring well is 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, centrifugal 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 light non-aqueous phase liquids (LNAPLs) are being investigated (e.g., gasoline, fuel oil) and at the bottom of the well when dense non-aqueous phase liquids (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), centrifugal 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 when well yields permit 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.

I:\2018 SOP Updates\SOP - EDR008 - REV005 - Monitoring Well Sampling.docx

Template: Master SOP Template – February 2014

SOP – EDR013 – REV004 – SAMPLE HANDLING DOCUMENTATION

Title:	Sample Handling Documentation
Practice:	EDR
First Effective Date:	August 03, 2009
Version:	004
Version Date:	January 3, 2018
Author:	Mark McCormack and Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	

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
004	April 28, 2017	Removed reference to Pinchin West	RLM
004	January 3, 2018	Reviewed and confirmed current	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

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 Environmental Due Diligence and Remediation (EDR) Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at Le Groupe Gesfor Poirier and Pinchin LeBlanc for distribution as appropriate.

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 the Ontario Ministry of the Environment Climate Change (MOECC, formerly the Ontario Ministry of the Environment) 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, 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 a pen 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;
- 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 duplicate 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 must 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 duplicate 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 Ontario Regulation. 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 Quality Assurance/Quality Control section of the Phase Two Environmental Site Assessment report.

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

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

I:\2018 SOP Updates\SOP - EDR013 - REV004 - Sample Handling Documentation.docx

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 – REV003 – FIELD MEASUREMENT OF WATER QUALITY PARAMETERS

Title:	Field Measurement of Water Quality Parameters
Practice:	EDR
First Effective Date:	November 24, 2010
Version:	003
Version Date:	January 3, 2018
Author:	Paresh Patel
Authorized by:	Robert MacKenzie
Signature:	

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
003	April 28, 2017	Removed reference to Pinchin West	RLM
003	January 3, 2018	Reviewed and confirmed current	RLM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes 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 Environmental Due Diligence and Remediation (EDR) Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at 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 (^{o}C)
Conductivity:	± 1 microSiemens per centimetre (µS/cm)
pH:	±0.1 pH unit
Dissolved Oxygen:	±0.2 milligrams per litre (mg/L) up to20 mg/L
	± 0.6 mg/L greater than 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 must 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 must be calibrated prior to further use:

pH	±0.1 pH units
Specific Conductance	±3%
Temperature	±3%

DO	±10%
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 Ontario Regulation 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 or how 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. These measurements can be made by filling a clean bucket or beaker with purge water and immersing the probes in the purge water.

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

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, Chapters A1-A9,* Various dates.

9.0 APPENDICES

None.

I:\2018 SOP Updates\SOP - EDR016 - REV003 - Field Measurement of Water Quality Parameters.docx

Template: Master SOP Template – February 2014

SOP – EDR017 – REV006 – MONITORING WELL DEVELOPMENT

Title:	Monitoring Well Development
Practice:	EDR
First Effective Date:	November 23, 2010
Version:	006
Version Date:	January 3, 2018
Author:	Paresh Patel and Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	

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
005	April 28, 2017	Removed references to Pinchin West	RLM
006	January 3, 2018	Modified Section 3.0 to allow well development to occur immediately after well installation under certain circumstances.	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, unless both of the following conditions are met:

- The well seal is entirely above the water table; and
- Surface runoff (e.g., from heavy rainfall or snow melt) is not occurring at the well location at the time of development.

Any deviation from this procedure must be approved by the Project Manager before proceeding.

4.0 DISTRIBUTION

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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 developing 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 procedure for developing a low yield or high yield monitoring well is as follows:

1. Decontaminate all non-dedicated monitoring and pumping 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, well stick up, 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 top of the free-phase product and the depth to the free-phase product/water boundary (i.e., water level), 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 $\pi = 3.14$

   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)

$\pi = 3.14$

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).

<u>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</u>. 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 pipe 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 unless dry. 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 procedure for the second stage of developing a high yield monitoring well is 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 following the same procedure as above 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 procedure for the second stage of developing a low yield monitoring well is 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, and 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 the development of a low yield well. 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 when using the less than 0.5 milligrams per litre over 3 consecutive readings criterion), 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.

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 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.

SOP – EDR019 – REV004 – SOIL SAMPLE LOGGING

Title:	Soil Sample Logging
Practice:	EDR
First Effective Date:	August 03, 2013
Version:	004
Version Date:	January 3, 2018
Author:	Francesco Gagliardi and Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	

TABLE OF CONTENTS

1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	November 26, 2010	N/A	FG
001	October 31, 2013	Streamlined SOP to focus only on soil sample logging/Added O. Reg. 153/04 compliance section	RLM
002	April 29, 2016	Updated Section 4.0	RLM
003	April 28, 2017	Removed reference to Pinchin West	RLM
004	January 3, 2018	Modified percentages of minor constituents in Section 5.1.3/Clarified when geotechnical terms can be used for soil logging in Section 5.2	RLM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) presents the methods used to describe the physical characteristics of soil samples collected during site investigations.

The methods and equipment used for retrieving soil samples are provided in other SOPs (e.g., SOP-EDR007 – Borehole Drilling) and will not be repeated herein.

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 Environmental Due Diligence and Remediation (EDR) Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at Le Groupe Gesfor Poirier and Pinchin LeBlanc for distribution as appropriate.

5.0 PROCEDURE

5.1 General Procedures

For each soil sample collected during a site investigation, the following information is to be recorded in the field log book or field forms in the order presented below:

- Depth;
- Primary soil texture;
- Colour;
- Minor constituents*;
- Noticeable odours;
- Noticeable staining;
- Noticeable free-phase product/sheen*; and
- Moisture content.

*These constituents only need to be noted if they are actually present in the sample.

5.1.1 Primary Soil Texture

The primary soil texture should be determined using the attached flow chart as a guide to help classify the soil.

5.1.2 Colour

Describe the primary colour of the soil sample (e.g., brown, grey, black, green, white, yellow, red). The relative lightness or darkness of the primary colour can be described using the adjectives “light” or “dark” as appropriate. Soil that exhibits different shades or tints is to be described by using two colours (e.g., brown-grey). If the soil sample contains spots of a different colour, this is to be described as “mottling” (e.g., grey with green mottling).

5.1.3 Minor Constituents

Note the presence of minor constituents in the soil that are “natural” materials (e.g., gravel, cobbles, sand, oxidation, etc.) or “man-made” materials (e.g., asphalt, brick, concrete, coal or glass fragments, coal ash, etc.). Gravel comprises particles between 5 millimetres (mm) and 75 mm in diameter. Cobbles comprise particles greater than 75 mm in diameter (approximately the size of a man’s fist) and boulders are particles greater than 150 mm in diameter (approximately the size of man’s head).

When the percentage of the minor constituents in the soil is between approximately 1 and 10%, the adjective used to describe the relative amount of the minor constituent is “trace” (e.g., silty sand with trace brick fragments).

When the percentage of minor constituents of soil is between approximately 10 and 20%, the adjective used to describe the relative amount of the minor constituent is “some” (e.g., silty sand with some concrete fragments).

When the percentage of the “natural” minor soil constituents is between approximately 20 and 35%, the minor soil type is described by adding a ‘y’ or ‘ey’ to the soil type (e.g., silty, sandy, clayey).

When the percentage of the “natural” minor soil constituents is also greater than 35%, the minor soil type is described by using “and” the soil type (e.g., sand and gravel, sand and silt).

When the percentage of the “man-made” minor soil constituents is between approximately 30 and 50%, describe the soil as per the normal procedure and add “with” the minor constituent type(s) (e.g., silty sand with coal ash and brick fragments).

5.1.4 Noticeable Odours

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 then this information should be recorded along with a comment on the severity of the odour (e.g., slight, strong, etc.). Identification of specific chemical compounds, such as petroleum hydrocarbons (PHCs) or solvents is acceptable; however, this identification should be referenced as “xxxx-like” (e.g., PHC-like, solvent-like, etc.). This principle also applies when describing staining and free-phase product.

If the odour cannot be readily identified, it should be described in the field notes as “unidentified odour”. If no noticeable odours are observed, this needs to be recorded in the field notes as “no odour”.

5.1.5 Noticeable Staining

Describe the colour and possible source of the staining (e.g., black PHC-like staining).

If no noticeable staining is observed, this needs to be recorded in the field notes as “no staining”.

5.1.6 Noticeable Free-Phase Product/Sheen

Describe the colour, odour, possible composition and relative viscosity (if sufficient product is present to assess) of the product (e.g., dark brown, viscous, motor oil-like product). Identification of the composition of the product is acceptable but needs to be described as PHC-like, motor oil-like. Alternatively, the product can be described as “resembling” a substance (e.g., “resembling motor oil”).

The presence of any observed iridescent sheen is to be recorded in the field notes. Note that the presence of an iridescent sheen by itself in the soil does not constitute the presence of free-phase product but may be an indicator that free-phase product is present within the vicinity of the borehole.

5.1.7 Moisture Content

Describe the moisture content of the soil sample using one of the following three terms:

- Dry – no visible evidence of water and the soil is dry to the touch;
- Moist – visible evidence of water but the soil is relatively dry to the touch. Do not use the term "damp" to describe this type of soil; and
- Wet – visible evidence of water and the soil is wet to the touch. Free water is evident when sandy soil is squeezed. Do not use the term "saturated" to describe this type of soil.

5.1.8 Recording Soil Sample Descriptions in Field Notes

Recording the information in the field notes consistently in the above order will make it easier to prepare the borehole logs for the site investigation report.

Example soil sample descriptions are as follows:

- Sand, grey, trace gravel, PHC-like odours, free-phase PHC-like product, wet;
- Silty sand, brownish-grey, some gravel, trace asphalt and brick fragments, no odours or staining, moist; and
- Silty clay, brown, trace gravel, no odours or staining, moist to wet at 2.4 mbgs.

5.2 General Considerations

Where any physical properties change within a soil sample, the depth at which this transition takes place needs to be recorded. For example, for a soil sample collected from 1.8 to 2.4 metres below ground surface (mbgs), if the upper 0.3 metres has no odours but PHC-like odours are present below this depth then the field notes need to state "no odours from 1.8 to 2.1 mbgs, PHC-like odours from 2.1 to 2.4 mbgs".

Some soil samples will contain a thin seam of a different soil type, such as a sand seam within a silty clay. The depth interval of any such seam is to be recorded in the field notes, and the material comprising the seam should be described separately using the logging procedure outlined above.

Unless soil sampling is being completed as part of a combined environmental/geotechnical investigation and EDR staff logging the soil samples have the appropriate geotechnical training, avoid the use of geotechnical terms (e.g., stiff, dense, high plasticity, etc.) when logging soil samples. If any geotechnical terms are inadvertently included in the field notes by staff who have not had geotechnical training, they must not be included in the borehole logs provided in our report.

5.3 Additional Considerations for Ontario Regulation 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 ESAs with respect to field logging. Risk assessments completed in accordance with Ontario Regulation 153/04 will typically require soil samples to be submitted to a laboratory for full soil texture analysis, but this is beyond the scope of field logging.

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

American Society for Testing and Materials, *ASTM D2487-11 - Standard Practice for Classification of Soils for Engineering Purposes (United Soil Classification System)*, 2011.

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

9.0 APPENDICES

Appendix 1 Soil Texture by Feel Chart

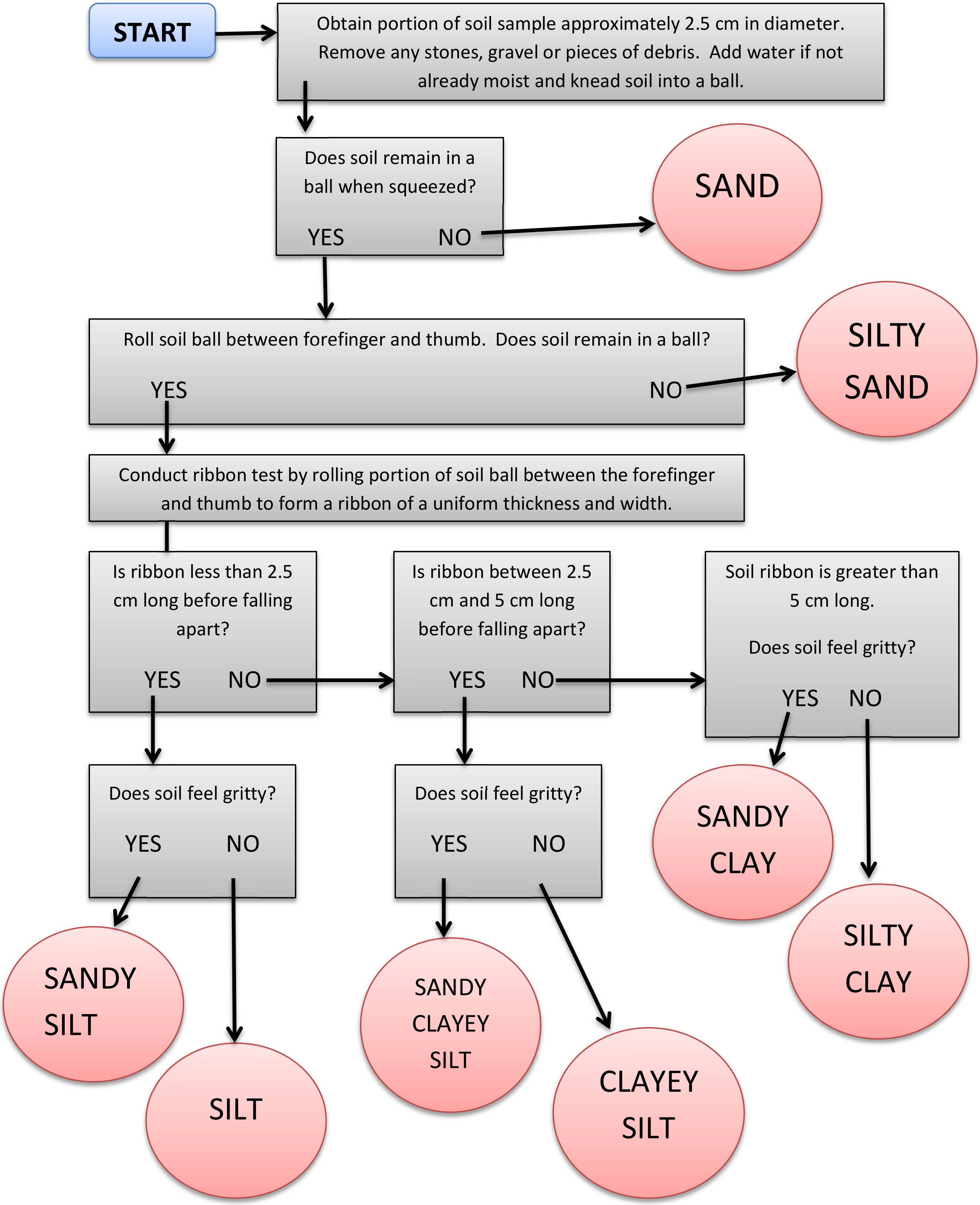
I:\2018 SOP Updates\SOP - EDR019 - REV004 - Soil Sampling Logging.docx

Template: Master SOP Template – February 2014

APPENDIX I

Soil Texture by Feel Chart

Key to Soil Texture by Feel



SOP – EDR020 – REV003 – INVESTIGATION DERIVED WASTES

Title:	Investigation Derived Wastes
Practice:	EDR
First Effective Date:	August 03, 2013
Version:	003
Version Date:	January 3, 2018
Author:	Francesco Gagliardi and Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	

TABLE OF CONTENTS

1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	November 26, 2010	N/A	FG
001	September 20, 2013	Revised text to reflect current practices/Added section on O. Reg. 153/04 compliance	RLM
002	April 29, 2016	Updated Section 4.0	RLM
003	April 28, 2017	Removed reference to Pinchin West	RLM
003	January 3, 2018	Reviewed and confirmed current	RLM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) presents the general practices for the proper containment, storage and disposal of investigation derived wastes (IDWs) generated during site investigations. IDWs generally consist of the following:

- Soil cuttings generated by borehole drilling;
- Purge waters generated by groundwater monitoring well development and sampling;
- Used soil sampling equipment (e.g., nitrile gloves, plastic bags, glass soil jars, paper towels, etc.);
- Used groundwater sampling equipment (e.g., nitrile gloves, bailers, tubing, filters, surge blocks, etc.); and
- Wash water generated by non-dedicated equipment decontamination.

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 Environmental Due Diligence and Remediation (EDR) Practice Line on the Pinchin Orchard; and

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

5.0 PROCEDURE

5.1 Prior Planning and Preparation

Prior to generating IDWs during a site investigation, field personnel will participate in a project briefing with the Project Manager as per SOP-EDR004 during which the work plan, sampling and analysis plan, health and safety plan and project to-do list will be discussed with the Project Manager. During the project briefing and within these documents, it will be made clear as to the type and anticipated amount of IDWs that will be generated, what type of storage containers will be utilized to contain the IDWs, how to determine the best place to store the IDWs and what analysis will be required to characterize the IDWs for disposal.

5.2 IDW Containment

Excess soil generated during site investigations (e.g., auger cuttings) is typically stored within 20-litre (5-gallon) steel pails with lids, 205-litre (45-gallon) steel drums with lids or soil bags. These pails, drums and bags are generally provided by our drilling subcontractor. The drilling crew will place the soil cuttings generated at each borehole within the pails, drums or bags and Pinchin field personnel will place the soil left over from soil sampling activities into the pails, drums or bags.

Note that only soil is to be placed within containers dedicated to storing excess soil. Specifically, no used gloves, soil sample jars or bags are to be placed in the containers along with the soil. Purge water generated by monitoring well development and sampling is typically contained within 20-litre (5-gallon) plastic pails, complete with lids; however, in some instances the volume of purge water generated may warrant the use of 205-litre (45-gallon) drums. The 20-litre (5-gallon) pails are available for purchase at the local hardware store (e.g., Home Hardware, Home Depot, Rona, etc.). Drums for purge water containment can be ordered in advance and brought to the site by the driller.

Wash water generated by non-dedicated equipment decontamination is to be contained in the same manner as purge water.

With the exception of soil sample jars containing methanol preservative, used soil and groundwater sampling equipment can be placed in garbage bags for disposal as regular domestic waste.

Soil sample jars containing methanol preservative that are not submitted to the laboratory for analysis are not to be disposed of on-site but are to be brought back to the Pinchin office.

Field personnel must record the number of pails and drums of IDWs generated and their contents in the field log book or field forms. This information will be used to obtain a quotation from the waste disposal contractor to remove the IDWs.

5.3 IDW Storage

Prior to the start of the site investigation, Pinchin field personnel are responsible for communicating with on-site personnel (i.e., site representative or site owner) to determine the most appropriate location to temporarily store the containers containing IDWs. Before leaving a project site, field personnel must check that the lids on the containers are firmly secured and that all containers are stored at the appropriate location.

Field personnel are required to clearly label the containers of excess soil, purge water or wash water with the following information using a permanent marker:

- The company name;
- The date of generation;
- The Project Manager’s contact number; and
- Type of IDW and instructions to not remove the container (e.g., “Soil Cuttings – Do Not Remove”). Avoid using the word “waste” when identifying the IDW type on the labels of containers left at a project site.

Note that when selecting the storage location, consider that a wheeled vehicle will likely be used to retrieve the containers from the site, so try to select a location that will allow easy access.

5.4 IDW Disposal

In order to remove excess soil from a site, a sample of the excess soil generated by the borehole drilling program may need to be collected and submitted for Toxicity Characteristic Leaching Procedure (TCLP) analysis. The TCLP analysis will likely include at a minimum analysis of inorganics, volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs) and benzo(a)pyrene; however, the specific analysis list may be dictated by site conditions, provincial regulations, and the requirements of the receiving facility. If the soil has potential volatile constituents (e.g., petroleum hydrocarbons or VOCs), the excess soil sample should also be analyzed for ignitability at the discretion of the Project Manager. The results of the TCLP analysis and ignitability are compared with the criteria contained within the applicable provincial regulations (e.g., *Ontario Regulation 347* in Ontario) to confirm whether the soil requires disposal as a non-hazardous or hazardous waste. As noted above, some waste receivers require additional TCLP parameters to be analyzed or may require bulk parameter analysis (e.g., PCBs, metals) before they will accept the soil.

The sample collected for TCLP analysis and ignitability should be a grab sample of any obvious “worst case” soil. If there is no obvious “worst case” soil, then a composite sample comprised of soil from each of the containers containing the excess soil is to be collected.

Groundwater analytical results are typically sufficient for the waste disposal contractor to remove the purge/wash water, and additional sampling and analysis of the excess water is usually not required.

Once the analytical results have been received, it is the responsibility of the Project Manager to contact an appropriate disposal contractor to arrange for pick up of the IDWs at the site. The Project Manager must ensure that the waste disposal contractor and intended waste receiver are approved and licensed by the appropriate regulatory body to transport and receive the IDWs.

To comply with *Ontario Regulation 347,* disposal of liquid wastes in Ontario requires that the site has a waste generator number and that the transport of the waste from the site to the waste receiver is documented by a waste manifest. If the site has an existing waste generator number that includes the waste class being removed, then the existing number can be used on the waste manifest. Otherwise, a waste generator number for liquid waste disposal must be obtained on-line through the Hazardous Waste Information Network (HWIN). The waste disposal contractor will usually obtain the waste generator number through HWIN, although Pinchin can obtain this on behalf of our client if needed. Other provinces have similar requirements, and it is the responsibility of the Project Manager to be aware of and follow the provincial regulations.

Note that if the results of the site investigation show no exceedances of the applicable regulatory standards for soil at all of the borehole locations, it may be permissible to spread the soil out on the site provided it is feasible and if permission is obtained from the site owner. Similarly, if no groundwater exceedances are identified in any of the groundwater monitoring wells sampled, the purged groundwater may be poured onto the ground if feasible and if permission is obtained from the site owner, provided this water does not drain to a surface water body, sewer catch basin/manhole or onto a neighbouring property. It is the responsibility of the Project Manager to be aware of any provincial regulations that may limit this type of disposal.

Garbage bags containing waste sampling equipment are to be returned to the Pinchin office for disposal within our garbage bin, unless the site has a garbage bin and permission has been provided by the site representative or site owner to do so.

5.5 Additional Considerations for Ontario Regulation 153/04 Phase Two ESA Compliance

When completing a Phase Two Environmental Assessment (ESA) in accordance with Ontario Regulation 153/04, the containment, storage and disposal of IDWs must be well documented in the field for inclusion in the Phase Two ESA report, and the report must include copies of all waste manifests for liquid waste disposal.

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

Ontario Ministry of the Environment, *Environmental Protection Act, R.R.O. 1990, Regulation 347, General - Waste Management*, 1990.

9.0 APPENDICES

None.

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Template: Master SOP Template – February 2014

SOP – EDR023 – REV006 – LOW FLOW GROUNDWATER SAMPLING

Title:	Low Flow Groundwater Sampling
Practice:	EDR
First Effective Date:	July 08, 2011
Version:	006
Version Date:	January 3, 2018
Author:	Paresh Patel and Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	

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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
005	April 28, 2017	Removed reference to Pinchin West/In Section 5.2, removed the requirement to complete a post-sampling water level and total purge volume, and added requirement to record pump intake depth at the time of sampling	RLM
006	January 3, 2018	Minor wording changes throughout	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, submersible 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 first, a stable water level is achieved, and second, 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 water level and field parameter stabilization are 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 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 pump.

Peristaltic pumps cannot be used where the suction lift (i.e., vertical distance between the pump and ground 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 Environmental Due Diligence and Remediation (EDR) Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at 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 de-gas resulting in 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, centrifugal pump or bladder pump;
- Tubing;
- Pails or drums for storing purge water;
- Paper towels or wipes;
- Calculator;
- Field forms (see Section 5.3) and/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 of each type 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 when calibrating 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. 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;
   - Turbidity; and
   - All other parameters (there is no recommended order for these parameters).

4. Review the well construction details provided in the well development forms, borehole logs or well construction summary table from a previous report. Determine the well depth, well stick up, 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;

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;

5. 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;

6. 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).

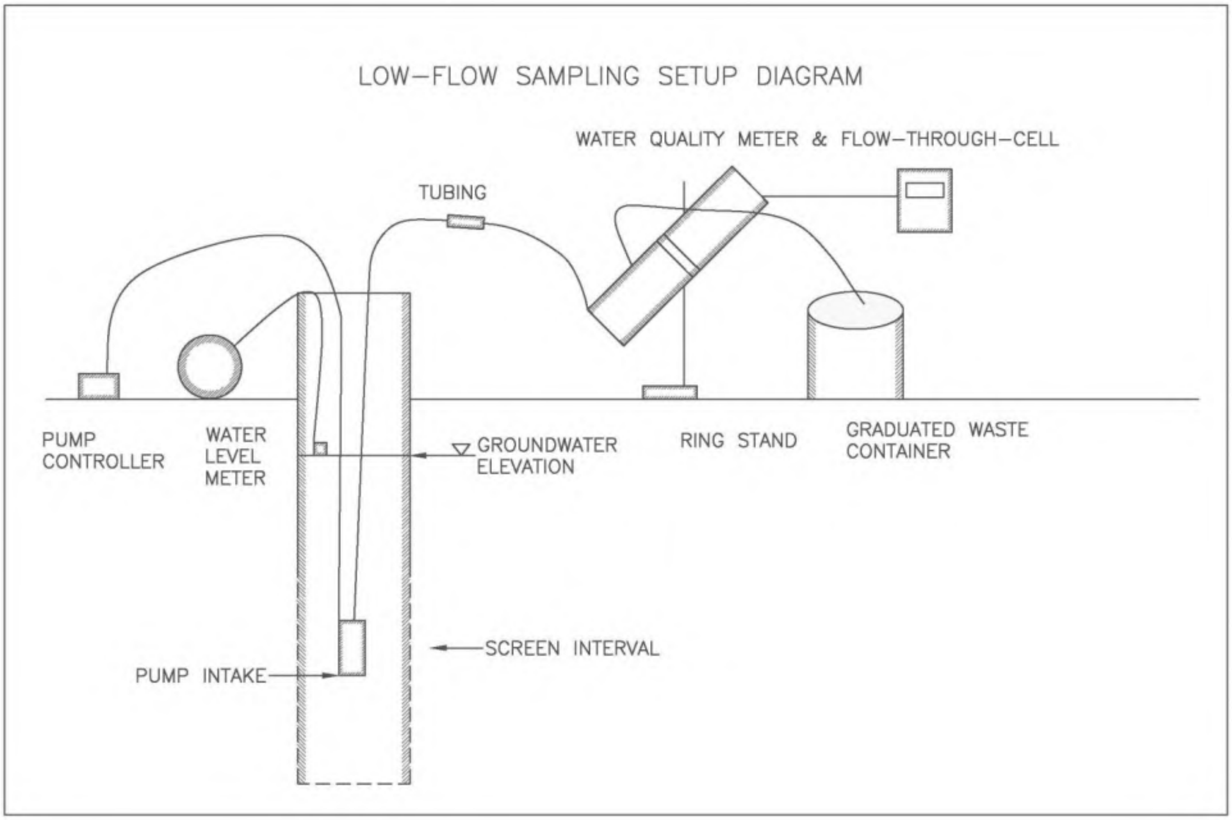
Whenever possible, purge at a pumping rate low enough to keep the total drawdown in the well to less than 10 centimetres although this may not be achievable for low to moderate yield wells. Once a steady state condition is achieved, the purge rate must be maintained constant and should not be changed. 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;

7. 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;
8. 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 with the water quality probes inserted 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 no less than 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. If the pumping rate for the same flow-through cell is 100 mL/min, although it will take only 3

minutes for the volume of water equivalent to the flow-through cell volume to pass through the cell, field parameter readings are to be taken at 5 minute intervals.

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;

9. 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 <u>all</u> of the parameters are within the following ranges for <u>three consecutive</u> 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

10. 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. Confirm the new pumping rate as per Step 7 and record it in the field notes;
11. Record the time of all water level and field parameter measurements in the field notes;
12. 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 aerated during the purging process which could result in volatile loss from the groundwater samples;

13. 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. If pumping at a moderate to high pumping (i.e., > 200 mL/min), the pumping rate should be reduced to prevent overfilling or the splashing of preservatives out of the sample containers. 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. 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.

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

14. Record the pump intake depth at the time of sample collection. 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.

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 at the frequency specified in Step 3 of Section 5.2. 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 pump should be completed whenever well yields are high enough to 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 – REV004 – QA/QC SAMPLING

Title:	QA/QC Sampling
Practice:	EDR
First Effective Date:	January 17, 2014
Version:	004
Version Date:	January 3, 2018
Author:	Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	

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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
003	April 28, 2017	Removed reference to Pinchin West	RLM
004	January 3, 2018	In Section 5.2.6, clarified order of regular investigative sample and duplicate sample collection	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, water or sediment 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 or to meet regulatory requirements.

The QA/QC sampling requirements and procedures for indoor air, soil vapour and sorbent tube samples are described in SOP-EDR012, SOP-EDR018 and SOP-EDR027, respectively.

3.0 OVERVIEW

The types of samples collected for the QA/QC program during site investigations may 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 Environmental Due Diligence and Remediation (EDR) Practice Line on the Pinchin Orchard; and
- Distributed to senior staff at 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 are 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 principles 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., adjacent to and downwind of the pump island of an active retail fuel outlet, 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 principles 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 the 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 assessed on a case-by-case basis, but the following general principles 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 are considered representative and usable for assessing the environmental quality of the site. If the regular investigative sample data are 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 to fill the sample container for a particular parameter or parameters for the regular investigative sample first and then fill the sample container for the same parameter or parameters for the duplicate sample second. For example, if groundwater was being sampled for PAHs and metals and a duplicate sample was required, the order of filling the sample containers would regular investigative sample for PAHs, duplicate sample for PAHs, regular investigative sample for metals and duplicate sample for metals.

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:

$$\text{RPD} = \frac{\text{Absolute Value (Original Concentration – Duplicate Concentration)}}{\text{(Original Concentration + Duplicate Concentration)/2}} \text{ X } 100\%$$

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 the 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 and Climate Change (formerly 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, water 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 Ontario Regulation 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 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 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.

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:\2018 SOP Updates\SOP - EDR025 - REV004 - QA QC Sampling.docx

Template: Master SOP Template – February 2014

SOP – EDR026 – REV005 – VERTICAL ELEVATION SURVEYING

Title:	Vertical Elevation Survey
Practice:	EDR
First Effective Date:	April 3, 2014
Version:	005
Version Date:	January 3, 2018
Author:	Kathryn Matheson and Robert MacKenzie
Authorized by:	Robert MacKenzie
Signature:	

TABLE OF CONTENTS

1.0 VERSION HISTORY

Version	Date	Summary of Changes	Author
Original	April 2, 2014	N/A	KM
001	April 22, 2014	Text and figure edits	KM/RM
002	January 22, 2015	Added instruction regarding need to include a least one TP in a survey	RM
003	April 29, 2016	Updated Section 4.0	RM
004	April 28, 2017	Removed reference to Pinchin West	RM
005	January 3, 2018	Minor wording changes throughout	RM

2.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) presents a description of the methods employed for the completion of vertical elevation surveys of monitoring wells.

Relative vertical elevation surveys are typically completed on sites where three or more monitoring wells have been installed in order to allow for the triangulation of groundwater flow direction. The relative vertical elevation surveys completed by Pinchin are typically not used to determine elevations relative to sea level. However, if elevations relative to sea level are needed, a local benchmark with a known geodetic elevation is required.

Two methods are available for the completion of vertical elevation surveys: completion of the survey using a manual scope and survey rod (which requires a two-person team); or completion of the survey using a laser level. The use of a laser level and associated sensor is the most common surveying method used by Pinchin and will be the focus of this SOP. With minor modifications, this SOP can also be used for “conventional” surveying using a manual scope, survey rod and two-person team.

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 Environmental Due Diligence and Remediation (EDR) Practice Line on the Pinchin Orchard; and

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

5.0 PROCEDURE

The following terms are used in the completion of a vertical elevation survey:

Temporary Benchmark (TBM): A permanent landmark either on the site, or in a nearby location, which is used as an elevation reference and can be located again if required, including during winter. For our purposes, the benchmark is assigned an arbitrary elevation of 100.00 metres (m). If a geodetic benchmark is available and will be used instead, the elevation of this benchmark relative to sea level is used in lieu of 100.00 m.

Turning Point (TP): A temporary benchmark used to provide a reference point so that the tripod and laser level can be moved to a new location.

Backsight (BS): A reading taken on a point of known or assigned elevation (This will always be the first reading to determine the Height of the Instrument (HI)).

Foresight (FS): A reading taken on a point where the elevation is unknown.

Intermediate Sight (IS): A reading taken that is not a part of the main circuit of the survey. These points are not used as TPs or benchmark readings. Monitoring well elevations are usually recorded as IS.

5.1 Equipment and Supplies

5.1.1 Documents and Information Gathering

- A copy of the Site plan with monitoring well locations;
- A copy of Pinchin's Elevation Survey Sheet obtained from the Pinchin Orchard;
- 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 Vertical Survey Equipment

- Laser level and associated sensor;
- Tri-pod;
- Survey rod;
- Interface probe and equipment cleaning materials (Optional if water level measurements are required);
- Well keys;
- Tools to open monitoring wells (T-bar, socket set, Allen keys, etc.);

- Extra batteries; and
- Field forms or field log book.

5.2 Theory

Vertical elevation surveys use a benchmark to determine the relative or actual elevation of select points (i.e., monitoring wells). For relative elevation surveys, the benchmark is given an arbitrary elevation of 100.00 m and is used to calculate the relative elevations of the monitoring wells. If a geodetic benchmark is available, the elevation of this benchmark may be used to calculate the actual elevations of the monitoring wells relative to sea level.

BS, FS and IS are measured using a laser level mounted on a tripod. The laser level shoots a beam at a survey rod which is equipped with a sensor. With the rod standing vertically on top of the point to be measured, the field technician moves the laser receiver up the rod until the receiver indicates it is in the right position. The measurement is then read off the rod and recorded on the survey sheet. This process is repeated until measurements are obtained at all required locations.

Vertical elevation surveys are typically completed on a site in the following situations:

- At least three monitoring wells have been installed on-site and determining inferred groundwater flow direction is required;
- The casing or pipe elevation of a well has changed. This could be due to repairs, damage or frost heave;
- New monitoring well(s) have been installed on the site. Note that in this situation, the new monitoring well(s) may be “tied in” to the existing survey by using the original TBM or to at least three of the previously surveyed wells as reference points. If this is not possible, then an entirely new survey must be completed that includes all new and previously installed wells; and
- The survey error exceeds the allowable error.

5.3 Vertical Elevation Survey

The following general procedures and considerations apply to all vertical elevation surveys:

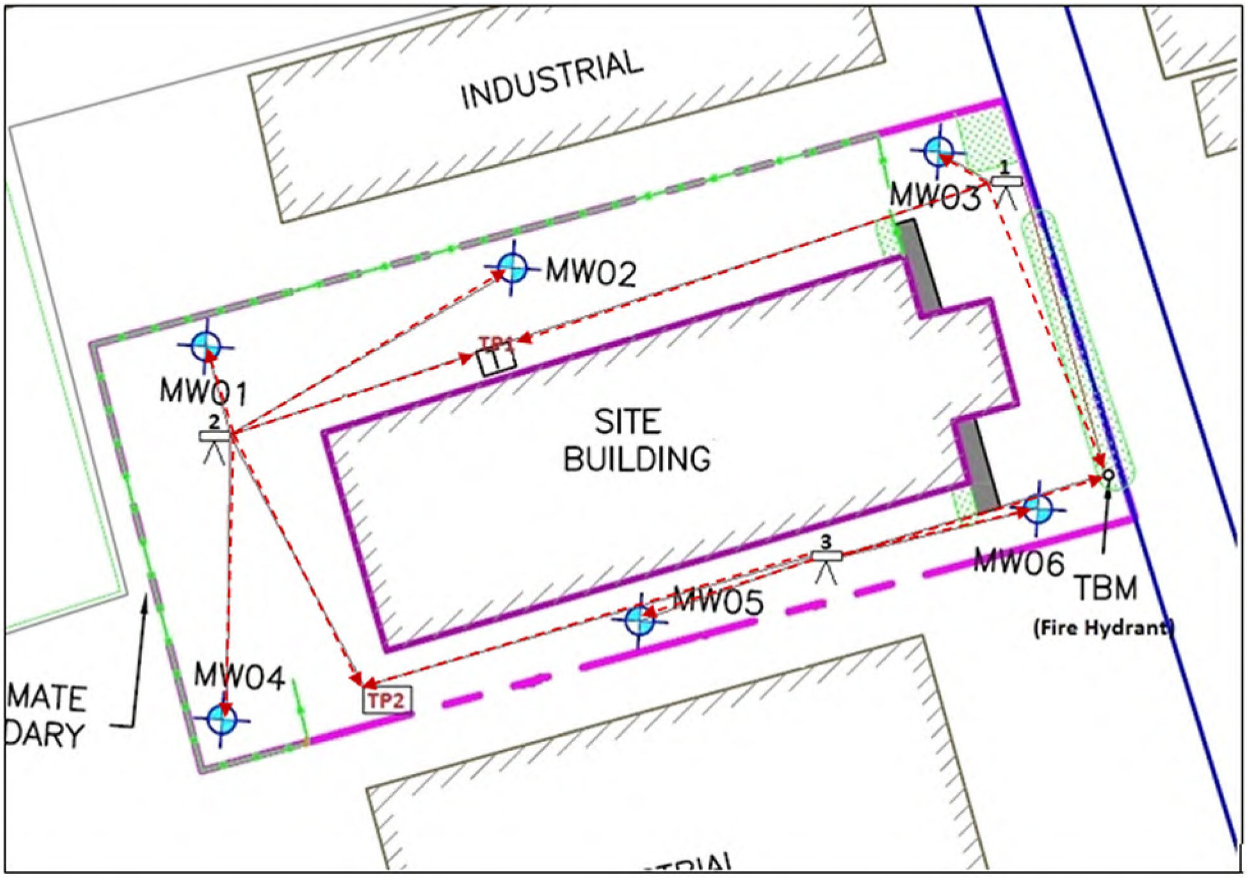
- Prior to use, turn on the laser level and receiver to ensure the batteries are fully charged; and
- Check equipment calibration (Equipment rentals should come with a calibration sheet for the survey equipment).

The following presents the general procedure for vertical elevation surveying:

1. Open all wells and, if required by the Project Manager, monitor the depth to groundwater from the top of the well casing with the interface probe. If the wells are flushmount installations located in an area with vehicle or pedestrian traffic, place a traffic cone or the original well cover over top of each well after it is opened so that the open well doesn't get run over or pedestrians do not trip over the open well.

   Select a permanent fixture to be the TBM whose elevation **should not change over time.** All elevations will be relative to this spot. Good choices for a TBM include concrete pads, gas shut offs, corners of catch basins or fire hydrants. The TBM will be assigned an arbitrary reference elevation of 100.00 m for ease of calculation. *Note: if using a fire hydrant as the TBM, do not use the bolts on the top or sides of the hydrant. If the hydrant is used in the future, the elevation of those bolts may change. Ideally, new personnel should be able to come to the site and reproduce or continue the survey using the same TBM at a later date;*

2. Using the Site Plan, plan the route for the survey. The ideal route requires as few TPs as possible as moving the tri-pod increases the chance of error in the measurements. However, at least one TP is required to create a survey loop and allow the error to be assessed unless a calibrated, self-levelling survey instrument is being used. The survey route must start by taking a BS to the TBM, followed by an IS to each of the well locations. The last shot of the survey will be a FS to the TBM location. Figure 1 below shows an example of a survey route;



3. Once the survey layout is complete, walk the survey route to ensure it is free of obstructions. Next, set up the tripod in a secure location where it is not likely to tip or be knocked over;
4. Hold the survey rod vertically on top of the TBM. Use the leveling bubble on the sensor to ensure the rod is level, and then move the sensor up the rod until it signals it is in the correct position. Record the BS of the TBM on the survey sheet;
5. Use the same method to record IS for the monitoring wells. Record an IS for both the top of casing and grade level for each monitoring well location. The top of casing elevation is to be measured with the survey rod placed at the reference point marked at the time of well installation. If no reference point is marked on the well, one should be added and used for all subsequent elevation survey and depth to groundwater measurements. All FS, BS and IS are to be recorded to the nearest 0.001 m;
6. If it is necessary to move the tri-pod, record the FS to the TP. Next, move the tripod to the new location and shoot a BS back to the TP (see Figure 2). **Make sure the location of the TP does not change between shooting the FS and the BS**;

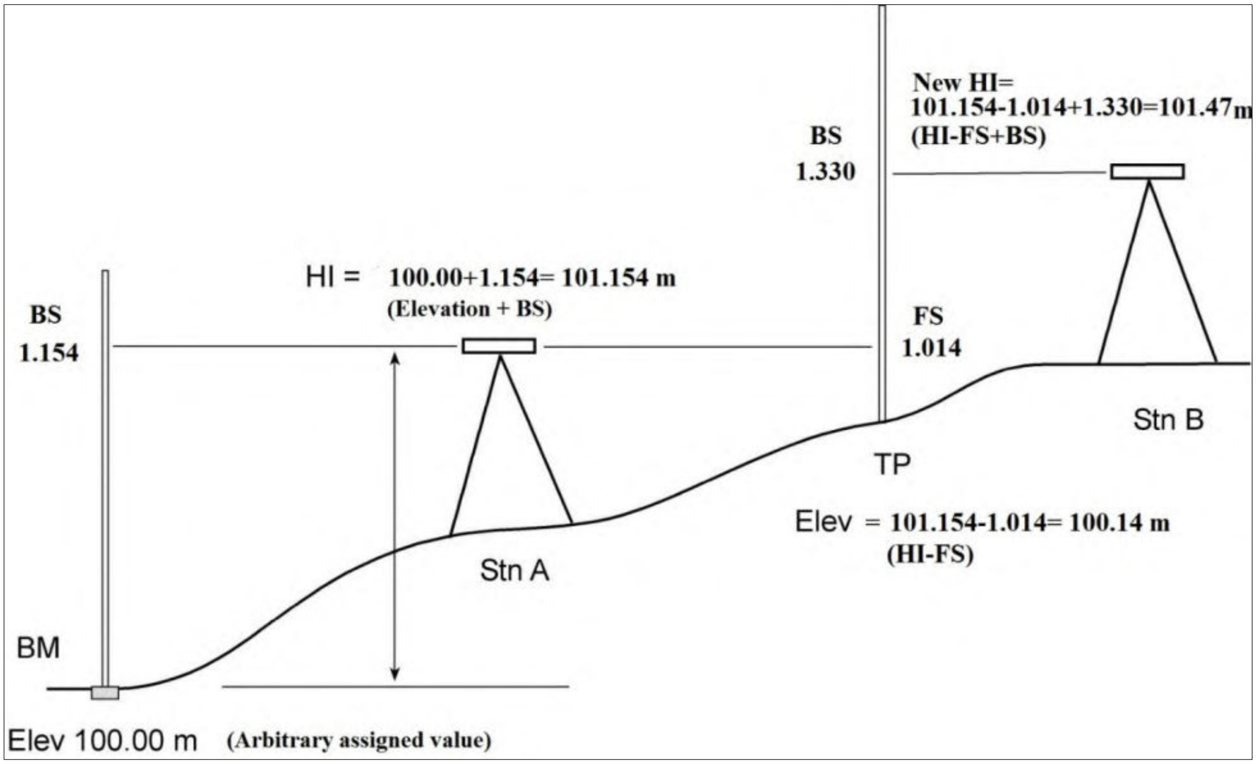


Figure 1: Survey set up from TBM with one TP.

7. Repeat steps 5 and 6 until a top of casing and grade IS have been recorded for all monitoring wells;
8. Record a final FS reading back to the TBM to close the survey; and
9. Perform a field calculation to ensure the survey error is within acceptable limits. The calculated difference between the sum of the FS and the sum of the BS values should be approximately equal. The difference between these values will be equal to the error. If the difference between these values is greater than the allowable error (see Section 5.4), the survey will have to be repeated. If the error is acceptable, the survey is complete and you may leave the site. The remaining calculations may be completed at the office.

5.4 Allowable Error

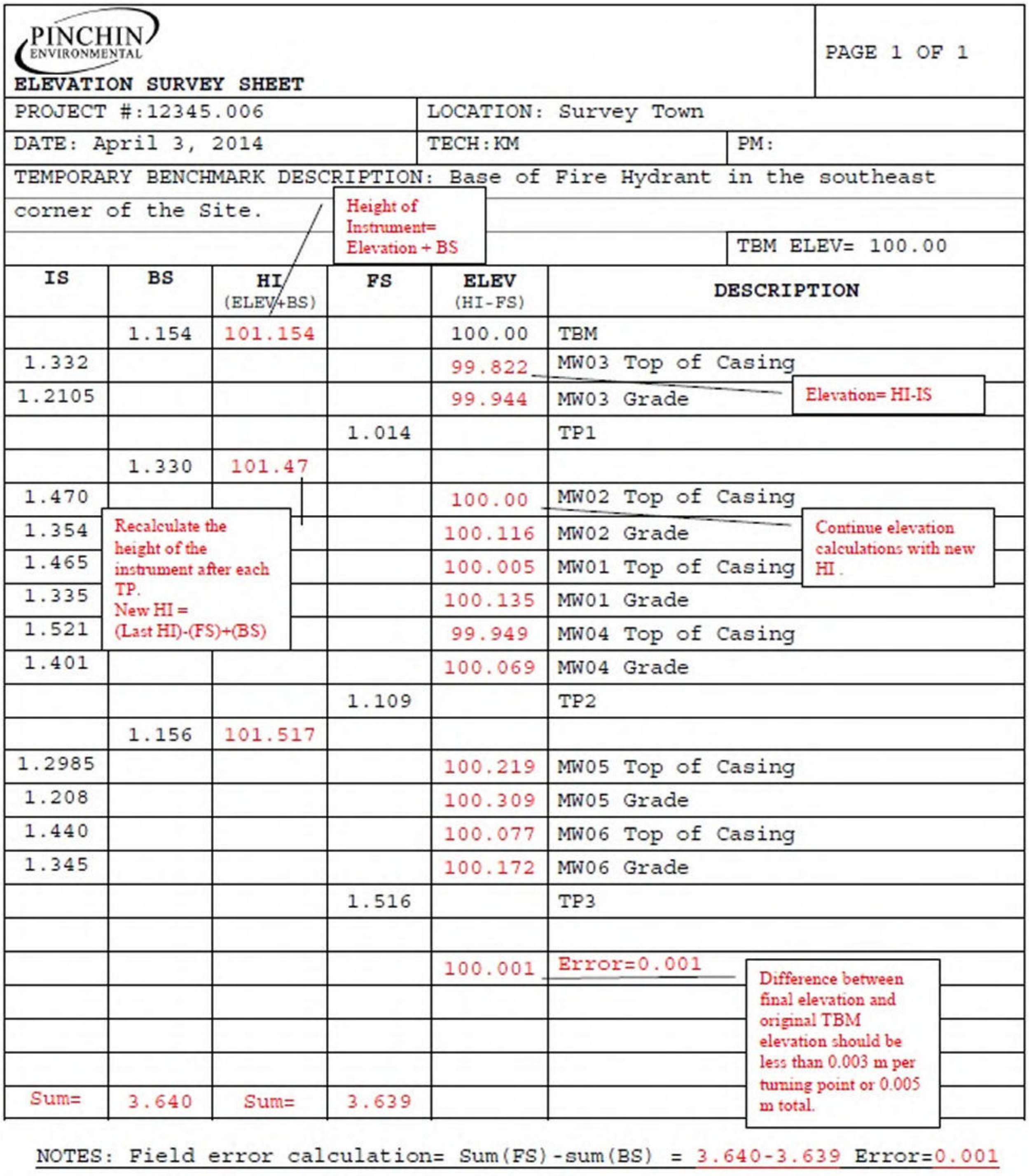
The acceptable error limit is 3 millimetres (mm) (0.003 m) per TP, with a maximum allowable error of 5 mm per survey. If the total error per survey exceeds 0.003 m per TP or 0.005 m per survey, the survey must be repeated. Common sources of error include:

- Tripod movement;
- Errors in reading the survey rod; and
- Not keeping the TP location consistent between FS and BS readings.

As noted in Section 5.3, an error check must be performed **before leaving the site** to ensure the survey error is within acceptable limits.

5.5 Calculations

Once the survey is complete, calculate the relative elevations of each surveyed point. This can be done in the field or at the office. Calculate each elevation by subtracting the IS values from the height of the instrument. A new HI will need to be calculated following each TP. The following is an example of the survey calculations for the survey layout shown in Figure 1.



PINCHIN ENVIRONMENTAL

ELEVATION SURVEY SHEET

PAGE 1 OF 1

PROJECT #:12345.006	LOCATION: Survey Town	
DATE: April 3, 2014	TECH:KM	PM:

TEMPORARY BENCHMARK DESCRIPTION: Base of Fire Hydrant in the southeast corner of the Site.

TBM ELEV= 100.00

Height of Instrument= Elevation + BS

IS	BS	HI (ELEV+BS)	FS	ELEV (HI-FS)	DESCRIPTION
	1.154	101.154		100.00	TBM
1.332				99.822	MW03 Top of Casing
1.2105				99.944	MW03 Grade
			1.014		TP1
	1.330	101.47			
1.470				100.00	MW02 Top of Casing
1.354				100.116	MW02 Grade
1.465				100.005	MW01 Top of Casing
1.335				100.135	MW01 Grade
1.521				99.949	MW04 Top of Casing
1.401				100.069	MW04 Grade
			1.109		TP2
	1.156	101.517			
1.2985				100.219	MW05 Top of Casing
1.208				100.309	MW05 Grade
1.440				100.077	MW06 Top of Casing
1.345				100.172	MW06 Grade
			1.516		TP3
				100.001	Error=0.001
Sum=	3.640	Sum=	3.639		

Elevation= HI-IS

Recalculate the height of the instrument after each TP.
New HI =
(Last HI)-(FS)+(BS)

Continue elevation calculations with new HI.

Difference between final elevation and original TBM elevation should be less than 0.003 m per turning point or 0.005 m total.

NOTES: Field error calculation= Sum(FS)-sum(BS) = 3.640-3.639 Error=0.001

5.6 Horizontal Survey

A horizontal survey should be completed on every site in conjunction with the vertical elevation survey if not already completed during the borehole drilling/well installation program. To complete a horizontal survey, measure the distance of each of the well locations relative to a nearby permanent or semi-permanent landmark (e.g., corner of the nearest building, fire hydrant, etc.) using a measuring wheel or tape. Measurements are to be made at 90 degree angles relative to the orientation of the landmark, and parallel or perpendicular to the long or short axis of the landmark or to a fixed axis (i.e., relative to true north) as appropriate. Record these measurements in a field book or on the site plan. If required by the Project Manager, measure the UTM coordinates of the well location with a hand-held GPS device.

5.7 General Considerations

When surveying a site where one or more well locations are located inside a building and inaccessible to survey, it is acceptable to survey the concrete foundation of the building in place of the well. If this method is used this must be noted on the survey sheet.

A higher error factor may be acceptable on very large sites and sites where a large number of TPs are used. These situations should be discussed with the Project Manager.

On sites with large elevation changes, the use of a scope and manual survey rod in place of the laser level may be more appropriate. This method requires a two-person team and allows the surveying of sites with large elevation changes without the use of unnecessary TPs. This method should be discussed with the Project Manager prior to use to ensure it meets project budget requirements.

5.8 Additional Considerations for Ontario Regulation 153/04 Phase Two ESA Compliance

When completing a Phase Two Environmental Assessment in accordance with Ontario Regulation 153/04, all surveying work must be undertaken by a licensed Ontario Land Surveyor and this SOP is not applicable.

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

Canadian Standards Association, *Environmental Investigation Methodology for Contaminated Sites*, 2005.

9.0 APPENDICES

None.

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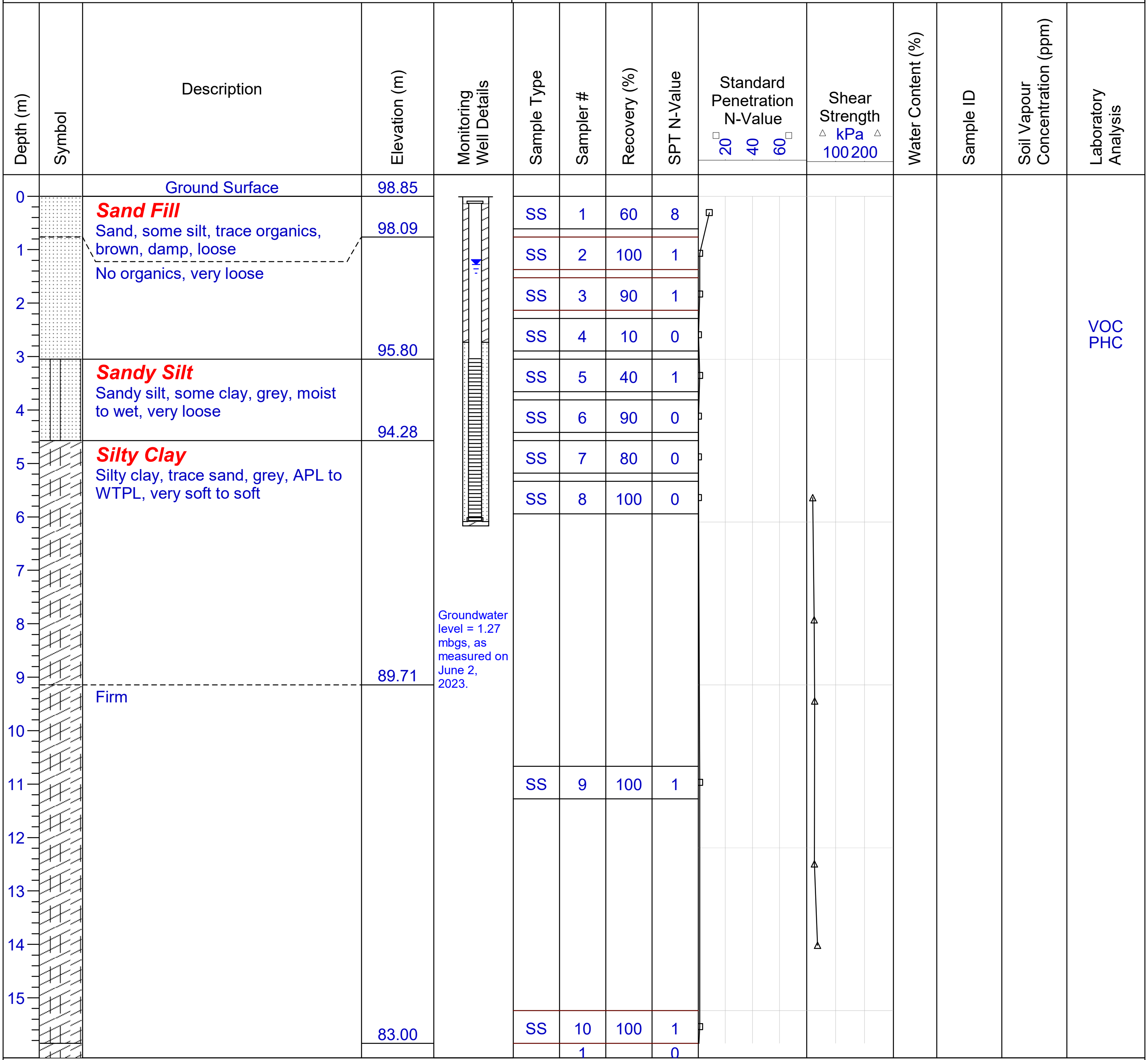
Template: Master SOP Template – February 2014

APPENDIX B

Borehole Logs

Log of Borehole: BH1

Project #: 324269.001
Logged By: MK
Project: Geotechnical Investigation
Client: Sobey's Inc.
Location: 1887 St. Joseph's Boulevard, Ottawa, ON
Drill Date: May 19, 2023
Project Manager: WT



Depth (m)	Description	Elevation (m)
0	Ground Surface	98.85
	Sand Fill Sand, some silt, trace organics, brown, damp, loose	98.09
	No organics, very loose	95.80
	Sandy Silt Sandy silt, some clay, grey, moist to wet, very loose	94.28
	Silty Clay Silty clay, trace sand, grey, APL to WTPL, very soft to soft	89.71
	Firm	83.00

Groundwater level = 1.27 mbgs, as measured on June 2, 2023.

Sample Type	Sampler #	Recovery (%)	SPT N-Value	Laboratory Analysis
SS	1	60	8	
SS	2	100	1	
SS	3	90	1	
SS	4	10	0	VOC PHC
SS	5	40	1	
SS	6	90	0	
SS	7	80	0	
SS	8	100	0	
SS	9	100	1	
SS	10	100	1	
	1		0	

Contractor: Strata Drilling Group
Grade Elevation: 98.85 m
Drilling Method: Direct Push/Split Spoon Sample
Top of Casing Elevation: 99.65 m
Well Casing Size: 38 mm
Sheet: 1 of 4

Log of Borehole: BH1

Project #: 324269.001

Logged By: MK

Project: Geotechnical Investigation

Client: Sobey's Inc.

Location: 1887 St. Joseph's Boulevard, Ottawa, ON

Drill Date: May 19, 2023

Project Manager: WT

SUBSURFACE PROFILE

Dynamic Cone Penetration Test

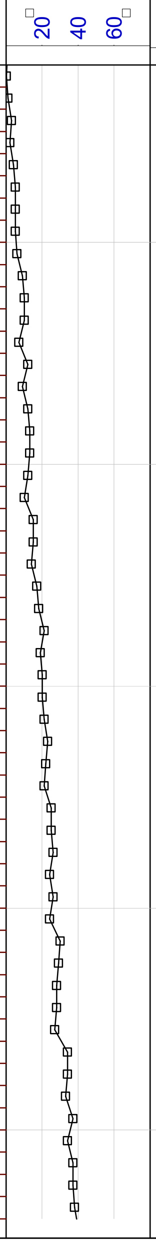
Probable silty clay

Depth (m): 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31

SAMPLE

Sample Type	Sampler #	Recovery (%)	SPT N-Value	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis
DCPT	1		0				
DCPT	2		1				
DCPT	3		3				
DCPT	4		2				
DCPT	5		4				
DCPT	6		5				
DCPT	7		5				
DCPT	8		5				
DCPT	9		6				
DCPT	10		9				
DCPT	11		10				
DCPT	12		10				
DCPT	13		7				
DCPT	14		12				
DCPT	15		9				
DCPT	16		12				
DCPT	17		13				
DCPT	18		13				
DCPT	19		12				
DCPT	20		10				
DCPT	21		15				
DCPT	22		15				
DCPT	23		14				
DCPT	24		17				
DCPT	25		18				
DCPT	26		21				
DCPT	27		19				
DCPT	28		20				
DCPT	29		20				
DCPT	30		21				
DCPT	31		23				
DCPT	32		22				
DCPT	33		21				
DCPT	34		25				
DCPT	35		25				
DCPT	36		26				
DCPT	37		24				
DCPT	38		26				
DCPT	39		24				
DCPT	40		30				
DCPT	41		29				
DCPT	42		28				
DCPT	43		28				
DCPT	44		27				
DCPT	45		34				
DCPT	46		34				
DCPT	47		33				
DCPT	48		37				
DCPT	49		34				
DCPT	50		37				
DCPT	51		37				
DCPT	52		38				
	53		40				

Standard Penetration N-Value



Shear Strength △ kPa △

100 200

Contractor: Strata Drilling Group

Grade Elevation: 98.85 m

Drilling Method: Direct Push/Split Spoon Sample

Top of Casing Elevation: 99.65 m

Well Casing Size: 38 mm

Sheet: 2 of 4

Log of Borehole: BH1

Project #: 324269.001 **Logged By:** MK

Project: Geotechnical Investigation

Client: Sobey's Inc.

Location: 1887 St. Joseph's Boulevard, Ottawa, ON

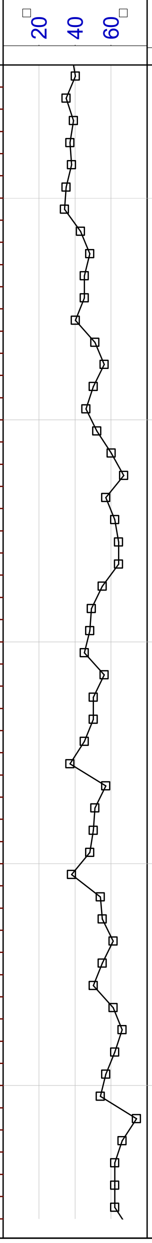
Drill Date: May 19, 2023 **Project Manager:** WT

SUBSURFACE PROFILE | **SAMPLE**

Depth (m): 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47

Sample Type	Sampler #	Recovery (%)	SPT N-Value
DCPT	53		40
DCPT	54		35
DCPT	55		39
DCPT	56		37
DCPT	57		38
DCPT	58		35
DCPT	59		34
DCPT	60		43
DCPT	61		48
DCPT	62		45
DCPT	63		45
DCPT	64		40
DCPT	65		51
DCPT	66		56
DCPT	67		50
DCPT	68		46
DCPT	69		52
DCPT	70		60
DCPT	71		67
DCPT	72		57
DCPT	73		62
DCPT	74		64
DCPT	75		64
DCPT	76		55
DCPT	77		49
DCPT	78		48
DCPT	79		45
DCPT	80		56
DCPT	81		50
DCPT	82		50
DCPT	83		45
DCPT	84		37
DCPT	85		57
DCPT	86		51
DCPT	87		50
DCPT	88		48
DCPT	89		38
DCPT	90		54
DCPT	91		55
DCPT	92		61
DCPT	93		55
DCPT	94		50
DCPT	95		61
DCPT	96		66
DCPT	97		62
DCPT	98		57
DCPT	99		54
DCPT	100		74
DCPT	101		66
DCPT	102		62
DCPT	103		62
DCPT	104		62
	105		70

Standard Penetration N-Value



Shear Strength △ kPa △ 100 200

Water Content (%) | Sample ID | Soil Vapour Concentration (ppm) | Laboratory Analysis

Contractor: Strata Drilling Group **Grade Elevation:** 98.85 m

Drilling Method: Direct Push/Split Spoon Sample **Top of Casing Elevation:** 99.65 m

Well Casing Size: 38 mm **Sheet:** 3 of 4

Log of Borehole: BH1

Project #: 324269.001 **Logged By:** MK

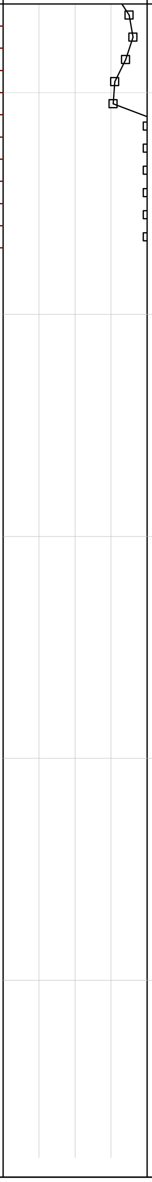
Project: Geotechnical Investigation

Client: Sobey's Inc.

Location: 1887 St. Joseph's Boulevard, Ottawa, ON

Drill Date: May 19, 2023 **Project Manager:** WT

SUBSURFACE PROFILE					SAMPLE									
Depth (m)	Symbol	Description	Elevation (m)	Monitoring Well Details	Sample Type	Sampler #	Recovery (%)	SPT N-Value	Standard Penetration N-Value □ 20 40 60 □	Shear Strength △ kPa △ 100 200	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis
					DCPT	105		70						
48					DCPT	106		72						
					DCPT	107		68						
					DCPT	108		62						
49					DCPT	109		61						
					DCPT	110		94						
					DCPT	111		90						
50					DCPT	112		99						
					DCPT	113		92						
					DCPT	114		115						
			47.95		DCPT	115		108						
51		End of Borehole												
52														
53		Borehole terminated at 50.9 m due to refusal on probable bedrock.												
54														
55														
56														
57														
58														
59														
60														
61														
62														
63														



Contractor: Strata Drilling Group **Grade Elevation:** 98.85 m

Drilling Method: Direct Push/Split Spoon Sample **Top of Casing Elevation:** 99.65 m

Well Casing Size: 38 mm **Sheet:** 4 of 4

Log of Borehole: BH2

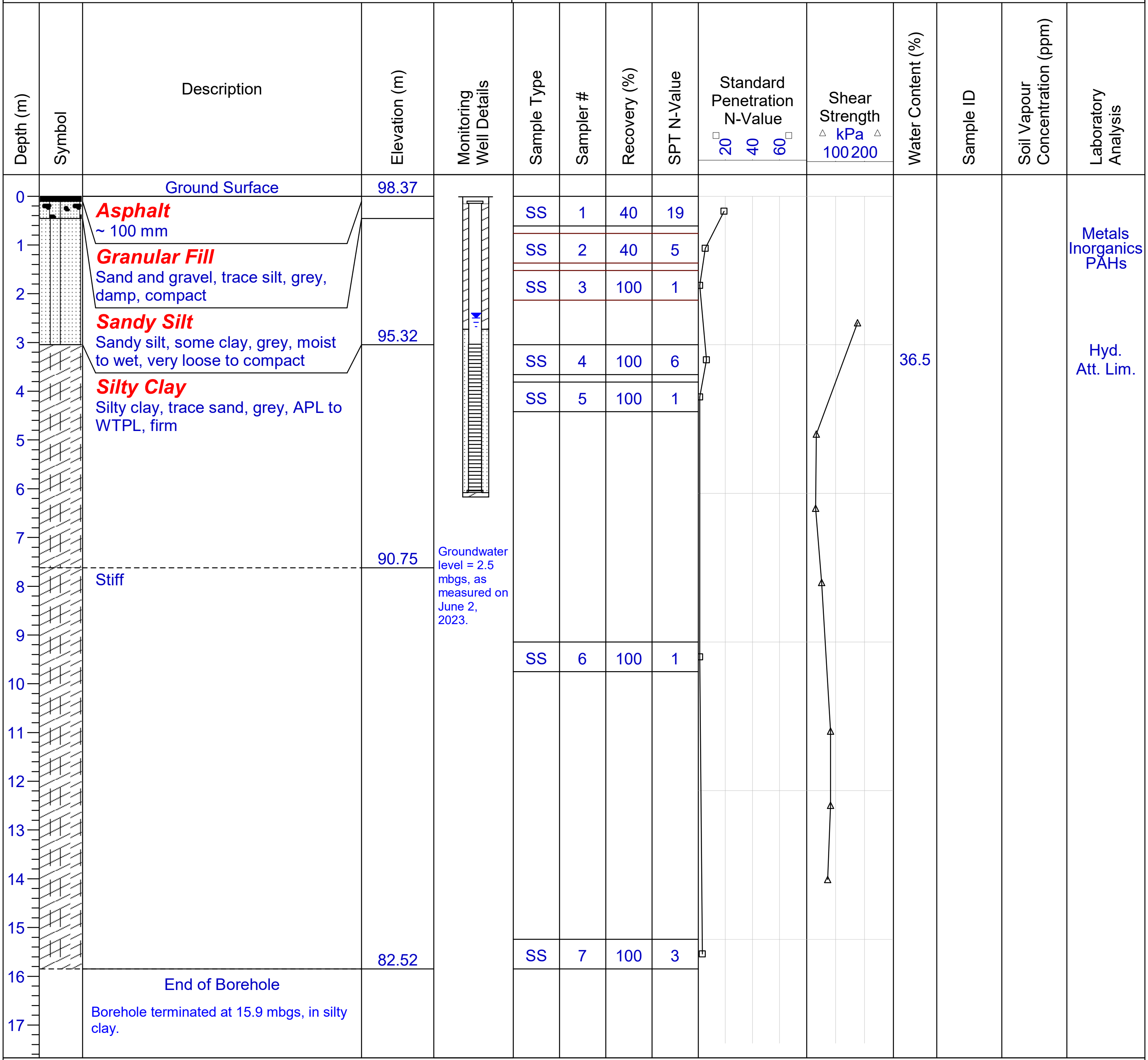
Project #: 324269.001 **Logged By:** MK

Project: Geotechnical Investigation

Client: Sobey's Inc.

Location: 1887 St. Joseph's Boulevard, Ottawa, ON

Drill Date: May 24, 2023 **Project Manager:** WT



SUBSURFACE PROFILE

Description	Elevation (m)
Ground Surface	98.37
Asphalt ~ 100 mm	
Granular Fill Sand and gravel, trace silt, grey, damp, compact	
Sandy Silt Sandy silt, some clay, grey, moist to wet, very loose to compact	95.32
Silty Clay Silty clay, trace sand, grey, APL to WTPL, firm	
Stiff	90.75
End of Borehole Borehole terminated at 15.9 mbgs, in silty clay.	82.52

Groundwater level = 2.5 mbgs, as measured on June 2, 2023.

SAMPLE

Sample Type	Sampler #	Recovery (%)	SPT N-Value	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis
SS	1	40	19				
SS	2	40	5				Metals Inorganics PAHs
SS	3	100	1				
SS	4	100	6	36.5			Hyd. Att. Lim.
SS	5	100	1				
SS	6	100	1				
SS	7	100	3				

Contractor: Strata Drilling Group

Grade Elevation: 98.37 m

Drilling Method: Direct Push/Split Spoon Sample

Top of Casing Elevation: 98.23 m

Well Casing Size: 38 mm

Sheet: 1 of 1

Log of Borehole: BH3

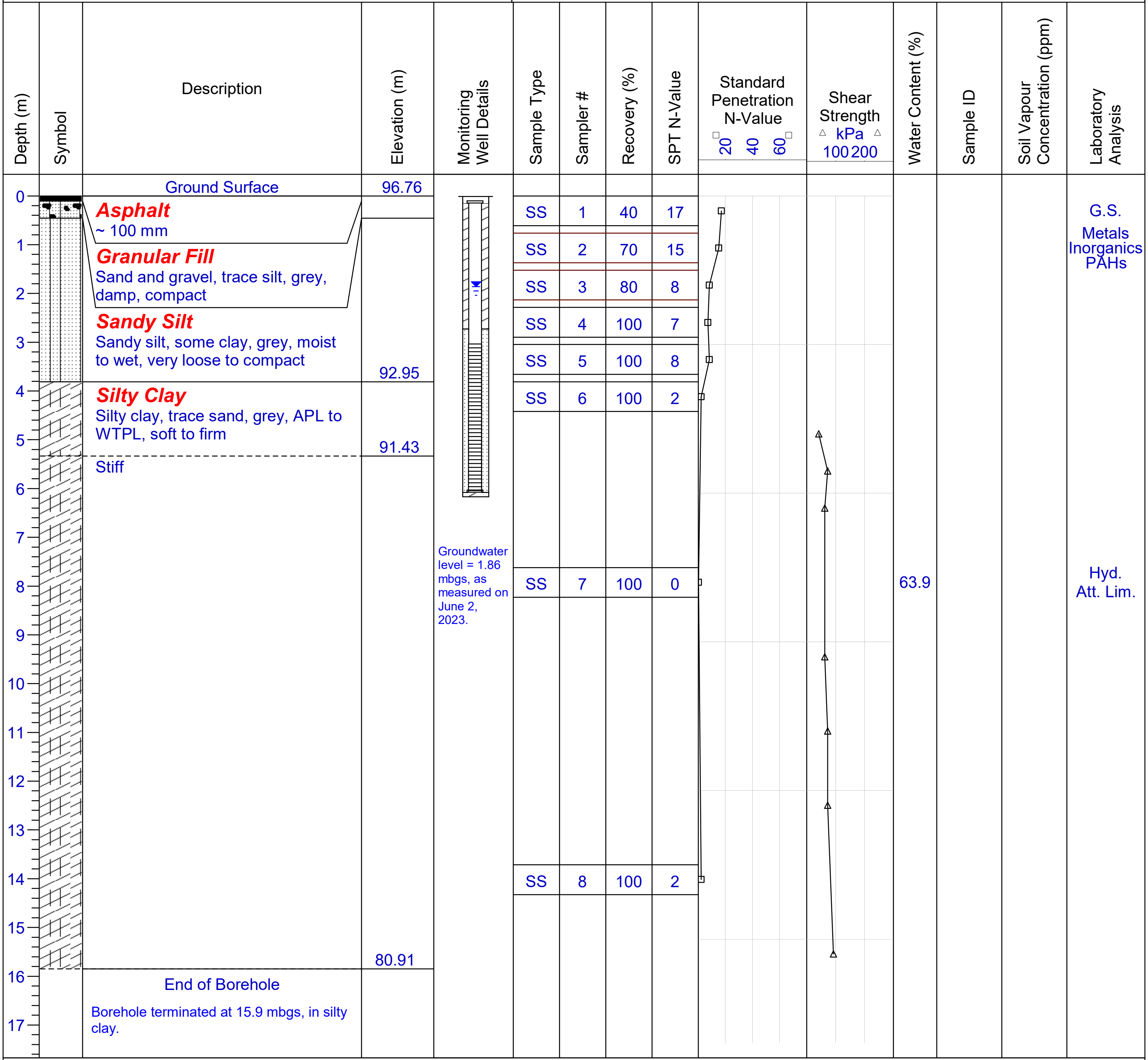
Project #: 324269.001 **Logged By:** MK

Project: Geotechnical Investigation

Client: Sobey's Inc.

Location: 1887 St. Joseph's Boulevard, Ottawa, ON

Drill Date: May 25, 2023 **Project Manager:** WT



Description	Elevation (m)	Sample Type	Sampler #	Recovery (%)	SPT N-Value	Water Content (%)	Laboratory Analysis
Ground Surface	96.76						
Asphalt ~ 100 mm		SS	1	40	17		G.S.
Granular Fill Sand and gravel, trace silt, grey, damp, compact		SS	2	70	15		Metals Inorganics PAHs
Sandy Silt Sandy silt, some clay, grey, moist to wet, very loose to compact		SS	3	80	8		
		SS	4	100	7		
	92.95	SS	5	100	8		
Silty Clay Silty clay, trace sand, grey, APL to WTPL, soft to firm	91.43	SS	6	100	2		
Stiff		SS	7	100	0	63.9	Hyd. Att. Lim.
	80.91	SS	8	100	2		
End of Borehole Borehole terminated at 15.9 mbgs, in silty clay.							

Groundwater level = 1.86 mbgs, as measured on June 2, 2023.

Contractor: Strata Drilling Group **Grade Elevation:** 96.76 m

Drilling Method: Direct Push/Split Spoon Sample **Top of Casing Elevation:** 96.71 m

Well Casing Size: 38 mm **Sheet:** 1 of 1

Log of Borehole: BH4

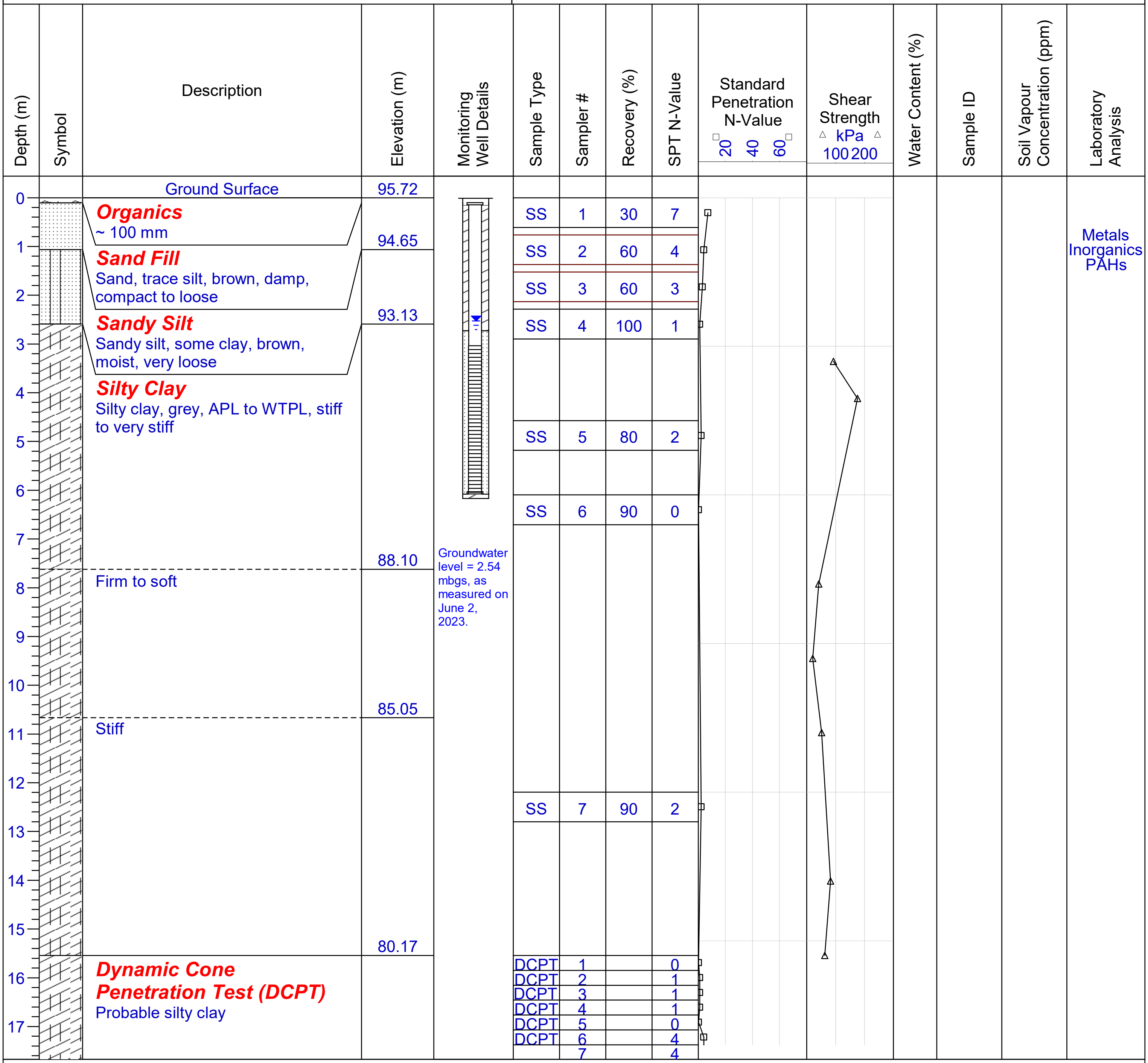
Project #: 324269.001 **Logged By:** MK

Project: Geotechnical Investigation

Client: Sobey's Inc.

Location: 1887 St. Joseph's Boulevard, Ottawa, ON

Drill Date: May 25, 2023 **Project Manager:** WT



SUBSURFACE PROFILE

Description	Elevation (m)
Ground Surface	95.72
Organics ~ 100 mm	
Sand Fill Sand, trace silt, brown, damp, compact to loose	94.65
Sandy Silt Sandy silt, some clay, brown, moist, very loose	93.13
Silty Clay Silty clay, grey, APL to WTPL, stiff to very stiff	
Firm to soft	88.10
Stiff	85.05
Dynamic Cone Penetration Test (DCPT) Probable silty clay	80.17

Groundwater level = 2.54 mbgs, as measured on June 2, 2023.

SAMPLE

Sample Type	Sampler #	Recovery (%)	SPT N-Value	Laboratory Analysis
SS	1	30	7	
SS	2	60	4	Metals Inorganics PAHs
SS	3	60	3	
SS	4	100	1	
SS	5	80	2	
SS	6	90	0	
SS	7	90	2	
DCPT	1		0	
DCPT	2		1	
DCPT	3		1	
DCPT	4		1	
DCPT	5		0	
DCPT	6		4	
	7		4	

Contractor: Strata Drilling Group **Grade Elevation:** 95.72 m

Drilling Method: Direct Push/Split Spoon Sample **Top of Casing Elevation:** 96.65 m

Well Casing Size: 38 mm **Sheet:** 1 of 3

Log of Borehole: BH4

Project #: 324269.001 **Logged By:** MK

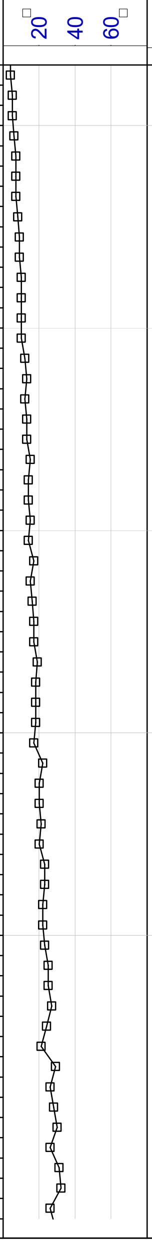
Project: Geotechnical Investigation

Client: Sobey's Inc.

Location: 1887 St. Joseph's Boulevard, Ottawa, ON

Drill Date: May 25, 2023 **Project Manager:** WT

SUBSURFACE PROFILE					SAMPLE									
Depth (m)	Symbol	Description	Elevation (m)	Monitoring Well Details	Sample Type	Sampler #	Recovery (%)	SPT N-Value	Standard Penetration N-Value ◻ 20 40 60 ◻	Shear Strength △ kPa △ 100 200	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis
					DCPT	7		4						
18					DCPT	8		5						
					DCPT	9		5						
					DCPT	10		6						
					DCPT	11		7						
19					DCPT	12		7						
					DCPT	13		7						
					DCPT	14		8						
20					DCPT	15		9						
					DCPT	16		9						
					DCPT	17		10						
21					DCPT	18		10						
					DCPT	19		10						
					DCPT	20		10						
					DCPT	21		12						
22					DCPT	22		13						
					DCPT	23		12						
					DCPT	24		13						
23					DCPT	25		13						
					DCPT	26		15						
					DCPT	27		14						
24					DCPT	28		14						
					DCPT	29		15						
					DCPT	30		14						
25					DCPT	31		17						
					DCPT	32		15						
					DCPT	33		16						
					DCPT	34		17						
26					DCPT	35		17						
					DCPT	36		19						
					DCPT	37		18						
27					DCPT	38		18						
					DCPT	39		18						
					DCPT	40		17						
28					DCPT	41		22						
					DCPT	42		20						
					DCPT	43		20						
					DCPT	44		21						
29					DCPT	45		20						
					DCPT	46		23						
					DCPT	47		23						
30					DCPT	48		22						
					DCPT	49		22						
					DCPT	50		23						
31					DCPT	51		25						
					DCPT	52		25						
					DCPT	53		27						
32					DCPT	54		24						
					DCPT	55		21						
					DCPT	56		29						
					DCPT	57		26						
33					DCPT	58		28						
					DCPT	59		30						
					DCPT	60		26						
34					DCPT	61		31						
					DCPT	62		32						
					DCPT	63		26						
						64		29						



Contractor: Strata Drilling Group **Grade Elevation:** 95.72 m

Drilling Method: Direct Push/Split Spoon Sample **Top of Casing Elevation:** 96.65 m

Well Casing Size: 38 mm **Sheet:** 2 of 3

Log of Borehole: BH4

Project #: 324269.001 **Logged By:** MK

Project: Geotechnical Investigation

Client: Sobey's Inc.

Location: 1887 St. Joseph's Boulevard, Ottawa, ON

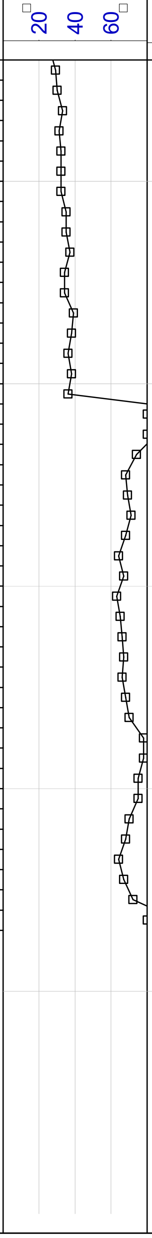
Drill Date: May 25, 2023 **Project Manager:** WT

SUBSURFACE PROFILE | **SAMPLE**

Depth (m)	Description	Elevation (m)
35–47.9		
47.9	End of Borehole Borehole terminated at 47.9 mbgs on probable bedrock.	47.87

Sample Type	Sampler #	Recovery (%)	SPT N-Value
DCPT	64		29
DCPT	65		30
DCPT	66		33
DCPT	67		31
DCPT	68		32
DCPT	69		32
DCPT	70		32
DCPT	71		35
DCPT	72		35
DCPT	73		37
DCPT	74		34
DCPT	75		34
DCPT	76		39
DCPT	77		38
DCPT	78		36
DCPT	79		38
DCPT	80		36
DCPT	81		126
DCPT	82		85
DCPT	83		74
DCPT	84		68
DCPT	85		69
DCPT	86		71
DCPT	87		68
DCPT	88		64
DCPT	89		67
DCPT	90		63
DCPT	91		65
DCPT	92		66
DCPT	93		67
DCPT	94		66
DCPT	95		68
DCPT	96		70
DCPT	97		78
DCPT	98		78
DCPT	99		75
DCPT	100		75
DCPT	101		70
DCPT	102		68
DCPT	103		64
DCPT	104		67
DCPT	105		72
DCPT	106		97

Standard Penetration N-Value



Shear Strength
△ kPa △
100 200

Water Content (%) | Sample ID | Soil Vapour Concentration (ppm) | Laboratory Analysis | Monitoring Well Details | Symbol

Contractor: Strata Drilling Group **Grade Elevation:** 95.72 m

Drilling Method: Direct Push/Split Spoon Sample **Top of Casing Elevation:** 96.65 m

Well Casing Size: 38 mm **Sheet:** 3 of 3

Log of Borehole: BH5

Project #: 324269.001 **Logged By:** MK

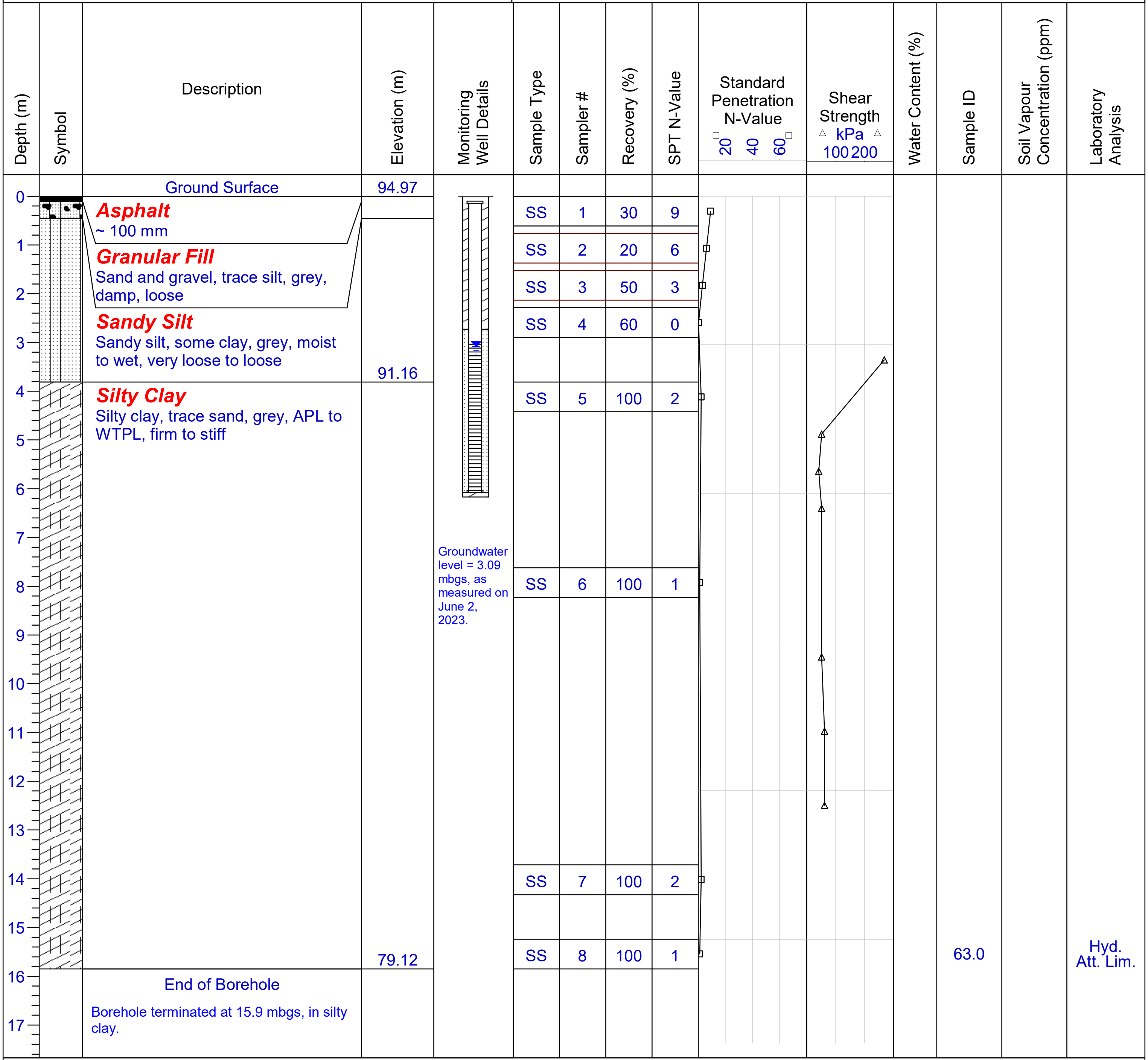
Project: Geotechnical Investigation

Client: Sobey's Inc.

Location: 1887 St. Joseph's Boulevard, Ottawa, ON

Drill Date: May 26, 2023 **Project Manager:** WT

SUBSURFACE PROFILE **SAMPLE**



Description	Elevation (m)
Ground Surface	94.97
Asphalt ~ 100 mm	
Granular Fill Sand and gravel, trace silt, grey, damp, loose	
Sandy Silt Sandy silt, some clay, grey, moist to wet, very loose to loose	91.16
Silty Clay Silty clay, trace sand, grey, APL to WTPL, firm to stiff	79.12
End of Borehole Borehole terminated at 15.9 mbgs, in silty clay.	

Groundwater level = 3.09 mbgs, as measured on June 2, 2023.

Sample Type	Sampler #	Recovery (%)	SPT N-Value	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis
SS	1	30	9				
SS	2	20	6				
SS	3	50	3				
SS	4	60	0				
SS	5	100	2				
SS	6	100	1				
SS	7	100	2				
SS	8	100	1		63.0		Hyd. Att. Lim.

Contractor: Strata Drilling Group **Grade Elevation:** 94.97 m

Drilling Method: Direct Push/Split Spoon Sample **Top of Casing Elevation:** 94.86 m

Well Casing Size: 38 mm **Sheet:** 1 of 1

Log of Borehole: BH6

Project #: 324269.001 **Logged By:** MK

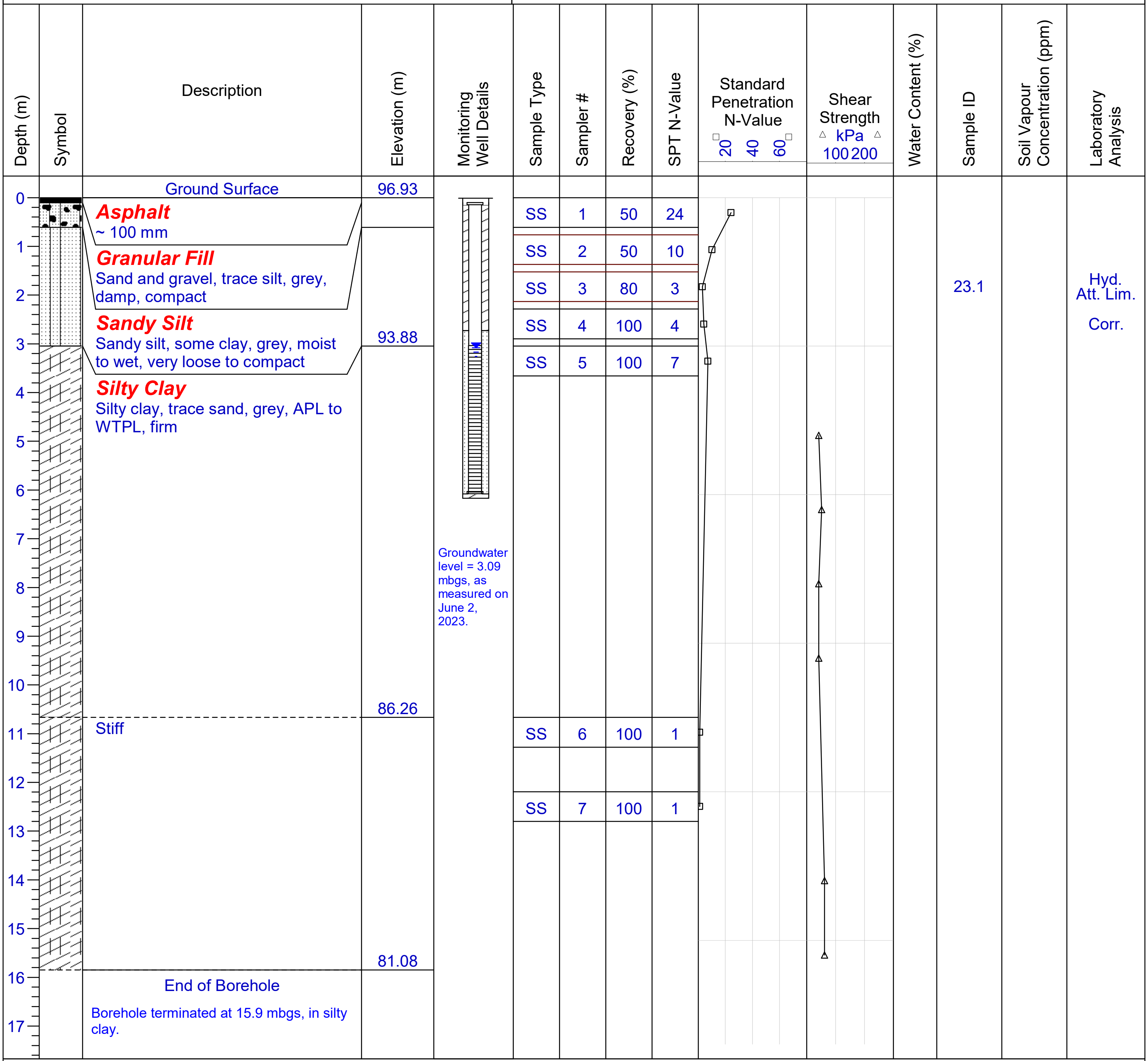
Project: Geotechnical Investigation

Client: Sobey's Inc.

Location: 1887 St. Joseph's Boulevard, Ottawa, ON

Drill Date: May 29, 2023 **Project Manager:** WT

SUBSURFACE PROFILE **SAMPLE**



Depth (m)	Description	Elevation (m)
0	Ground Surface	96.93
	Asphalt ~ 100 mm	
	Granular Fill Sand and gravel, trace silt, grey, damp, compact	
	Sandy Silt Sandy silt, some clay, grey, moist to wet, very loose to compact	93.88
	Silty Clay Silty clay, trace sand, grey, APL to WTPL, firm	
	Stiff	86.26
	End of Borehole Borehole terminated at 15.9 mbgs, in silty clay.	81.08

Groundwater level = 3.09 mbgs, as measured on June 2, 2023.

Sample Type	Sampler #	Recovery (%)	SPT N-Value	Water Content (%)	Sample ID	Soil Vapour Concentration (ppm)	Laboratory Analysis
SS	1	50	24				
SS	2	50	10				
SS	3	80	3		23.1		Hyd. Att. Lim.
SS	4	100	4				Corr.
SS	5	100	7				
SS	6	100	1				
SS	7	100	1				

Contractor: Strata Drilling Group **Grade Elevation:** 96.93 m

Drilling Method: Direct Push/Split Spoon Sample **Top of Casing Elevation:** 96.81 m

Well Casing Size: 38 mm **Sheet:** 1 of 1

APPENDIX C

Laboratory Certificates of Analysis

Certificate of Analysis

Pinchin Ltd. (Ottawa)

1 Hines Road, Suite 200
Kanata, ON K2K 3C7
Attn: Mike Leach

Client PO:
Project: 329269.002
Custody: 134191

Report Date: 29-May-2023
Order Date: 19-May-2023

Order #: 2320512

This Certificate of Analysis contains analytical data applicable to the following samples as submitted :

Paracel ID	Client ID
2320512-01	BH-1 SS2
2320512-02	BH-1 SS6

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: **Pinchin Ltd. (Ottawa)**
Client PO:

Report Date: 29-May-2023
Order Date: 19-May-2023
Project Description: 329269.002

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Conductivity	MOE E3138 - probe @25 °C, water ext	26-May-23	29-May-23
Cyanide, free	MOE E3015 - Auto Colour, water extraction	26-May-23	29-May-23
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	26-May-23	26-May-23
PHC F1	CWS Tier 1 - P&T GC-FID	24-May-23	24-May-23
PHCs F2 to F4	CWS Tier 1 - GC-FID, extraction	24-May-23	27-May-23
REG 153: Metals by ICP/MS, soil	EPA 6020 - Digestion - ICP-MS	26-May-23	26-May-23
REG 153: PAHs by GC-MS	EPA 8270 - GC-MS, extraction	25-May-23	26-May-23
REG 153: VOCs by P&T GC/MS	EPA 8260 - P&T GC-MS	24-May-23	24-May-23
SAR	Calculated	29-May-23	29-May-23
Solids, %	CWS Tier 1 - Gravimetric	25-May-23	26-May-23

Certificate of Analysis
Client: Pinchin Ltd. (Ottawa)
Client PO:

Report Date: 29-May-2023
Order Date: 19-May-2023
Project Description: 329269.002

	Client ID:	BH-1 SS2	BH-1 SS6	-	-
	Sample Date:	19-May-23 09:00	19-May-23 09:00	-	-
	Sample ID:	2320512-01	2320512-02	-	-
	MDL/Units	Soil	Soil	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	84.9	63.1	-	-
General Inorganics					
SAR	0.01 N/A	0.46	-	-	-
Conductivity	5 uS/cm	43	-	-	-
Cyanide, free	0.03 ug/g dry	<0.03	-	-	-
pH	0.05 pH Units	7.46	7.88	-	-
Metals					
Antimony	1.0 ug/g dry	<1.0	-	-	-
Arsenic	1.0 ug/g dry	1.0	-	-	-
Barium	1.0 ug/g dry	30.0	-	-	-
Beryllium	0.5 ug/g dry	<0.5	-	-	-
Boron	5.0 ug/g dry	<5.0	-	-	-
Cadmium	0.5 ug/g dry	<0.5	-	-	-
Chromium	5.0 ug/g dry	10.2	-	-	-
Cobalt	1.0 ug/g dry	3.6	-	-	-
Copper	5.0 ug/g dry	<5.0	-	-	-
Lead	1.0 ug/g dry	1.7	-	-	-
Molybdenum	1.0 ug/g dry	<1.0	-	-	-
Nickel	5.0 ug/g dry	9.1	-	-	-
Selenium	1.0 ug/g dry	<1.0	-	-	-
Silver	0.3 ug/g dry	<0.3	-	-	-
Thallium	1.0 ug/g dry	<1.0	-	-	-
Uranium	1.0 ug/g dry	<1.0	-	-	-
Vanadium	10.0 ug/g dry	15.1	-	-	-
Zinc	20.0 ug/g dry	25.5	-	-	-
Volatiles					
Acetone	0.50 ug/g dry	-	<0.50	-	-
Benzene	0.02 ug/g dry	-	<0.02	-	-
Bromodichloromethane	0.05 ug/g dry	-	<0.05	-	-
Bromoform	0.05 ug/g dry	-	<0.05	-	-
Bromomethane	0.05 ug/g dry	-	<0.05	-	-
Carbon Tetrachloride	0.05 ug/g dry	-	<0.05	-	-
Chlorobenzene	0.05 ug/g dry	-	<0.05	-	-
Chloroform	0.05 ug/g dry	-	<0.05	-	-
Dibromochloromethane	0.05 ug/g dry	-	<0.05	-	-

Client ID: **Sample Date:** **Sample ID:**		BH-1 SS2 19-May-23 09:00 2320512-01	BH-1 SS6 19-May-23 09:00 2320512-02	- - -	- - -
	MDL/Units	Soil	Soil	-	-
Dichlorodifluoromethane	0.05 ug/g dry	-	<0.05	-	-
1,2-Dichlorobenzene	0.05 ug/g dry	-	<0.05	-	-
1,3-Dichlorobenzene	0.05 ug/g dry	-	<0.05	-	-
1,4-Dichlorobenzene	0.05 ug/g dry	-	<0.05	-	-
1,1-Dichloroethane	0.05 ug/g dry	-	<0.05	-	-
1,2-Dichloroethane	0.05 ug/g dry	-	<0.05	-	-
1,1-Dichloroethylene	0.05 ug/g dry	-	<0.05	-	-
cis-1,2-Dichloroethylene	0.05 ug/g dry	-	<0.05	-	-
trans-1,2-Dichloroethylene	0.05 ug/g dry	-	<0.05	-	-
1,2-Dichloropropane	0.05 ug/g dry	-	<0.05	-	-
cis-1,3-Dichloropropylene	0.05 ug/g dry	-	<0.05	-	-
trans-1,3-Dichloropropylene	0.05 ug/g dry	-	<0.05	-	-
1,3-Dichloropropene, total	0.05 ug/g dry	-	<0.05	-	-
Ethylbenzene	0.05 ug/g dry	-	<0.05	-	-
Ethylene dibromide (dibromoethane, 1,2-)	0.05 ug/g dry	-	<0.05	-	-
Hexane	0.05 ug/g dry	-	<0.05	-	-
Methyl Ethyl Ketone (2-Butanone)	0.50 ug/g dry	-	<0.50	-	-
Methyl Isobutyl Ketone	0.50 ug/g dry	-	<0.50	-	-
Methyl tert-butyl ether	0.05 ug/g dry	-	<0.05	-	-
Methylene Chloride	0.05 ug/g dry	-	<0.05	-	-
Styrene	0.05 ug/g dry	-	<0.05	-	-
1,1,1,2-Tetrachloroethane	0.05 ug/g dry	-	<0.05	-	-
1,1,2,2-Tetrachloroethane	0.05 ug/g dry	-	<0.05	-	-
Tetrachloroethylene	0.05 ug/g dry	-	<0.05	-	-
Toluene	0.05 ug/g dry	-	<0.05	-	-
1,1,1-Trichloroethane	0.05 ug/g dry	-	<0.05	-	-
1,1,2-Trichloroethane	0.05 ug/g dry	-	<0.05	-	-
Trichloroethylene	0.05 ug/g dry	-	<0.05	-	-
Trichlorofluoromethane	0.05 ug/g dry	-	<0.05	-	-
Vinyl chloride	0.02 ug/g dry	-	<0.02	-	-
m,p-Xylenes	0.05 ug/g dry	-	<0.05	-	-
o-Xylene	0.05 ug/g dry	-	<0.05	-	-
Xylenes, total	0.05 ug/g dry	-	<0.05	-	-
4-Bromofluorobenzene	Surrogate	-	117%	-	-
Dibromofluoromethane	Surrogate	-	79.7%	-	-
Toluene-d8	Surrogate	-	102%	-	-

Certificate of Analysis

Report Date: 29-May-2023

Client: **Pinchin Ltd. (Ottawa)**

Order Date: 19-May-2023

Client PO:

Project Description: 329269.002

Client ID:		BH-1 SS2	BH-1 SS6	-	-
Sample Date:		19-May-23 09:00	19-May-23 09:00	-	-
Sample ID:		2320512-01	2320512-02	-	-
	MDL/Units	Soil	Soil	-	-
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	-	<7	-	-
F2 PHCs (C10-C16)	4 ug/g dry	-	<4	-	-
F3 PHCs (C16-C34)	8 ug/g dry	-	<8	-	-
F4 PHCs (C34-C50)	6 ug/g dry	-	<6	-	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	<0.02	<0.02	-	-
Acenaphthylene	0.02 ug/g dry	<0.02	<0.02	-	-
Anthracene	0.02 ug/g dry	<0.02	<0.02	-	-
Benzo [a] anthracene	0.02 ug/g dry	<0.02	<0.02	-	-
Benzo [a] pyrene	0.02 ug/g dry	<0.02	<0.02	-	-
Benzo [b] fluoranthene	0.02 ug/g dry	<0.02	<0.02	-	-
Benzo [g,h,i] perylene	0.02 ug/g dry	<0.02	<0.02	-	-
Benzo [k] fluoranthene	0.02 ug/g dry	<0.02	<0.02	-	-
Chrysene	0.02 ug/g dry	<0.02	<0.02	-	-
Dibenzo [a,h] anthracene	0.02 ug/g dry	<0.02	<0.02	-	-
Fluoranthene	0.02 ug/g dry	<0.02	<0.02	-	-
Fluorene	0.02 ug/g dry	<0.02	<0.02	-	-
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	<0.02	<0.02	-	-
1-Methylnaphthalene	0.02 ug/g dry	<0.02	<0.02	-	-
2-Methylnaphthalene	0.02 ug/g dry	<0.02	<0.02	-	-
Methylnaphthalene (1&2)	0.04 ug/g dry	<0.04	<0.04	-	-
Naphthalene	0.01 ug/g dry	<0.01	<0.01	-	-
Phenanthrene	0.02 ug/g dry	<0.02	<0.02	-	-
Pyrene	0.02 ug/g dry	<0.02	<0.02	-	-
2-Fluorobiphenyl	Surrogate	79.7%	81.5%	-	-
Terphenyl-d14	Surrogate	80.3%	78.3%	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Conductivity	ND	5	uS/cm						
Cyanide, free	ND	0.03	ug/g						
Hydrocarbons									
F1 PHCs (C6-C10)	ND	7	ug/g						
F2 PHCs (C10-C16)	ND	4	ug/g						
F3 PHCs (C16-C34)	ND	8	ug/g						
F4 PHCs (C34-C50)	ND	6	ug/g						
Metals									
Antimony	ND	1.0	ug/g						
Arsenic	ND	1.0	ug/g						
Barium	ND	1.0	ug/g						
Beryllium	ND	0.5	ug/g						
Boron	ND	5.0	ug/g						
Cadmium	ND	0.5	ug/g						
Chromium	ND	5.0	ug/g						
Cobalt	ND	1.0	ug/g						
Copper	ND	5.0	ug/g						
Lead	ND	1.0	ug/g						
Molybdenum	ND	1.0	ug/g						
Nickel	ND	5.0	ug/g						
Selenium	ND	1.0	ug/g						
Silver	ND	0.3	ug/g						
Thallium	ND	1.0	ug/g						
Uranium	ND	1.0	ug/g						
Vanadium	ND	10.0	ug/g						
Zinc	ND	20.0	ug/g						
Semi-Volatiles									
Acenaphthene	ND	0.02	ug/g						
Acenaphthylene	ND	0.02	ug/g						
Anthracene	ND	0.02	ug/g						
Benzo [a] anthracene	ND	0.02	ug/g						
Benzo [a] pyrene	ND	0.02	ug/g						
Benzo [b] fluoranthene	ND	0.02	ug/g						
Benzo [g,h,i] perylene	ND	0.02	ug/g						
Benzo [k] fluoranthene	ND	0.02	ug/g						
Chrysene	ND	0.02	ug/g						
Dibenzo [a,h] anthracene	ND	0.02	ug/g						
Fluoranthene	ND	0.02	ug/g						
Fluorene	ND	0.02	ug/g						
Indeno [1,2,3-cd] pyrene	ND	0.02	ug/g						
1-Methylnaphthalene	ND	0.02	ug/g						
2-Methylnaphthalene	ND	0.02	ug/g						
Methylnaphthalene (1&2)	ND	0.04	ug/g						
Naphthalene	ND	0.01	ug/g						
Phenanthrene	ND	0.02	ug/g						
Pyrene	ND	0.02	ug/g						
Surrogate: 2-Fluorobiphenyl	*1.14*		*ug/g*		*85.3*	*50-140*			
Surrogate: Terphenyl-d14	*1.08*		*ug/g*		*81.1*	*50-140*			
Volatiles									
Acetone	ND	0.50	ug/g						
Benzene	ND	0.02	ug/g						
Bromodichloromethane	ND	0.05	ug/g						
Bromoform	ND	0.05	ug/g						
Bromomethane	ND	0.05	ug/g						
Carbon Tetrachloride	ND	0.05	ug/g						
Chlorobenzene	ND	0.05	ug/g						
Chloroform	ND	0.05	ug/g						

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Dibromochloromethane	ND	0.05	ug/g						
Dichlorodifluoromethane	ND	0.05	ug/g						
1,2-Dichlorobenzene	ND	0.05	ug/g						
1,3-Dichlorobenzene	ND	0.05	ug/g						
1,4-Dichlorobenzene	ND	0.05	ug/g						
1,1-Dichloroethane	ND	0.05	ug/g						
1,2-Dichloroethane	ND	0.05	ug/g						
1,1-Dichloroethylene	ND	0.05	ug/g						
cis-1,2-Dichloroethylene	ND	0.05	ug/g						
trans-1,2-Dichloroethylene	ND	0.05	ug/g						
1,2-Dichloropropane	ND	0.05	ug/g						
cis-1,3-Dichloropropylene	ND	0.05	ug/g						
trans-1,3-Dichloropropylene	ND	0.05	ug/g						
1,3-Dichloropropene, total	ND	0.05	ug/g						
Ethylbenzene	ND	0.05	ug/g						
Ethylene dibromide (dibromoethane, 1,2-	ND	0.05	ug/g						
Hexane	ND	0.05	ug/g						
Methyl Ethyl Ketone (2-Butanone)	ND	0.50	ug/g						
Methyl Isobutyl Ketone	ND	0.50	ug/g						
Methyl tert-butyl ether	ND	0.05	ug/g						
Methylene Chloride	ND	0.05	ug/g						
Styrene	ND	0.05	ug/g						
1,1,1,2-Tetrachloroethane	ND	0.05	ug/g						
1,1,2,2-Tetrachloroethane	ND	0.05	ug/g						
Tetrachloroethylene	ND	0.05	ug/g						
Toluene	ND	0.05	ug/g						
1,1,1-Trichloroethane	ND	0.05	ug/g						
1,1,2-Trichloroethane	ND	0.05	ug/g						
Trichloroethylene	ND	0.05	ug/g						
Trichlorofluoromethane	ND	0.05	ug/g						
Vinyl chloride	ND	0.02	ug/g						
m,p-Xylenes	ND	0.05	ug/g						
o-Xylene	ND	0.05	ug/g						
Xylenes, total	ND	0.05	ug/g						
Surrogate: 4-Bromofluorobenzene	*3.76*		*ug/g*		*118*	*50-140*			
Surrogate: Dibromofluoromethane	*2.74*		*ug/g*		*85.7*	*50-140*			
Surrogate: Toluene-d8	*3.08*		*ug/g*		*96.3*	*50-140*			

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
SAR	0.47	0.01	N/A	0.46			2.2	30	
Conductivity	174	5	uS/cm	172			1.2	5	
Cyanide, free	ND	0.03	ug/g	ND			NC	35	
pH	6.83	0.05	pH Units	6.85			0.3	2.3	
Hydrocarbons									
F1 PHCs (C6-C10)	ND	7	ug/g	ND			NC	40	
F2 PHCs (C10-C16)	ND	4	ug/g	ND			NC	30	
F3 PHCs (C16-C34)	ND	8	ug/g	ND			NC	30	
F4 PHCs (C34-C50)	ND	6	ug/g	ND			NC	30	
Metals									
Antimony	3.9	1.0	ug/g	3.7			5.8	30	
Arsenic	28.4	1.0	ug/g	24.7			13.8	30	
Barium	784	1.0	ug/g	676			14.8	30	
Beryllium	1.0	0.5	ug/g	0.7			NC	30	
Boron	27.2	5.0	ug/g	19.5			NC	30	
Cadmium	1.9	0.5	ug/g	1.7			14.4	30	
Chromium	51.4	5.0	ug/g	40.8			23.0	30	
Cobalt	10.2	1.0	ug/g	8.7			15.5	30	
Copper	4110	5.0	ug/g	3820			7.3	30	
Lead	587	1.0	ug/g	507			14.7	30	
Molybdenum	3.1	1.0	ug/g	2.6			17.6	30	
Nickel	22.4	5.0	ug/g	18.3			20.2	30	
Selenium	1.1	1.0	ug/g	ND			NC	30	
Silver	ND	0.3	ug/g	ND			NC	30	
Thallium	ND	1.0	ug/g	ND			NC	30	
Uranium	ND	1.0	ug/g	ND			NC	30	
Vanadium	44.8	10.0	ug/g	34.7			25.3	30	
Zinc	554	20.0	ug/g	456			19.5	30	
Physical Characteristics									
% Solids	89.9	0.1	% by Wt.	89.4			0.6	25	
Semi-Volatiles									
Acenaphthene	ND	0.02	ug/g	ND			NC	40	
Acenaphthylene	ND	0.02	ug/g	ND			NC	40	
Anthracene	ND	0.02	ug/g	ND			NC	40	
Benzo [a] anthracene	ND	0.02	ug/g	ND			NC	40	
Benzo [a] pyrene	ND	0.02	ug/g	ND			NC	40	
Benzo [b] fluoranthene	ND	0.02	ug/g	ND			NC	40	
Benzo [g,h,i] perylene	ND	0.02	ug/g	ND			NC	40	
Benzo [k] fluoranthene	ND	0.02	ug/g	ND			NC	40	
Chrysene	ND	0.02	ug/g	ND			NC	40	
Dibenzo [a,h] anthracene	ND	0.02	ug/g	ND			NC	40	
Fluoranthene	ND	0.02	ug/g	ND			NC	40	
Fluorene	ND	0.02	ug/g	ND			NC	40	
Indeno [1,2,3-cd] pyrene	ND	0.02	ug/g	ND			NC	40	
1-Methylnaphthalene	ND	0.02	ug/g	ND			NC	40	
2-Methylnaphthalene	ND	0.02	ug/g	ND			NC	40	
Naphthalene	ND	0.01	ug/g	ND			NC	40	
Phenanthrene	ND	0.02	ug/g	ND			NC	40	
Pyrene	ND	0.02	ug/g	ND			NC	40	
Surrogate: 2-Fluorobiphenyl	*1.06*		*ug/g*		*71.2*	*50-140*			
Surrogate: Terphenyl-d14	*1.05*		*ug/g*		*70.2*	*50-140*			
Volatiles									
Acetone	ND	0.50	ug/g	ND			NC	50	
Benzene	ND	0.02	ug/g	ND			NC	50	
Bromodichloromethane	ND	0.05	ug/g	ND			NC	50	

Certificate of Analysis
Client: Pinchin Ltd. (Ottawa)
Client PO:

Report Date: 29-May-2023
Order Date: 19-May-2023
Project Description: 329269.002

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Bromoform	ND	0.05	ug/g	ND			NC	50	
Bromomethane	ND	0.05	ug/g	ND			NC	50	
Carbon Tetrachloride	ND	0.05	ug/g	ND			NC	50	
Chlorobenzene	ND	0.05	ug/g	ND			NC	50	
Chloroform	ND	0.05	ug/g	ND			NC	50	
Dibromochloromethane	ND	0.05	ug/g	ND			NC	50	
Dichlorodifluoromethane	ND	0.05	ug/g	ND			NC	50	
1,2-Dichlorobenzene	ND	0.05	ug/g	ND			NC	50	
1,3-Dichlorobenzene	ND	0.05	ug/g	ND			NC	50	
1,4-Dichlorobenzene	ND	0.05	ug/g	ND			NC	50	
1,1-Dichloroethane	ND	0.05	ug/g	ND			NC	50	
1,2-Dichloroethane	ND	0.05	ug/g	ND			NC	50	
1,1-Dichloroethylene	ND	0.05	ug/g	ND			NC	50	
cis-1,2-Dichloroethylene	ND	0.05	ug/g	ND			NC	50	
trans-1,2-Dichloroethylene	ND	0.05	ug/g	ND			NC	50	
1,2-Dichloropropane	ND	0.05	ug/g	ND			NC	50	
cis-1,3-Dichloropropylene	ND	0.05	ug/g	ND			NC	50	
trans-1,3-Dichloropropylene	ND	0.05	ug/g	ND			NC	50	
Ethylbenzene	ND	0.05	ug/g	ND			NC	50	
Ethylene dibromide (dibromoethane, 1,2-	ND	0.05	ug/g	ND			NC	50	
Hexane	ND	0.05	ug/g	ND			NC	50	
Methyl Ethyl Ketone (2-Butanone)	ND	0.50	ug/g	ND			NC	50	
Methyl Isobutyl Ketone	ND	0.50	ug/g	ND			NC	50	
Methyl tert-butyl ether	ND	0.05	ug/g	ND			NC	50	
Methylene Chloride	ND	0.05	ug/g	ND			NC	50	
Styrene	ND	0.05	ug/g	ND			NC	50	
1,1,1,2-Tetrachloroethane	ND	0.05	ug/g	ND			NC	50	
1,1,2,2-Tetrachloroethane	ND	0.05	ug/g	ND			NC	50	
Tetrachloroethylene	ND	0.05	ug/g	ND			NC	50	
Toluene	ND	0.05	ug/g	ND			NC	50	
1,1,1-Trichloroethane	ND	0.05	ug/g	ND			NC	50	
1,1,2-Trichloroethane	ND	0.05	ug/g	ND			NC	50	
Trichloroethylene	ND	0.05	ug/g	ND			NC	50	
Trichlorofluoromethane	ND	0.05	ug/g	ND			NC	50	
Vinyl chloride	ND	0.02	ug/g	ND			NC	50	
m,p-Xylenes	ND	0.05	ug/g	ND			NC	50	
o-Xylene	ND	0.05	ug/g	ND			NC	50	
Surrogate: 4-Bromofluorobenzene	*3.78*		*ug/g*		*109*	*50-140*			
Surrogate: Dibromofluoromethane	*2.88*		*ug/g*		*83.1*	*50-140*			
Surrogate: Toluene-d8	*3.20*		*ug/g*		*92.3*	*50-140*			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Cyanide, free	0.285	0.03	ug/g	ND	81.3	50-150			
Hydrocarbons									
F1 PHCs (C6-C10)	182	7	ug/g	ND	91.2	80-120			
F2 PHCs (C10-C16)	110	4	ug/g	ND	114	60-140			
F3 PHCs (C16-C34)	284	8	ug/g	ND	120	60-140			
F4 PHCs (C34-C50)	187	6	ug/g	ND	125	60-140			
Metals									
Antimony	48.4	1.0	ug/g	1.5	93.8	70-130			
Arsenic	69.7	1.0	ug/g	9.9	120	70-130			
Barium	57.7	1.0	ug/g	ND	115	70-130			
Beryllium	63.5	0.5	ug/g	ND	126	70-130			
Boron	66.2	5.0	ug/g	7.8	117	70-130			
Cadmium	59.2	0.5	ug/g	0.7	117	70-130			
Chromium	80.6	5.0	ug/g	16.3	129	70-130			
Cobalt	64.6	1.0	ug/g	3.5	122	70-130			
Copper	62.2	5.0	ug/g	6.3	112	70-130			
Lead	62.6	1.0	ug/g	7.4	110	70-130			
Molybdenum	60.6	1.0	ug/g	1.0	119	70-130			
Nickel	68.4	5.0	ug/g	7.3	122	70-130			
Selenium	54.9	1.0	ug/g	ND	109	70-130			
Silver	74.1	0.3	ug/g	31.1	85.9	70-130			
Thallium	53.3	1.0	ug/g	ND	106	70-130			
Uranium	53.1	1.0	ug/g	ND	106	70-130			
Vanadium	78.9	10.0	ug/g	13.9	130	70-130			
Zinc	82.1	20.0	ug/g	21.6	121	70-130			
Semi-Volatiles									
Acenaphthene	0.132	0.02	ug/g	ND	71.1	50-140			
Acenaphthylene	0.126	0.02	ug/g	ND	67.7	50-140			
Anthracene	0.124	0.02	ug/g	ND	66.4	50-140			
Benzo [a] anthracene	0.133	0.02	ug/g	ND	71.3	50-140			
Benzo [a] pyrene	0.131	0.02	ug/g	ND	70.5	50-140			
Benzo [b] fluoranthene	0.127	0.02	ug/g	ND	68.3	50-140			
Benzo [g,h,i] perylene	0.111	0.02	ug/g	ND	59.8	50-140			
Benzo [k] fluoranthene	0.110	0.02	ug/g	ND	59.1	50-140			
Chrysene	0.162	0.02	ug/g	ND	87.1	50-140			
Dibenzo [a,h] anthracene	0.117	0.02	ug/g	ND	62.7	50-140			
Fluoranthene	0.123	0.02	ug/g	ND	65.9	50-140			
Fluorene	0.139	0.02	ug/g	ND	74.8	50-140			
Indeno [1,2,3-cd] pyrene	0.112	0.02	ug/g	ND	60.3	50-140			
1-Methylnaphthalene	0.170	0.02	ug/g	ND	91.2	50-140			
2-Methylnaphthalene	0.183	0.02	ug/g	ND	98.3	50-140			
Naphthalene	0.146	0.01	ug/g	ND	78.3	50-140			
Phenanthrene	0.177	0.02	ug/g	ND	95.2	50-140			
Pyrene	0.120	0.02	ug/g	ND	64.2	50-140			
Surrogate: 2-Fluorobiphenyl	*1.04*		*ug/g*		*69.5*	*50-140*			
Surrogate: Terphenyl-d14	*1.33*		*ug/g*		*89.1*	*50-140*			
Volatiles									
Acetone	8.00	0.50	ug/g	ND	80.0	50-140			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Benzene	2.79	0.02	ug/g	ND	69.7	60-130			
Bromodichloromethane	3.60	0.05	ug/g	ND	90.1	60-130			
Bromoform	4.08	0.05	ug/g	ND	102	60-130			
Bromomethane	3.26	0.05	ug/g	ND	81.5	50-140			
Carbon Tetrachloride	4.09	0.05	ug/g	ND	102	60-130			
Chlorobenzene	3.28	0.05	ug/g	ND	81.9	60-130			
Chloroform	3.26	0.05	ug/g	ND	81.6	60-130			
Dibromochloromethane	3.95	0.05	ug/g	ND	98.8	60-130			
Dichlorodifluoromethane	4.52	0.05	ug/g	ND	113	50-140			
1,2-Dichlorobenzene	4.23	0.05	ug/g	ND	106	60-130			
1,3-Dichlorobenzene	4.00	0.05	ug/g	ND	100	60-130			
1,4-Dichlorobenzene	3.84	0.05	ug/g	ND	95.9	60-130			
1,1-Dichloroethane	3.50	0.05	ug/g	ND	87.6	60-130			
1,2-Dichloroethane	4.37	0.05	ug/g	ND	109	60-130			
1,1-Dichloroethylene	3.38	0.05	ug/g	ND	84.6	60-130			
cis-1,2-Dichloroethylene	3.25	0.05	ug/g	ND	81.2	60-130			
trans-1,2-Dichloroethylene	3.29	0.05	ug/g	ND	82.3	60-130			
1,2-Dichloropropane	2.61	0.05	ug/g	ND	65.3	60-130			
cis-1,3-Dichloropropylene	3.95	0.05	ug/g	ND	98.9	60-130			
trans-1,3-Dichloropropylene	3.09	0.05	ug/g	ND	77.2	60-130			
Ethylbenzene	3.51	0.05	ug/g	ND	87.6	60-130			
Ethylene dibromide (dibromoethane, 1,2	3.42	0.05	ug/g	ND	85.5	60-130			
Hexane	2.71	0.05	ug/g	ND	67.7	60-130			
Methyl Ethyl Ketone (2-Butanone)	9.47	0.50	ug/g	ND	94.7	50-140			
Methyl Isobutyl Ketone	8.46	0.50	ug/g	ND	84.6	50-140			
Methyl tert-butyl ether	11.9	0.05	ug/g	ND	119	50-140			
Methylene Chloride	2.97	0.05	ug/g	ND	74.1	60-130			
Styrene	3.59	0.05	ug/g	ND	89.7	60-130			
1,1,1,2-Tetrachloroethane	3.68	0.05	ug/g	ND	91.9	60-130			
1,1,2,2-Tetrachloroethane	3.74	0.05	ug/g	ND	93.5	60-130			
Tetrachloroethylene	3.14	0.05	ug/g	ND	78.6	60-130			
Toluene	3.41	0.05	ug/g	ND	85.3	60-130			
1,1,1-Trichloroethane	3.86	0.05	ug/g	ND	96.6	60-130			
1,1,2-Trichloroethane	2.94	0.05	ug/g	ND	73.5	60-130			
Trichloroethylene	2.98	0.05	ug/g	ND	74.5	60-130			
Trichlorofluoromethane	2.99	0.05	ug/g	ND	74.8	50-140			
Vinyl chloride	2.73	0.02	ug/g	ND	68.4	50-140			
m,p-Xylenes	7.48	0.05	ug/g	ND	93.5	60-130			
o-Xylene	4.03	0.05	ug/g	ND	101	60-130			
Surrogate: 4-Bromofluorobenzene	*2.16*		*ug/g*		*67.5*	*50-140*			
Surrogate: Dibromofluoromethane	*2.66*		*ug/g*		*83.0*	*50-140*			
Surrogate: Toluene-d8	*2.87*		*ug/g*		*89.7*	*50-140*			

Qualifier Notes:

Login Qualifiers :

Received at temperature > 25C [all samples]

Applies to samples:

Container(s) - Labeled improperly/insufficient information - 120 ml soil jar has a sample collection date of May 18, 2023, the chain of custody reads as May 19, 2023.

Applies to samples: BH-1 SS6

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.
- When reported, data for F4G has been processed using a silica gel cleanup.

PARACEL
LABORATORIES LTD.

Paracel ID: 2320512

Paracel Order Number
(Lab Use Only)

Chain Of Custody
(Lab Use Only)
№ 134191

Client Name: Pinchin	Project Ref: 324269.002
Contact Name: Mike Leach, Matt Ryan	Quote #:
Address: 1 Hines Road	PO #:
Telephone: 613 592 3387	E-mail: mleach@pinchin.com mryan@pinchin.com

Page __ of __

Turnaround Time
☐ 1 day ☐ 3 day
☐ 2 day ☒ Regular
Date Required: ________

☒ REG 153/04 ☐ REG 406/19
☐ Table 1 ☐ Res/Park ☐ Med/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☒ Table 3 ☐ Agri/Other
☐ Table ___
For RSC: ☐ Yes ☐ No

Other Regulation
☐ REG 558 ☐ PWQO
☐ CCME ☐ MISA
☐ SU - Sani ☐ SU - Storm
Mun: ________
☐ Other:

Matrix Type: **S** (Soil/Sed.) **GW** (Ground Water) **SW** (Surface Water) **SS** (Storm/Sanitary Sewer) **P** (Paint) **A** (Air) **O** (Other)

Required Analysis

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP	Hg	CrVI	B (HWS)	inorganics	pH			
1	BH-1 SS2	S		2	May 19 2023				X	X				X				
2	BH-1 SS6	S		4	May 19 2023		X	X	X						X			
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

Comments:

Method of Delivery: Walkin

Relinquished By (Sign):	Received By Driver/Depot: UR Bloom	Received at Lab: Suneeparn Dolmai	Verified By:
Relinquished By (Print): Mike Leach	Date/Time: May 19, 23 4:05	Date/Time: May 23, 2023 12.41	Date/Time: May 23/23 12:54
Date/Time: May 19 2023	Temperature: 27.5 °C	Temperature: 6.6 °C	pH Verified: ☐ By:

Chain of Custody (Env) xlsx

Revision 4.0

Certificate of Analysis

Pinchin Ltd. (Ottawa)

1 Hines Road, Suite 200
Kanata, ON K2K 3C7
Attn: Mike Leach

Client PO:
Project: 324269.002
Custody: 138322

Report Date: 30-May-2023
Order Date: 23-May-2023

Order #: 2321179

This Certificate of Analysis contains analytical data applicable to the following samples as submitted :

Paracel ID	Client ID
2321179-01	BH-101 SS2
2321179-02	BH-101 SS7
2321179-03	BH-102 SS4
2321179-04	BH-103 SS7

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis

Client: **Pinchin Ltd. (Ottawa)**

Client PO:

Report Date: 30-May-2023

Order Date: 23-May-2023

Project Description: 324269.002

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	25-May-23	26-May-23
PHC F1	CWS Tier 1 - P&T GC-FID	26-May-23	28-May-23
PHCs F2 to F4	CWS Tier 1 - GC-FID, extraction	25-May-23	27-May-23
REG 153: PAHs by GC-MS	EPA 8270 - GC-MS, extraction	25-May-23	27-May-23
REG 153: VOCs by P&T GC/MS	EPA 8260 - P&T GC-MS	26-May-23	28-May-23
Solids, %	CWS Tier 1 - Gravimetric	29-May-23	29-May-23

Certificate of Analysis

Client: **Pinchin Ltd. (Ottawa)**

Client PO:

Report Date: 30-May-2023

Order Date: 23-May-2023

Project Description: 324269.002

Client ID: **Sample Date:** **Sample ID:**		BH-101 SS2 23-May-23 09:00 2321179-01	BH-101 SS7 23-May-23 09:00 2321179-02	BH-102 SS4 23-May-23 09:00 2321179-03	BH-103 SS7 23-May-23 09:00 2321179-04
	MDL/Units	Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	-	62.4	62.9	61.3
General Inorganics					
pH	0.05 pH Units	7.13	-	-	-
Volatiles					
Acetone	0.50 ug/g dry	-	<0.50	<0.50	<0.50
Benzene	0.02 ug/g dry	-	<0.02	<0.02	<0.02
Bromodichloromethane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Bromoform	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Bromomethane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Carbon Tetrachloride	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Chlorobenzene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Chloroform	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Dibromochloromethane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Dichlorodifluoromethane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
1,2-Dichlorobenzene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
1,3-Dichlorobenzene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
1,4-Dichlorobenzene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
1,1-Dichloroethane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
1,2-Dichloroethane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
1,1-Dichloroethylene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
cis-1,2-Dichloroethylene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
trans-1,2-Dichloroethylene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
1,2-Dichloropropane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
cis-1,3-Dichloropropylene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
trans-1,3-Dichloropropylene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
1,3-Dichloropropene, total	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Ethylbenzene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Ethylene dibromide (dibromoethane, 1,2-)	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Hexane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Methyl Ethyl Ketone (2-Butanone)	0.50 ug/g dry	-	<0.50	<0.50	<0.50
Methyl Isobutyl Ketone	0.50 ug/g dry	-	<0.50	<0.50	<0.50
Methyl tert-butyl ether	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Methylene Chloride	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Styrene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
1,1,1,2-Tetrachloroethane	0.05 ug/g dry	-	<0.05	<0.05	<0.05

Certificate of Analysis

Client: **Pinchin Ltd. (Ottawa)**

Client PO:

Report Date: 30-May-2023

Order Date: 23-May-2023

Project Description: 324269.002

Client ID: **Sample Date:** **Sample ID:**		BH-101 SS2 23-May-23 09:00 2321179-01	BH-101 SS7 23-May-23 09:00 2321179-02	BH-102 SS4 23-May-23 09:00 2321179-03	BH-103 SS7 23-May-23 09:00 2321179-04
	MDL/Units	Soil	Soil	Soil	Soil
1,1,2,2-Tetrachloroethane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Tetrachloroethylene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Toluene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
1,1,1-Trichloroethane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
1,1,2-Trichloroethane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Trichloroethylene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Trichlorofluoromethane	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Vinyl chloride	0.02 ug/g dry	-	<0.02	<0.02	<0.02
m,p-Xylenes	0.05 ug/g dry	-	<0.05	<0.05	<0.05
o-Xylene	0.05 ug/g dry	-	<0.05	<0.05	<0.05
Xylenes, total	0.05 ug/g dry	-	<0.05	<0.05	<0.05
4-Bromofluorobenzene	Surrogate	-	123%	116%	117%
Dibromofluoromethane	Surrogate	-	100%	98.3%	135%
Toluene-d8	Surrogate	-	99.8%	96.7%	72.6%
Hydrocarbons					
F1 PHCs (C6-C10)	7 ug/g dry	-	<7	<7	<7
F2 PHCs (C10-C16)	4 ug/g dry	-	<4	<4	<4
F3 PHCs (C16-C34)	8 ug/g dry	-	<8	<8	<8
F4 PHCs (C34-C50)	6 ug/g dry	-	<6	<6	<6
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	-	-	-	<0.02
Acenaphthylene	0.02 ug/g dry	-	-	-	<0.02
Anthracene	0.02 ug/g dry	-	-	-	<0.02
Benzo [a] anthracene	0.02 ug/g dry	-	-	-	<0.02
Benzo [a] pyrene	0.02 ug/g dry	-	-	-	<0.02
Benzo [b] fluoranthene	0.02 ug/g dry	-	-	-	<0.02
Benzo [g,h,i] perylene	0.02 ug/g dry	-	-	-	<0.02
Benzo [k] fluoranthene	0.02 ug/g dry	-	-	-	<0.02
Chrysene	0.02 ug/g dry	-	-	-	<0.02
Dibenzo [a,h] anthracene	0.02 ug/g dry	-	-	-	<0.02
Fluoranthene	0.02 ug/g dry	-	-	-	<0.02
Fluorene	0.02 ug/g dry	-	-	-	<0.02
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	-	-	-	<0.02
1-Methylnaphthalene	0.02 ug/g dry	-	-	-	<0.02
2-Methylnaphthalene	0.02 ug/g dry	-	-	-	<0.02
Methylnaphthalene (1&2)	0.04 ug/g dry	-	-	-	<0.04

Client ID:		BH-101 SS2	BH-101 SS7	BH-102 SS4	BH-103 SS7
Sample Date:		23-May-23 09:00	23-May-23 09:00	23-May-23 09:00	23-May-23 09:00
Sample ID:		2321179-01	2321179-02	2321179-03	2321179-04
	MDL/Units	Soil	Soil	Soil	Soil
Naphthalene	0.01 ug/g dry	-	-	-	<0.01
Phenanthrene	0.02 ug/g dry	-	-	-	<0.02
Pyrene	0.02 ug/g dry	-	-	-	<0.02
2-Fluorobiphenyl	Surrogate	-	-	-	83.2%
Terphenyl-d14	Surrogate	-	-	-	78.3%

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	7	ug/g						
F2 PHCs (C10-C16)	ND	4	ug/g						
F3 PHCs (C16-C34)	ND	8	ug/g						
F4 PHCs (C34-C50)	ND	6	ug/g						
Semi-Volatiles									
Acenaphthene	ND	0.02	ug/g						
Acenaphthylene	ND	0.02	ug/g						
Anthracene	ND	0.02	ug/g						
Benzo [a] anthracene	ND	0.02	ug/g						
Benzo [a] pyrene	ND	0.02	ug/g						
Benzo [b] fluoranthene	ND	0.02	ug/g						
Benzo [g,h,i] perylene	ND	0.02	ug/g						
Benzo [k] fluoranthene	ND	0.02	ug/g						
Chrysene	ND	0.02	ug/g						
Dibenzo [a,h] anthracene	ND	0.02	ug/g						
Fluoranthene	ND	0.02	ug/g						
Fluorene	ND	0.02	ug/g						
Indeno [1,2,3-cd] pyrene	ND	0.02	ug/g						
1-Methylnaphthalene	ND	0.02	ug/g						
2-Methylnaphthalene	ND	0.02	ug/g						
Methylnaphthalene (1&2)	ND	0.04	ug/g						
Naphthalene	ND	0.01	ug/g						
Phenanthrene	ND	0.02	ug/g						
Pyrene	ND	0.02	ug/g						
Surrogate: 2-Fluorobiphenyl	*1.08*		*ug/g*		*80.7*	*50-140*			
Surrogate: Terphenyl-d14	*1.00*		*ug/g*		*75.3*	*50-140*			
Volatiles									
Acetone	ND	0.50	ug/g						
Benzene	ND	0.02	ug/g						
Bromodichloromethane	ND	0.05	ug/g						
Bromoform	ND	0.05	ug/g						
Bromomethane	ND	0.05	ug/g						
Carbon Tetrachloride	ND	0.05	ug/g						
Chlorobenzene	ND	0.05	ug/g						
Chloroform	ND	0.05	ug/g						
Dibromochloromethane	ND	0.05	ug/g						
Dichlorodifluoromethane	ND	0.05	ug/g						
1,2-Dichlorobenzene	ND	0.05	ug/g						
1,3-Dichlorobenzene	ND	0.05	ug/g						
1,4-Dichlorobenzene	ND	0.05	ug/g						
1,1-Dichloroethane	ND	0.05	ug/g						
1,2-Dichloroethane	ND	0.05	ug/g						
1,1-Dichloroethylene	ND	0.05	ug/g						
cis-1,2-Dichloroethylene	ND	0.05	ug/g						
trans-1,2-Dichloroethylene	ND	0.05	ug/g						
1,2-Dichloropropane	ND	0.05	ug/g						
cis-1,3-Dichloropropylene	ND	0.05	ug/g						
trans-1,3-Dichloropropylene	ND	0.05	ug/g						
1,3-Dichloropropene, total	ND	0.05	ug/g						
Ethylbenzene	ND	0.05	ug/g						
Ethylene dibromide (dibromoethane, 1,2	ND	0.05	ug/g						
Hexane	ND	0.05	ug/g						
Methyl Ethyl Ketone (2-Butanone)	ND	0.50	ug/g						
Methyl Isobutyl Ketone	ND	0.50	ug/g						
Methyl tert-butyl ether	ND	0.05	ug/g						
Methylene Chloride	ND	0.05	ug/g						
Styrene	ND	0.05	ug/g						
1,1,1,2-Tetrachloroethane	ND	0.05	ug/g						

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
1,1,2,2-Tetrachloroethane	ND	0.05	ug/g						
Tetrachloroethylene	ND	0.05	ug/g						
Toluene	ND	0.05	ug/g						
1,1,1-Trichloroethane	ND	0.05	ug/g						
1,1,2-Trichloroethane	ND	0.05	ug/g						
Trichloroethylene	ND	0.05	ug/g						
Trichlorofluoromethane	ND	0.05	ug/g						
Vinyl chloride	ND	0.02	ug/g						
m,p-Xylenes	ND	0.05	ug/g						
o-Xylene	ND	0.05	ug/g						
Xylenes, total	ND	0.05	ug/g						
Surrogate: 4-Bromofluorobenzene	*9.08*		*ug/g*		*114*	*50-140*			
Surrogate: Dibromofluoromethane	*7.17*		*ug/g*		*89.6*	*50-140*			
Surrogate: Toluene-d8	*6.73*		*ug/g*		*84.1*	*50-140*			

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
pH	7.11	0.05	pH Units	7.13			0.3	2.3	
Hydrocarbons									
F1 PHCs (C6-C10)	ND	7	ug/g	ND			NC	40	
F2 PHCs (C10-C16)	17900	80	ug/g	13500			27.8	30	
F3 PHCs (C16-C34)	14800	160	ug/g	19800			29.2	30	
F4 PHCs (C34-C50)	1650	120	ug/g	3450			70.3	30	QR-04
Physical Characteristics									
% Solids	88.8	0.1	% by Wt.	89.2			0.4	25	
Semi-Volatiles									
Acenaphthene	ND	0.02	ug/g	ND			NC	40	
Acenaphthylene	ND	0.02	ug/g	ND			NC	40	
Anthracene	ND	0.02	ug/g	ND			NC	40	
Benzo [a] anthracene	ND	0.02	ug/g	ND			NC	40	
Benzo [a] pyrene	ND	0.02	ug/g	ND			NC	40	
Benzo [b] fluoranthene	ND	0.02	ug/g	ND			NC	40	
Benzo [g,h,i] perylene	ND	0.02	ug/g	ND			NC	40	
Benzo [k] fluoranthene	ND	0.02	ug/g	ND			NC	40	
Chrysene	ND	0.02	ug/g	ND			NC	40	
Dibenzo [a,h] anthracene	ND	0.02	ug/g	ND			NC	40	
Fluoranthene	ND	0.02	ug/g	ND			NC	40	
Fluorene	ND	0.02	ug/g	ND			NC	40	
Indeno [1,2,3-cd] pyrene	ND	0.02	ug/g	ND			NC	40	
1-Methylnaphthalene	ND	0.02	ug/g	ND			NC	40	
2-Methylnaphthalene	ND	0.02	ug/g	ND			NC	40	
Naphthalene	ND	0.01	ug/g	ND			NC	40	
Phenanthrene	ND	0.02	ug/g	ND			NC	40	
Pyrene	ND	0.02	ug/g	ND			NC	40	
Surrogate: 2-Fluorobiphenyl	*1.10*		*ug/g*		*63.0*	*50-140*			
Surrogate: Terphenyl-d14	*1.08*		*ug/g*		*61.6*	*50-140*			
Volatiles									
Acetone	ND	0.50	ug/g	ND			NC	50	
Benzene	ND	0.02	ug/g	ND			NC	50	
Bromodichloromethane	ND	0.05	ug/g	ND			NC	50	
Bromoform	ND	0.05	ug/g	ND			NC	50	
Bromomethane	ND	0.05	ug/g	ND			NC	50	
Carbon Tetrachloride	ND	0.05	ug/g	ND			NC	50	
Chlorobenzene	ND	0.05	ug/g	ND			NC	50	
Chloroform	ND	0.05	ug/g	ND			NC	50	
Dibromochloromethane	ND	0.05	ug/g	ND			NC	50	
Dichlorodifluoromethane	ND	0.05	ug/g	ND			NC	50	
1,2-Dichlorobenzene	ND	0.05	ug/g	ND			NC	50	
1,3-Dichlorobenzene	ND	0.05	ug/g	ND			NC	50	
1,4-Dichlorobenzene	ND	0.05	ug/g	ND			NC	50	
1,1-Dichloroethane	ND	0.05	ug/g	ND			NC	50	
1,2-Dichloroethane	ND	0.05	ug/g	ND			NC	50	
1,1-Dichloroethylene	ND	0.05	ug/g	ND			NC	50	
cis-1,2-Dichloroethylene	ND	0.05	ug/g	ND			NC	50	
trans-1,2-Dichloroethylene	ND	0.05	ug/g	ND			NC	50	
1,2-Dichloropropane	ND	0.05	ug/g	ND			NC	50	
cis-1,3-Dichloropropylene	ND	0.05	ug/g	ND			NC	50	
trans-1,3-Dichloropropylene	ND	0.05	ug/g	ND			NC	50	
Ethylbenzene	ND	0.05	ug/g	ND			NC	50	
Ethylene dibromide (dibromoethane, 1,2	ND	0.05	ug/g	ND			NC	50	
Hexane	ND	0.05	ug/g	ND			NC	50	
Methyl Ethyl Ketone (2-Butanone)	ND	0.50	ug/g	ND			NC	50	
Methyl Isobutyl Ketone	ND	0.50	ug/g	ND			NC	50	

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Methyl tert-butyl ether	ND	0.05	ug/g	ND			NC	50	
Methylene Chloride	ND	0.05	ug/g	ND			NC	50	
Styrene	ND	0.05	ug/g	ND			NC	50	
1,1,1,2-Tetrachloroethane	ND	0.05	ug/g	ND			NC	50	
1,1,2,2-Tetrachloroethane	ND	0.05	ug/g	ND			NC	50	
Tetrachloroethylene	ND	0.05	ug/g	ND			NC	50	
Toluene	ND	0.05	ug/g	ND			NC	50	
1,1,1-Trichloroethane	ND	0.05	ug/g	ND			NC	50	
1,1,2-Trichloroethane	ND	0.05	ug/g	ND			NC	50	
Trichloroethylene	ND	0.05	ug/g	ND			NC	50	
Trichlorofluoromethane	ND	0.05	ug/g	ND			NC	50	
Vinyl chloride	ND	0.02	ug/g	ND			NC	50	
m,p-Xylenes	ND	0.05	ug/g	ND			NC	50	
o-Xylene	ND	0.05	ug/g	ND			NC	50	
Surrogate: 4-Bromofluorobenzene	*9.86*		*ug/g*		*107*	*50-140*			
Surrogate: Dibromofluoromethane	*8.73*		*ug/g*		*94.6*	*50-140*			
Surrogate: Toluene-d8	*8.20*		*ug/g*		*88.9*	*50-140*			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	161	7	ug/g	ND	80.3	80-120			
F2 PHCs (C10-C16)	88	4	ug/g	ND	110	80-120			
F3 PHCs (C16-C34)	223	8	ug/g	ND	114	80-120			
F4 PHCs (C34-C50)	134	6	ug/g	ND	108	80-120			
Semi-Volatiles									
Acenaphthene	0.128	0.02	ug/g	ND	58.9	50-140			
Acenaphthylene	0.123	0.02	ug/g	ND	56.3	50-140			
Anthracene	0.145	0.02	ug/g	ND	66.7	50-140			
Benzo [a] anthracene	0.148	0.02	ug/g	ND	68.1	50-140			
Benzo [a] pyrene	0.160	0.02	ug/g	ND	73.4	50-140			
Benzo [b] fluoranthene	0.126	0.02	ug/g	ND	57.8	50-140			
Benzo [g,h,i] perylene	0.143	0.02	ug/g	ND	65.4	50-140			
Benzo [k] fluoranthene	0.128	0.02	ug/g	ND	58.5	50-140			
Chrysene	0.142	0.02	ug/g	ND	65.1	50-140			
Dibenzo [a,h] anthracene	0.151	0.02	ug/g	ND	69.0	50-140			
Fluoranthene	0.141	0.02	ug/g	ND	64.7	50-140			
Fluorene	0.131	0.02	ug/g	ND	60.0	50-140			
Indeno [1,2,3-cd] pyrene	0.153	0.02	ug/g	ND	70.0	50-140			
1-Methylnaphthalene	0.199	0.02	ug/g	ND	91.4	50-140			
2-Methylnaphthalene	0.218	0.02	ug/g	ND	100	50-140			
Naphthalene	0.165	0.01	ug/g	ND	75.6	50-140			
Phenanthrene	0.173	0.02	ug/g	ND	79.1	50-140			
Pyrene	0.146	0.02	ug/g	ND	66.9	50-140			
Surrogate: 2-Fluorobiphenyl	*1.23*		*ug/g*		*70.6*	*50-140*			
Surrogate: Terphenyl-d14	*1.10*		*ug/g*		*62.8*	*50-140*			
Volatiles									
Acetone	7.33	0.50	ug/g	ND	73.3	50-140			
Benzene	3.61	0.02	ug/g	ND	90.2	60-130			
Bromodichloromethane	4.02	0.05	ug/g	ND	101	60-130			
Bromoform	4.80	0.05	ug/g	ND	120	60-130			
Bromomethane	3.71	0.05	ug/g	ND	92.7	50-140			
Carbon Tetrachloride	4.39	0.05	ug/g	ND	110	60-130			
Chlorobenzene	4.57	0.05	ug/g	ND	114	60-130			
Chloroform	4.17	0.05	ug/g	ND	104	60-130			
Dibromochloromethane	4.74	0.05	ug/g	ND	118	60-130			
Dichlorodifluoromethane	3.97	0.05	ug/g	ND	99.1	50-140			
1,2-Dichlorobenzene	4.14	0.05	ug/g	ND	103	60-130			
1,3-Dichlorobenzene	3.90	0.05	ug/g	ND	97.4	60-130			
1,4-Dichlorobenzene	3.85	0.05	ug/g	ND	96.2	60-130			
1,1-Dichloroethane	3.75	0.05	ug/g	ND	93.7	60-130			
1,2-Dichloroethane	4.96	0.05	ug/g	ND	124	60-130			
1,1-Dichloroethylene	3.51	0.05	ug/g	ND	87.7	60-130			
cis-1,2-Dichloroethylene	3.55	0.05	ug/g	ND	88.8	60-130			
trans-1,2-Dichloroethylene	3.49	0.05	ug/g	ND	87.3	60-130			
1,2-Dichloropropane	3.68	0.05	ug/g	ND	91.9	60-130			
cis-1,3-Dichloropropylene	2.73	0.05	ug/g	ND	68.3	60-130			
trans-1,3-Dichloropropylene	2.68	0.05	ug/g	ND	66.9	60-130			
Ethylbenzene	3.74	0.05	ug/g	ND	93.5	60-130			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Ethylene dibromide (dibromoethane, 1,2-	4.14	0.05	ug/g	ND	104	60-130			
Hexane	3.23	0.05	ug/g	ND	80.7	60-130			
Methyl Ethyl Ketone (2-Butanone)	7.42	0.50	ug/g	ND	74.2	50-140			
Methyl Isobutyl Ketone	6.88	0.50	ug/g	ND	68.8	50-140			
Methyl tert-butyl ether	7.35	0.05	ug/g	ND	73.5	50-140			
Methylene Chloride	4.30	0.05	ug/g	ND	108	60-130			
Styrene	4.27	0.05	ug/g	ND	107	60-130			
1,1,1,2-Tetrachloroethane	4.31	0.05	ug/g	ND	108	60-130			
1,1,2,2-Tetrachloroethane	2.72	0.05	ug/g	ND	68.1	60-130			
Tetrachloroethylene	4.92	0.05	ug/g	ND	123	60-130			
Toluene	4.10	0.05	ug/g	ND	102	60-130			
1,1,1-Trichloroethane	4.97	0.05	ug/g	ND	124	60-130			
1,1,2-Trichloroethane	3.66	0.05	ug/g	ND	91.6	60-130			
Trichloroethylene	4.48	0.05	ug/g	ND	112	60-130			
Trichlorofluoromethane	3.71	0.05	ug/g	ND	92.9	50-140			
Vinyl chloride	3.70	0.02	ug/g	ND	92.4	50-140			
m,p-Xylenes	8.45	0.05	ug/g	ND	106	60-130			
o-Xylene	3.83	0.05	ug/g	ND	95.9	60-130			
Surrogate: 4-Bromofluorobenzene	*7.47*		*ug/g*		*93.4*	*50-140*			
Surrogate: Dibromofluoromethane	*7.03*		*ug/g*		*87.8*	*50-140*			
Surrogate: Toluene-d8	*5.46*		*ug/g*		*68.2*	*50-140*			

Qualifier Notes:

Login Qualifiers :

Container and COC sample IDs don't match - Sample labelled as "BH-103 SS7" and the chain of custody reads "BH-103 SS."

Applies to samples: BH-103 SS7

QC Qualifiers :

QR-04 Duplicate results exceeds RPD limits due to non-homogeneous matrix.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC criteria.
- When reported, data for F4G has been processed using a silica gel cleanup.

PARACEL
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Paracel ID: 2321179

Paracel Order Number (Lab Use Only): 2321179

Chain Of Custody (Lab Use Only) № 138322

Client Name: Pinchin
Contact Name: Mike Leach ; Matt Ryan
Address: 1 Hines Road
Telephone: 613 592 3387

Project Ref: 324269.002
Quote #:
PO #:
E-mail: mleach@pinchin.com
mryan@pinchin.com

Page _ of _

Turnaround Time
☐ 1 day ☐ 3 day
☐ 2 day ☒ Regular
Date Required:

☒ REG 153/04 ☐ REG 406/19
☐ Table 1 ☐ Res/Park ☐ Med/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☒ Table 3 ☐ Agri/Other
☐ Table
For RSC: ☐ Yes ☐ No

Other Regulation
☐ REG 558 ☐ PWQO
☐ CCME ☐ MISA
☐ SU - Sani ☐ SU - Storm
Mun:
☐ Other:

Matrix Type: **S** (Soil/Sed.) **GW** (Ground Water) **SW** (Surface Water) **SS** (Storm/Sanitary Sewer) **P** (Paint) **A** (Air) **O** (Other)

Required Analysis

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP	Hg	CrVI	B (HWS)	pH				
1	BH-101 SS2	S		1	May 23									X				
2	BH-101 SS7	|		3	|		X	X										
3	BH-102 SS4	|		3	|		X	X										
4	BH-103 SS	|		3	|		X	X	X									
5																		
6																		
7																		
8																		
9																		
10																		

Comments:

Method of Delivery: Walker

Relinquished By (Sign): M Leach	Received By Driver/Depot:	Received at Lab:	Verified By:
Relinquished By (Print): Mike Leach	Date/Time: May 23/23 4:48 pm	Date/Time: May 24 2023 11:55	Date/Time: May 24/23 16:45
Date/Time: May 23 2023	Temperature: 25.2 °C	Temperature: 3.7 °C	pH Verified: ☐ By:

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Certificate of Analysis

Pinchin Ltd. (Ottawa)

1 Hines Road, Suite 200
Kanata, ON K2K 3C7
Attn: Mike Leach

Client PO:
Project: 324269.002
Custody: 134185

Report Date: 5-Jun-2023
Order Date: 29-May-2023

Order #: 2322184

This Certificate of Analysis contains analytical data applicable to the following samples as submitted :

Paracel ID	Client ID
2322184-01	BH-2 SS2
2322184-02	BH-3 SS2
2322184-03	BH-4 SS2

Approved By:

Dale Robertson, BSc
Laboratory Director

Certificate of Analysis
Client: **Pinchin Ltd. (Ottawa)**
Client PO:

Report Date: 05-Jun-2023
Order Date: 29-May-2023
Project Description: 324269.002

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Conductivity	MOE E3138 - probe @25 °C, water ext	1-Jun-23	1-Jun-23
Cyanide, free	MOE E3015 - Auto Colour, water extraction	1-Jun-23	1-Jun-23
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	30-May-23	31-May-23
REG 153: Metals by ICP/MS, soil	EPA 6020 - Digestion - ICP-MS	1-Jun-23	1-Jun-23
REG 153: PAHs by GC-MS	EPA 8270 - GC-MS, extraction	31-May-23	3-Jun-23
SAR	Calculated	1-Jun-23	1-Jun-23
Solids, %	CWS Tier 1 - Gravimetric	31-May-23	1-Jun-23

Certificate of Analysis

Client: **Pinchin Ltd. (Ottawa)**

Client PO:

Report Date: 05-Jun-2023

Order Date: 29-May-2023

Project Description: 324269.002

Client ID:		BH-2 SS2	BH-3 SS2	BH-4 SS2	-
Sample Date:		24-May-23 09:00	24-May-23 09:00	25-May-23 09:00	-
Sample ID:		2322184-01	2322184-02	2322184-03	-
	MDL/Units	Soil	Soil	Soil	-
Physical Characteristics					
% Solids	0.1 % by Wt.	88.3	85.2	97.8	-
General Inorganics					
SAR	0.01 N/A	1.49	2.35	0.68	-
Conductivity	5 uS/cm	146	357	71	-
Cyanide, free	0.03 ug/g dry	<0.03	<0.03	<0.03	-
pH	0.05 pH Units	7.53	7.49	7.54	-
Metals					
Antimony	1.0 ug/g dry	<1.0	<1.0	<1.0	-
Arsenic	1.0 ug/g dry	1.1	<1.0	<1.0	-
Barium	1.0 ug/g dry	23.9	18.8	20.7	-
Beryllium	0.5 ug/g dry	<0.5	<0.5	<0.5	-
Boron	5.0 ug/g dry	<5.0	<5.0	<5.0	-
Cadmium	0.5 ug/g dry	<0.5	<0.5	<0.5	-
Chromium	5.0 ug/g dry	14.0	11.0	9.9	-
Cobalt	1.0 ug/g dry	3.1	2.6	2.9	-
Copper	5.0 ug/g dry	6.1	<5.0	<5.0	-
Lead	1.0 ug/g dry	1.8	1.5	1.3	-
Molybdenum	1.0 ug/g dry	<1.0	<1.0	<1.0	-
Nickel	5.0 ug/g dry	7.9	6.4	7.1	-
Selenium	1.0 ug/g dry	<1.0	<1.0	<1.0	-
Silver	0.3 ug/g dry	<0.3	<0.3	<0.3	-
Thallium	1.0 ug/g dry	<1.0	<1.0	<1.0	-
Uranium	1.0 ug/g dry	<1.0	<1.0	<1.0	-
Vanadium	10.0 ug/g dry	16.9	15.7	15.8	-
Zinc	20.0 ug/g dry	<20.0	<20.0	20.6	-
Semi-Volatiles					
Acenaphthene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Acenaphthylene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Anthracene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Benzo [a] anthracene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Benzo [a] pyrene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Benzo [b] fluoranthene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Benzo [g,h,i] perylene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Benzo [k] fluoranthene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Chrysene	0.02 ug/g dry	<0.02	<0.02	<0.02	-

	Client ID:	BH-2 SS2	BH-3 SS2	BH-4 SS2	-
	Sample Date:	24-May-23 09:00	24-May-23 09:00	25-May-23 09:00	-
	Sample ID:	2322184-01	2322184-02	2322184-03	-
	MDL/Units	Soil	Soil	Soil	-
Dibenzo [a,h] anthracene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Fluoranthene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Fluorene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Indeno [1,2,3-cd] pyrene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
1-Methylnaphthalene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
2-Methylnaphthalene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Methylnaphthalene (1&2)	0.04 ug/g dry	<0.04	<0.04	<0.04	-
Naphthalene	0.01 ug/g dry	<0.01	<0.01	<0.01	-
Phenanthrene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
Pyrene	0.02 ug/g dry	<0.02	<0.02	<0.02	-
2-Fluorobiphenyl	Surrogate	104%	81.0%	113%	-
Terphenyl-d14	Surrogate	89.4%	67.1%	94.8%	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Conductivity	ND	5	uS/cm						
Cyanide, free	ND	0.03	ug/g						
Metals									
Antimony	ND	1.0	ug/g						
Arsenic	ND	1.0	ug/g						
Barium	ND	1.0	ug/g						
Beryllium	ND	0.5	ug/g						
Boron	ND	5.0	ug/g						
Cadmium	ND	0.5	ug/g						
Chromium	ND	5.0	ug/g						
Cobalt	ND	1.0	ug/g						
Copper	ND	5.0	ug/g						
Lead	ND	1.0	ug/g						
Molybdenum	ND	1.0	ug/g						
Nickel	ND	5.0	ug/g						
Selenium	ND	1.0	ug/g						
Silver	ND	0.3	ug/g						
Thallium	ND	1.0	ug/g						
Uranium	ND	1.0	ug/g						
Vanadium	ND	10.0	ug/g						
Zinc	ND	20.0	ug/g						
Semi-Volatiles									
Acenaphthene	ND	0.02	ug/g						
Acenaphthylene	ND	0.02	ug/g						
Anthracene	ND	0.02	ug/g						
Benzo [a] anthracene	ND	0.02	ug/g						
Benzo [a] pyrene	ND	0.02	ug/g						
Benzo [b] fluoranthene	ND	0.02	ug/g						
Benzo [g,h,i] perylene	ND	0.02	ug/g						
Benzo [k] fluoranthene	ND	0.02	ug/g						
Chrysene	ND	0.02	ug/g						
Dibenzo [a,h] anthracene	ND	0.02	ug/g						
Fluoranthene	ND	0.02	ug/g						
Fluorene	ND	0.02	ug/g						
Indeno [1,2,3-cd] pyrene	ND	0.02	ug/g						
1-Methylnaphthalene	ND	0.02	ug/g						
2-Methylnaphthalene	ND	0.02	ug/g						
Methylnaphthalene (1&2)	ND	0.04	ug/g						
Naphthalene	ND	0.01	ug/g						
Phenanthrene	ND	0.02	ug/g						
Pyrene	ND	0.02	ug/g						
Surrogate: 2-Fluorobiphenyl	*1.55*		*ug/g*		*116*	*50-140*			
Surrogate: Terphenyl-d14	*1.31*		*ug/g*		*98.5*	*50-140*			

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
SAR	11.4	0.01	N/A	11.7			3.1	30	
Conductivity	425	5	uS/cm	423			0.5	5	
Cyanide, free	ND	0.03	ug/g	ND			NC	35	
pH	6.22	0.05	pH Units	6.25			0.5	2.3	
Metals									
Antimony	ND	1.0	ug/g	ND			NC	30	
Arsenic	2.7	1.0	ug/g	2.5			6.6	30	
Barium	210	1.0	ug/g	226			7.2	30	
Beryllium	0.9	0.5	ug/g	1.0			6.4	30	
Boron	9.0	5.0	ug/g	11.2			22.3	30	
Cadmium	ND	0.5	ug/g	ND			NC	30	
Chromium	34.6	5.0	ug/g	37.9			9.1	30	
Cobalt	12.2	1.0	ug/g	12.4			1.6	30	
Copper	22.6	5.0	ug/g	23.7			5.0	30	
Lead	9.7	1.0	ug/g	9.8			0.7	30	
Molybdenum	ND	1.0	ug/g	ND			NC	30	
Nickel	23.5	5.0	ug/g	24.8			5.3	30	
Selenium	ND	1.0	ug/g	ND			NC	30	
Silver	ND	0.3	ug/g	ND			NC	30	
Thallium	ND	1.0	ug/g	ND			NC	30	
Uranium	ND	1.0	ug/g	ND			NC	30	
Vanadium	46.0	10.0	ug/g	49.7			7.8	30	
Zinc	67.1	20.0	ug/g	70.2			4.6	30	
Physical Characteristics									
% Solids	84.0	0.1	% by Wt.	84.6			0.8	25	
Semi-Volatiles									
Acenaphthene	ND	0.02	ug/g	ND			NC	40	
Acenaphthylene	ND	0.02	ug/g	ND			NC	40	
Anthracene	ND	0.02	ug/g	ND			NC	40	
Benzo [a] anthracene	ND	0.02	ug/g	ND			NC	40	
Benzo [a] pyrene	ND	0.02	ug/g	ND			NC	40	
Benzo [b] fluoranthene	ND	0.02	ug/g	ND			NC	40	
Benzo [g,h,i] perylene	ND	0.02	ug/g	ND			NC	40	
Benzo [k] fluoranthene	ND	0.02	ug/g	ND			NC	40	
Chrysene	ND	0.02	ug/g	ND			NC	40	
Dibenzo [a,h] anthracene	ND	0.02	ug/g	ND			NC	40	
Fluoranthene	ND	0.02	ug/g	ND			NC	40	
Fluorene	ND	0.02	ug/g	ND			NC	40	
Indeno [1,2,3-cd] pyrene	ND	0.02	ug/g	ND			NC	40	
1-Methylnaphthalene	ND	0.02	ug/g	ND			NC	40	
2-Methylnaphthalene	ND	0.02	ug/g	ND			NC	40	
Naphthalene	ND	0.01	ug/g	ND			NC	40	
Phenanthrene	ND	0.02	ug/g	ND			NC	40	
Pyrene	ND	0.02	ug/g	ND			NC	40	
Surrogate: 2-Fluorobiphenyl	*1.56*		*ug/g*		*103*	*50-140*			
Surrogate: Terphenyl-d14	*1.32*		*ug/g*		*87.6*	*50-140*			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Cyanide, free	0.354	0.03	ug/g	ND	104	50-150			
Metals									
Antimony	43.2	1.0	ug/g	ND	86.2	70-130			
Arsenic	53.4	1.0	ug/g	1.0	105	70-130			
Barium	150	1.0	ug/g	90.5	120	70-130			
Beryllium	60.1	0.5	ug/g	ND	119	70-130			
Boron	59.5	5.0	ug/g	ND	110	70-130			
Cadmium	56.6	0.5	ug/g	ND	113	70-130			
Chromium	71.4	5.0	ug/g	15.2	112	70-130			
Cobalt	59.8	1.0	ug/g	5.0	110	70-130			
Copper	63.4	5.0	ug/g	9.5	108	70-130			
Lead	52.6	1.0	ug/g	3.9	97.3	70-130			
Molybdenum	54.1	1.0	ug/g	ND	108	70-130			
Nickel	63.9	5.0	ug/g	9.9	108	70-130			
Selenium	48.9	1.0	ug/g	ND	97.6	70-130			
Silver	48.0	0.3	ug/g	ND	95.9	70-130			
Thallium	53.7	1.0	ug/g	ND	107	70-130			
Uranium	43.3	1.0	ug/g	ND	86.3	70-130			
Vanadium	75.3	10.0	ug/g	19.9	111	70-130			
Zinc	79.7	20.0	ug/g	28.1	103	70-130			
Semi-Volatiles									
Acenaphthene	0.146	0.02	ug/g	ND	77.1	50-140			
Acenaphthylene	0.152	0.02	ug/g	ND	80.3	50-140			
Anthracene	0.135	0.02	ug/g	ND	71.5	50-140			
Benzo [a] anthracene	0.131	0.02	ug/g	ND	69.2	50-140			
Benzo [a] pyrene	0.138	0.02	ug/g	ND	73.4	50-140			
Benzo [b] fluoranthene	0.122	0.02	ug/g	ND	64.7	50-140			
Benzo [g,h,i] perylene	0.118	0.02	ug/g	ND	62.3	50-140			
Benzo [k] fluoranthene	0.124	0.02	ug/g	ND	65.6	50-140			
Chrysene	0.142	0.02	ug/g	ND	75.3	50-140			
Dibenzo [a,h] anthracene	0.108	0.02	ug/g	ND	57.0	50-140			
Fluoranthene	0.128	0.02	ug/g	ND	68.0	50-140			
Fluorene	0.159	0.02	ug/g	ND	84.2	50-140			
Indeno [1,2,3-cd] pyrene	0.106	0.02	ug/g	ND	56.3	50-140			
1-Methylnaphthalene	0.194	0.02	ug/g	ND	103	50-140			
2-Methylnaphthalene	0.194	0.02	ug/g	ND	103	50-140			
Naphthalene	0.157	0.01	ug/g	ND	83.4	50-140			
Phenanthrene	0.171	0.02	ug/g	ND	90.4	50-140			
Pyrene	0.130	0.02	ug/g	ND	68.6	50-140			
Surrogate: 2-Fluorobiphenyl	*1.13*		*ug/g*		*74.9*	*50-140*			
Surrogate: Terphenyl-d14	*1.06*		*ug/g*		*70.3*	*50-140*			

Qualifier Notes:

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

PARACE
LABORATORIES LTI

Paracel ID: 2322184

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com

Paracel Order Number (Lab Use Only)	2322184
Chain Of Custody (Lab Use Only)	№ 134185

Client Name: Pinchin
Contact Name: Mike leach, Matt Ryan
Address: 1 Hines Road
Telephone: 613 592 3387
Project Ref: 324269.002
Quote #:
PO #:
E-mail: mleach@pinchin.com mryan@pinchin.com
Page __ of __

Turnaround Time

☐ 1 day ☐ 3 day
☐ 2 day ☒ Regular
Date Required: ________

☒ REG 153/04 ☐ REG 406/19

☐ Table 1 ☐ Res/Park ☐ Med/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☒ Table 3 ☐ Agri/Other
☐ Table ___
For RSC: ☐ Yes ☐ No

Other Regulation

☐ REG 558 ☐ PWQO
☐ CCME ☐ MISA
☐ SU - Sani ☐ SU - Storm
Mun: ________
☐ Other:

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analysis

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP	Hg	CrVI	B (HWS)	Inorganics				
1	BH-2 SS2	S		2	May 24/23				X	X				X				
2	BH-3 SS2	S		2	May 24/23				X	X				X				
3	BH-4 SS2	S		2	May 25/23				X	X				X				
4																		
5																		
6																		
7																		
8																		
9																		
10																		

Comments:

Method of Delivery: Walk-in

Relinquished By (Sign): Megan Kern	Received By Driver/Depot: 4:30	Received at Lab: Suneegam Dohmal	Verified By:
Relinquished By (Print): Megan Keon	Date/Time: May 29/23 pm	Date/Time: May 30, 2023 12.25	Date/Time: May 30/23 14:03
Date/Time: May 29 @ 4:31 pm	Temperature: 24.6 °C	Temperature: 12.5 °C	pH Verified: ☐ By: NA

Chain of Custody (Env) xlsx

Revision 4.0

Certificate of Analysis

Pinchin Ltd. (Ottawa)

1 Hines Road, Suite 200
Kanata, ON K2K 3C7
Attn: Mike Leach

Client PO:
Project: 324269.002
Custody: 138323

Report Date: 5-Jun-2023
Order Date: 30-May-2023

Order #: 2322204

This Certificate of Analysis contains analytical data applicable to the following samples as submitted :

Paracel ID	Client ID
2322204-01	MW-1
2322204-02	MW-101
2322204-03	MW-102
2322204-04	MW-103

Approved By:

Dale Robertson, BSc
Laboratory Director

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
PHC F1	CWS Tier 1 - P&T GC-FID	31-May-23	31-May-23
PHCs F2 to F4	CWS Tier 1 - GC-FID, extraction	1-Jun-23	1-Jun-23
REG 153: PAHs by GC-MS	EPA 625 - GC-MS, extraction	2-Jun-23	2-Jun-23
REG 153: VOCs by P&T GC/MS	EPA 624 - P&T GC-MS	31-May-23	31-May-23

Certificate of Analysis
Client: **Pinchin Ltd. (Ottawa)**
Client PO:

Report Date: 05-Jun-2023
Order Date: 30-May-2023
Project Description: 324269.002

Client ID:		MW-1	MW-101	MW-102	MW-103
Sample Date:		30-May-23 09:00	30-May-23 09:00	30-May-23 09:00	30-May-23 09:00
Sample ID:		2322204-01	2322204-02	2322204-03	2322204-04
	MDL/Units	Ground Water	Ground Water	Ground Water	Ground Water
Volatiles					
Acetone	5.0 ug/L	<5.0	<5.0	<5.0	<5.0
Benzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Bromodichloromethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Bromoform	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Bromomethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Carbon Tetrachloride	0.2 ug/L	<0.2	<0.2	<0.2	<0.2
Chlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Chloroform	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Dibromochloromethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Dichlorodifluoromethane	1.0 ug/L	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,3-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,4-Dichlorobenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,2-Dichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
cis-1,2-Dichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
trans-1,2-Dichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,2-Dichloropropane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
cis-1,3-Dichloropropylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
trans-1,3-Dichloropropylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,3-Dichloropropene, total	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Ethylene dibromide (dibromoethane, 1,2-)	0.2 ug/L	<0.2	<0.2	<0.2	<0.2
Hexane	1.0 ug/L	<1.0	<1.0	<1.0	<1.0
Methyl Ethyl Ketone (2-Butanone)	5.0 ug/L	<5.0	<5.0	<5.0	<5.0
Methyl Isobutyl Ketone	5.0 ug/L	<5.0	<5.0	<5.0	<5.0
Methyl tert-butyl ether	2.0 ug/L	13.5	<2.0	125	15.0
Methylene Chloride	5.0 ug/L	<5.0	<5.0	<5.0	<5.0
Styrene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1,1,2-Tetrachloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1,2,2-Tetrachloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Tetrachloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Toluene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5

Certificate of Analysis
Client: **Pinchin Ltd. (Ottawa)**
Client PO:

Report Date: 05-Jun-2023
Order Date: 30-May-2023
Project Description: 324269.002

	Client ID:	MW-1	MW-101	MW-102	MW-103
	Sample Date:	30-May-23 09:00	30-May-23 09:00	30-May-23 09:00	30-May-23 09:00
	Sample ID:	2322204-01	2322204-02	2322204-03	2322204-04
	MDL/Units	Ground Water	Ground Water	Ground Water	Ground Water
1,1,1-Trichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Trichloroethylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Trichlorofluoromethane	1.0 ug/L	<1.0	<1.0	<1.0	<1.0
Vinyl chloride	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
m,p-Xylenes	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
o-Xylene	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
Xylenes, total	0.5 ug/L	<0.5	<0.5	<0.5	<0.5
4-Bromofluorobenzene	Surrogate	96.6%	97.8%	98.0%	94.5%
Dibromofluoromethane	Surrogate	121%	121%	121%	120%
Toluene-d8	Surrogate	111%	111%	111%	112%
Hydrocarbons					
F1 PHCs (C6-C10)	25 ug/L	<25	<25	<25	<25
F2 PHCs (C10-C16)	100 ug/L	<100	<100	<100	<100
F3 PHCs (C16-C34)	100 ug/L	<100	<100	<100	<100
F4 PHCs (C34-C50)	100 ug/L	<100	<100	<100	<100
Semi-Volatiles					
Acenaphthene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Acenaphthylene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Anthracene	0.01 ug/L	<0.01	<0.01	<0.01	<0.01
Benzo [a] anthracene	0.01 ug/L	<0.01	<0.01	<0.01	<0.01
Benzo [a] pyrene	0.01 ug/L	<0.01	<0.01	<0.01	<0.01
Benzo [b] fluoranthene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Benzo [g,h,i] perylene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Benzo [k] fluoranthene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Chrysene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Dibenzo [a,h] anthracene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Fluoranthene	0.01 ug/L	<0.01	<0.01	<0.01	<0.01
Fluorene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Indeno [1,2,3-cd] pyrene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
1-Methylnaphthalene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
2-Methylnaphthalene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Methylnaphthalene (1&2)	0.10 ug/L	<0.10	<0.10	<0.10	<0.10
Naphthalene	0.05 ug/L	0.06	<0.05	<0.05	<0.05
Phenanthrene	0.05 ug/L	<0.05	<0.05	<0.05	<0.05
Pyrene	0.01 ug/L	0.02	<0.01	<0.01	<0.01

Certificate of Analysis

Client: **Pinchin Ltd. (Ottawa)**

Client PO:

Report Date: 05-Jun-2023

Order Date: 30-May-2023

Project Description: 324269.002

	Client ID:	MW-1	MW-101	MW-102	MW-103
	Sample Date:	30-May-23 09:00	30-May-23 09:00	30-May-23 09:00	30-May-23 09:00
	Sample ID:	2322204-01	2322204-02	2322204-03	2322204-04
	MDL/Units	Ground Water	Ground Water	Ground Water	Ground Water
2-Fluorobiphenyl	Surrogate	100%	101%	98.4%	109%
Terphenyl-d14	Surrogate	95.2%	96.3%	81.7%	97.3%

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L						
F2 PHCs (C10-C16)	ND	100	ug/L						
F3 PHCs (C16-C34)	ND	100	ug/L						
F4 PHCs (C34-C50)	ND	100	ug/L						
Volatiles									
Acetone	ND	5.0	ug/L						
Benzene	ND	0.5	ug/L						
Bromodichloromethane	ND	0.5	ug/L						
Bromoform	ND	0.5	ug/L						
Bromomethane	ND	0.5	ug/L						
Carbon Tetrachloride	ND	0.2	ug/L						
Chlorobenzene	ND	0.5	ug/L						
Chloroform	ND	0.5	ug/L						
Dibromochloromethane	ND	0.5	ug/L						
Dichlorodifluoromethane	ND	1.0	ug/L						
1,2-Dichlorobenzene	ND	0.5	ug/L						
1,3-Dichlorobenzene	ND	0.5	ug/L						
1,4-Dichlorobenzene	ND	0.5	ug/L						
1,1-Dichloroethane	ND	0.5	ug/L						
1,2-Dichloroethane	ND	0.5	ug/L						
1,1-Dichloroethylene	ND	0.5	ug/L						
cis-1,2-Dichloroethylene	ND	0.5	ug/L						
trans-1,2-Dichloroethylene	ND	0.5	ug/L						
1,2-Dichloropropane	ND	0.5	ug/L						
cis-1,3-Dichloropropylene	ND	0.5	ug/L						
trans-1,3-Dichloropropylene	ND	0.5	ug/L						
1,3-Dichloropropene, total	ND	0.5	ug/L						
Ethylbenzene	ND	0.5	ug/L						
Ethylene dibromide (dibromoethane, 1,2-	ND	0.2	ug/L						
Hexane	ND	1.0	ug/L						
Methyl Ethyl Ketone (2-Butanone)	ND	5.0	ug/L						
Methyl Isobutyl Ketone	ND	5.0	ug/L						
Methyl tert-butyl ether	ND	2.0	ug/L						
Methylene Chloride	ND	5.0	ug/L						
Styrene	ND	0.5	ug/L						
1,1,1,2-Tetrachloroethane	ND	0.5	ug/L						
1,1,2,2-Tetrachloroethane	ND	0.5	ug/L						
Tetrachloroethylene	ND	0.5	ug/L						
Toluene	ND	0.5	ug/L						
1,1,1-Trichloroethane	ND	0.5	ug/L						
1,1,2-Trichloroethane	ND	0.5	ug/L						
Trichloroethylene	ND	0.5	ug/L						
Trichlorofluoromethane	ND	1.0	ug/L						
Vinyl chloride	ND	0.5	ug/L						
m,p-Xylenes	ND	0.5	ug/L						
o-Xylene	ND	0.5	ug/L						
Xylenes, total	ND	0.5	ug/L						
Surrogate: 4-Bromofluorobenzene	*78.0*		*ug/L*		*97.4*	*50-140*			
Surrogate: Dibromofluoromethane	*94.5*		*ug/L*		*118*	*50-140*			
Surrogate: Toluene-d8	*89.3*		*ug/L*		*112*	*50-140*			

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	ND	25	ug/L	ND			NC	30	
Volatiles									
Acetone	ND	5.0	ug/L	ND			NC	30	
Benzene	ND	0.5	ug/L	ND			NC	30	
Bromodichloromethane	4.58	0.5	ug/L	5.82			23.8	30	
Bromoform	ND	0.5	ug/L	ND			NC	30	
Bromomethane	ND	0.5	ug/L	ND			NC	30	
Carbon Tetrachloride	ND	0.2	ug/L	ND			NC	30	
Chlorobenzene	ND	0.5	ug/L	ND			NC	30	
Chloroform	10.0	0.5	ug/L	12.2			19.5	30	
Dibromochloromethane	1.87	0.5	ug/L	2.36			23.2	30	
Dichlorodifluoromethane	ND	1.0	ug/L	ND			NC	30	
1,2-Dichlorobenzene	ND	0.5	ug/L	ND			NC	30	
1,3-Dichlorobenzene	ND	0.5	ug/L	ND			NC	30	
1,4-Dichlorobenzene	ND	0.5	ug/L	ND			NC	30	
1,1-Dichloroethane	ND	0.5	ug/L	ND			NC	30	
1,2-Dichloroethane	ND	0.5	ug/L	ND			NC	30	
1,1-Dichloroethylene	ND	0.5	ug/L	ND			NC	30	
cis-1,2-Dichloroethylene	ND	0.5	ug/L	ND			NC	30	
trans-1,2-Dichloroethylene	ND	0.5	ug/L	ND			NC	30	
1,2-Dichloropropane	ND	0.5	ug/L	ND			NC	30	
cis-1,3-Dichloropropylene	ND	0.5	ug/L	ND			NC	30	
trans-1,3-Dichloropropylene	ND	0.5	ug/L	ND			NC	30	
Ethylbenzene	ND	0.5	ug/L	ND			NC	30	
Ethylene dibromide (dibromoethane, 1,2-	ND	0.2	ug/L	ND			NC	30	
Hexane	ND	1.0	ug/L	ND			NC	30	
Methyl Ethyl Ketone (2-Butanone)	ND	5.0	ug/L	ND			NC	30	
Methyl Isobutyl Ketone	ND	5.0	ug/L	ND			NC	30	
Methyl tert-butyl ether	ND	2.0	ug/L	ND			NC	30	
Methylene Chloride	ND	5.0	ug/L	ND			NC	30	
Styrene	ND	0.5	ug/L	ND			NC	30	
1,1,1,2-Tetrachloroethane	ND	0.5	ug/L	ND			NC	30	
1,1,2,2-Tetrachloroethane	ND	0.5	ug/L	ND			NC	30	
Tetrachloroethylene	ND	0.5	ug/L	ND			NC	30	
Toluene	ND	0.5	ug/L	ND			NC	30	
1,1,1-Trichloroethane	ND	0.5	ug/L	ND			NC	30	
1,1,2-Trichloroethane	ND	0.5	ug/L	ND			NC	30	
Trichloroethylene	ND	0.5	ug/L	ND			NC	30	
Trichlorofluoromethane	ND	1.0	ug/L	ND			NC	30	
Vinyl chloride	ND	0.5	ug/L	ND			NC	30	
m,p-Xylenes	ND	0.5	ug/L	ND			NC	30	
o-Xylene	ND	0.5	ug/L	ND			NC	30	
Surrogate: 4-Bromofluorobenzene	*79.8*		*ug/L*		*99.8*	*50-140*			
Surrogate: Dibromofluoromethane	*99.6*		*ug/L*		*124*	*50-140*			
Surrogate: Toluene-d8	*87.4*		*ug/L*		*109*	*50-140*			

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Hydrocarbons									
F1 PHCs (C6-C10)	2240	25	ug/L	ND	112	68-117			
F2 PHCs (C10-C16)	1670	100	ug/L	ND	104	60-140			
F3 PHCs (C16-C34)	3850	100	ug/L	ND	98.1	60-140			
F4 PHCs (C34-C50)	2560	100	ug/L	ND	103	60-140			
Volatiles									
Acetone	81.9	5.0	ug/L	ND	81.9	50-140			
Benzene	35.7	0.5	ug/L	ND	89.3	60-130			
Bromodichloromethane	36.8	0.5	ug/L	ND	92.0	60-130			
Bromoform	43.4	0.5	ug/L	ND	109	60-130			
Bromomethane	40.3	0.5	ug/L	ND	101	50-140			
Carbon Tetrachloride	46.8	0.2	ug/L	ND	117	60-130			
Chlorobenzene	43.2	0.5	ug/L	ND	108	60-130			
Chloroform	35.0	0.5	ug/L	ND	87.5	60-130			
Dibromochloromethane	47.8	0.5	ug/L	ND	120	60-130			
Dichlorodifluoromethane	38.2	1.0	ug/L	ND	95.5	50-140			
1,2-Dichlorobenzene	40.4	0.5	ug/L	ND	101	60-130			
1,3-Dichlorobenzene	37.9	0.5	ug/L	ND	94.8	60-130			
1,4-Dichlorobenzene	37.5	0.5	ug/L	ND	93.7	60-130			
1,1-Dichloroethane	37.8	0.5	ug/L	ND	94.5	60-130			
1,2-Dichloroethane	42.1	0.5	ug/L	ND	105	60-130			
1,1-Dichloroethylene	33.8	0.5	ug/L	ND	84.5	60-130			
cis-1,2-Dichloroethylene	35.7	0.5	ug/L	ND	89.3	60-130			
trans-1,2-Dichloroethylene	34.1	0.5	ug/L	ND	85.4	60-130			
1,2-Dichloropropane	35.5	0.5	ug/L	ND	88.8	60-130			
cis-1,3-Dichloropropylene	45.0	0.5	ug/L	ND	112	60-130			
trans-1,3-Dichloropropylene	39.6	0.5	ug/L	ND	99.0	60-130			
Ethylbenzene	37.3	0.5	ug/L	ND	93.2	60-130			
Ethylene dibromide (dibromoethane, 1,2	44.4	0.2	ug/L	ND	111	60-130			
Hexane	41.4	1.0	ug/L	ND	104	60-130			
Methyl Ethyl Ketone (2-Butanone)	86.2	5.0	ug/L	ND	86.2	50-140			
Methyl Isobutyl Ketone	92.6	5.0	ug/L	ND	92.6	50-140			
Methyl tert-butyl ether	91.3	2.0	ug/L	ND	91.3	50-140			
Methylene Chloride	36.0	5.0	ug/L	ND	90.1	60-130			
Styrene	42.4	0.5	ug/L	ND	106	60-130			
1,1,1,2-Tetrachloroethane	41.9	0.5	ug/L	ND	105	60-130			
1,1,2,2-Tetrachloroethane	49.0	0.5	ug/L	ND	122	60-130			
Tetrachloroethylene	43.6	0.5	ug/L	ND	109	60-130			
Toluene	40.7	0.5	ug/L	ND	102	60-130			
1,1,1-Trichloroethane	43.2	0.5	ug/L	ND	108	60-130			
1,1,2-Trichloroethane	37.7	0.5	ug/L	ND	94.4	60-130			
Trichloroethylene	35.0	0.5	ug/L	ND	87.6	60-130			
Trichlorofluoromethane	49.4	1.0	ug/L	ND	124	60-130			
Vinyl chloride	43.6	0.5	ug/L	ND	109	50-140			
m,p-Xylenes	84.4	0.5	ug/L	ND	105	60-130			
o-Xylene	37.5	0.5	ug/L	ND	93.7	60-130			
Surrogate: 4-Bromofluorobenzene	*70.8*		*ug/L*		*88.5*	*50-140*			
Surrogate: Dibromofluoromethane	*95.0*		*ug/L*		*119*	*50-140*			
Surrogate: Toluene-d8	*73.4*		*ug/L*		*91.7*	*50-140*			

Qualifier Notes:

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

CCME PHC additional information:

- The method for the analysis of PHCs complies with the Reference Method for the CWS PHC and is validated for use in the laboratory. All prescribed quality criteria identified in the method has been met.
- F1 range corrected for BTEX.
- F2 to F3 ranges corrected for appropriate PAHs where available.
- The gravimetric heavy hydrocarbons (F4G) are not to be added to C6 to C50 hydrocarbons.
- In the case where F4 and F4G are both reported, the greater of the two results is to be used for comparison to CWS PHC crite
- When reported, data for F4G has been processed using a silica gel cleanup.

PARACEL
LABORATORIES LTD

Paracel ID: 2322204

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com

Paracel Order Number (Lab Use Only)	2322204
Chain Of Custody (Lab Use Only)	№ 138323

Client Name: Pinchin	Project Ref: 324269.002
Contact Name: Mike Leach, Matt Ryan	Quote #:
Address: 1 Hines Road	PO #:
Telephone:	E-mail: mleach@pinchin.com mryan@pinchin.com

Page _ of _

Turnaround Time

☐ 1 day ☐ 3 day
☐ 2 day ☒ Regular
Date Required: ______

☒ REG 153/04 ☐ REG 406/19

☐ Table 1 ☐ Res/Park ☐ Med/Fine
☐ Table 2 ☒ Ind/Comm ☐ Coarse
☒ Table 3 ☐ Agri/Other
☐ Table __
For RSC: ☐ Yes ☐ No

Other Regulation

☐ REG 558 ☐ PWQO
☐ CCME ☐ MISA
☐ SU - Sani ☐ SU - Storm
Mun: ______
☐ Other:

Matrix Type: **S** (Soil/Sed.) **GW** (Ground Water)
SW (Surface Water) **SS** (Storm/Sanitary Sewer)
P (Paint) **A** (Air) **O** (Other)

Required Analysis

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP	Hg	CrVI	B (HWS)					
1	MW-1	GW		4	May 30		X	X	X									
2	MW-101	〃		〃	〃		X	X	X									
3	MW-102	〃		〃	〃		X	X	X									
4	MW-103	〃		〃	〃		X	X	X									
5																		
6																		
7																		
8																		
9																		
10																		

Comments:

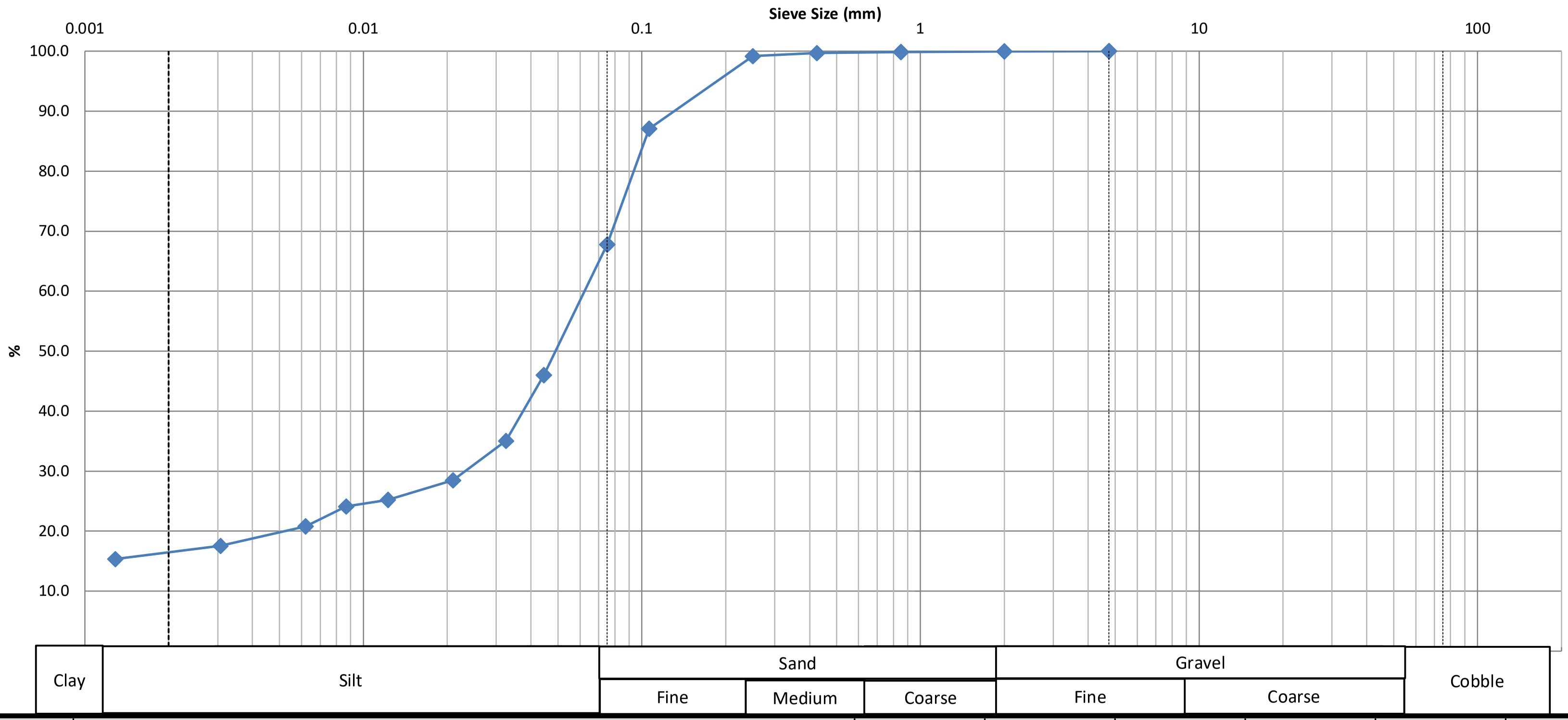
Method of Delivery: Walk In

Relinquished By (Sign):	Received By Driver/Depot:	Received at Lab: CB 1335	Verified By: SD
Relinquished By (Print): Mike Leach	Date/Time:	Date/Time: May 30/23	Date/Time: May 30 3:41
Date/Time: May 30 2023	Temperature: °C	Temperature: 18.3 °C	pH Verified: ☐ By:

PATERSON GROUP

SIEVE ANALYSIS
ASTM C136

CLIENT:	Pinchin	DEPTH:	5' - 7'	FILE NO:	PM4184
CONTRACT NO.:		BH OR TP No.:	BH6 SS3	LAB NO:	43078
PROJECT:	324269.001			DATE RECEIVED:	29-May-23
				DATE TESTED:	31-May-23
DATE SAMPLED:	29-May-23			DATE REPORTED:	7-Jun-23
SAMPLED BY:	Client			TESTED BY:	DK



Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
					23.1					
	D100	D60	D30	D10	Gravel (%)	Sand (%)		Silt (%)		Clay (%)
					0.0	32.2		50.8		17.0

Comments:

REVIEWED BY:	Curtis Beadow	Joe Forsyth, P. Eng.

PATERSON GROUP

HYDROMETER
LS-702 ASTM-422

CLIENT:	Pinchin	DEPTH:	5' - 7'	FILE NO.:	PM4184
PROJECT:	324269.001	BH OR TP No.:	BH6 SS3	DATE SAMPLEI	29-May-23
LAB No. :	43078	TESTED BY:	DK	DATE RECEIVE	29-May-23
SAMPLED BY:	Client	DATE REPT'D:	7-Jun-23	DATE TESTED:	31-May-23

SAMPLE INFORMATION

SAMPLE MASS	SPECIFIC GRAVITY
167.7	2.700

		HYGROSCOPIC MOISTURE		
INITIAL WEIGHT	50.00			
WEIGHT CORRECTED	45.10	TARE WEIGHT	0.00	ACTUAL WEIGHT
WT. AFTER WASH BACK SIEVE	19.87	AIR DRY	185.90	185.90
SOLUTION CONCENTRATION	40 g/L	OVEN DRY	167.70	167.70
		CORRECTED	0.902	

GRAIN SIZE ANALYSIS

SIEVE DIAMETER (mm)	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT PASSING
26.5			
19			
13.2			
9.5			
4.75	**0.0**	0.0	**100.0**
2.0	**0.1**	0.0	**100.0**
Pan	**167.6**		
0.850	**0.05**	0.1	**99.9**
0.425	**0.14**	0.3	**99.7**
0.250	**0.41**	0.9	**99.1**
0.106	**6.44**	12.9	**87.1**
0.075	**16.09**	32.2	**67.8**
Pan	**19.87**		
SIEVE CHECK 0.0	MAX = 0.3%		

HYDROMETER DATA

ELAPSED	TIME (24 hours)	Hs	Hc	Temp. (^{o}C)	DIAMETER	(P)	TOTAL PERCENT PASSING
1	8:00	27.0	6.0	23.0	0.0445	46.0	**46.0**
2	8:01	22.0	6.0	23.0	0.0326	35.1	**35.1**
5	8:04	19.0	6.0	23.0	0.0210	28.5	**28.5**
15	8:14	17.5	6.0	23.0	0.0122	25.2	**25.2**
30	8:29	17.0	6.0	23.0	0.0087	24.1	**24.1**
60	8:59	15.5	6.0	23.0	0.0062	20.8	**20.8**
250	12:09	14.0	6.0	23.0	0.0031	17.5	**17.5**
1440	7:59	13.0	6.0	23.0	0.0013	15.3	**15.3**

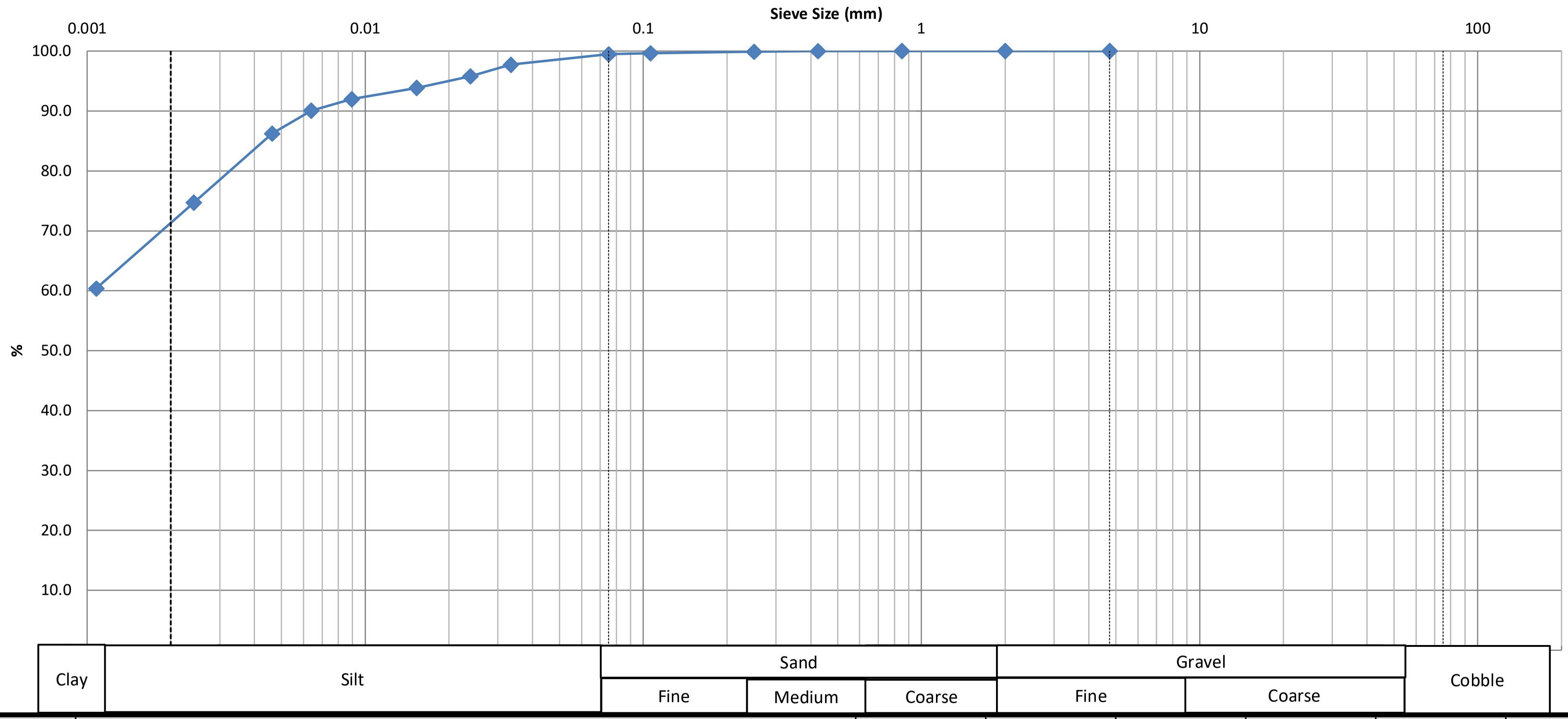
Moisture = 23.1%

REVIEWED BY:	**C. Beadow**	**Joe Forsyth, P. Eng.**

PATERSON GROUP

SIEVE ANALYSIS
ASTM C136

CLIENT:	Pinchin	DEPTH:	10' - 12'	FILE NO:	PM4184
CONTRACT NO.:		BH OR TP No.:	BH2 SS4	LAB NO:	43079
PROJECT:	324269.001			DATE RECEIVED:	29-May-23
				DATE TESTED:	31-May-23
DATE SAMPLED:	29-May-23			DATE REPORTED:	7-Jun-23
SAMPLED BY:	Client			TESTED BY:	DK



Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
					36.5					
	D100	D60	D30	D10	Gravel (%)	Sand (%)		Silt (%)		Clay (%)
					0.0	0.5		28.5		71.0

Comments:

REVIEWED BY:	Curtis Beadow	Joe Forsyth, P. Eng.

PATERSON GROUP

HYDROMETER
LS-702 ASTM-422

CLIENT:	Pinchin	DEPTH:	10' - 12'	FILE NO.:	PM4184
PROJECT:	324269.001	BH OR TP No.:	BH2 SS4	DATE SAMPLE	29-May-23
LAB No. :	43079	TESTED BY:	DK	DATE RECEIVE	29-May-23
SAMPLED BY:	Client	DATE REPT'D:	7-Jun-23	DATE TESTED:	31-May-23

SAMPLE INFORMATION

SAMPLE MASS	SPECIFIC GRAVITY
139.9	2.700

INITIAL WEIGHT	50.00	**HYGROSCOPIC MOISTURE**		
WEIGHT CORRECTED	40.72	TARE WEIGHT	0.00	ACTUAL WEIGHT
WT. AFTER WASH BACK SIEVE	0.29	AIR DRY	171.80	171.80
SOLUTION CONCENTRATION	40 g/L	OVEN DRY	139.90	139.90
		CORRECTED	0.814	

GRAIN SIZE ANALYSIS

SIEVE DIAMETER (mm)	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT PASSING
26.5			
19			
13.2			
9.5			
4.75	**0.0**	0.0	**100.0**
2.0	**0.0**	0.0	**100.0**
Pan	**139.9**		
0.850	**0.00**	0.0	**100.0**
0.425	**0.02**	0.0	**100.0**
0.250	**0.06**	0.1	**99.9**
0.106	**0.19**	0.4	**99.6**
0.075	**0.27**	0.5	**99.5**
Pan	**0.29**		
SIEVE CHECK 0.0	MAX = 0.3%		

HYDROMETER DATA

ELAPSED	TIME (24 hours)	Hs	Hc	Temp. (^{o}C)	DIAMETER	(P)	TOTAL PERCENT PASSING
1	7:57	57.0	6.0	23.0	0.0334	97.7	**97.7**
2	7:58	56.0	6.0	23.0	0.0239	95.8	**95.8**
5	8:01	55.0	6.0	23.0	0.0153	93.9	**93.9**
15	8:11	54.0	6.0	23.0	0.0089	92.0	**92.0**
30	8:26	53.0	6.0	23.0	0.0064	90.0	**90.0**
60	8:56	51.0	6.0	23.0	0.0046	86.2	**86.2**
250	12:06	45.0	6.0	23.0	0.0024	74.7	**74.7**
1440	7:56	37.5	6.0	23.0	0.0011	60.3	**60.3**

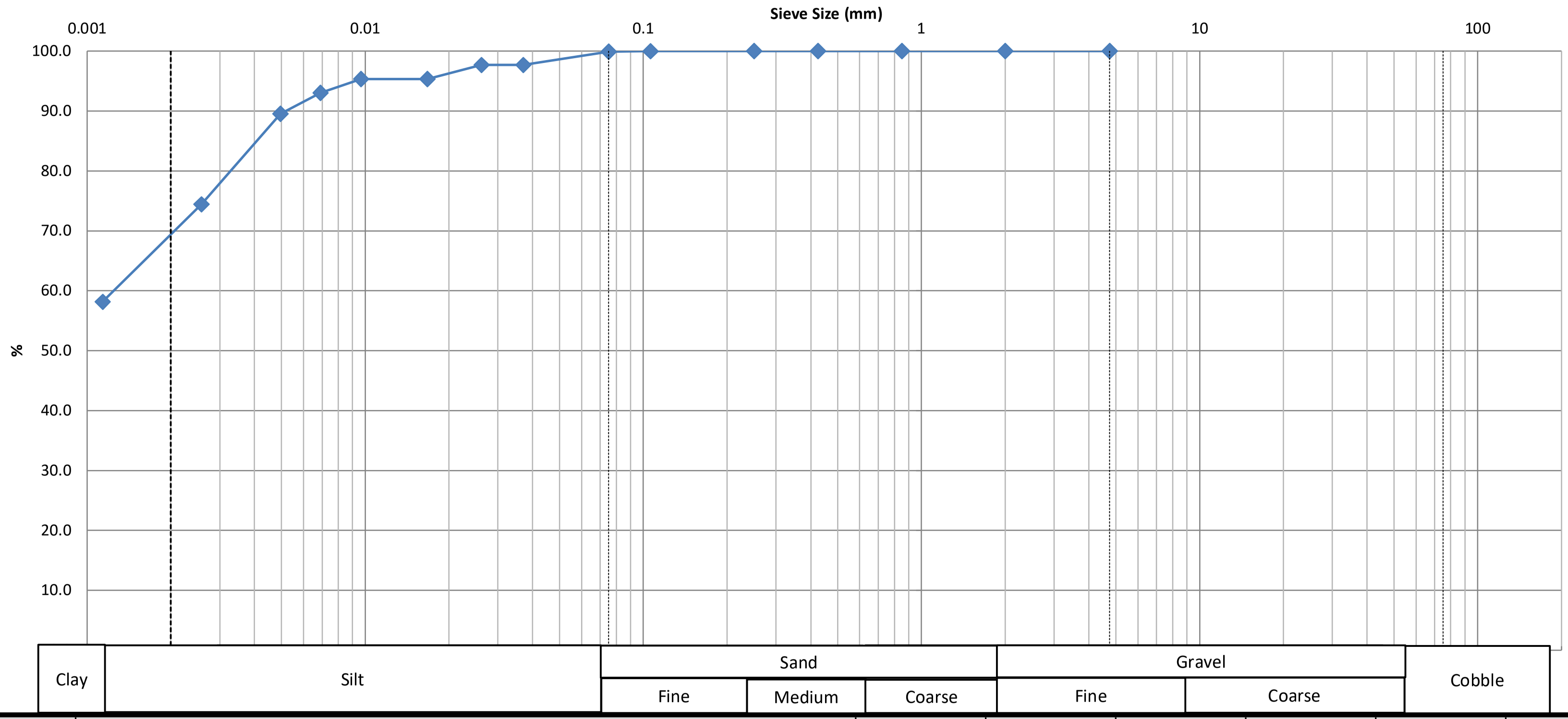
Moisture = 36.5%

REVIEWED BY:	**C. Beadow**	**Joe Forsyth, P. Eng.**

PATERSON GROUP

SIEVE ANALYSIS
ASTM C136

CLIENT:	Pinchin	DEPTH:	25' - 27'	FILE NO:	PM4184
CONTRACT NO.:		BH OR TP No.:	BH3 SS7	LAB NO:	43080
PROJECT:	324269.001			DATE RECEIVED:	29-May-23
				DATE TESTED:	31-May-23
DATE SAMPLED:	29-May-23			DATE REPORTED:	7-Jun-23
SAMPLED BY:	Client			TESTED BY:	DK



Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
					63.9					
	D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)	Clay (%)		
					0.0	0.1	30.4	69.5		

Comments:

REVIEWED BY:	Curtis Beadow	Joe Forsyth, P. Eng.

PATERSON GROUP

HYDROMETER
LS-702 ASTM-422

CLIENT:	Pinchin	DEPTH:	25' - 27'	FILE NO.:	PM4184
PROJECT:	324269.001	BH OR TP No.:	BH3 SS7	DATE SAMPLEI	29-May-23
LAB No. :	43080	TESTED BY:	DK	DATE RECEIVE	29-May-23
SAMPLED BY:	Client	DATE REPT'D:	7-Jun-23	DATE TESTED:	31-May-23

SAMPLE INFORMATION

SAMPLE MASS	SPECIFIC GRAVITY
117.6	2.700

		HYGROSCOPIC MOISTURE		
INITIAL WEIGHT	50.00			
WEIGHT CORRECTED	34.94	TARE WEIGHT	0.00	ACTUAL WEIGHT
WT. AFTER WASH BACK SIEVE	0.05	AIR DRY	168.30	168.30
SOLUTION CONCENTRATION	40 g/L	OVEN DRY	117.60	117.60
		CORRECTED	0.699	

GRAIN SIZE ANALYSIS

SIEVE DIAMETER (mm)	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT PASSING
26.5			
19			
13.2			
9.5			
4.75	**0.0**	0.0	**100.0**
2.0	**0.0**	0.0	**100.0**
Pan	**117.6**		
0.850	**0.00**	0.0	**100.0**
0.425	**0.00**	0.0	**100.0**
0.250	**0.00**	0.0	**100.0**
0.106	**0.02**	0.0	**100.0**
0.075	**0.04**	0.1	**99.9**
Pan	**0.05**		
SIEVE CHECK 0.0	MAX = 0.3%		

HYDROMETER DATA

ELAPSED	TIME (24 hours)	Hs	Hc	Temp. (^{o}C)	DIAMETER	(P)	TOTAL PERCENT PASSING
1	8:15	48.0	6.0	23.0	0.0371	97.7	**97.7**
2	8:16	48.0	6.0	23.0	0.0262	97.7	**97.7**
5	8:19	47.0	6.0	23.0	0.0167	95.3	**95.3**
15	8:29	47.0	6.0	23.0	0.0097	95.3	**95.3**
30	8:44	46.0	6.0	23.0	0.0069	93.0	**93.0**
60	9:14	44.5	6.0	23.0	0.0050	89.5	**89.5**
250	12:24	38.0	6.0	23.0	0.0026	74.4	**74.4**
1440	8:14	31.0	6.0	23.0	0.0011	58.1	**58.1**

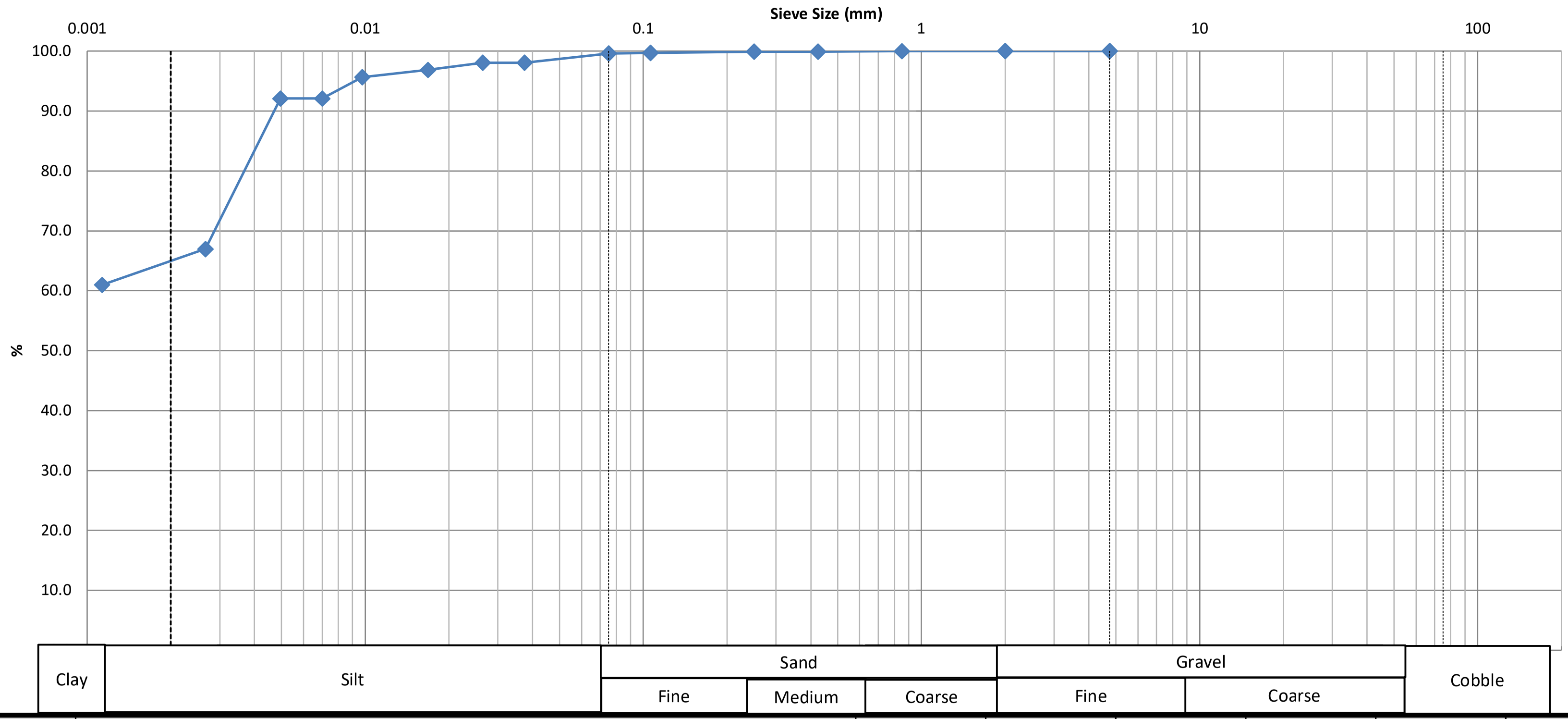
Moisture = 63.9%

REVIEWED BY:	**C. Beadow**	**Joe Forsyth, P. Eng.**

PATERSON GROUP

SIEVE ANALYSIS
ASTM C136

CLIENT:	Pinchin	DEPTH:	50' - 52'	FILE NO:	PM4184
CONTRACT NO.:		BH OR TP No.:	BH5 SS8	LAB NO:	43081
PROJECT:	324269.001			DATE RECEIVED:	29-May-23
				DATE TESTED:	31-May-23
DATE SAMPLED:	29-May-23			DATE REPORTED:	7-Jun-23
SAMPLED BY:	Client			TESTED BY:	DK



Identification	Soil Classification				MC(%)	LL	PL	PI	Cc	Cu
					63.0					
	D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)	Clay (%)		
					0.0	0.4	34.6	65.0		

Comments:

REVIEWED BY:	Curtis Beadow	Joe Forsyth, P. Eng.

PATERSON GROUP

HYDROMETER
LS-702 ASTM-422

CLIENT:	Pinchin	DEPTH:	50' - 52'	FILE NO.:	PM4184
PROJECT:	324269.001	BH OR TP No.:	BH5 SS8	DATE SAMPLEI	29-May-23
LAB No. :	43081	TESTED BY:	DK	DATE RECEIVE	29-May-23
SAMPLED BY:	Client	DATE REPT'D:	7-Jun-23	DATE TESTED:	31-May-23

SAMPLE INFORMATION

SAMPLE MASS	SPECIFIC GRAVITY
119.2	2.700

		HYGROSCOPIC MOISTURE		
INITIAL WEIGHT	50.00			
WEIGHT CORRECTED	34.71	TARE WEIGHT	0.00	ACTUAL WEIGHT
WT. AFTER WASH BACK SIEVE	0.24	AIR DRY	171.70	171.70
SOLUTION CONCENTRATION	40 g/L	OVEN DRY	119.20	119.20
		CORRECTED	0.694	

GRAIN SIZE ANALYSIS

SIEVE DIAMETER (mm)	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT PASSING
26.5			
19			
13.2			
9.5			
4.75	**0.0**	0.0	**100.0**
2.0	**0.0**	0.0	**100.0**
Pan	**119.2**		
0.850	**0.02**	0.0	**100.0**
0.425	**0.04**	0.1	**99.9**
0.250	**0.05**	0.1	**99.9**
0.106	**0.15**	0.3	**99.7**
0.075	**0.20**	0.4	**99.6**
Pan	**0.24**		

SIEVE CHECK	0.0	MAX = 0.3%

HYDROMETER DATA

ELAPSED	TIME (24 hours)	Hs	Hc	Temp. (^{o}C)	DIAMETER	(P)	TOTAL PERCENT PASSING
1	8:19	47.0	6.0	23.0	0.0374	98.0	**98.0**
2	8:20	47.0	6.0	23.0	0.0265	98.0	**98.0**
5	8:23	46.5	6.0	23.0	0.0168	96.8	**96.8**
15	8:33	46.0	6.0	23.0	0.0098	95.6	**95.6**
30	8:48	44.5	6.0	23.0	0.0070	92.1	**92.1**
60	9:18	44.5	6.0	23.0	0.0050	92.1	**92.1**
250	12:28	34.0	6.0	23.0	0.0027	67.0	**67.0**
1440	8:18	31.5	6.0	23.0	0.0011	61.0	**61.0**

Moisture = 63.0%

REVIEWED BY:	C. Beadow	Joe Forsyth, P. Eng.