REPORT

Geotechnical Investigation

170 Slater Street, Ottawa, ON

Submitted to:

The Canada Life Assurance Company

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1.0 INTRODUCTION AND SITE DESCRIPTION

The Canada Life Assurance Company c/o GWL Realty Advisors Inc. (GWL) retained WSP to undertake a geotechnical investigation in support of the redevelopment plans for the property located at 170 Slater Street (the Site) in Ottawa, Ontario, as shown on the attached Figure 1.

The purpose of this investigation was to assess the general subsurface and groundwater conditions within the Site by means of several boreholes and associated laboratory testing. Based on an interpretation of the factual information obtained during the current investigation, a general description of the soil and groundwater conditions is presented. These interpreted subsurface conditions and available project details were used to prepare engineering guidelines on the geotechnical design aspects of the project, including construction considerations which could influence design decisions.

The investigation and reporting were carried out in general accordance with the scope of work provided in WSP's proposal number CX23592402, dated February 14, 2022. A preliminary geotechnical desktop study was prepared by WSP and was submitted on March 27, 2023 to inform early design planning.

The current report was prepared at the request and for the sole use of GWL according to the specific terms of the mandate given to WSP. The use of this report by a third party, as well as any decision based upon this report, is under this party's sole responsibility. Reference should be made to the Limitations of this Report, attached in **Appendix G**.

2.0 DESCRIPTION OF PROJECT AND SITE

The Site is currently occupied by a three and a half story or seven level staggered aboveground parking garage, built in 1985. The Site is 1.06 acres large (0.43 hectares) and is bounded by Slater Street on the north, Laurier Avenue on the south, and commercial properties east and west at the location shown on the Site Plan, Figure 1. It is understood that the Site will be undergoing future redevelopment to a multi-use high-rise commercial and residential building with two levels of underground parking.

WSP reviewed available geological maps and databases, as well as the reports of two past Phase Two ESAs conducted in 2002 by Paterson and the second one in 2015 by Golder. The borehole logs from these reports are attached in **Appendix B** and **C**.

Surficial geology maps indicate the soils in the project area consist of fine textured glaciomarine deposits, including silt and clay and minor sand and gravel.

Soil mapping indicates that the overburden in the project area also consists of undifferentiated till, consisting of boulders, cobbles, gravel, and clay in a matrix of silt and sand. Bedrock geology maps indicate the bedrock in the project area consists of limestone, dolostone, shale, arkose, sandstone of the Ottawa group, Simcoe group and Shadow Lake formation.

The Ontario Geotechnical Boreholes database indicates that there is one borehole drilled within the Site. The borehole log shows variable overburden consisting of granular fill materials (sand and gravel, pavement structure), sand, silt and clay, sandy till with shale fragments and a shale bedrock that starts at 3.8 m.

The Ministry of the Environment, Conservation and Parks (MOECP) well record database indicates that there is one past well installed within the Site. The well records encountered granular fill materials (pavement structure), sand with boulders, and fractured shale starting at 4.3 m.

Based on the report and the eight boreholes advanced as part of the Phase Two ESA Investigation conducted in 2002 by Paterson and Associates, the overburden is variable and appeared to consist of asphaltic concrete or concrete and crushed stone over fill followed by a layer of either sand or silty clay and clayey silt. Glacial till was observed underlying the silty clay deposit in several boreholes. It is to be noted that only BH-1, BH-2, BH-5, and BH-6 are placed inside the current Site boundaries, and these boreholes were extended to a depth of 2.49 m to 5.94 m. The fill layer at those boreholes extended to depths ranging from 0.6 m to 2.5 m and was encountered at all borehole locations underneath the pavement structure. The fill generally consisted of sand with variable amounts of silt and gravel, with organic matter, brick fragments, cinders and wood debris occasionally observed within the fill stratum. Weathered shale bedrock was encountered in BH-5 and BH-6 at 3.35 m and 5.49 m respectively. All boreholes were dry to full depth during the field program. “N” values were provided in the borehole logs, however without hammer weight and drop height these values cannot be used.

Based on the report and the five boreholes advanced as part of the previous Phase Two ESA investigation conducted in 2015 by Golder, the overburden is variable and appears to consist of a silty clay with trace gravel, silty sand and glacial till consisting mainly of clay and silt, and variable amounts of sand, gravel, and shale fragments. Fill material (silty sand with gravel) and debris (old concrete fragments, wood fragments) were noted in one of the boreholes in the southeast corner of the existing aboveground parking garage. The pavement structure had thicknesses varying between 0.4 m and 1.8 m. Shale bedrock was encountered at depths ranging between 4.3 mbgs and 4.5 mbgs. The shale was generally slightly to moderately weathered to an approximate depth of 7 m, where fresh shale bedrock was encountered. Clay and fractures infilled seams were noted in some of the recovered rock samples. Water levels were measured in 3 different wells at different times of the year (October, November, May) and varied between 10 m and 12 m. No quantitative data (“N” values, shear vane tests, rock RQD, rock UCS) relative to the soil’s compaction state, cohesion, rock quality and strength was available.

3.0 SITE INVESTIGATION

The drilling program was carried out between March 7 and March 24, 2023. At that time, a total of seven (7) boreholes were advanced within the Site area.

One borehole (labelled BH23-01) was advanced within the access lane close to the parking garage entrance. Four boreholes (numbered BH23-02 to BH23-05) were advanced within the parking garage. Two extra boreholes (BH23-02A and BH23-04A) were drilled next to their respective borehole. Borehole BH23-02A was drilled to obtain SPT “N” values within the overburden, and borehole BH23-04A was drilled for monitoring well installation purposes only.

The borehole approximate locations are shown in the attached borehole location plan, Figure 2.

The boreholes were advanced using a Geoprobe 420M, a Massenza MI3 and a Massenza SPT, supplied and operated by Strata Drilling Group, established in Whitchurch-Stoufville, Ontario. Standard Penetration Tests (SPTs) were carried in all boreholes, except in boreholes BH23-02 and BH23-04A, at regular depth intervals in general conformance with ASTM D 1586. Soil samples were recovered using split-spoon and drive-open sampling equipment.

Refusal on shale bedrock was encountered in all boreholes. At all boreholes, except BH23-02A, sampling continued in the shale bedrock using diamond coring and direct push techniques.

Monitoring wells were sealed into all boreholes, except BH23-02A, to allow for ground water sampling and measurements of the groundwater level at the Site. A Vertical Seismic Profile test was conducted in borehole BH23-01.

The fieldwork was supervised by a member of our engineering staff who located the boreholes, directed the drilling operations and in situ testing, and logged the boreholes and samples. During drilling, all collected soil samples were screened for possible contamination by both visual/olfactory means and by field screening using a combustible and organic vapour metre. Upon completion of the drilling operations, all soil and rock samples obtained from the boreholes were transported to our laboratory for further examination and laboratory testing.

A laboratory testing program, which was carried out on selected representative soil and rock samples, included the determination of natural water content, grain size distribution, Atterberg limits and Unconfined Compressive Strength tests (UCS). Four soil samples were submitted to Eurofins for basic chemical analysis related to potential corrosion of buried ferrous elements and concrete sulphate attacks. The results of the natural water content tests are included in the borehole logs in **Appendix A**. All laboratory testing results are included in **Appendix D**.

The borehole locations were selected, marked in the field, and subsequently surveyed by WSP personnel. The borehole's ground elevations and relative positions to different site features were determined using a Trimble R10 GPS survey unit. The elevations are referenced to the Geodetic datum (CGVD28) The borehole coordinates were approximated based on the survey notes and are based on the Universal Transverse Mercator (UTM) coordinate system. The geodetic reference system used is the North American Datum of 1983 (NAD83). The borehole coordinates, ground surface elevations and drilled depths are presented in the borehole logs in **Appendix A** and are summarized in Tables 1 and 2 below:

Table 1: Boreholes Coordinates and Ground Elevations

Borehole No.	Coordinates: UTM NAD83 Z18		Ground Surface Elevation (m)	Termination Depth (m)
	Northing (m)	Easting (m)		
BH23-01	5029810.32	445340.96	71.97	12.95
BH23-02	5029772.11	445375.89	71.06	12.42
BH23-02A	5029774.45	445374.33	-	4.80
BH23-03	5029816.20	445370.04	71.54	13.59
BH23-04	5029792.34	445394.28	72.08	16.86
BH23-04A	5029794.60	445392.79	72.04	13.10
BH23-05	5029753.33	445397.42	70.39	16.46

4.0 SUBSURFACE CONDITIONS

4.1 General

The following section provides a general description of the major soil and bedrock types encountered during the current geotechnical investigation. It should be noted that the following discussion includes some simplifications for the purposes of discussing broadly similar soil strata and bedrock types. The differences in soil and bedrock types change between various strata are often gradational, as opposed to precise boundaries of geological change.

A detailed description of soil and bedrock stratigraphy encountered at each borehole location is shown on the borehole logs included in **Appendix A**. Please note that the factual descriptions shown in each borehole log takes precedence over the generalized (and simplified) descriptions presented below.

In general, the subsurface conditions at the Site consist of a pavement structure overlying a fill layer and/or a natural cohesive deposit, which in turns overlies glacial till, followed by a shale bedrock.

4.2 Pavement Structure

A flexible pavement structure was encountered at all boreholes. The existing pavement structure consisted of asphaltic concrete overlying a granular road base/subbase fill. The measured asphaltic concrete thickness was 50 mm within the parking garage (BH23-02 to BH23-05), and 100 mm at the access lane (BH23-01). Underlying the asphaltic concrete was a granular fill consisting of variables amounts of sand and gravel with trace silt. The granular fill extended to approximate depths ranging from 150 mm to 460 mm below the existing ground surface.

Natural moisture content determination conducted carried out on three samples of the pavement granular fill material yielded moisture contents ranging from about 1% to 4%.

4.3 Fill Material

A layer of heterogeneous fill material was encountered below the pavement structure at all boreholes except BH23-02 and BH23-02A. The fill thickness ranged from between about 0.9 m to 2.2 m. The fill appeared to mainly consist of sand, with variable amounts of silt gravel, and clay. Glass and debris were encountered in the fill layer at BH23-04.

Standard Penetrations Tests (SPTs) carried out within the fill layer yielded SPT ‘N’ values ranging from 2 to 17 blows per 0.3 m of penetration, indicating a very loose to compact state of packing.

Natural moisture content determination conducted carried out on five samples of the fill material yielded moisture contents ranging from between about 4% and 13%.

4.4 Clayey Silt to Clay

A deposit of clayey silt to clay with trace to some sand was encountered in all boreholes except boreholes BH23-03 and BH23-05. The thickness of this deposit ranged from between about 0.6 m and 1.4 m and the deposit extended to a maximum depth of about 2.9 mbgs.

Based on the SPT “N” values recorded within the deposit and visual observations of the samples, the natural cohesive deposit appeared to be firm to very stiff.

Atterberg limits and water content tests were conducted on two samples of the natural cohesive deposit and the results are presented in **Appendix D**. A summary of the results is also presented in the table below.

Table 2: Results of Atterberg Limits Tests - Natural Cohesive Deposit

Borehole No.	Sample No.	Depth (m)	Water content (%)	Liquid limit (%)	Plastic limit (%)	Plasticity index (%)	Liquidity Index	USCS
BH23-02A	SA-03	1.2 – 1.8	33	61	24	37	0.3	CH
BH23-04	SA-04	1.8 – 2.4	36	69	27	42	0.2	CH

4.5 Glacial Till

A glacial till deposit was encountered at all boreholes with the exception of borehole BH23-01, at depths ranging from about 1.1 mbgs to 2.6 mbgs. The glacial till thickness ranged from between about 1.3 m to 3.2 m and the deposit extended to a maximum depth of 5.2 mbgs. In general, the glacial till consists of a heterogeneous mixture of cobbles, boulders, clay and gravel in a matrix of silty sand.

Standard penetration tests carried out within the glacial till yielded SPT ‘N’ values ranging from 6 to over 79 blows per 0.3 m of penetration, indicating a loose to very dense state of packing. It should be noted the higher values may be due to presence of cobbles and boulders in the till and not the state of packing of the deposit.

Natural moisture content determination conducted carried out on ten samples of the glacial till yielded moisture contents ranging from between about 4% and 25%.

Grain size distribution tests were conducted on four samples of the glacial till and the results are presented in **Appendix D**. A summary of the grain size distribution is also presented in the table below.

Table 3: Results of Grain Size Analyses - Glacial Till

Borehole No.	Sample No.	Depth (m)	Grain Size Distribution			
			% Gravel	% Sand	% Silt	% Clay
BH23-02A	SA-06	3.1 – 3.7	39	41	20	
BH23-03	SA-05	2.4 – 3.1	14	51	26	9
BH23-04	SA-07	3.7 – 4.2	14	47	29	10
BH23-05	SA-04	2.4 – 3.7	59	30	11	

4.6 Bedrock

A layer of weathered and fractured shale rock was encountered underlying the glacial till layer. Samples of this layer were collected with both split-spoons and coring equipment. The thickness of the weathered and fractured rock layer ranged from between about 0.4 m to 3.1 m.

Shale bedrock was proven at all boreholes, except borehole BH23-02A, by extending the boreholes using rotary diamond drilling and direct push techniques and by retrieving rock cores up to depths ranging from 6.0 mbgs to 16.9 mbgs.

The cored rock generally consisted of weathered and fractured shale to fresh shale, bedded, black, fine grained, non-porous to slightly porous, brittle, sulfide rich, with limestone beds (Billings Formation). Photographs of retrieved rock core samples are provided in **Appendix F**.

The rock quality Designation (RQD) values measured on the recovered rock core samples ranged from 0% to 99 %, but more generally between 60% and 90%. In general, the rock quality can be characterized as fair.

Unconfined compressive strength (UCS) tests were performed on three representative rock core samples and yielded results of between 49 MPa and 85 MPa. The laboratory results are presented in **Appendix D**.

4.7 Groundwater

Monitoring wells were installed in all boreholes, except borehole BH23-02A, to allow for subsequent measurements of the groundwater level at the Site.

The following table summarizes the measured groundwater levels and date of measurement.

Table 4: Measured Water Levels

Borehole No.	Water Level Depth (m)	Water Level Elevation (masl)	Date of Measurement (DD-MM-YYYY)
BH23-01	10.3 12.2	61.7 59.6	24-03-2023 29-03-2023
BH23-02	10.4 10.4	60.7 60.6	17-03-2023 29-03-2023
BH23-03	10.9 11.1	60.6 60.3	22-03-2023 29-03-2023
BH23-04	10.0 11.1	61.1 60.9	22-03-2023 29-03-2023
BH23-04A	8.5 9.3	63.5 62.6	22-03-2023 29-03-2023
BH23-05	9.5 9.5	60.9 60.8	13-03-2023 29-03-2023

It should be noted that groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring (i.e., snow melting).

4.8 Corrosion Testing

Soil samples from boreholes BH23-02A, BH23-03, BH23-04 and BH23-05 were submitted to Eurofins Environmental Testing for basic chemical analyses related to potential sulphate attack on buried concrete elements and potential corrosion of buried ferrous elements. The results of this testing are provided in **Appendix D** and are summarized in the following table.

Table 5: Results of Basic Chemical Testing

Borehole No.	Sample Number	Sample Depth (m)	Chloride (%)	Sulphate (%)	Electrical Conductivity (mS/cm)	pH	Resistivity (ohm-cm)
BH23-02A	SA-05	2.44 – 3.05	0.044	0.14	1.40	7.31	714
BH23-03	SA-06	3.05 – 3.66	0.120	0.36	2.78	7.12	360

Borehole No.	Sample Number	Sample Depth (m)	Chloride (%)	Sulphate (%)	Electrical Conductivity (mS/cm)	pH	Resistivity (ohm-cm)
BH23-04	SA-04	4.27 – 4.88	0.013	0.12	1.14	7.38	877
BH23-05	SA-05	3.66 – 4.27	0.035	0.08	1.39	7.56	714

5.0 DISCUSSION AND GEOTECHNICAL RECOMMENDATIONS

5.1 General

This section of the report provides engineering guidance related to the geotechnical design aspects of the project based on our interpretation of the available information described herein and project requirements. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the factual information for construction, and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, safety, and equipment capabilities. Reference should be made to the Limitations of this Report, which follows the text but forms an integral part of this document. This report is intended to be used in its entirety, and no excerpts may be taken to be representative of the findings in the assessment. Design recommendations given in this report are applicable only to the project and areas as described in the text and then only if constructed in accordance with the details stated in this report.

5.2 Site Grading

It is understood that, as currently proposed, the design finished grades will generally remain unchanged.

5.3 Seismic Design

5.3.1 Liquefaction

It is understood that the proposed structure will be founded closer to or on the underlying bedrock and liquefaction does not need to be considered.

5.3.2 Seismic Site Classification

As outlined in the Ontario Building Code, building foundations must be designed to resist a minimum earthquake force. In accordance with Table 4.1.8.4.A of the Ontario Building Code, the seismic site response for foundations placed either directly on bedrock or on engineered fill within 3 m of the underside of the foundations would have a site classification of Class C. Based on the results of the geophysical testing, which included VSP testing at borehole BH23-01, the average shear wave velocity for foundations founded at 7.5 mbgs (Elevation of 64.5 masl) is 1461 m/s. Therefore, Site Class B can be considered for design.

The geophysical technical memorandum is included in **Appendix E**.

5.4 Foundations

The proposed redevelopment includes two levels of underground parking. It has been assumed that the underside of the foundations will be at 6 mbgs (Elevation of 66.0 masl) or deeper. Based on the results of the subsurface investigation, the foundations would be placed on slightly to moderately weathered shale bedrock. Considering the nature and quality of the rock, the foundations need to be placed deeper, on the fresh shale bedrock starting approximately at 7.5 mbgs (Elevation of 64.5 masl).

Spread footings founded on clean, sound and undisturbed bedrock are considered to be a feasible option. The subsurface investigation indicated the presence of a fractured and weathered zone of rock near the bedrock surface. When they are encountered, these zones of more fractured rock should be removed. For spread footings placed on sound bedrock, a factored Ultimate Limit States (ULS) bearing resistance of 1,000 kilopascals can be used for design of the foundations. Serviceability Limit States (SLS) net bearing resistances do not generally apply to the design of foundations on the bedrock, provided the bedrock surface is properly cleaned of soil and highly weathered/fractured bedrock at the time of construction.

For ULS sliding resistance of a cast-in-place footing placed on bedrock, an unfactored sliding friction coefficient of 0.70 can be used. In accordance with OBC 2012 requirements, a resistance factor of 0.8 should be applied to the sliding resistance between the footings and the underlying bedrock.

All bearing surfaces should be checked, evaluated and approved at the time of construction by a geotechnical engineer who is familiar with the findings of this investigation and the design and construction of similar projects prior to placement of any concrete, back fill, etc.

5.4.1 Rock Anchors

The use of rock anchors to resist uplift forces on the foundations could be considered where additional uplift resistance is required.

In designing grouted rock anchors, consideration should be given to four possible anchor failure modes:

i) Failure of the steel tendon or top anchorage

ii) Failure of the grout/tendon bond

iii) Failure of the rock/grout bond, and

iv) Failure within the rock mass, or rock cone pull-out.

Potential failure modes i) and ii) are structural and are best addressed by a structural engineer.

For potential failure mode iii), the *factored* bond stress at the grout/rock interface may be taken as 1,000 kPa (or 1/30 of the compressive strength of the grout) for ULS design purposes. This value should be used in calculating the resistance under ULS conditions. If the response of the anchor under SLS conditions needs to be evaluated, it may conservatively be taken as the elastic elongation of the unbonded portion of the anchor under the design loading.

For potential failure mode iv), the resistance is calculated based on the weight of the potential mass of rock and soil which could be mobilized by the anchor. This is typically considered as the mass of rock included within a cone (or wedge for a line of closely spaced anchors) having an apex at the tip of the anchor and having an apex angle of 60 degrees. For each individual anchor, the ULS factored geotechnical resistance can be calculated based on the following equation:

$$Q_r = \varphi \frac{\pi}{3} \gamma' D^3 \tan^2\!-\theta$$

Where: Q_r = Factored uplift resistance of the anchor (kN);

φ = Geotechnical resistance factor (use 0.4);

γ' = Effective unit weight of rock and soil (use 13 kN/m^3 below the groundwater level);

D = Anchor length in metres; and,

θ = one-half of the apex angle of the rock failure cone (use 30°).

For a group of anchors or for a line of closely spaced anchors, the resistance must consider the potential overlap between the rock masses mobilized by individual anchors. In the case of group effects for a series of rock anchors in a rectangle with width “a” and length “b” installed to a depth “D”, the equation for the volume of the truncated trapezoid failure zone would be as follows:

$$V = \frac{4}{3}\,D^3 sin^2\varphi + \ aD^2 \sin\varphi + bD^2 \sin\varphi + abD$$

Where: V = Volume of the truncated trapezoid failure zone (m^3);

D = Depth of anchor group (m);

a = Width of anchor group (m);

b = Length of the anchor group (m); and,

φ = ½ of the apex angle of the rock failure cone, use 30°.

The ULS factored geotechnical resistance for the truncated trapezoid failure formed by the group of anchors can then be calculated based on the following equation:

$$Q_r = \varphi\gamma' V$$

Where: Qr = Factored uplift resistance of the anchor (KN);

φ = Geotechnical resistance factor, use 0.4;

γ' = Effective unit weight of rock and soil, use 13 kN/m^3 below the water table; and,

V = Volume of truncated trapezoid (m^3).

It is recommended that proof load tests be carried out on any new anchors to confirm their resistance. The proof load tests should be carried out in accordance with the Post Tensioning Institute (PTI) Recommendations for Prestressed Rock and Soil Anchors (2004).

A member of geotechnical staff should be present during the installation and testing of the anchors. Care must be taken during grouting to ensure that the grouting pressure is sufficient to bond the entire length of the grouted area with minimum voids.

Confirmation of sufficient embedment into the rock beneath the foundations should be carried out during construction to make sure that the anchors are being installed in rock of adequate quality. The anchor holes must be thoroughly flushed with water to remove all debris and rock flour. It is essential that rock flour be completely removed from the holes to be grouted to promote an adequate bond between the grout and the rock. Prestressing of the anchors prior to loading will minimize anchor movement due to service loads.

5.5 Frost Protection

All perimeter and exterior foundation elements or interior foundation elements (i.e., footings, pile caps, grade beams, etc.) in unheated areas should be provided with a minimum of 1.5 metres of earth cover for frost protection purposes. Isolated, unheated exterior foundation elements adjacent to surfaces which are cleared of snow cover during winter months should be provided with a minimum of 1.8 metres of earth cover.

As an alternative to earth cover, consideration could be provided to the use of an insulation detail. Additional guidance on insulation details can be provided if required. Based on an assumed foundation depth of 6 to 8 m, the foundations would therefore be located below the design frost depth.

In the event that foundations are to be constructed during the winter months, foundation soils and shale rock are required to be protected from freezing temperatures using suitable construction techniques. Therefore, the base of all excavations should be insulated from freezing temperatures immediately upon exposure, until the time that heat can be supplied to the building interior and/or the foundations have sufficient earth cover to prevent freezing of the subgrade soils.

5.6 Foundation Wall Backfill

Foundation/basement walls should be backfilled with free draining non-frost susceptible granular fill meeting the requirements of OPSS Granular B Type I materials. The backfill should be compacted to 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment. To reduce compaction induced stresses, only light compaction rollers or plate tampers should be used within 1.0 metre of the wall. In any areas where the temporary shoring wall serves as the outside form for the foundation wall, vertical drainage must be installed against the shoring wall. The drainage channels could consist of filtered drainage wick such as Miradrain (or proven equivalent).

Water flow from either the granular backfill or drainage channels should be collected by means of a perforated drain line located at the base of the wall. This drain line should be provided with a granular surround and should lead to a sump pit from which water can be pumped.

Beneath hard surfacing (e.g., pavements or sidewalks/walkways), the granular backfill for the foundation wall should be placed to form a frost taper at 3 horizontal to 1 vertical to a depth of 1.8 metres (i.e., the frost depth). The purpose of this frost taper is to limit the severity of differential heaving that could occur between areas backfilled with non-frost susceptible engineered fill and the adjacent areas underlain by the existing frost susceptible soils.

5.7 Garage Floor Slab

In preparation for the construction of the garage floor slab, all fill and, all loose, wet, and disturbed material should be removed from beneath the floor slab down to the bedrock. Provision should be made for at least 250 millimetres of Ontario Provincial Standard Specification (OPSS) Granular A to form the base of the floor slab. Any bulk fill required to raise the grade up to the underside of the Granular A should consist of OPSS Granular B Type II. The underslab fill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the standard Proctor maximum dry density using suitable vibratory compaction equipment.

The floor slabs should be structurally separate from the foundation walls and columns. Sawcut control joints should be provided at regular intervals and along column lines to minimize shrinkage cracking.

Provision should be made for drainage underneath the floor slab consisting of a perforated pipe subdrain in a surround of 19 millimetre clear stone, fully wrapped in geotextile, which leads by gravity drainage to an adjacent storm sewer or sump pit from which the water is pumped.

5.8 Excavations

Based on the stratigraphy of the site and our understanding of the project, the garage/foundation walls construction will require trench excavations of up to 8 m in depth. According to the data collected from the boreholes, the excavations will be carried out in the existing fill materials, the natural cohesive deposit, the glacial till and the shale bedrock.

Temporary excavation slopes with an inclination of about 1V : 2H could be profiled in soils above the water table. For submerged soils, the slope would be 1V : 3H.

Excavations at the Site are anticipated to encounter shale bedrock at approximate depths of 2.9 mbgs to 5.2 mbgs (Elevations of 69.1 to 66.1 masl). The upper portion of the shale bedrock is weathered and fractured. Shallow excavations within this weathered zone may be feasible with conventional hydraulic excavating equipment with rock teeth and with the aid of pneumatic/hydraulic rock excavation equipment such as hoe-ramming. Deeper excavations, greater than two metres in more intact or competent rock are typically more economically made by controlled blasting, but due to the location of this project with several buildings in close proximity, controlled blasting may not be feasible. Rock removal for this project therefore could be accomplished by either mechanical methods (hoe-ramming or splitters) or by chemical expansion, however this work would likely be slow and tedious.

Excavation slopes into bedrock can be made with a near-vertical face. The face of the excavation, however, must be scaled of any loose rock to protect the workers in the excavation. Line drilling could be considered to define and control the extent of rock removal and prevent over-break. All rock faces should be reviewed by a qualified person as excavated. A minimum 1 m horizontal ledge should remain between the overburden excavation and bedrock surface to provide an area to allow for potential sloughing and a stable base for the overburden shoring system.

5.8.1 Protection of Expansive Shale Subgrade

Excavation for the foundations may result in exposure of the shale bedrock to air. The shale bedrock at this site may have the potential to swell following exposure to oxygen. This process involves a series of chemical reactions, some of which are purely chemical and others of which are at least catalyzed by micro-organisms. The general mechanism is considered to be that pyrite (FeS_2), which is present at low concentrations in the shale, weathers in the combined presence of oxygen and water to form sulphuric acid. That sulphuric acid then reacts with calcite, which is also present within the shale either as an integral part of the rock or as infilling, to form gypsum. The gypsum crystals tend to form within existing fractures and are volumetrically larger than the materials that formed them, thus resulting in heaving. Other mineral by-products of these reactions, such as the mineral jarosite, form a yellowish powder that is a characteristic indicator of this process.

For the above reactions to occur, there must be both water and oxygen available. It is considered that this new excavation may introduce oxygen to the shale if left unprotected. It is also possible for the products of the above reactions to attack the concrete (i.e., sulphate attack).

To prevent expansion of the shale and/or reaction with the concrete, the shale must be protected from exposure to oxygen both in the long term as well as temporarily during construction. During excavation, the exposed shale subgrade should be covered as soon as practical with a full strength (25 MPa) concrete mud slab layer. Construction planning should ensure the shale is not left exposed and uncovered overnight. It is unlikely that the form work, installation of steel reinforcements, and the concrete pour for the footings can all occur on the same day. Therefore, provisions should be made to include a concrete mud slab to cover the shale rock on the same day that it is exposed.

That concrete mud slab should be made with sulphate resistant cement (HS or HSb). Where shale is exposed on the sides of the excavation, the mud slab should be placed such that the concrete covers the shale to the top-of-rock level. This could be accomplished by sloping the bedrock on the sides of the excavation to allow the concrete to stay in place, or by using shotcrete on the vertical bedrock surfaces.

5.9 Lateral Earth Pressures for Design

The lateral earth pressures acting on the garage/foundation walls will depend on the existing soil conditions, on the magnitude of surcharge including construction loadings, on the freedom of lateral movement of the structure, and on the drainage conditions behind the walls. Seismic (earthquake) loading must also be taken into account in the design.

The details on the wall backfill drainage are provided in Section 5.6 of this report.

The following recommendations are made concerning the design of the foundation walls. Where the wall support and structure allow lateral yielding, (e.g., for unrestrained retaining walls), active earth pressures may be used in the design of the wall. Where the support does not allow lateral yielding, (i.e., for the proposed basement walls) at-rest earth pressures should be assumed for design.

If a shored excavation (in overburden) is used as part of the formwork for the wall, the lateral earth pressures for foundation walls are based on the existing retained soils and are shown in the table below:

Table 6: Lateral Earth Pressure - Parameters

Material	Unit Weight (kN/m^3)	Coefficients of static lateral earth pressure	
		Active, Ka	At rest, Ko
Fill	18	0.38	0.55
Clayey Silt to Clay	17	0.36	0.53
Glacial Till	21	0.31	0.47

If the garage/foundation wall is backfilled with granular free draining fill either in a zone with width equal to at least 50 percent of the height of the wall or within the wedge-shaped zone defined by a line drawn at 1 horizontal to 1 vertical (1H:1V) extending up and back from the rear face of the footing/pile cap/grade beam, the following parameters (unfactored) may be used:

Table 7: Lateral Earth Pressure - Parameters

Material	Unit Weight (kN/m^3)	Coefficients of static lateral earth pressure	
		Active, Ka	At rest, Ko
Granular A or Granular B Type II	22	0.27	0.43
Granular B Type I	22	0.31	0.47

Seismic loading will result in increased lateral earth pressures acting on the walls. The walls should be designed to withstand the combined lateral loading for the appropriate static pressure conditions given above, plus the earthquake-induced dynamic earth pressure.

The horizontal seismic coefficient, k_h, used in the calculation of the seismic active pressure coefficient is taken as 1.0 times the design PGA. For structures which allow lateral yielding, k_h is taken as 0.5 times the design PGA.

The seismic active pressure coefficients (K_{AE}) used in design will be provided once the results of the geophysical investigation are complete and the seismic site class is confirmed.

The earthquake-induced dynamic pressure distribution, which is to be added to the static earth pressure distribution, is a linear distribution with maximum pressure at the top of the wall and minimum pressure at its toe (i.e., an inverted triangular pressure distribution).

A minimum surcharge pressure of 12 kilopascals due to traffic and compaction induced pressure should be included in the total lateral earth pressures for the structural design of the wall.

The total pressure distribution (static plus seismic) may be determined as follows:

$$\sigma_h(d) = K_o \gamma d + (K_{AE} - K_a) \gamma (H-d) + q$$

Where:

$\sigma_h(d)$	=	Lateral earth pressure at depth, d, (kPa);
K_o	=	Coefficient of static earth pressure;
γ	=	Unit weight of the backfill soil (kN/m^3); as given previously;
d	=	Depth below the top of the wall (m);
K_{AE}	=	Seismic active earth pressure coefficient;
q	=	Surcharge to account for traffic and compaction pressure, where applicable; and,
H	=	Total height of the wall (m).

All of the lateral earth pressure equations are given in an unfactored format and will need to be factored for Ultimate Limit States design purposes.

5.10 Permanent Drainage

Based on the available information, the groundwater level at the site was found to be 8.5 mbgs to 12.2 mbgs (Elevations of 63.5 to 59.6 masl). The assumed foundation depth is 6 m to 8 m and could potentially be within close proximity of the seasonally high groundwater table which typically occurs in the spring or after major precipitation event. Permanent groundwater control would therefore be required Permanent groundwater control should include sub-drains below the finished floor slab structure and perimeter drains around the exterior footings. The drainage plan should be reviewed by a geotechnical engineer who has reviewed the findings of this report.

5.11 Pavement Design

Detailed traffic loads have not been provided at this time, however based on the available information of the subsoil conditions encountered, conventional asphaltic (flexible) pavement designs are considered to be appropriate for paved parking areas and access lanes.

The following pavement structure is recommended for pavement reinstatement following reconstruction of the retaining wall:

Table 8: Recommended Pavement Structures

Pavement Layer	Option 1 – Heavy Duty Access	Option 2 – Light Access Only
Hot Mix Asphalt	40 mm SP12.5 50 mm SP19.0	50 mm HL3 or SP12.5
Granular Base Course	150 mm	150 mm
Granular Subbase Course	400 mm	300 mm
Total Pavement Structure	640 mm	500 mm

The asphalt materials and placement specifications should be in accordance with relevant City of Ottawa standard specifications.

Any topsoil, all disturbed, loosened, softened, organic and other deleterious material should be removed from the pavement areas.

At the completion of the stripping and prior to any placement of new fill, the subgrade within the pavement areas should be proof-rolled. Soft or weak areas should be removed and repaired with acceptable earth borrow or OPSS Select Subgrade Material (SSM). Both stripping and proof-rolling operations should be observed and carried out to the satisfaction of geotechnical personnel. All stripping and earthwork activities should be performed in a manner consistent with good erosion and sediment control practices.

Pavement areas requiring grade raising to proposed subgrade level should be brought to grade using acceptable (compactable and inorganic) earth borrow or OPSS SSM. These materials should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the materials standard Proctor maximum dry density using suitable compaction equipment.

The surface of the pavement subgrade should be crowned or sloped to promote drainage of the pavement granular structure towards perimeter swales or subdrains placed at the subgrade level

Prior to placing engineered fill, the exposed subgrade should be inspected by qualified geotechnical personnel to confirm that the exposed soils are suitable and undisturbed and have been adequately cleaned of ponded water and all disturbed, loosened, softened, organic and other deleterious material. Remedial work (i.e. further sub-excavation and replacement) should be carried out as directed by a geotechnical engineer.

5.12 Site Servicing

The depth of bedrock encountered during the field investigation ranged from 2.9 mbgs to 5.2 mbgs (Elevations of 69.1 to 66.1 masl). Excavation for the installation of site services for the proposed redevelopment will be through fill materials, natural cohesive deposit, glacial till and the underlying shale bedrock. No unusual problems are anticipated in trenching in these overburden materials using conventional hydraulic excavating equipment. Some difficulty maybe encountered if cobble and boulder sized rock fragments are encountered within the overburden. The water and sewer services will need to be protected against freezing conditions and water-bearing services should be placed a minimum of 2 m below grade to provide protection from frost.

At least 150 millimetres of OPSS Granular A should be used as pipe bedding for sewer and water pipes. Where unavoidable disturbance to the subgrade surface occurs during construction, it may be necessary to place a sub-bedding layer consisting of 300 millimetres of compacted OPSS Granular B Type II beneath the Granular A. The bedding material should, in all cases, extend to the spring line of the pipe and should be compacted to at least 95 percent of the material’s standard Proctor maximum dry density. The use of clear crushed stone as a bedding layer should not be permitted anywhere on this project since fine particles from the sandy backfill materials and native soils could potentially migrate into the voids in the clear crushed stone and cause loss of lateral pipe support.

Cover material, from the spring line of the pipe to at least 300 millimetres above the top of pipe, should consist of OPSS Granular A or Granular B Type I with a maximum particle size of 25 millimetres. The cover material should be compacted to at least 95 percent of the material’s standard Proctor maximum dry density.

The existing overburden soils should not be re-used as trench backfill. Where the trench will be covered with hard surfaced areas, the type of material placed in the frost zone (between subgrade level and 1.8 metres depth) should match the soil exposed on the trench walls for frost heave compatibility. Trench backfill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material’s standard Proctor maximum dry density using suitable vibratory compaction equipment.

5.13 Corrosion and Cement Type

Soil samples from boreholes BH23-02A, BH23-03, BH23-04 and BH23-05 were submitted to Eurofins Environmental Testing for basic chemical analyses related to potential sulphate attack on buried concrete elements and potential corrosion of buried ferrous elements. The results of this testing are provided in **Appendix D**.

The pH, resistivity and chloride concentration give an indication of the degree of corrosiveness of the sub-surface environment. Generally, the test results indicate a high potential for corrosion of exposed ferrous metal at the Site which should be considered in the design of substructures.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater. Based on the standard A23.1-14 (CSA A23.1) by Canadian Standards Association, the sulphate attack potential is considered moderate to severe (i.e., less than moderate) on concrete structures at this site. Therefore, sulphate resistant Portland cement (HSb, HSLb, or HSe) should be used for buried concrete substructures.

5.14 Construction Considerations

At the time of writing this report, only conceptual details related to the building were available. WSP should review the final drawings and specifications for this project prior to tendering to confirm that the guidelines in this report have been adequately interpreted.

The construction activities could impact the existing adjacent structures and buildings. Appropriate damage assessments (pre and post condition surveys for example) should be carried out as necessary.

During construction, sufficient foundation inspections, subgrade inspections, in-situ density tests, materials testing should be carried out to confirm that the conditions exposed are consistent with those encountered in the field investigation, and to monitor conformance to the pertinent project specifications. Concrete testing should be carried out in a CCIL certified laboratory.

6.0 CLOSURE

This report presents the results of the geotechnical investigation. The Limitations of Report, as presented in the attachments, are an integral part of this report.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

Signature Page

WSP Canada Inc.

Othamane Benkirane, CPI
Geotechnical Consultant

Sarah MacDonald, P.Eng.
Senior Geotechnical Engineer

OB/SM/ljv/al

https://golderassociates.sharepoint.com/sites/170393/project files/6 deliverables/geotechnical report/final/23592402-001_170 slater_geotech final report_sm.docx

LEGEND

APPROXIMATE SITE LOCATION

0 100 200 400

SCALE 1:10,000 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
2. COORDINATE SYSTEM: NAD 1983 UTM ZONE 18N

CLIENT

THE CANADA LIFE ASSURANCE COMPANY C/O GWL REALTY ADVISORS INC.

PROJECT

GEOTECHNICAL INVESTIGATION – REDEVELOPMENT AT 170 SLATER STREET, OTTAWA, ON

TITLE

SITE PLAN

CONSULTANT

wsp

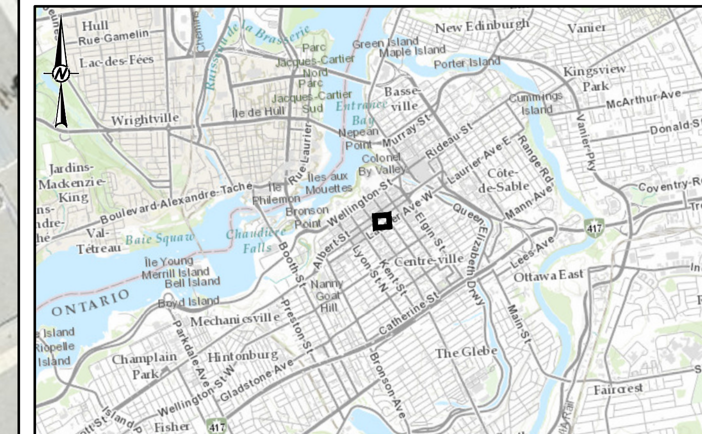
YYYY-MM-DD	2023-04-03
DESIGNED	SD
PREPARED	SD
REVIEWED	OB
APPROVED	SM

PROJECT NO.	CONTROL	REV.	FIGURE
23592402 & 231-02263-00	0001	A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

25mm

KEY MAP



SCALE 1:100,000

LEGEND

BOREHOLE

0 5 10 20

SCALE 1:600 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
2. IMAGERY CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY © 2023 MICROSOFT CORPORATION © 2023 MAXAR ©CNES (2023) DISTRIBUTION AIRBUS DS
3. COORDINATE SYSTEM: NAD 1983 UTM ZONE 18N

CLIENT

THE CANADA LIFE ASSURANCE COMPANY C/O GWL REALTY ADVISORS INC.

PROJECT

GEOTECHNICAL INVESTIGATION – REDEVELOPMENT AT 170 SLATER STR EET, OTTAWA, ON

TITLE

BOREHOLE LOCATION PLAN

CONSULTANT

wsp

YYYY-MM-DD	2023-04-04
DESIGNED	SD
PREPARED	SD
REVIEWED	OB
APPROVED	SM

PROJECT NO.	CONTROL	REV.	FIGURE
23592402 & 231-02263-00	0001	A	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

APPENDIX A

Borehole Logs - Current Geotechnical Investigation

BOREHOLE DRILLING RECORD : **BH23-01**

Prepared by: **James Sullivan**
Reviewed by: **Prosper Ahimbe Kitandala**
Date (Start): **2023-03-23**
Date (End): **2023-03-24**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445341 mE Y = 5029810 mN
Sector:	**Northwest, outside the parking garage.**	Surface Elevation:	71.97 m *(Geodetic)*
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**	Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza MI3
Drilling Method:	Wash bore / HW + air hammer
Borehole Diameter:	114 mm
Drilling Fluid:	Water

WELL DETAILS
- COPING Elevation : 71.97 m
- SCREEN Bottom Depth : 12.95 m
- Length : 0.91 m
- Opening : 51 mm
- WATER Elevation: 61.67 m
- WATER Date: 2023-03-24
- Water Level / Free Phase

SAMPLE TYPE
- DC - Diamond Core
- SS - Split Spoon
- PS - Piston Sample
- TC - Hollow Tube
- MA - Manual Auger
- TR - Trowel
- ST - Shelby Tube
- TT - DT-32 Liner

ANALYSIS
- AL - Atterberg Limits
- GSA - Grain Size Analysis
- PENTEST - Blow Counts/300mm
- PL - Point Load Test
- Sg - Specific Gravity
- SPT - N Value (Blow Counts/300mm)
- UCS - Uniaxial Compressive Strength
- w - Moisture Content
- wL - Liquidity Limit
- wP - Plasticity Limit

SAMPLE STATE
- Undisturbed
- Remoulded
- Lost
- Cored

GEOTECHNICAL legend: R □ Shear (kPa) 30 60 90 120 I ■; SPT=N Value ▲; PENTEST △; RQD (%) ⊙; PLASTIC LIMIT w (%) LIQUID; 20 40 60 80

DEPTH (m)	ELEVATION (m)	DESCRIPTION	TYPE & NO.	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)
		Ground surface.			
0,10	71,87	**ASPHALTIC CONCRETE.**			
0,46	71,51	**FILL (PAVEMENT STRUCTURE): GRAVELLY SAND,** grey to brown, non-cohesive, moist.	GR-1		
		FILL: SAND, fine to medium, brown, non-cohesive, moist, loose.	SS-2	42	6 3 2 5 (5)
1,83	70,14		SS-3	0	1 1 2 3 (3)
		CLAYEY SILT, some sand, brown-grey, mottled, cohesive, w ~ PL, firm to stiff.	SS-4	50	14 8 7 7 (15)
2,90	69,07	**WEATHERED SHALE.**	SS-5	8	24 27 31 34 (58)
3,81	68,16	**WEATHERED and FRACTURED SHALE BEDROCK.**	SS-6	13	29 39 50/4" (R) >>
			RC-1	64 (6)	

Depth scale: 0,5 — 1,0 — 1,5 — 2,0 — 2,5 — 3,0 — 3,5 — 4,0 — 4,5 — 5,0

Prepared by: **James Sullivan**
Reviewed by: **Prosper Ahimbe Kitandala**

Date (Start): **2023-03-23**
Date (End): **2023-03-24**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**
Site:	**170 Slater Street, Ottawa, ON**
Sector:	**Northwest, outside the parking garage.**
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**
Project Number:	**23592402**
Geographic Coordinates:	X = 445341 mE Y = 5029810 mN
Surface Elevation:	71.97 m *(Geodetic)*
Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza MI3
Drilling Method:	Wash bore / HW + air hammer
Borehole Diameter:	114 mm
Drilling Fluid:	Water

WELL DETAILS

COPING	Elevation :	71.97 m
SCREEN	Bottom Depth :	12.95 m
	Length :	0.91 m
	Opening :	51 mm
WATER Elevation:		61.67 m
WATER Date:		2023-03-24

Water Level — Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
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Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

GEOTECHNICAL legend: R □ Shear (kPa) 30 60 90 120 I ■; SPT=N Value ▲; PENTEST △; RQD (%) ⊙; PLASTIC LIMIT w (%) LIQUID; 20 40 60 80

DEPTH / *ELEVATION* (m)	STRATIGRAPHY	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	STATE	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)	GEOTECHNICAL	WELL DIAGRAM
		WEATHERED and FRACTURED SHALE BEDROCK.					Remoulded			RQD 6	
6,00 / *65,97*		**INFERRED SHALE.** Air hammer from 6.0 mbgs to 12.95 mbgs, no sampling.									

Depth scale (m): 5,5 – 6,0 – 6,5 – 7,0 – 7,5 – 8,0 – 8,5 – 9,0 – 9,5 – 10,0

BOREHOLE DRILLING RECORD : **BH23-01**

Prepared by: **James Sullivan** Date (Start): **2023-03-23**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-24**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**
Site:	**170 Slater Street, Ottawa, ON**
Sector:	**Northwest, outside the parking garage.**
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**
Project Number:	**23592402**
Geographic Coordinates:	X = 445341 mE Y = 5029810 mN
Surface Elevation:	71.97 m *(Geodetic)*
Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza MI3
Drilling Method:	Wash bore / HW + air hammer
Borehole Diameter:	114 mm
Drilling Fluid:	Water

WELL DETAILS

COPING	Elevation :	71.97 m
SCREEN	Bottom Depth :	12.95 m
	Length :	0.91 m
	Opening :	51 mm
WATER Elevation:		61.67 m
WATER Date:		2023-03-24

Water Level — Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
PL - Point Load Test
Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

DEPTH / *ELEVATION* (m)	STRATIGRAPHY	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	STATE	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)	GEOTECHNICAL	WELL DIAGRAM
		INFERRED SHALE. Air hammer from 6.0 mbgs to 12.95 mbgs, no sampling.									
12,95 *59,02*		End of borehole at 12,95 m.									

GEOTECHNICAL: R □ Shear (kPa) I ■ 30 60 90 120; SPT=N Value ▲; PENTEST △; RQD (%) ⊙; PLASTIC LIMIT w (%) LIQUID 20 40 60 80

Depth scale: 10,5 11,0 11,5 12,0 12,5 13,0 13,5 14,0 14,5 15,0

BOREHOLE DRILLING RECORD : **BH23-02**

Prepared by: **James Sullivan** Date (Start): **2023-03-10**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-14**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445376 mE Y = 5029772 mN
Sector:	**West, inside the parking garage.**	Surface Elevation:	71.06 m *(Geodetic)*
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**	Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Geoprobe 420M / Husky
Drilling Method:	Direct push + wash bore / B + W
Borehole Diameter:	56.5 mm
Drilling Fluid:	Water

WELL DETAILS

COPING Elevation :	70.96 m
SCREEN Bottom Depth :	12.42 m
Length :	3.05 m
Opening :	30 mm
WATER Elevation:	60.65 m
WATER Date:	2023-03-17

Water Level; Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
PL - Point Load Test
Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

GEOTECHNICAL: R □ Shear (kPa) 30 60 90 120 I ■; SPT=N Value ▲; PENTEST △; RQD (%); PLASTIC LIMIT w (%) LIQUID 20 40 60 80

DEPTH (m)	*ELEVATION* (m)	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)
		Ground surface.						
0.05	*71,01*	**ASPHALTIC CONCRETE.**	SA-01			DO-1	58	
		FILL (PAVEMENT STRUCTURE): SAND and GRAVEL to GRAVELLY SAND, brown, non-cohesive, moist.						
0.46	*70,60*	**SILT to CLAYEY SILT,** mostly non-plastic silt, some to trace sand, brown, slightly mottled, non-cohesive, moist.				DO-2	100	
1.22	*69,84*	**CLAYEY SILT,** mostly silt with plastic fines, trace sand, brown, cohesive, w ~ PL, stiff.				DO-3	100	
1.83	*69,23*	**GLACIAL TILL: CLAYEY SILT,** some sand, some gravel, contains cobbles and boulders, brown, cohesive, w ~ PL.				DO-4	50	
2.44	*68,62*	**GLACIAL TILL: GRAVELLY SILTY SAND to GRAVELLY SAND,** some silt, some clay, contains cobbles and boulders, dark-brown, non-cohesive, moist to wet.				DO-5	50	
						DO-6	73	
4.70	*66,36*					RC-1	97 (65)	

Prepared by: **James Sullivan** Date (Start): **2023-03-10**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-14**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445376 mE Y = 5029772 mN
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Drilling Company:	Strata Drilling Group
Drilling Equipment:	Geoprobe 420M / Husky
Drilling Method:	Direct push + wash bore / B + W
Borehole Diameter:	56.5 mm
Drilling Fluid:	Water

WELL DETAILS

COPING	Elevation :	70.96 m
SCREEN	Bottom Depth :	12.42 m
	Length :	3.05 m
	Opening :	30 mm
WATER Elevation:		60.65 m
WATER Date:		2023-03-17

Water Level / Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
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UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

GEOTECHNICAL legend: R □ Shear (kPa) 30 60 90 120 I ■; SPT=N Value ▲; PENTEST △; RQD (%); PLASTIC LIMIT w (%) LIQUID; 20 40 60 80

DEPTH ELEVATION (m)	GEOLOGY / LITHOLOGY – DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	STATE	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)	GEOTECHNICAL (RQD %)
5,0–5,5	**WEATHERED TO FRESH SHALE,** bedded, black, fine-grained, slightly to non-porous, brittle, Billings Shale, sulfide rich.					Cored			65
5,55–6,37					RC-2	Cored	99 (34)		34
6,37–7,46	←0.03 m void at approximately 6.9 m.				RC-3	Cored	95 (60)		60
7,46–8,53					RC-4	Cored	100 (83)		83
8,53–9,6					RC-5	Cored	99 (99)		99
9,6–10,0					RC-6	Cored	100 (82)		

Depth scale: 5,5 · 6,0 · 6,5 · 7,0 · 7,5 · 8,0 · 8,5 · 9,0 · 9,5 · 10,0

WELL DIAGRAM

Prepared by: **James Sullivan** Date (Start): **2023-03-10**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-14**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445376 mE Y = 5029772 mN
Sector:	**West, inside the parking garage.**		
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**	Surface Elevation:	71.06 m *(Geodetic)*
		Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Geoprobe 420M / Husky
Drilling Method:	Direct push + wash bore / B + W
Borehole Diameter:	56.5 mm
Drilling Fluid:	Water

WELL DETAILS

COPING	Elevation :	70.96 m
SCREEN	Bottom Depth :	12.42 m
	Length :	3.05 m
	Opening :	30 mm
WATER Elevation:		60.65 m
WATER Date:		2023-03-17

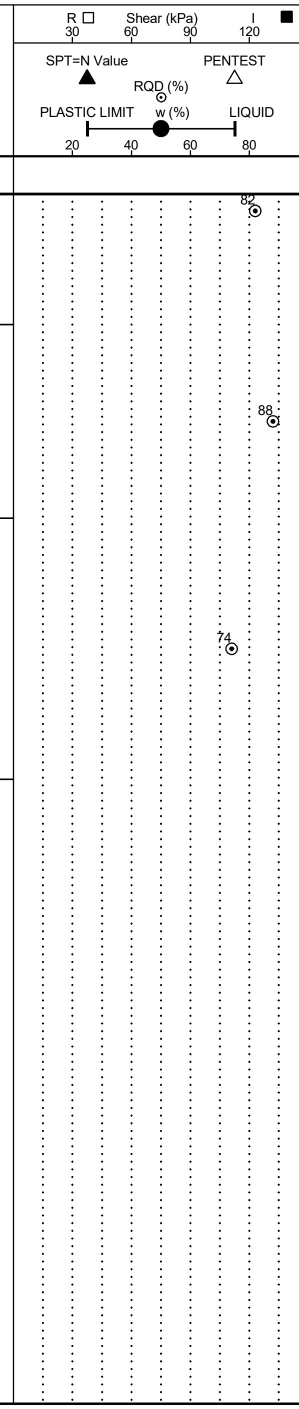
Water Level / Free Phase

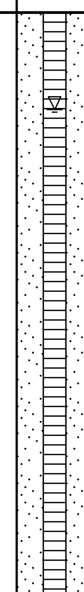
SAMPLE TYPE: DC - Diamond Core; SS - Split Spoon; PS - Piston Sample; TC - Hollow Tube; MA - Manual Auger; TR - Trowel; ST - Shelby Tube; TT - DT-32 Liner

ANALYSIS: AL - Atterberg Limits; GSA - Grain Size Analysis; PENTEST - Blow Counts/300mm; PL - Point Load Test; Sg - Specific Gravity; SPT - N Value (Blow Counts/300mm); UCS - Uniaxial Compressive Strength; w - Moisture Content; wL - Liquidity Limit; wP - Plasticity Limit

SAMPLE STATE: Undisturbed; Remoulded; Lost; Cored

DEPTH *ELEVATION* (m)	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	STATE	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)
	WEATHERED TO FRESH SHALE, bedded, black, fine-grained, slightly to non-porous, brittle, Billings Shale, sulfide rich.							
					RC-7		99 (88)	
					RC-8		100 (74)	
12,42 *58,64*	End of borehole at 12,42 m.							





BOREHOLE DRILLING RECORD : **BH23-02A**

Prepared by: **James Sullivan** Date (Start): **2023-03-13**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-13**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445374 mE Y = 5029774 mN
Sector:	**1m south of BH23-02.**	Surface Elevation:	Not measured
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**	Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza SPT
Drilling Method:	SPT / DO casing / B + W
Borehole Diameter:	72 mm
Drilling Fluid:	N/A

WELL DETAILS
COPING Elevation :
SCREEN Bottom Depth :
Length :
Opening :
WATER Elevation:
WATER Date:
Water Level; Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
PL - Point Load Test
Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

GEOTECHNICAL: R □ Shear (kPa) 30 60 90 120 I ■; SPT=N Value ▲; PENTEST △; RQD (%); PLASTIC LIMIT w (%) LIQUID; 20 40 60 80

DEPTH ELEVATION (m)	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	STATE	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)
	Ground surface.							
0,05	**ASPHALTIC CONCRETE.**							
0,15	**FILL (PAVEMENT STRUCTURE): SAND,** some gravel, grey, non-cohesive, moist.	SA-01A SA-01B			SS-1	Remoulded	67	13 15 16 7 (31)
0,46	**FILL (PAVEMENT STRUCTURE): GRAVELLY SAND,** trace silt, brown, non-cohesive, moist.				SS-2	Remoulded	42	7 14 15 11 (29)
	CLAYEY SILT to SILTY CLAY, some to trace sand, trace gravel, brown, slightly mottled, cohesive, w < PL to ~ PL.	SA-03	w AL		SS-3	Remoulded	92	3 3 4 4 (7)
1,83	**GLACIAL TILL: SILTY SAND, some gravel to GRAVELLY SAND, some silt,** some to trace clay, contains cobbles, brown, non-cohesive, moist, dense to compact.				SS-4	Remoulded	83	4 25 54 65 (79)
		SA-05	Corrosivity		SS-5	Remoulded	83	20 14 14 11 (28)
3,05	**GLACIAL TILL: SAND and GRAVEL,** some silt, trace clay, contains cobbles, dark-brown to black, non-cohesive, moist.	SA-06	GSA		SS-6	Remoulded	50	5 4 3 2 (7)
					SS-7	Remoulded	42	3 3 5 8 (8)
	Contains shale fragments.				SS-8	Remoulded	78	5 50/5"
4,80	**BH23-02A was drilled next to BH23-02 for SPT "N" values purposes.** End of borehole at 4,80 m.							

Depth scale (m): 0,5 1,0 1,5 2,0 2,5 3,0 3,5 4,0 4,5 5,0 5,5 6,0

BOREHOLE DRILLING RECORD : **BH23-03**

Prepared by: **James Sullivan** Date (Start): **2023-03-20**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-21**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445370 mE Y = 5029816 mN
Sector:	**Northeast, inside the parking garage.**	Surface Elevation:	71.54 m *(Geodetic)*
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**	Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza SPT
Drilling Method:	SPT / direct push / B + W
Borehole Diameter:	82.5 mm
Drilling Fluid:	Water

WELL DETAILS
COPING Elevation : 71.47 m
SCREEN Bottom Depth : 13.29 m
Length : 3.05 m
Opening : 25.4 mm
WATER Elevation: 60.64 m
WATER Date: 2023-03-22
Water Level / Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
PL - Point Load Test
Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

GEOTECHNICAL legend: R □ Shear (kPa) 30 60 90 120 I ■; SPT=N Value ▲; PENTEST △; RQD (%); PLASTIC LIMIT w (%) LIQUID; 20 40 60 80

DEPTH / *ELEVATION* (m)	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)
	Ground surface.						
0.05 / *71,49*	**ASPHALTIC CONCRETE.**	SA-01	w		SS-1	67	16 14 11 10 (25)
0.36 / *71,18*	**FILL (PAVEMENT STRUCTURE): SAND and GRAVEL,** grey, non-cohesive, moist, compact.						
	FILL: SAND, fine to medium, brown, non-cohesive, moist, compact.	SA-02	w		SS-2	75	8 8 9 11 (17)
		SA-03	w		SS-3	83	10 8 6 4 (14)
1.98 / *69,56*	**FILL: SANDY SILT to SILT,** some clay, gravel, brown-grey, mottled, non-cohesive, moist, compact.	SA-04	w		SS-4	75	4 7 10 8 (17)
2.54 / *69,00*	**GLACIAL TILL: SILTY SAND,** some gravel, trace clay, contains cobbles, contains shale, brown to dark-brown to black, non-cohesive, moist, loose to compact.	SA-05	w GSA		SS-5	100	9 8 8 5 (16)
		SA-06	w Corrosivity		SS-6	63	3 2 4 8 (6)
					SS-7	100	10 50/2"
3.86 / *67,68*	**WEATHERED to FRESH SHALE,** bedded, black, fine grained, brittle, non-porous to slightly porous, Billings Shale, sulfide rich.				RC-1	82 (42)	
					RC-2	98 (80)	

Depth scale (m): 0,5 1,0 1,5 2,0 2,5 3,0 3,5 4,0 4,5 5,0

RQD: 42

BOREHOLE DRILLING RECORD : **BH23-03**

Prepared by: **James Sullivan** Date (Start): **2023-03-20**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-21**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445370 mE Y = 5029816 mN
Sector:	**Northeast, inside the parking garage.**	Surface Elevation:	71.54 m *(Geodetic)*
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**	Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza SPT
Drilling Method:	SPT / direct push / B + W
Borehole Diameter:	82.5 mm
Drilling Fluid:	Water

WELL DETAILS
COPING Elevation : 71.47 m
SCREEN Bottom Depth : 13.29 m
Length : 3.05 m
Opening : 25.4 mm
WATER Elevation: 60.64 m
WATER Date: 2023-03-22
Water Level / Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
PL - Point Load Test
Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

DEPTH ELEVATION (m)	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	% RECOVERY (RQD)	RQD (%) plotted
5.0–5.6	**WEATHERED to FRESH SHALE,** bedded, black, fine grained, brittle, non-porous to slightly porous, Billings Shale, sulfide rich.						80
5.6–6.5		RC-3	UCS		RC-3	85 (30)	30
6.5–7.3					RC-4	100 (81)	81
7.3–8.4					RC-5	96 (93)	93
8.4–9.6					RC-6	92 (42)	42
9.6–10.0					RC-7	100 (61)	

GEOTECHNICAL: R □ Shear (kPa) 30 60 90 120 I ■; SPT=N Value ▲; PENTEST △; RQD (%); PLASTIC LIMIT w (%) LIQUID; 20 40 60 80

Depth scale: 5,5 6,0 6,5 7,0 7,5 8,0 8,5 9,0 9,5 10,0

BOREHOLE DRILLING RECORD : **BH23-03**

Prepared by: **James Sullivan** Date (Start): **2023-03-20**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-21**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445370 mE Y = 5029816 mN
Sector:	**Northeast, inside the parking garage.**	Surface Elevation:	71.54 m *(Geodetic)*
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**	Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza SPT
Drilling Method:	SPT / direct push / B + W
Borehole Diameter:	82.5 mm
Drilling Fluid:	Water

WELL DETAILS

COPING	Elevation :	71.47 m
SCREEN	Bottom Depth :	13.29 m
	Length :	3.05 m
	Opening :	25.4 mm
WATER Elevation:		60.64 m
WATER Date:		2023-03-22

Water Level / Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
PL - Point Load Test
Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

DEPTH / *ELEVATION* (m)	STRATIGRAPHY	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	STATE	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)	GEOTECHNICAL (RQD %)	WELL DIAGRAM
		WEATHERED to FRESH SHALE, bedded, black, fine grained, brittle, non-porous to slightly porous, Billings Shale, sulfide rich.								61	
10,5 – 11,0						RC-8		99 (28)		28	Water level ≈10,85
11,5 – 12,5		←*More weathered.* (≈12,25)				RC-9		85 (18)		18	
12,5 – 13,5						RC-10		96 (53)		53	
13,59 / *57,95*		End of borehole at 13,59 m.									

GEOTECHNICAL scale: R □ Shear (kPa) 30 60 90 120 I ■; SPT=N Value ▲; PENTEST △; RQD (%); PLASTIC LIMIT w (%) LIQUID; 20 40 60 80

Depth scale: 10,5 11,0 11,5 12,0 12,5 13,0 13,5 14,0 14,5 15,0

BOREHOLE DRILLING RECORD : **BH23-04**

Prepared by: **James Sullivan** Date (Start): **2023-03-14**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-17**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**
Site:	**170 Slater Street, Ottawa, ON**
Sector:	**East, inside the parking garage.**
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**
Project Number:	**23592402**
Geographic Coordinates:	X = 445394 mE Y = 5029792 mN
Surface Elevation:	72.08 m *(Geodetic)*
Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza SPT
Drilling Method:	SPT / direct push / B + W
Borehole Diameter:	82.5 mm
Drilling Fluid:	Water

WELL DETAILS

COPING Elevation :	72.01 m
SCREEN Bottom Depth :	16.86 m
Length :	1.52 m
Opening :	25.4 mm
WATER Elevation:	61.06 m
WATER Date:	2023-03-22

Water Level   Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
PL - Point Load Test
Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

GEOLOGY / LITHOLOGY — ANALYSIS — GEOTECHNICAL — WELL

Geotechnical plot legend: R □ Shear (kPa) I ■ (30, 60, 90, 120); SPT=N Value ▲; PENTEST △; RQD (%) ⊙; PLASTIC LIMIT — w (%) ● — LIQUID (20, 40, 60, 80)

DEPTH / ELEVATION (m)	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)
	Ground surface.						
0,05 / *72,03*	**ASPHALTIC CONCRETE.**	SA-01	w		SS-1	63	11 9 11 9 (20)
0,38 / *71,70*	**FILL (PAVEMENT STRUCTURE): GRAVELLY SAND,** grey-brown, non-cohesive, moist, compact.						
	FILL: SAND, fine to medium, trace gravel, brown, non-cohesive, moist, compact.	SA-02A	w		SS-2	75	11 7 8 5 (15)
1,07 / *71,01*	**FILL: SAND,** some silt, some gravel, trace clay, contains debris, contains glass, brown, mottled, non-cohesive, moist, compact to loose.	SA-02B					
					SS-3	50	3 1 1 2 (2)
1,98 / *70,10*	**WEATHERED CRUST: CLAYEY SILT to SILTY CLAY,** trace sand, brown-grey, mottled, non-cohesive, w < PL, stiff.	SA-04	w AL		SS-4	58	2 3 4 5 (7)
2,59 / *69,49*	**GLACIAL TILL: SAND,** some silt, some gravel, trace to some clay, contains cobbles, brown, non-cohesive, moist, compact to dense.	SA-05A	w		SS-5	83	1 3 11 18 (14)
		SA-05B	w				
		SA-06	w		SS-6	83	14 16 21 21 (37)
3,66 / *68,42*	**GLACIAL TILL: SILTY SAND,** some gravel, some clay, contains cobbles, contains shale, dark-brown to black, non-cohesive, moist, compact.	SA-07	w GSA		SS-7	92	13 10 11 11 (21)
		SA-08	w Corrosivity		SS-8	63	9 11 14 18 (25)
		SA-09	w		SS-9	83	7 7 20 22 (27)
5,18 / *66,90*	**WEATHERED SHALE,** with sand, gravel, black, bedded.						50/5"
5,61 / *66,47*		SA-10	w		SS-10	100	
					RC-1	72 (0)	

Depth scale (m): 0,5 – 1,0 – 1,5 – 2,0 – 2,5 – 3,0 – 3,5 – 4,0 – 4,5 – 5,0 – 5,5 – 6,0

Prepared by: **James Sullivan** Date (Start): **2023-03-14**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-17**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445394 mE Y = 5029792 mN
Sector:	**East, inside the parking garage.**	Surface Elevation:	72.08 m *(Geodetic)*
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**	Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza SPT
Drilling Method:	SPT / direct push / B + W
Borehole Diameter:	82.5 mm
Drilling Fluid:	Water

WELL DETAILS

COPING	Elevation :	72.01 m
SCREEN	Bottom Depth :	16.86 m
	Length :	1.52 m
	Opening :	25.4 mm
WATER Elevation:		61.06 m
WATER Date:		2023-03-22

Water Level / Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
PL - Point Load Test
Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

GEOTECHNICAL legend: R □ Shear (kPa) 30 60 90 120 I ■; SPT=N Value ▲; PENTEST △; RQD (%); PLASTIC LIMIT w (%) LIQUID; 20 40 60 80

DEPTH ELEVATION (m)	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	STATE	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)	RQD plotted
6.1–12.0	**WEATHERED to FRESH SHALE** bedded, black, fine grained, brittle, non-porous to slightly porous, Billings Shale.					Cored			0
6.5		RC-1	UCS		RC-2	Cored	95 (21)		21
7.5					RC-3	Cored	90 (40)		40
8.4					RC-4	Cored	100 (89)		89
9.5					RC-5	Cored	100 (93)		93
10.5					RC-6	Cored	94 (88)		88
11.5					RC-7	Cored	90 (63)		63

Depth scale: 6,5; 7,0; 7,5; 8,0; 8,5; 9,0; 9,5; 10,0; 10,5; 11,0; 11,5; 12,0

BOREHOLE DRILLING RECORD : **BH23-04**

Prepared by: **James Sullivan** Date (Start): **2023-03-14**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-17**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445394 mE Y = 5029792 mN
Sector:	**East, inside the parking garage.**	Surface Elevation:	72.08 m *(Geodetic)*
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**	Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza SPT
Drilling Method:	SPT / direct push / B + W
Borehole Diameter:	82.5 mm
Drilling Fluid:	Water

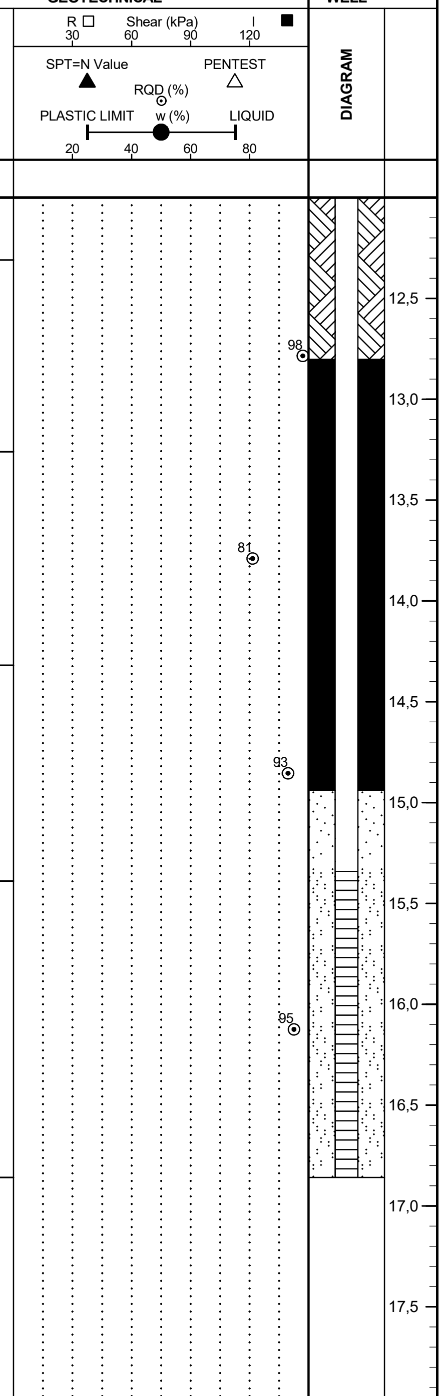
WELL DETAILS
COPING Elevation : 72.01 m
SCREEN Bottom Depth : 16.86 m
Length : 1.52 m
Opening : 25.4 mm
WATER Elevation: 61.06 m
WATER Date: 2023-03-22
Water Level · Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
PL - Point Load Test
Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

DEPTH / *ELEVATION* (m)	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)
	WEATHERED to FRESH SHALE bedded, black, fine grained, brittle, non-porous to slightly porous, Billings Shale.						
					RC-8	100 (98)	
					RC-9	93 (81)	
					RC-10	100 (93)	
	With limestone beds. (at approx. 15,4 m)				RC-11	100 (95)	
16,86 / *55,22*	End of borehole at 16,86 m.						



BOREHOLE DRILLING RECORD : **BH23-04A**

Prepared by: **James Sullivan** Date (Start): **2023-03-15**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-15**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445393 mE Y = 5029795 mN
Sector:	**2m north of BH23-04.**		
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**	Surface Elevation:	72.04 m *(Geodetic)*
		Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza SPT
Drilling Method:	- / -
Borehole Diameter:	82.5 mm
Drilling Fluid:	Water

WELL DETAILS

COPING	Elevation :	71.91 m
SCREEN	Bottom Depth :	13.1 m
	Length :	3.04 m
	Opening :	30 mm
WATER Elevation:		63.5 m
WATER Date:		2023-03-22

Water Level   Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
PL - Point Load Test
Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

DEPTH / *ELEVATION* (m)	GEOLOGY / LITHOLOGY: STRATIGRAPHY	DESCRIPTION	ANALYSIS: NUMBER	LABORATORY TESTING	DUPLICATE	GEOTECHNICAL: TYPE & NO.	STATE	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)	R □ Shear (kPa) I ■ 30 60 90 120; SPT=N Value ▲ PENTEST △; RQD (%) ⊙; PLASTIC LIMIT w (%) LIQUID 20 40 60 80	WELL: DIAGRAM
		Ground surface.									
72,04		**BH23-04A was drilled for monitoring well installation purposes only.**									

Depth scale: 0,5 1,0 1,5 2,0 2,5 3,0 3,5 4,0 4,5 5,0 5,5 6,0 6,5 7,0 7,5 8,0 8,5 9,0

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Date (Start): **2023-03-15**
Date (End): **2023-03-15**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**
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Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**
Project Number:	**23592402**
Geographic Coordinates:	X = 445393 mE Y = 5029795 mN
Surface Elevation:	72.04 m *(Geodetic)*
Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Massenza SPT
Drilling Method:	- / -
Borehole Diameter:	82.5 mm
Drilling Fluid:	Water

WELL DETAILS

COPING Elevation :	71.91 m
SCREEN Bottom Depth :	13.1 m
Length :	3.04 m
Opening :	30 mm
WATER Elevation:	63.5 m
WATER Date:	2023-03-22

∇ Water Level ▼ Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
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ANALYSIS
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SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

DEPTH / *ELEVATION* (m)	STRATIGRAPHY	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	STATE	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)	GEOTECHNICAL	WELL DIAGRAM
		BH23-04A was drilled for monitoring well installation purposes only.									
13,10 *58,94*		End of borehole at 13,10 m.									

GEOTECHNICAL: R □ Shear (kPa) 30 60 90 120 I ■; SPT=N Value ▲; PENTEST △; RQD (%) ⊙; PLASTIC LIMIT w (%) LIQUID; 20 40 60 80

Depth scale: 9,5 10,0 10,5 11,0 11,5 12,0 12,5 13,0 13,5 14,0 14,5 15,0 15,5 16,0 16,5 17,0 17,5 18,0

BOREHOLE DRILLING RECORD : **BH23-05**

Prepared by: **James Sullivan** Date (Start): **2023-03-07**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-09**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**	Project Number:	**23592402**
Site:	**170 Slater Street, Ottawa, ON**	Geographic Coordinates:	X = 445397 mE Y = 5029753 mN
Sector:	**South, inside the parking garage.**	Surface Elevation:	70.39 m *(Geodetic)*
Client:	**The Canada Life Assurance Company c/o GWL Realty Advisors Inc.**	Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Geoprobe 420M
Drilling Method:	Drive open - direct push - wash / B + W
Borehole Diameter:	82.5 mm
Drilling Fluid:	Water

WELL DETAILS

COPING	Elevation :	70.27 m
SCREEN	Bottom Depth :	16.46 m
	Length :	1.52 m
	Opening :	25.4 mm
WATER Elevation:		60.93 m
WATER Date:		2023-03-13

Water Level; Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
TR - Trowel
ST - Shelby Tube
TT - DT-32 Liner

ANALYSIS
AL - Atterberg Limits
GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
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w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

GEOLOGY / LITHOLOGY; ANALYSIS; GEOTECHNICAL (R Shear (kPa) I: 30, 60, 90, 120; SPT=N Value; PENTEST; RQD (%); PLASTIC LIMIT w (%) LIQUID: 20, 40, 60, 80); WELL

DEPTH / *ELEVATION* (m)	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)	Geotechnical values
	Ground surface.							
0,05	**ASPHALTIC CONCRETE.**							
0,15 / *70,24*	**FILL (PAVEMENT STRUCTURE): GRAVELLY SAND,** granular B, brown, non-cohesive, moist.	SA-01	w		DO-1	75		
	FILL: SAND, fine to medium, trace gravel, light-brown, non-cohesive, moist.	SA-02	w		DO-2	100		
1,07 / *69,32*	**GLACIAL TILL: SANDY GRAVEL,** some silt, trace clay, brown, non-cohesive, moist.	SA-03	w		DO-3	80		
		SA-04	w GSA		DO-4	50		
	Dark brown, moist to wet.	SA-05	w Corrosivity		DO-5	100		
4,27 / *66,12*	**WEATHERED SHALE** wet.				DO-6	34		
4,62 / *65,77*	**WEATHERED to FRESH SHALE** bedded, black, fine grained, brittle, non-porous to slightly porous, Billings Shale.				RC-1	40 (0)		RQD 0
		RC-1	UCS		RC-2	100 (90)		RQD 90
					RC-3	92 (82)		RQD 82

Depth scale (m): 0,5; 1,0; 1,5; 2,0; 2,5; 3,0; 3,5; 4,0; 4,5; 5,0; 5,5; 6,0

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Prepared by: **James Sullivan** Date (Start): **2023-03-07**
Reviewed by: **Prosper Ahimbe Kitandala** Date (End): **2023-03-09**

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Project Number:	**23592402**
Geographic Coordinates:	X = 445397 mE Y = 5029753 mN
Surface Elevation:	70.39 m *(Geodetic)*
Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Geoprobe 420M
Drilling Method:	Drive open - direct push - wash / B + W
Borehole Diameter:	82.5 mm
Drilling Fluid:	Water

WELL DETAILS

COPING Elevation :	70.27 m
SCREEN Bottom Depth :	16.46 m
Length :	1.52 m
Opening :	25.4 mm
WATER Elevation:	60.93 m
WATER Date:	2023-03-13

Water Level; Free Phase

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SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

GEOTECHNICAL: R □ Shear (kPa) 30 60 90 120 I ■; SPT=N Value ▲; PENTEST △; RQD (%) ⊙; PLASTIC LIMIT w (%) LIQUID; 20 40 60 80

DEPTH ELEVATION (m)	DESCRIPTION	TYPE & NO.	STATE	% RECOVERY (RQD)	RQD (%) plotted
6,0–12,0	**WEATHERED to FRESH SHALE** bedded, black, fine grained, brittle, non-porous to slightly porous, Billings Shale.		Cored		
6,5		RC-4	Cored	100 (78)	78
7,5		RC-5	Cored	100 (72)	72
8,5		RC-6	Cored	98 (84)	84
9,5		RC-7	Cored	95 (76)	76
10,5		RC-8	Cored	92 (75)	75
11,5		RC-9	Cored	97 (92)	

Depth scale: 6,5; 7,0; 7,5; 8,0; 8,5; 9,0; 9,5; 10,0; 10,5; 11,0; 11,5; 12,0

BOREHOLE DRILLING RECORD : **BH23-05**

Prepared by: **James Sullivan**
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Date (Start): **2023-03-07**
Date (End): **2023-03-09**

Project Name:	**Geotechnical Investigation - 170 Slater Street, Ottawa, ON**
Site:	**170 Slater Street, Ottawa, ON**
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Plunge / Azimuth:	

Drilling Company:	Strata Drilling Group
Drilling Equipment:	Geoprobe 420M
Drilling Method:	Drive open - direct push - wash / B + W
Borehole Diameter:	82.5 mm
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WELL DETAILS

COPING	Elevation :	70.27 m
SCREEN	Bottom Depth :	16.46 m
	Length :	1.52 m
	Opening :	25.4 mm
WATER Elevation:		60.93 m
WATER Date:		2023-03-13

Water Level — Free Phase

SAMPLE TYPE
DC - Diamond Core
SS - Split Spoon
PS - Piston Sample
TC - Hollow Tube
MA - Manual Auger
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ANALYSIS
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GSA - Grain Size Analysis
PENTEST - Blow Counts/300mm
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Sg - Specific Gravity
SPT - N Value (Blow Counts/300mm)
UCS - Uniaxial Compressive Strength
w - Moisture Content
wL - Liquidity Limit
wP - Plasticity Limit

SAMPLE STATE
Undisturbed
Remoulded
Lost
Cored

GEOTECHNICAL: R □ Shear (kPa) I ■ (30, 60, 90, 120); SPT=N Value ▲; PENTEST △; RQD (%) ⊙; PLASTIC LIMIT — w (%) — LIQUID (20, 40, 60, 80)

DEPTH / *ELEVATION* (m)	DESCRIPTION	NUMBER	LABORATORY TESTING	DUPLICATE	TYPE & NO.	STATE	% RECOVERY (RQD)	Blows Counts/6" (N Value = SPT)	GEOTECHNICAL	WELL DIAGRAM
	WEATHERED to FRESH SHALE bedded, black, fine grained, brittle, non-porous to slightly porous, Billings Shale.					Cored			RQD 92	
					RC-10	Cored	89 (72)		RQD 72	
	←*Drilling issues, shale recovery and RQD not representative below 13.36 m.*				RC-11	Cored	51 (18)		RQD 18	
16,46 / *53,93*	End of borehole at 16,46 m.									

Depth scale (m): 12,5 – 13,0 – 13,5 – 14,0 – 14,5 – 15,0 – 15,5 – 16,0 – 16,5 – 17,0 – 17,5 – 18,0

APPENDIX B

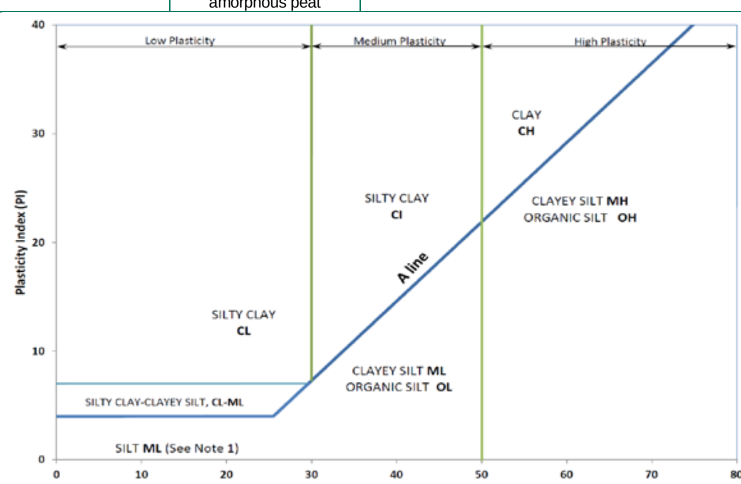
Borehole Logs - Previous 2015 Phase II ESA Investigation by Golder Associates

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators: Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)	Organic Content	USCS Group Symbol	Primary Name
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% (see Note 2)	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.

Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to ~~or~~ indicate~~s~~ a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL, SAND and CLAY)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

Golder Associates

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma$ - u)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes:
1. $\tau = c' + \sigma' \tan \phi'$
2. shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index
A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes
An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

RECORD OF BOREHOLE: 14-01

BORING DATE: September 24, 2014

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ND = Not Detected ⊕ / HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected □	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT Wp W Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE								
0	Geoprobe Direct Push	ASPHALTIC CONCRETE	0.00							Silica Sand
		Sand and gravel, granular B (FILL)	0.23							
		Brown silty sand, trcae clay (FILL)	0.43	1	50 DO	-	⊕			
1		Brown to dark brown SILTY CLAY, trace gravel								
2		Light brown CLAY, trace sand and gravel, orange and black mottling (GLACIAL TILL)	1.80	2	50 DO	-	⊕			
3		SILT to CLAYEY SILT (GLACIAL TILL)	3.33	3	50 DO	-	⊕			Bentonite Seal
4				4	50 DO	-	⊕			
		Brown to dark brown angular shale fragments (GLACIAL TILL)	4.30							
5	Geoprobe BQ Core	Slightly to moderately weathered black SHALE BEDROCK, iron oxide staining	4.52	C1	BQ RC	DD				
6		Slightly weathered to fresh black SHALE BEDROCK, clay infilled seams and mild hydrocarbon odour from 5.66 to 5.77 m depth	5.58	C2	BQ RC	DD				
7		Fresh black SHALE BEDROCK	7.09	C3	BQ RC	DD				Silica Sand
9		Fresh black SHALE BEDROCK, clay infilled seams and strong hydrocarbon odour from 8.79 to 9.04 m depth, open fracture (7.6 cm) from 9.75 to 10.36 m depth	8.79	C4	BQ RC	DD				32 mm Diam. PVC #10 Slot Screen
10		End of Borehole	10.36							
11										
12										
13										
14										
15										

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: NM
CHECKED: AT

RECORD OF DRILLHOLE: 14-01

PROJECT: 12-1185-0092/6905

LOCATION: See Site Plan

DRILLING DATE:

DATUM: Geodetic

DRILL RIG: Geoprobe 7822

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Strata Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate; BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage; PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular; PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	Installation
		BEDROCK SURFACE			
5	Geoprobe BW/BQ Core	Slightly to moderately weathered blue SHALE BEDROCK, iron oxide staining	4.52	C1	Bentonite Seal
6		Slightly weathered to fresh black SHALE BEDROCK, clay infilled seams and mild hydrocarbon odour from 5.66 to 5.77 m depth	5.58	C2	Silica Sand
7–8		Fresh black SHALE BEDROCK	7.09	C3	
9–10		Fresh black SHALE BEDROCK, clay infilled seams and strong hydrocarbon odour from 8.79 to 9.04 m depth, open fracture (7.6 cm) from 9.75 to 10.36 m depth	8.79	C4	32 mm Diam. PVC #10 Slot Screen
		End of Drillhole	10.36		

Columns also printed (graphical): SYMBOLIC LOG; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.3 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec; Diametral Point Load Index (MPa); RMC -Q' AVG.

Depth scale: 11, 12, 13, 14, 15, 16, 17, 18, 19

DEPTH SCALE 1 : 75

Golder Associates

LOGGED: NM

CHECKED: AT

RECORD OF BOREHOLE: 14-02

PROJECT: 12-1185-0092/6905

LOCATION: See Site Plan

BORING DATE: October 2, 2014

SHEET 1 OF 2

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕ *ND = Not Detected* (20, 40, 60, 80)

HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] *ND = Not Detected* □ (20, 40, 60, 80)

HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3})

WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20, 40, 60, 80)

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	HEADSPACE	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE							
0	Portable Drill	ASPHALTIC CONCRETE	0.00 / 0.09						Silica Sand
		Brown sand and gravel, granular B (FILL)	0.31						
1		Light brown sand (FILL)		1	50 DO	-	⊕		
		Light brown to grey CLAYEY SILT, trace gravel (GLACIAL TILL)	1.22	2	50 DO	-	⊕		
2				3	50 DO	-	⊕		
3		Dark brown SILTY CLAY, some gravel, wet (GLACIAL TILL)	2.90	4	50 DO	-	⊕ ND		
4									Bentonite Seal
	Power Drill, BQ Core	Moderately weathered black SHALE BEDROCK, slightly altered	4.32	C1	BQ RC	DD			
5		Fresh to slightly weathered black SHALE BEDROCK	5.23	C2	BQ RC	DD			
6				C3	BQ RC	DD			
7		Fresh black SHALE BEDROCK	7.19	C4	BQ RC	DD			Silica Sand
8				C5	BQ RC	DD			
9									
10				C6	BQ RC	DD			32 mm Diam. PVC #10 Slot Screen
11				C7	BQ RC	DD			
12				C8	BQ RC	DD			
13		End of Borehole	12.92						
14									
15									

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: NM

CHECKED: AT

RECORD OF DRILLHOLE: 14-02

LOCATION: See Site Plan

DRILLING DATE:

DATUM: Geodetic

DRILL RIG: Portable

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Strata Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.
		BEDROCK SURFACE		
	Power Drill, BQ Core	Moderately weathered black SHALE BEDROCK, slightly altered	4.32	C1
5		Fresh to slightly weathered black SHALE BEDROCK	5.23	C2
6				C3
7		Fresh black SHALE BEDROCK	7.19	C4
8				C5
9				
10				C6
11				C7
12				C8
13		End of Drillhole	12.92	

Other column headings: SYMBOLIC LOG; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20; R.Q.D. % 80 60 40 20; FRACT. INDEX PER 0.3 m 5 10 15 20; DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn); HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}; Diametral Point Load Index (MPa) 2 4 6; RMC -Q' AVG.

Depth scale: 14, 15, 16, 17, 18, 19

Installation: Bentonite Seal; Silica Sand; 32 mm Diam. PVC #10 Slot Screen

Golder Associates

LOGGED: NM

CHECKED: AT

PROJECT: 12-1185-0092/6905

LOCATION: See Site Plan

RECORD OF BOREHOLE: 14-03

BORING DATE: Septebmer 23 & 25, 2014

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

BORING METHOD	DESCRIPTION	ELEV. / DEPTH (m)
	GROUND SURFACE	
Portable Geoprobe	ASPHALTIC CONCRETE	0.00 0.03
Portable Geoprobe	Light grey sand and gravel, granular B (FILL)	
Portable Geoprobe	Light brown to grey sand, trace gravel, dry to moist (FILL)	0.46
Portable Geoprobe	Light brown SILTY SAND	1.83
Portable Geoprobe	Light brown to grey SILTY CLAY, trace gravel interbedded with light brown sand (GLACIAL TILL)	2.13
Power Drill BQ Core	Slightly weathered black SHALE BEDROCK	4.27
Power Drill BQ Core	Slightly to moderately weathered black SHALE BEDROCK, with infilling of fractures (iron oxide), hydrocarbon odour from 7.52 to 8.28 m depth	4.72
	End of Borehole	10.60

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	-
2A	50 DO	-
2B	50 DO	-
3	50 DO	-
4	50 DO	-
5	50 DO	-
C1	BQ RC	DD
C2	BQ RC	DD
C3	BQ RC	DD
C4	BQ RC	DD
C5	BQ RC	DD
C6	BQ RC	DD

HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕
ND = Not Detected
20 40 60 80

HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] *ND = Not Detected* □
20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s
10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT
Wp —○W— Wl
20 40 60 80

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

- Silica Sand
- Bentonite Seal
- Silica Sand
- 51 mm Diam. PVC #10 Slot Screen

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

GTA-BHS 001 \\GOLDER.GDS\GAL\OTTAWA\ACTIVE\2012\1185 - WHITBY\12-1185-0092 GWL PORTFOLIO PH. I ESAS\SPATIAL IM\DATABASE\1211850092-6905.GPJ GAL-MIS.GDT 10/1/15 JEM

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: NM

CHECKED: AT

RECORD OF DRILLHOLE: 14-03

PROJECT: 12-1185-0092/6905

LOCATION: See Site Plan

DRILLING DATE:

DATUM: Geodetic

DRILL RIG: Portable Geoprobe

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Strata Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. DEPTH (m)	RUN No.
		BEDROCK SURFACE		
	Power Drill, BQ Core	Slightly weathered black SHALE BEDROCK	4.27	C1
5		Slightly to moderately weathered black SHALE BEDROCK, with infilling of fractures (iron oxide), hydrocarbon odour from 7.52 to 8.28 m depth	4.72	C2
6–7				C3
8				C4
9				C5
10				C6
		End of Drillhole	10.60	

Column headings: PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.3 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

Installation: Bentonite Seal; Silica Sand; 51 mm Diam. PVC #10 Slot Screen

DEPTH SCALE 1 : 75

Golder Associates

LOGGED: NM

CHECKED: AT

RECORD OF BOREHOLE: 14-04

PROJECT: 12-1185-0092/6905
LOCATION: See Site Plan
BORING DATE: Septebmer 23, 2014
SHEET 1 OF 1
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕	HYDRAULIC CONDUCTIVITY / WATER CONTENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE								
0	Portable	ASPHALTIC CONCRETE	0.00 / 0.09							
		Sandy gravel, granular B (FILL)								
1		Light brown SILTY CLAY, some sand, trace gravel, with light grey clay interbeds (GLACIAL TILL)	0.84	1	DO	50				
				2	DO	50	⊕			
				3	DO	50	⊕			
2		Very compact light brown to dark brown SILTY CLAY, trace sand (GLACIAL TILL)	1.83	4	DO	50	⊕			
		End of Borehole	2.44							

HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕ *ND = Not Detected* 20 40 60 80
HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] *ND = Not Detected* □ 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}
WATER CONTENT PERCENT Wp —○W— Wl 20 40 60 80

Depth scale: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

GTA-BHS 001 \\GOLDER.GDS\GAL\OTTAWA\ACTIVE\2012\1185 - WHITBY\12-1185-0092 GWL PORTFOLIO PH. I ESAS\SPATIAL IM\DATABASE\1211850092-6905.GPJ GAL-MIS.GDT 10/1/15 JEM

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: NM
CHECKED: AT

RECORD OF BOREHOLE: 14-05

PROJECT: 12-1185-0092/6905

LOCATION: See Site Plan

BORING DATE: September 24, 2014

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (20 40 60 80) / HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [%LEL] ND = Not Detected □ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp —○W— Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	Geoprobe Direct Push	Brown silty sand, some gravel (FILL)		0.00							
		CONCRETE		0.15							
		Light brown sand, wood fragments, moist (FILL)		0.31	1	50 DO	-				
1		No Recovery		0.56							
		Brown sand, trace gravel, moist (FILL)		1.52	2	50 DO	-	⊕			
2		Grey to white silty sand to gravel - old broken concrete fragments (FILL)		2.16							
3		End of Borehole Refusal		3.12							

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: NM

CHECKED: AT

APPENDIX C

Borehole Logs - Previous 2002 Phase II ESA Investigation by Paterson and Associates Ltd.

JOHN D. PATERSON & ASSOCIATES LTD.
Consulting Engineers
28 Concourse Gate, Unit 1, Nepean, Ont. K2E 7T7

SOIL PROFILE & TEST DATA

Phase I-II Environmental Site Assessment
170 and 190 Slater Street
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant (see plan). Asssumed elevation = 100.00m.

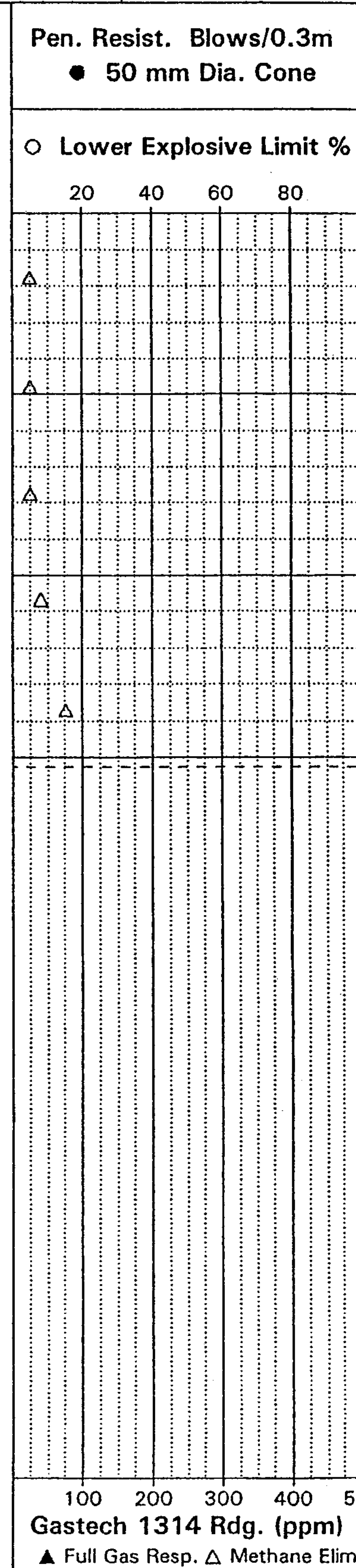
REMARKS

BORINGS BY Portable Drill DATE 18 JUN 02

FILE NO. E2434

HOLE NO. BH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.04
Asphaltic concrete 0.05							
FILL: Grey silty sand and gravel 0.66		SS	1	75	120		
Very dense, light grey SAND		SS	2	67	133	1	98.04
		SS	3	50	46		
		SS	4	58	13	2	97.04
3.05		SS	5	100	138	3	96.04
End of Borehole							
Practical refusal to augering @ 3.05m depth							



PIEZOMETER CONSTRUCTION

JOHN D. PATERSON & ASSOCIATES LTD.
Consulting Engineers
28 Concourse Gate, Unit 1, Nepean, Ont. K2E 7T7

SOIL PROFILE & TEST DATA

Phase I-II Environmental Site Assessment
170 and 190 Slater Street
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant (see plan). Asssumed elevation = 100.00m.

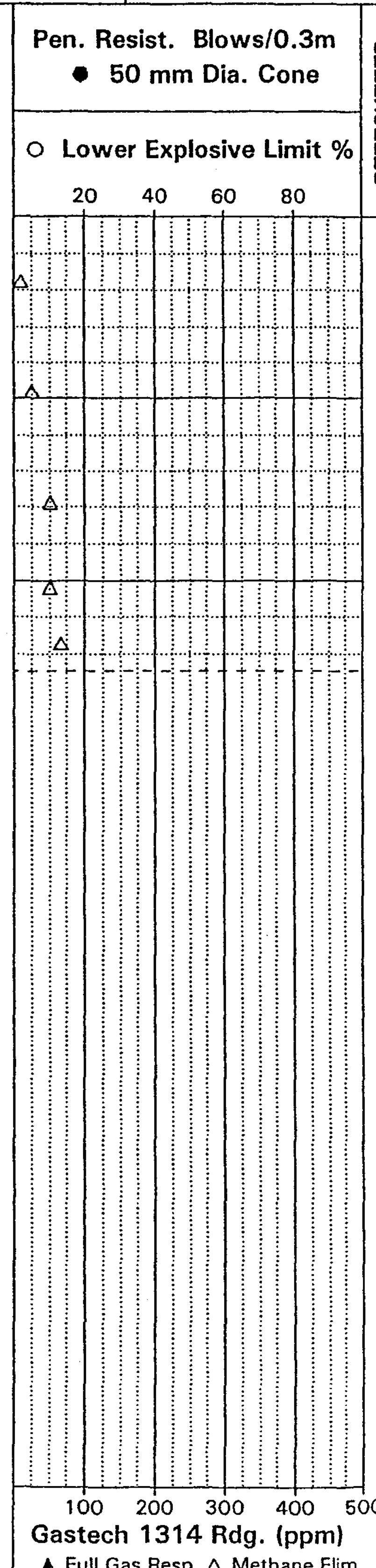
REMARKS

BORINGS BY Portable Drill **DATE** 18 JUN 02

FILE NO. E2434

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.28
Asphaltic concrete 0.05							
FILL: Grey sand and gravel 0.66		SS	1	38	30		
Compact, brown SAND, some gravel		SS	2	33	12	1	97.28
		SS	3	50	16		
1.88							
Compact, greyish brown SANDY SILT, some gravel 2.18		SS	4	75	50+	2	96.28
Very dense, grey SAND with shale fragments 2.49		SS	5	67	50+		
End of Borehole							
Practical refusal to augering @ 2.49m depth							



PIEZOMETER CONSTRUCTION

JOHN D. PATERSON & ASSOCIATES LTD.
Consulting Engineers
28 Concourse Gate, Unit 1, Nepean, Ont. K2E 7T7

SOIL PROFILE & TEST DATA

Phase I-II Environmental Site Assessment
170 and 190 Slater Street
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant (see plan). Asssumed elevation = 100.00m.

REMARKS

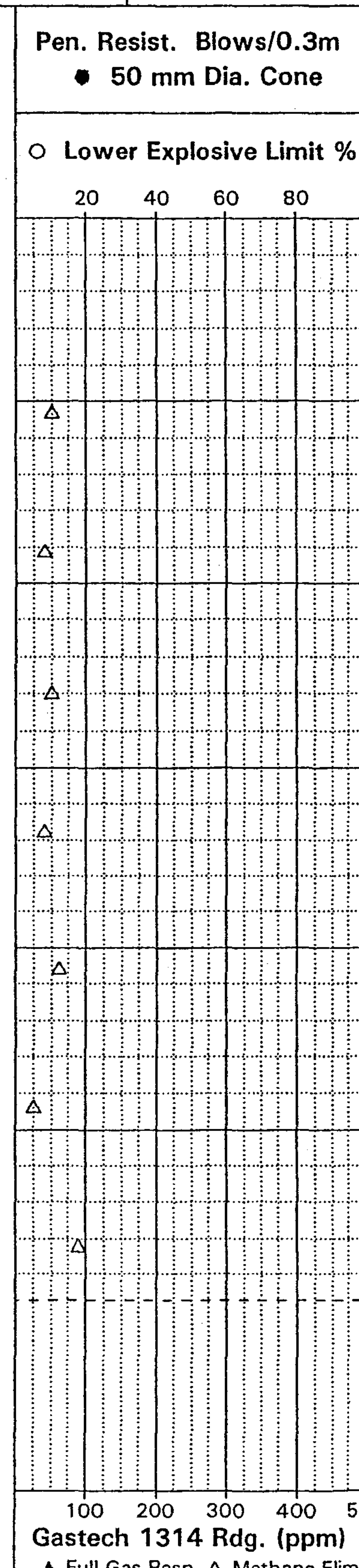
BORINGS BY CME 45 Power Auger

DATE 18 JUN 02

FILE NO. **E2434**

HOLE NO. **BH 3**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.48
Asphaltic concrete 0.10							
FILL: Greyish brown silty sand with gravel and construction debris		SS	1	17	16	1	98.48
		SS	2	12	6	2	97.48
- clayey silt fill by 2.1m depth		SS	3	67	8	3	96.48
3.66		SS	4	42	22		
GLACIAL TILL: Loose grey sandy silt with gravel		SS	5	62	5	4	95.48
5.18		SS	6	4	5	5	94.48
BEDROCK: Weathered, black shale		SS	7	29	34		
5.94 End of Borehole							



PIEZOMETER CONSTRUCTION

JOHN D. PATERSON & ASSOCIATES LTD.
Consulting Engineers
28 Concourse Gate, Unit 1, Nepean, Ont. K2E 7T7

SOIL PROFILE & TEST DATA

Phase I-II Environmental Site Assessment
170 and 190 Slater Street
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant (see plan). Asssumed elevation = 100.00m.

REMARKS

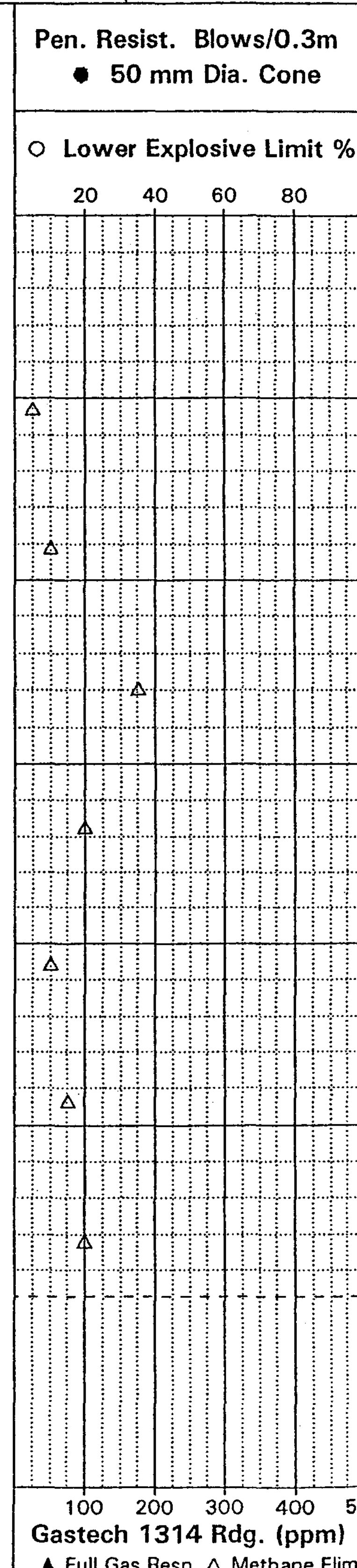
BORINGS BY CME 45 Power Auger **DATE** 18 JUN 02

FILE NO. E2434

HOLE NO. BH 4

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
Asphaltic concrete	0.08				
FILL: Brick pieces and construction debris	1.52	SS	1	25	13
FILL: Sand with construction debris and cinders	3.86	SS	2	4	14
		SS	3	29	36
		SS	4	17	17
GLACIAL TILL: Compact, grey clayey silt with sand and gravel	4.57	SS	5	62	14
GLACIAL TILL: Black silty sand with gravel	5.79	SS	6	33	6
		SS	7	79	42
BEDROCK: Weathered, black shale	5.94				
End of Borehole					

DEPTH (m)	ELEV. (m)
0	99.30
1	98.30
2	97.30
3	96.30
4	95.30
5	94.30



PIEZOMETER CONSTRUCTION

JOHN D. PATERSON & ASSOCIATES LTD.
Consulting Engineers
28 Concourse Gate, Unit 1, Nepean, Ont. K2E 7T7

SOIL PROFILE & TEST DATA

Phase I-II Environmental Site Assessment
170 and 190 Slater Street
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant (see plan). Asssumed elevation = 100.00m.

REMARKS

BORINGS BY CME 45 Power Auger DATE 18 JUN 02

FILE NO. **E2434**

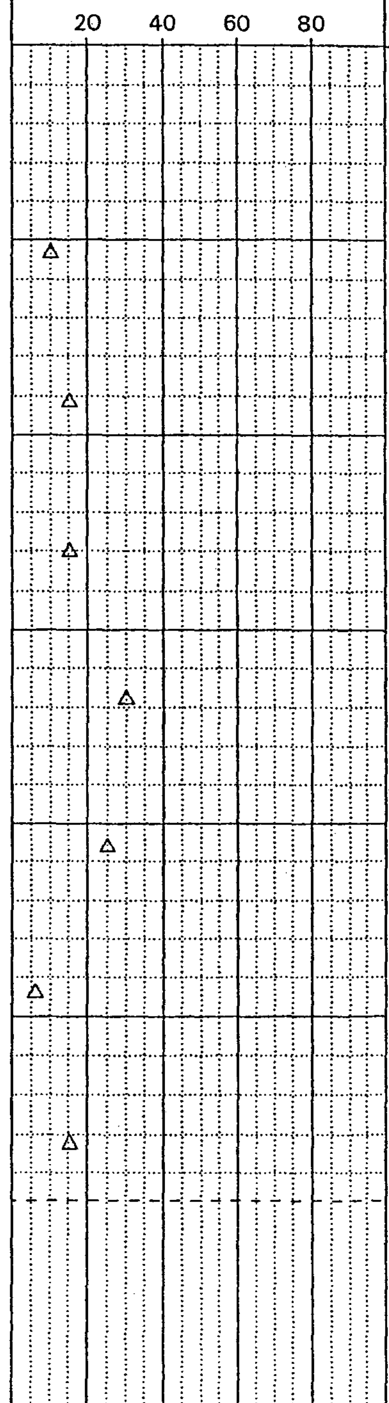
HOLE NO. **BH 5**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.15
Asphaltic concrete 0.10							
FILL: Silty sand with gravel and debris		SS	1	8	3	1	98.15
		SS	2	8	4		
2.13						2	97.15
Very stiff, grey **CLAYEY SILT**		SS	3	67	6		
3.05						3	96.15
GLACIAL TILL: Compact, black silty sand with gravel		SS	4	71	56		
		SS	5	67	16	4	95.15
		SS	6	4	13	5	94.15
5.49							
BEDROCK: Weathered, black shale		SS	7	75	34		
5.94 End of Borehole							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Lower Explosive Limit %

PIEZOMETER CONSTRUCTION



Gastech 1314 Rdg. (ppm)
▲ Full Gas Resp. △ Methane Elim.

JOHN D. PATERSON & ASSOCIATES LTD.
Consulting Engineers
28 Concourse Gate, Unit 1, Nepean, Ont. K2E 7T7

SOIL PROFILE & TEST DATA

Phase I-II Environmental Site Assessment
170 and 190 Slater Street
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant (see plan). Asssumed elevation = 100.00m.

REMARKS

BORINGS BY CME 45 Power Auger DATE 18 JUN 02

FILE NO. **E2434**

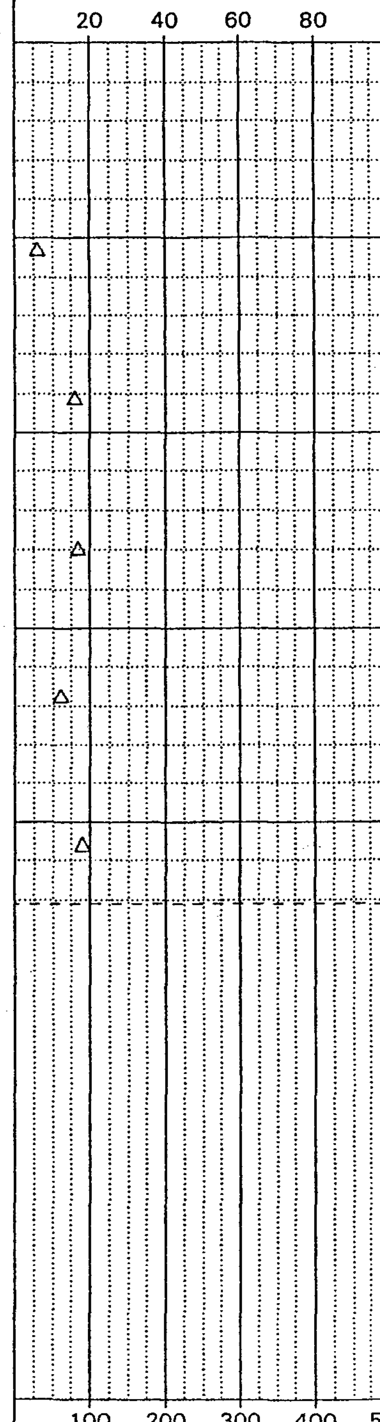
HOLE NO. **BH 6**

SOIL DESCRIPTION		SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.16
Asphaltic concrete	0.10						
FILL: Light brown sand with organic matter		SS	1	25	12	1	98.16
		SS	2	21	6	2	97.16
	2.51	SS	3	75	14		
Very stiff, light grey SILTY CLAY	3.35					3	96.16
BEDROCK: Weathered, black shale		SS	4	50	44	4	95.16
		SS	5	20	50+		
End of Borehole	4.42						

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Lower Explosive Limit %

PIEZOMETER CONSTRUCTION



Gastech 1314 Rdg. (ppm)
▲ Full Gas Resp. △ Methane Elim.

JOHN D. PATERSON & ASSOCIATES LTD.
Consulting Engineers
28 Concourse Gate, Unit 1, Nepean, Ont. K2E 7T7

SOIL PROFILE & TEST DATA

Phase I-II Environmental Site Assessment
170 and 190 Slater Street
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant (see plan). Asssumed elevation = 100.00m.

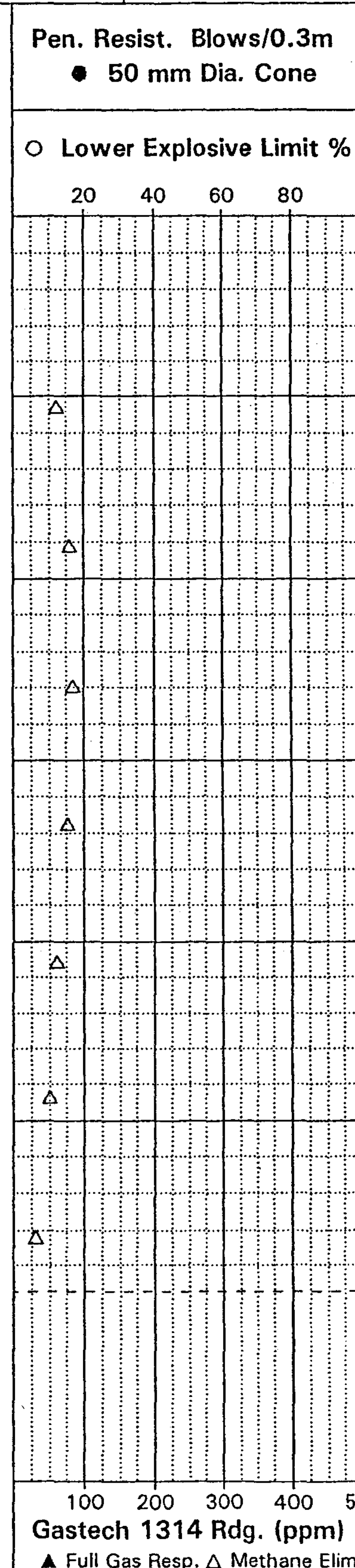
REMARKS

BORINGS BY CME 45 Power Auger DATE 18 JUN 02

FILE NO. **E2434**

HOLE NO. **BH 7**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.70
Asphaltic concrete							
FILL: Dark brown silty sand with debris		SS	1	1	7	1	98.70
		SS	2	42	9		
2.13						2	97.70
Very stiff, grey **CLAYEY SILT**		SS	3	75	15		
						3	96.70
		SS	4	100	8		
						4	95.70
		SS	5	100	2		
4.88		SS	6	33	12		
						5	94.70
BEDROCK: Weathered, black shale		SS	7	30	28		
5.94							
End of Borehole							



PIEZOMETER CONSTRUCTION

JOHN D. PATERSON & ASSOCIATES LTD.
Consulting Engineers
28 Concourse Gate, Unit 1, Nepean, Ont. K2E 7T7

SOIL PROFILE & TEST DATA

Phase I-II Environmental Site Assessment
170 and 190 Slater Street
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant (see plan). Asssumed elevation = 100.00m.

REMARKS

BORINGS BY CME 45 Power Auger DATE 18 JUN 02

FILE NO. E2434

HOLE NO. BH 8

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Lower Explosive Limit % (20 40 60 80)	PIEZOMETER CONSTRUCTION
GROUND SURFACE						0	99.32		
Asphaltic concrete 0.10									
FILL: Light brown sand with organic matter 1.22		SS	1	26	18	1	98.32	△	
End of Borehole Practical refusal to augering @ 1.22m depth									

100 200 300 400 500
Gastech 1314 Rdg. (ppm)
▲ Full Gas Resp. △ Methane Elim.

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	'N' Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also classified according to their "sensitivity". The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called "mechanical breaks") are easily distinguishable from the normal in-situ fractures.

RQD %	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.) Rock core samples are obtained with the use of standard diamond drilling bits

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture content or water content of sample, %
LL	-	Liquid limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic limit, % (water content above which soil behaves plastically)
PI	-	Plasticity index, % (difference between LL and PL)
Dxx	-	Grain size at which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu	-	Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sand and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

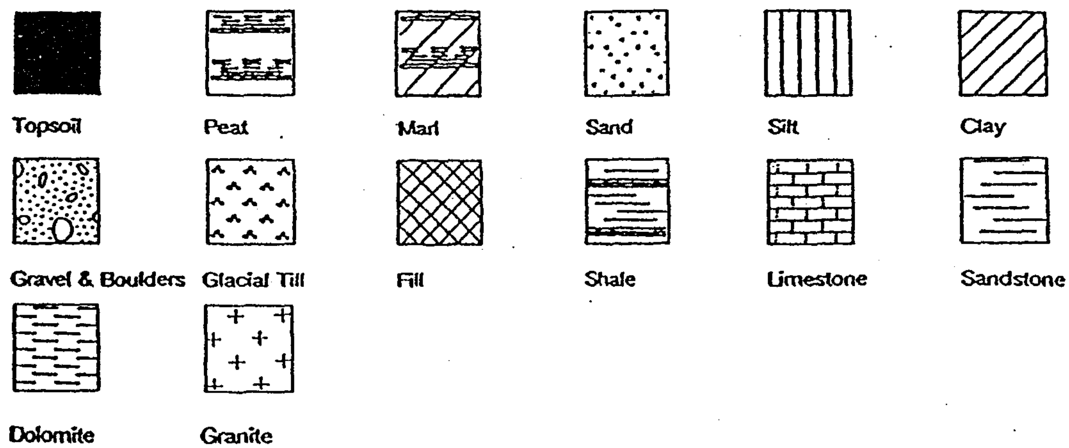
CONSOLIDATION TEST

p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidation ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

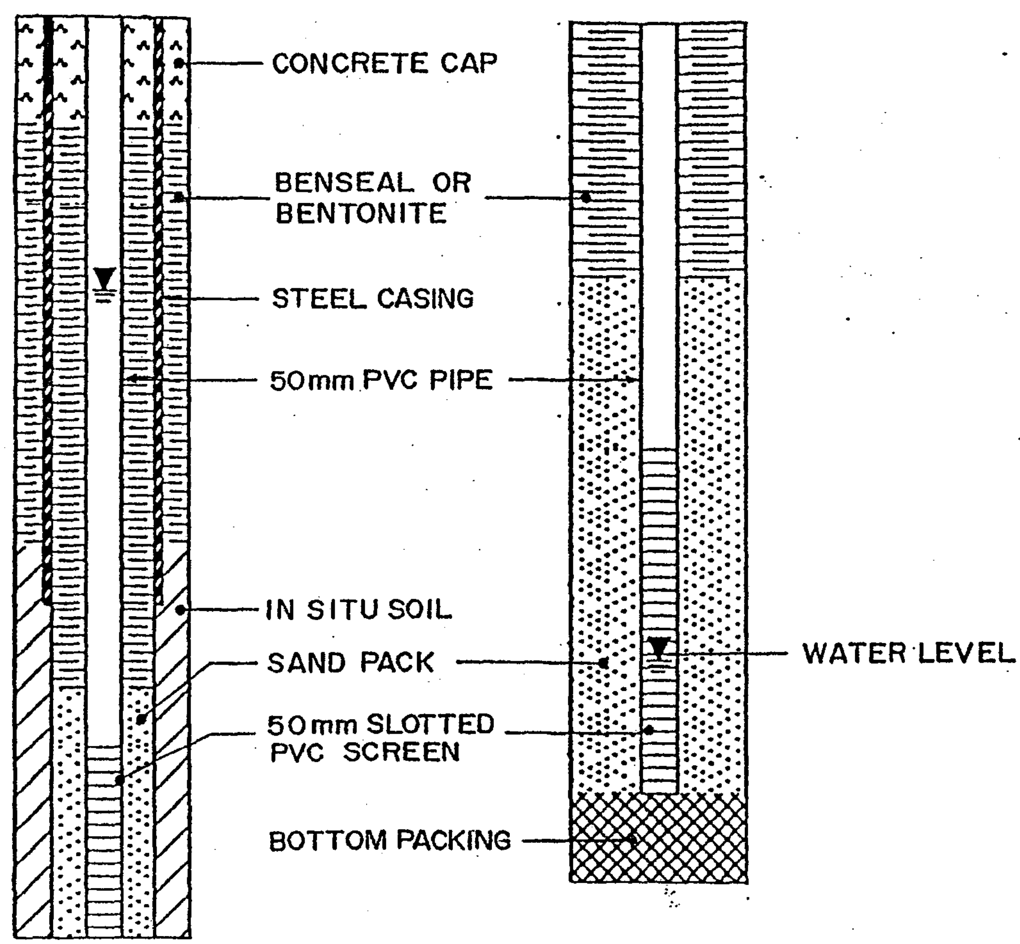
k	-	Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

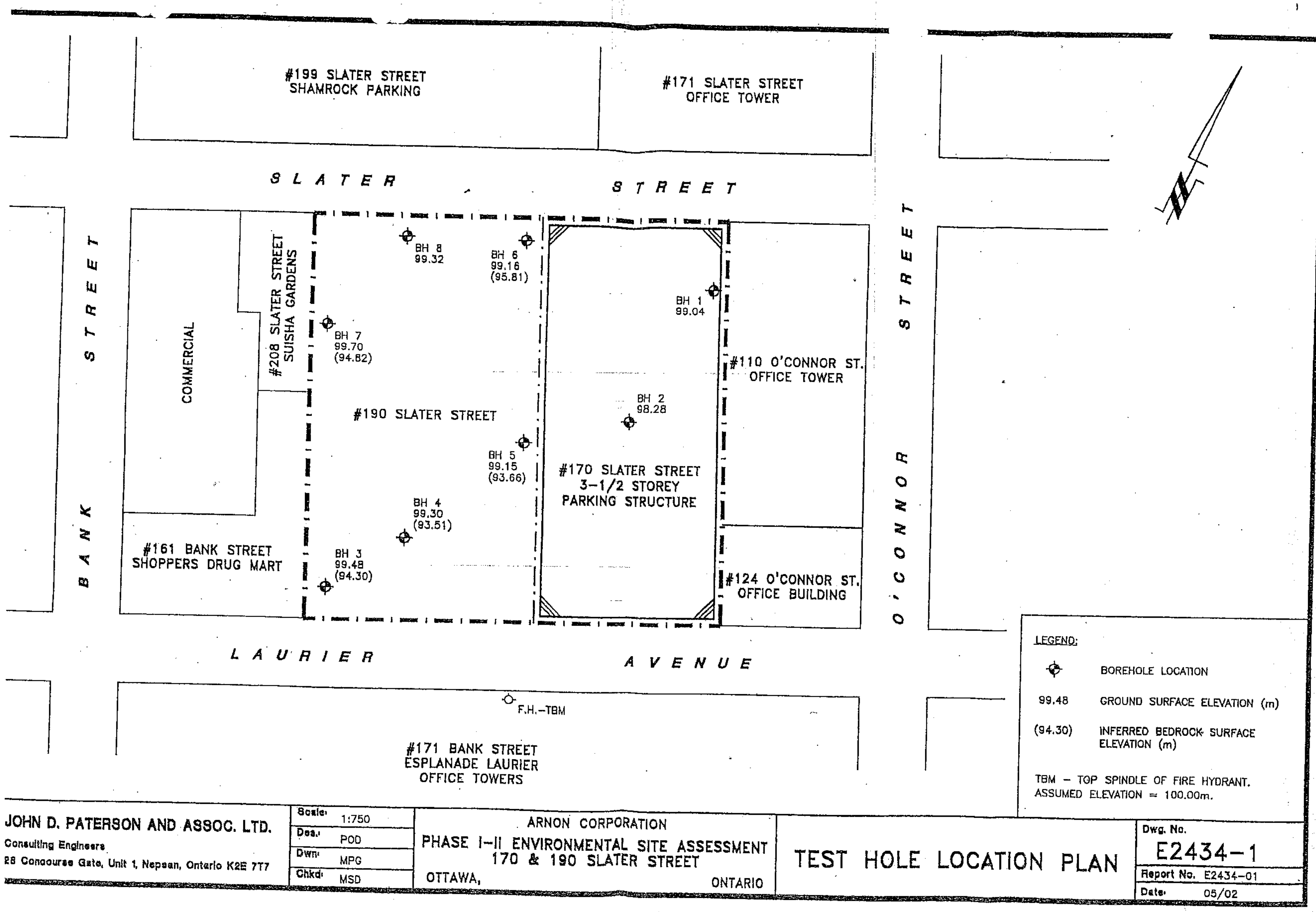
STRATA PLOT



MONITORING WELL AND PIEZOMETER CONSTRUCTION

Monitoring Well Construction / Piezometer Construction




#199 SLATER STREET
SHAMROCK PARKING
#171 SLATER STREET
OFFICE TOWER
SLATER STREET
BANK STREET
O'CONNOR STREET
COMMERCIAL
#208 SLATER STREET
SUISHA GARDENS
BH 8
99.32
BH 6
99.16
(95.81)
BH 1
99.04
BH 7
99.70
(94.82)
#110 O'CONNOR ST.
OFFICE TOWER
#190 SLATER STREET
BH 2
98.28
BH 5
99.15
(93.66)
#170 SLATER STREET
3-1/2 STOREY
PARKING STRUCTURE
BH 4
99.30
(93.51)
BH 3
99.48
(94.30)
#161 BANK STREET
SHOPPERS DRUG MART
#124 O'CONNOR ST.
OFFICE BUILDING
LAURIER AVENUE
F.H.-TBM
#171 BANK STREET
ESPLANADE LAURIER
OFFICE TOWERS
LEGEND:
BOREHOLE LOCATION
99.48 GROUND SURFACE ELEVATION (m)
(94.30) INFERRED BEDROCK SURFACE ELEVATION (m)
TBM - TOP SPINDLE OF FIRE HYDRANT. ASSUMED ELEVATION = 100.00m.
JOHN D. PATERSON AND ASSOC. LTD.
Consulting Engineers
28 Concourse Gate, Unit 1, Nepean, Ontario K2E 7T7
Scale: 1:750
Des.: POD
Dwn: MPG
Chkd: MSD
ARNON CORPORATION
PHASE I-II ENVIRONMENTAL SITE ASSESSMENT
170 & 190 SLATER STREET
OTTAWA, ONTARIO
TEST HOLE LOCATION PLAN
Dwg. No.
E2434-1
Report No. E2434-01
Date: 05/02

APPENDIX D

Laboratory Results

TABLE 1
SUMMARY OF WATER CONTENT DETERMINATIONS

PROJECT NUMBER 23592402
PROJECT NAME Geotechnical Investigation/170 Slater Street/ Ottawa
DATE TESTED April 11, 2023

Borehole No.	Sample No.	Depth (ft)	Depth (m)	Water Content (%)	Borehole No.	Sample No.	Depth (ft)	Depth (m)	Water Content (%)
23-02A	03	4'0"-6'0"	1.22-1.83	33.3%					
					23-05	01	0'2"-1'6"	0.05-0.46	3.7%
23-03	01	0'2"-1'2"	0.05-0.36	1.2%	23-05	02	2'0"-3'6"	0.61-1.07	5.3%
23-03	02	2'0"-4'0"	0.61-1.22	4.7%	23-05	03	3'6"-6'0"	1.07-1.83	25.1%
23-03	03	4'0"-6'0"	1.22-1.83	3.6%	23-05	04	8'0"-12'0"	2.44-3.66	5.5%
23-03	04	6'0"-8'0"	1.83-2.44	12.5%	23-05	05	12'0"-14'0"	3.66-4.27	9.3%
23-03	05	8'0"-10'0"	2.44-3.05	8.1%					
23-03	06	10'0"-12'0"	3.05-3.66	11.6%					
23-04	01	0'2"-1'3"	0.05-0.38	2.1%					
23-04	02A	2'0"-3'6"	0.61-1.07	6.1%					
23-04	04	6'0"-8'0"	1.83-2.44	36.3%					
23-04	05A	8'0"-8'6"	2.44-2.59	33.6%					
23-04	05B	8'6"-10'0"	2.59-3.05	10.0%					
23-04	06	10'0"-12'0"	3.05-3.66	8.4%					
23-04	07	12'0"-14'0"	3.66-4.27	10.4%					
23-04	08	14'0"-16'0"	4.27-4.88	8.6%					
23-04	09B/10	17'0"-18'5"	5.18-5.61	4.1%					

wsp

https://golderassociates.sharepoint.com/sites/35409g/Shared Documents/Active/2023/23592402/

Tested By: cw
Checked By: MI

TABLE 1
SUMMARY OF WATER CONTENT AND ATTERBERG LIMITS DETERMINATIONS

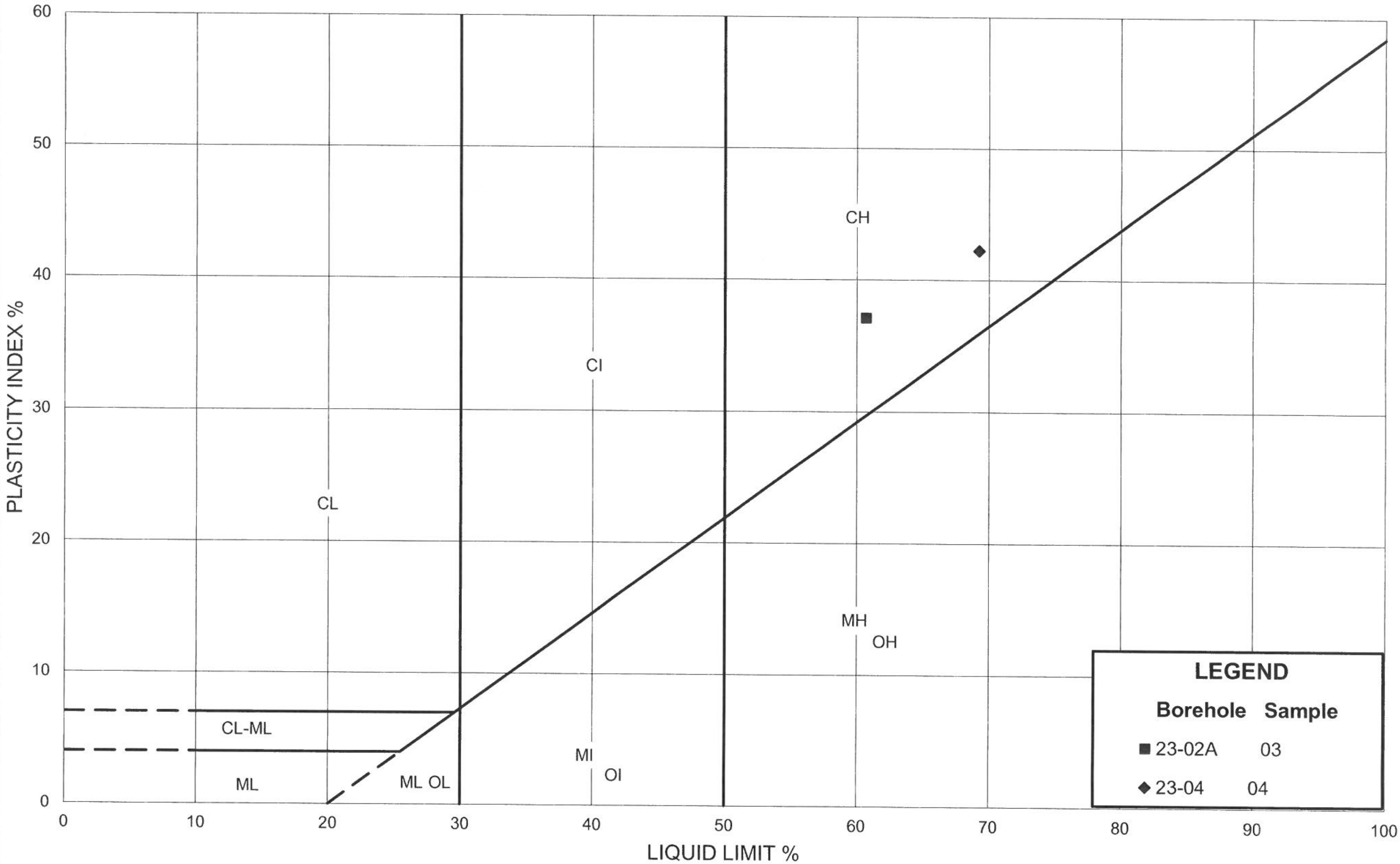
PROJECT NUMBER	23592402
PROJECT NAME	Geotechnical Investigation/170 Slater Street/ Ottawa
DATE TESTED	April 27, 2023

Borehole	Sample	Depth	Water Content	Atterberg Limits			
No.	No.	(m)	(%)	W_L	W_P	LI	PI
23-02A	03	1.22-1.83	33.30	60.7	23.6	0.3	37.1
23-04	04	1.83-2.44	36.30	69.3	27.1	0.2	42.2

Tested By: cw
Checked By: MI

wsp

V2021



wsp

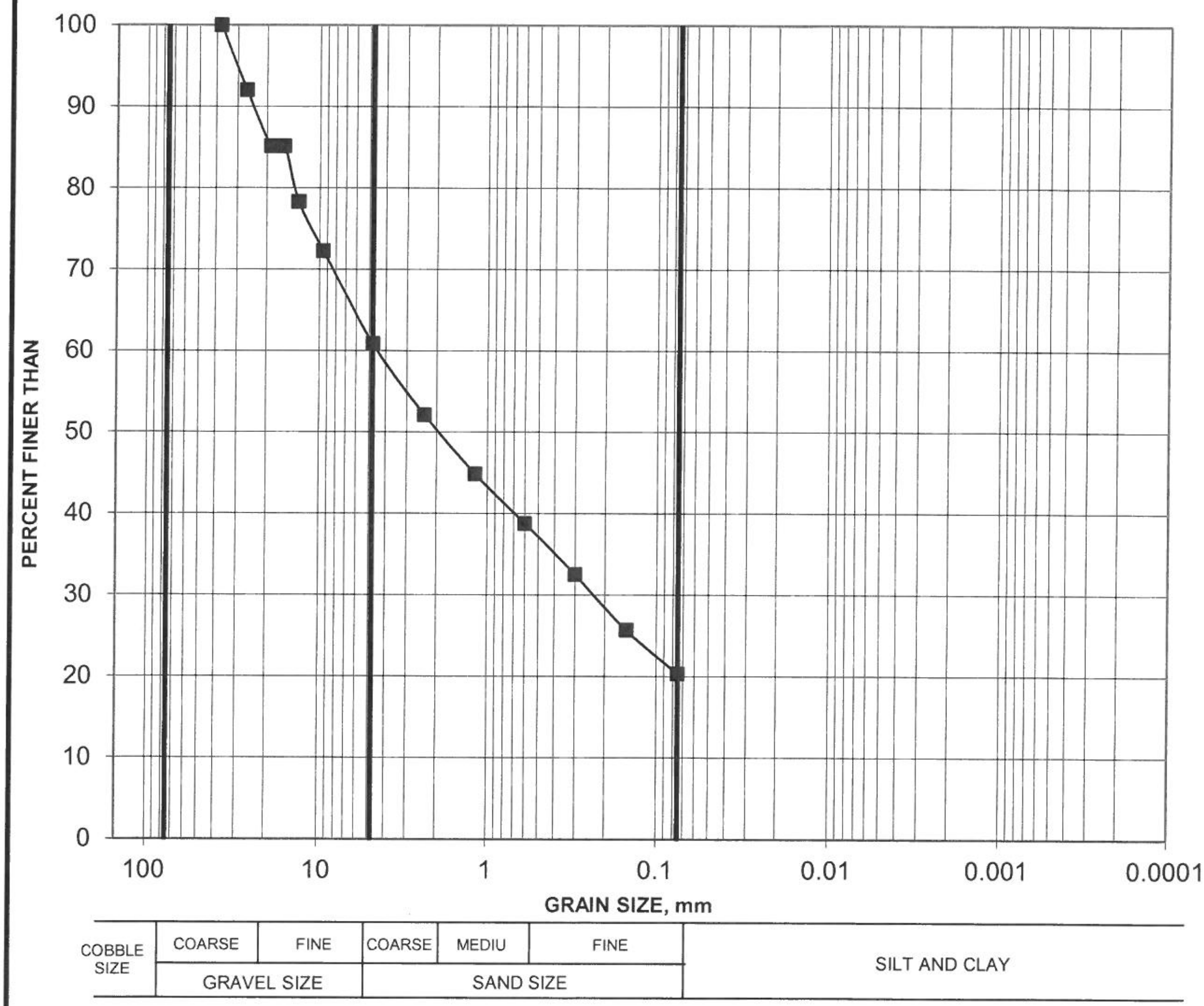
PLASTICITY CHART

Figure:	
Project:	23592402
Created By: cw	Checked By: MI

GRAIN SIZE DISTRIBUTION

FIGURE

ENTER TITLE HERE



Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
23-02A	06	3.05-3.66	39	41	20	

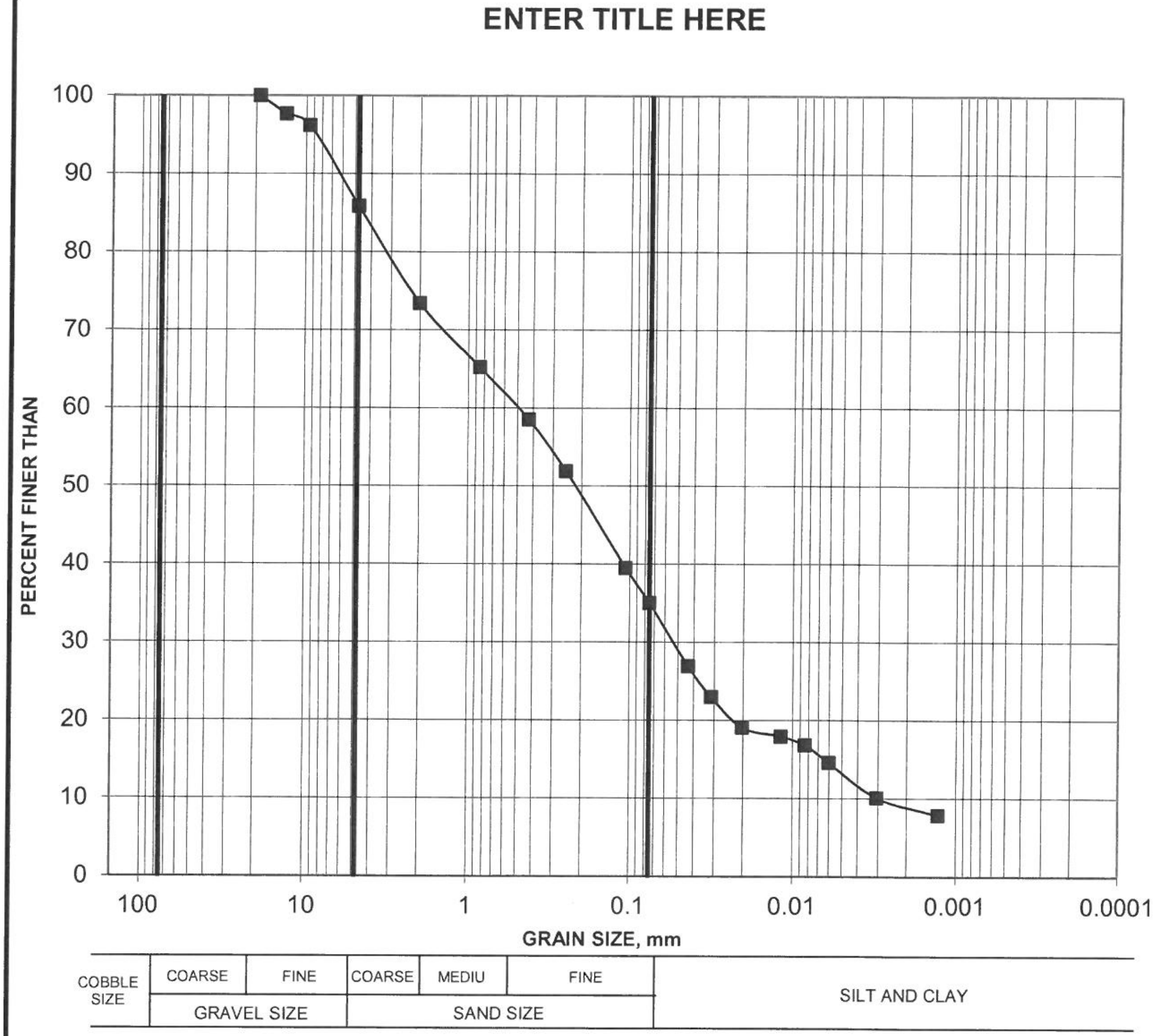
Project: 23592402

wsp

Created by: CW

Checked by: MF

GRAIN SIZE DISTRIBUTION	FIGURE



			Constituents (%)			
Borehole	Sample	Depth (m)	Gravel	Sand	Silt	Clay
23-03	05	2.44-3.05	14	51	26	9

Project: 23592402

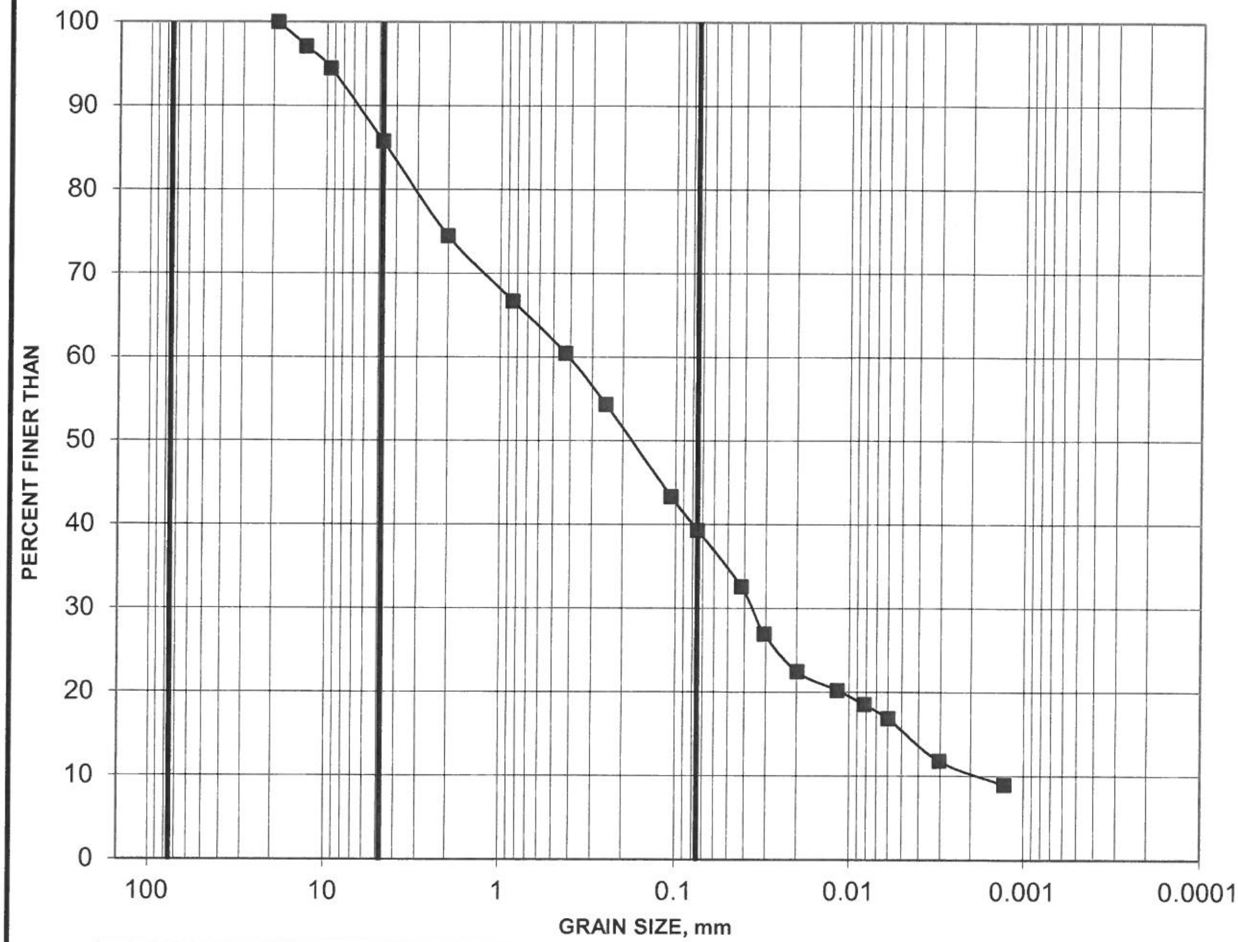
wsp

Created by: CW

Checked by: MK

GRAIN SIZE DISTRIBUTION	FIGURE

ENTER TITLE HERE



COBBLE SIZE	COARSE	FINE	COARSE	MEDIU	FINE	SILT AND CLAY
	GRAVEL SIZE		SAND SIZE			

	Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
—■—	23-04	7	3.66-4.27	14	47	29	10

Project: 23592402

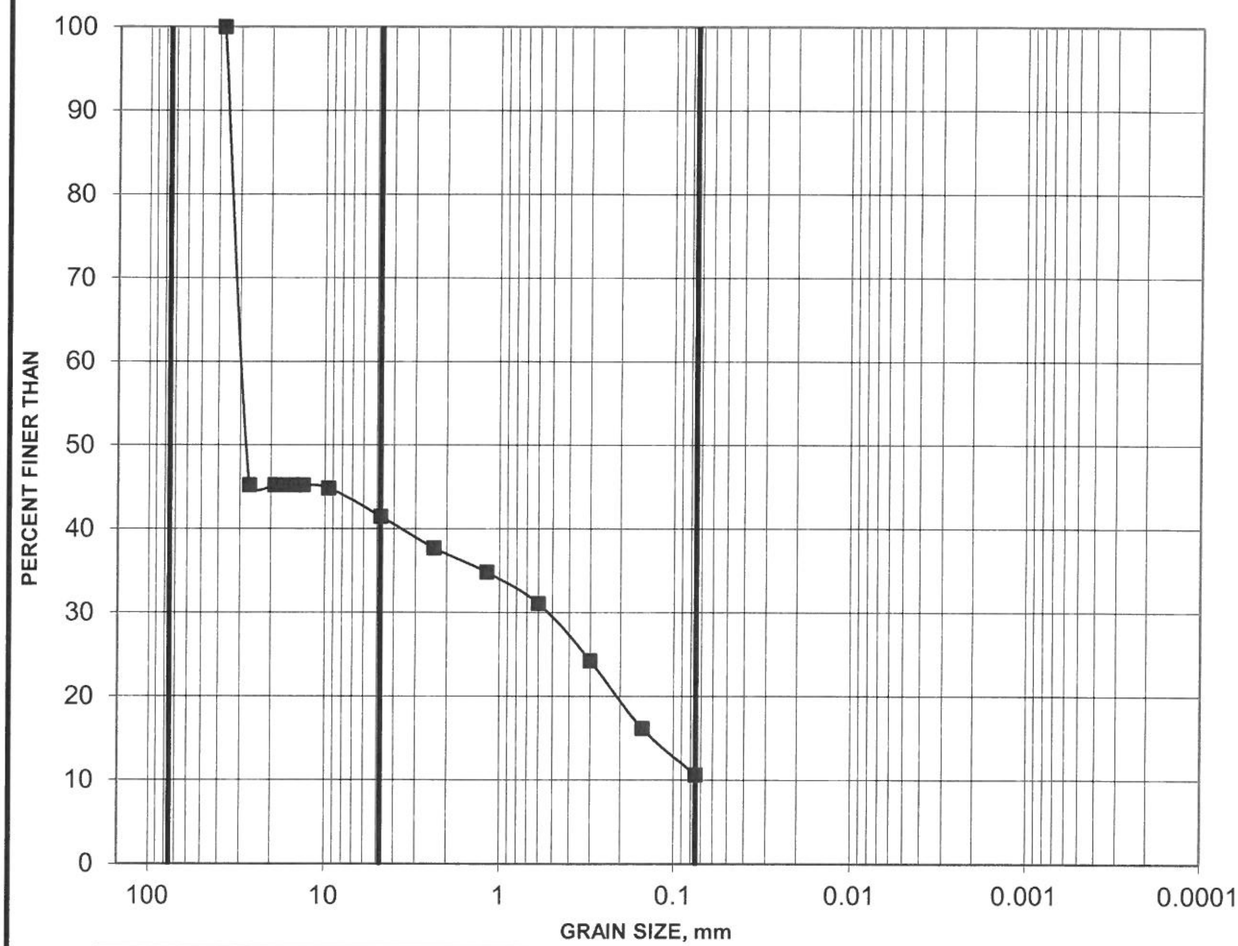
wsp

Created by: CW

Checked by: MT

GRAIN SIZE DISTRIBUTION	FIGURE

ENTER TITLE HERE



COBBLE SIZE	COARSE	FINE	COARSE	MEDIU	FINE	SILT AND CLAY
	GRAVEL SIZE		SAND SIZE			

	Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
■	23-05	04	2.44-3.66	59	30	11	

wsp

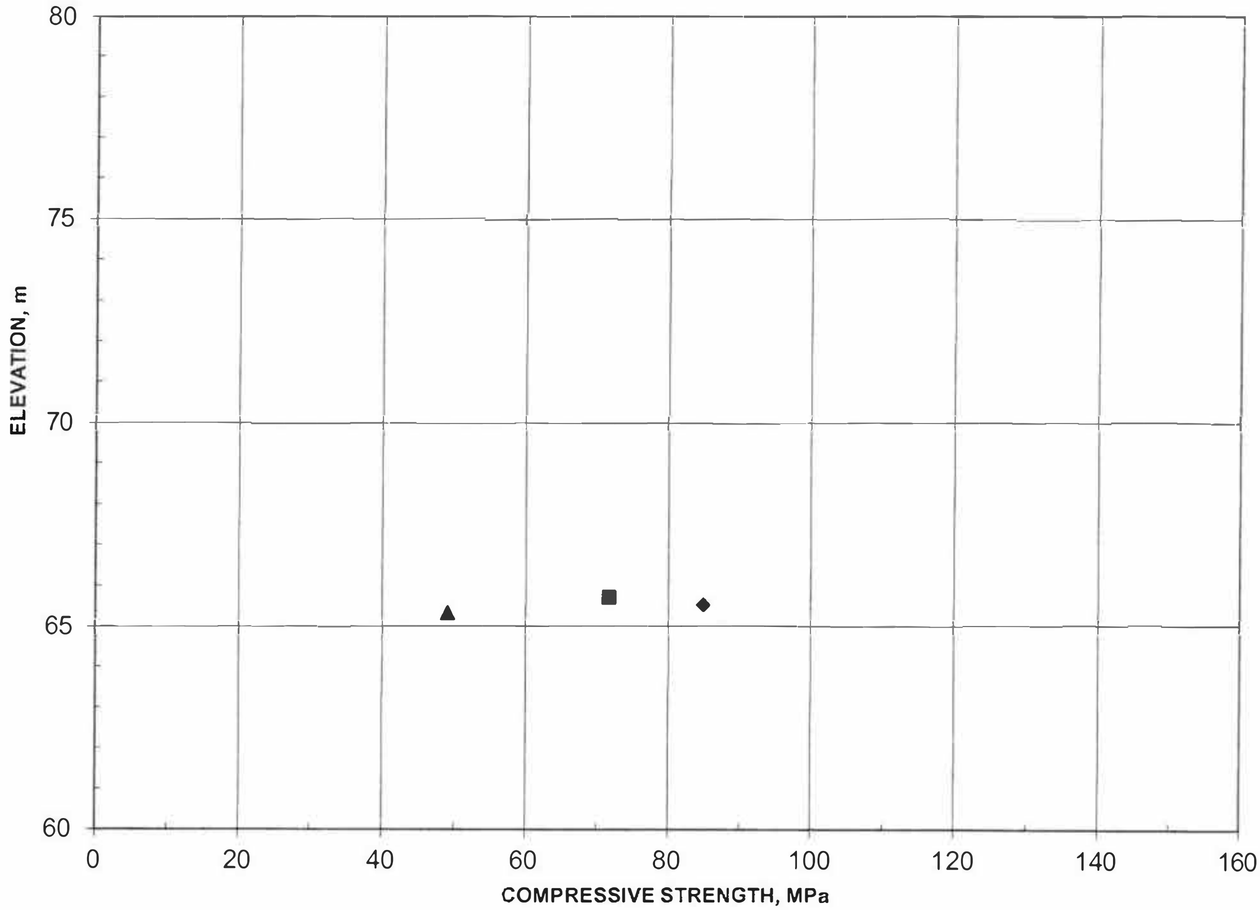
Project: 23592402

Created by: [signature]

Checked by: [signature]

ASTM D7012 - Method C
UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORE
SUMMARY OF LABORATORY TEST RESULTS

FIGURE B



	Borehole	Depth (m)	L/D	Bulk Density (kg/m^3)	Lithology	UCS (MPa)	Failure Type
■	BH23-03 RC3	5.8	2.9	2474	Shale	72	1
◆	BH23-04 RC2	6.6	2.7	2490	Shale	85	1
	BH23-05 RC3	5.1	2.6	2487	Shale	49	1

Notes:

Failure Types

1. Well formed cones on both ends
2. Well formed cones on one end, vertical cracks through cap
3. Columnar vertical craking through both ends
4. Diagonal fracture with no cracking through ends
5. Side fractures at top or bottom
6. Side fractures at both sides of top or bottom

Remarks

- Cores tested in vertical direction.
- Cores tested in air-dry condition.
- Time to failure > 2 and < 15 minutes.

Project: 23592402

Created by: cw
Checked by: MI

https://golderassociates.sharepoint.com/sites/35409g/Shared Documents/Active/2023/23592402/

Certificate of Analysis

Environment Testing

Client:	WSP Canada Inc. 1931 Robertson Road Ottawa, ON K2H 5B7	Report Number:	1995799
		Date Submitted:	2023-04-12
		Date Reported:	2023-04-19
		Project:	23592402
		COC #:	906918
Attention:	M. Othmane Benkirane		
PO#:			
Invoice to:	WSP Canada Inc.		

Dear Othmane Benkirane:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL: ______________________________

Raheleh Zafari, Environmental Chemist

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: https://directory.cala.ca/.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is licensed by the Ontario Ministry of the Environment, Conservation, and Parks (MECP) for specific tests in drinking water (license #2318). A copy of the license is available upon request.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

eurofins | Environment Testing

Certificate of Analysis

Client: WSP Canada Inc.
1931 Robertson Road
Ottawa, ON
K2H 5B7
Attention: M. Othmane Benkirane
PO#:
Invoice to: WSP Canada Inc.

Report Number: 1995799
Date Submitted: 2023-04-12
Date Reported: 2023-04-19
Project: 23592402
COC #: 906918

				Lab I.D.	1681879	1681880	1681881	1681882
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Type				
				Sampling Date	2023-03-13	2023-03-16	2023-03-15	2023-03-08
				Sample I.D.	23-02A Sa5/8-10'	23-03 Sa6/10-12'	23-04 Sa8/14-16'	23-05 Sa5/12-14
Group	**Analyte**	**MRL**	**Units**	**Guideline**				
Anions	Cl	0.002	%		0.044	0.120	0.013	0.035
	SO4	0.01	%		0.14	0.36	0.12	0.08
General Chemistry	Electrical Conductivity	0.05	mS/cm		1.40	2.78	1.14	1.39
	pH	2.00			7.31	7.12	7.38	7.56
	Resistivity	1	ohm-cm		714	360	877	714

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range eurofins | Environment Testing

Certificate of Analysis

Client:	WSP Canada Inc. 1931 Robertson Road Ottawa, ON K2H 5B7	Report Number:	1995799
		Date Submitted:	2023-04-12
		Date Reported:	2023-04-19
		Project:	23592402
Attention:	M. Othmane Benkirane	COC #:	906918
PO#:			
Invoice to:	WSP Canada Inc.		

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 440171 **Analysis/Extraction Date** 2023-04-17 **Analyst** IP **Method** Cond-Soil			
Electrical Conductivity	<0.05 mS/cm	102	90-110
pH	6.73	99	90-110
Resistivity			
Run No 440351 **Analysis/Extraction Date** 2023-04-19 **Analyst** IP **Method** AG SOIL			
SO4	<0.01 %	95	70-130
Run No 440355 **Analysis/Extraction Date** 2023-04-19 **Analyst** AsA **Method** C CSA A23.2-4B			
Chloride	<0.002 %		90-110

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

APPENDIX E

Technical Memorandum - Vertical Seismic Profiling Test Results

TECHNICAL MEMORANDUM

DATE May 8, 2023 **Project No.** 23592402

TO Keith Holmes, M.Sc; P.Geo
WSP

CC

FROM Alex Bilson Darko, Christopher Phillips **EMAIL alex.bilson.darko@wsp.com; christopher.phillips@wsp.com**

VERTICAL SEISMIC PROFILING TEST RESULTS

DORCHESTER RD, LONDON, ONTARIO

This memorandum presents the results of a Vertical Seismic Profiling (VSP) test carried out for a site located at 170 Slater St, Ottawa, Ontario. The borehole (BH23-01) was drilled to a depth of approximately 12.95 m below the existing ground surface and then cased with a 3-inch PVC pipe grouted in place.

Methodology

For the VSP method, seismic energy is generated at the ground surface by an active seismic source and recorded by a geophone located in a nearby borehole at a known depth (Figure 1). The active seismic source can be either compression or shear wave. The time required for the energy to travel from the source to the receiver (geophone) provides a measurement of the average compression or shear-wave seismic velocity of the medium between the source and the receiver. Data obtained from different geophone depths are used to calculate a detailed vertical seismic velocity profile of the subsurface in the immediate vicinity of the test borehole. The high-resolution results of a VSP survey are often used for earthquake engineering site classification, as per the National Building Code of Canada (2015).

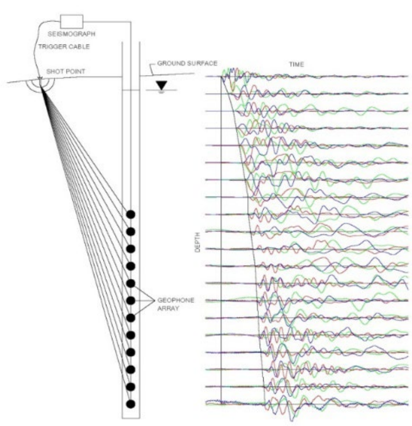


Figure 1: Layout and resulting time traces from a VSP survey.

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6925 Century Avenue, Suite #100, Mississauga, Ontario, L5N 7K2, Canada T: +1 905 567 4444 F: +1 905 567 6561

Field Work

The field work was carried out on April 4, 2023, by personnel from the WSP Mississauga office. For the borehole tested, both compression and shear-wave seismic sources were used. The seismic source for the compression wave test consisted of a 10-lb. sledge-hammer vertically impacted on a metal plate. The seismic source for the shear-wave test consisted of a 2.4-metre-long, 150 by 150 mm wooden beam, weighted by a vehicle and horizontally struck with a 10-lb. sledge-hammer on opposite ends of the beam to induce polarized shear waves. Test measurements started at ground surface and were recorded in the borehole with a 3-component receiver spaced at 1-metre intervals below the ground surface to the maximum depth of the casing. The source point was located at 2.56 m from the borehole.

The seismic records collected for each source location were stacked a minimum of five times to minimize the effects of ambient background seismic noise on the collected data. The field crew actively monitored the noise levels before collecting data as nearby roads could create unwanted signal. The data was sampled at 0.020833 millisecond intervals and a total time window of 0.341 milliseconds was collected for each seismic shot.

Data Processing

Processing of the VSP test results consisted of the following main steps:

1) Combination of seismic records to present seismic traces for all depth intervals on a single plot for each seismic source and for each component;

2) Low Pass Filtering of data to remove spurious high-frequency noise;

3) First break picking of the compression and shear-wave arrivals; and,

4) Calculation of the average compression and shear-wave velocity to each tested depth interval.

Processing of the VSP data was completed using the SeisImager/SW software package (Geometrics Inc.). The seismic records from the borehole are presented in Figures 2 and 3 showing the first break picks of the compression wave followed by the shear wave arrivals overlaid on the seismic waveform traces recorded at the different geophone depths. The arrivals were picked on the vertical component for the compression source and on the two horizontal components for the shear source.

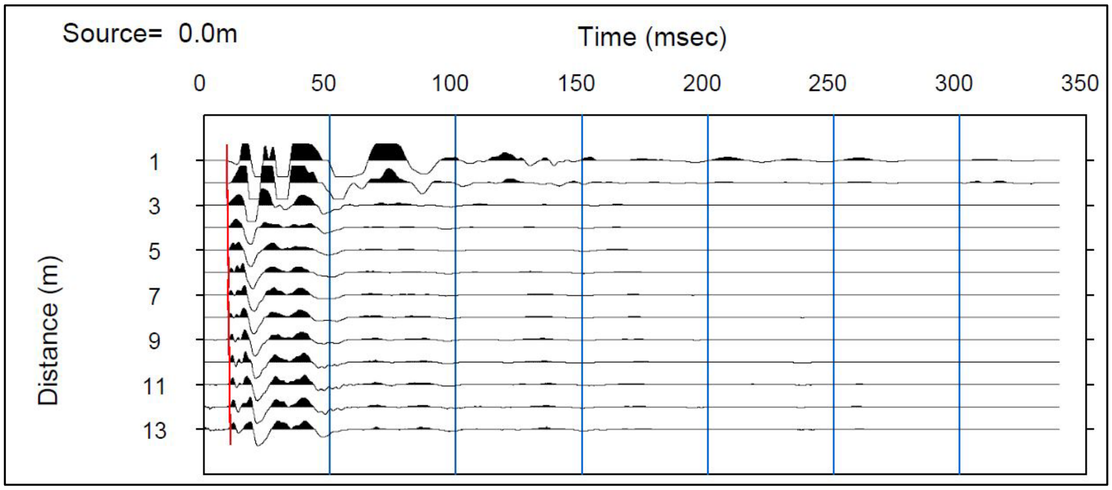


Figure 2: First break picking of compression wave arrivals (red) along the seismic traces recorded at each receiver depth of Borehole 2.

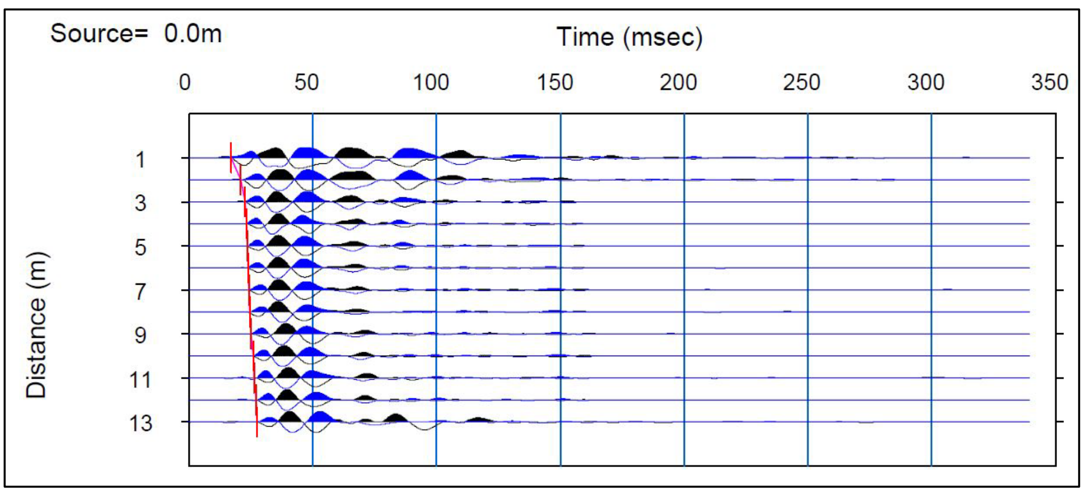


Figure 3: First break picking of shear wave arrivals (red) along the seismic traces recorded at each receiver depth of Borehole 2.

Results

The VSP results for the borehole are summarized in Table 1 (attached). The shear wave and compression wave layer velocities were calculated by best fitting a theoretical travel time model to the field data. The depths presented on the table are relative to ground surface.

The estimated dynamic engineering moduli, based on the calculated wave velocities, are also presented in Table 1. The engineering moduli were calculated using an estimated bulk density of 1300-2200 kg/m^3 based on the borehole log.

Closure

We trust that this technical memorandum meets your needs at the present time. If you have any questions or require clarification, please contact the undersigned at your convenience.

WSP Canada Inc.

DRAFT

Alex Bilson Darko, MSc
Geophysicist

DRAFT

Christopher Phillips, MSc, PGeo
Geophysicist VII, Senior Principal

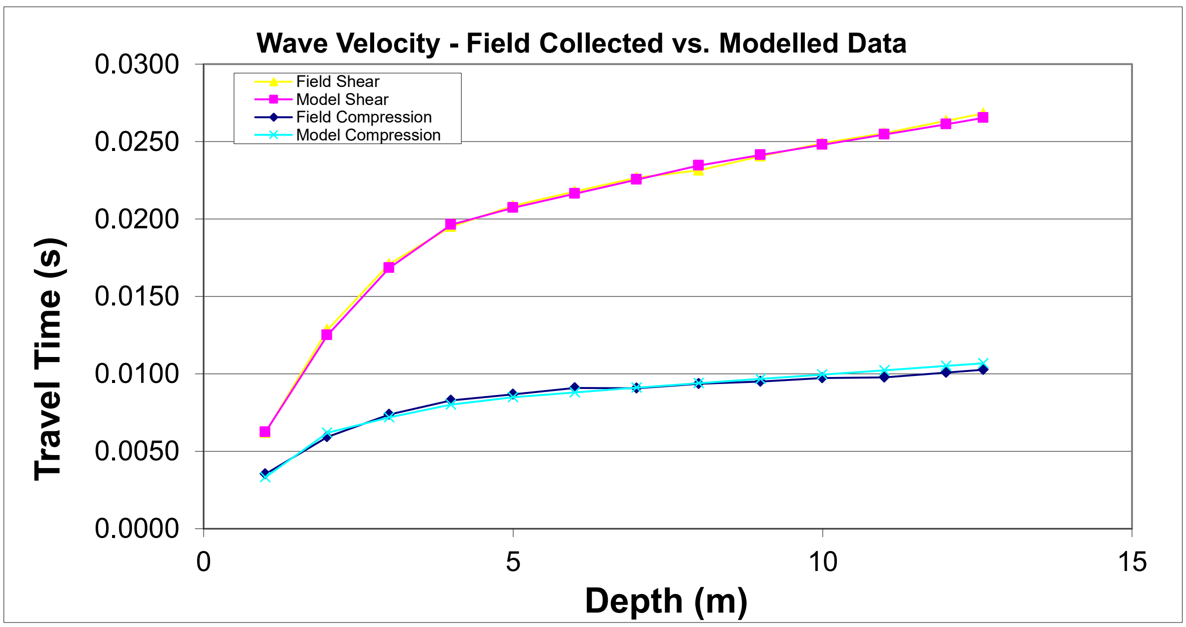
ABD/CRP/jl

Attachments: Table 1

TABLE 1
SHEAR WAVE VELOCITY PROFILE AT BH23-01

Layer Depth (m)				Estimated Bulk Density (kg/m^3)	Dynamic Engineering Properties			
Top	Bottom	Compressional Wave (m/s)	Shear Wave (m/s)		Poissons Ratio	Shear Modulus (MPa)	Deformation Modulus (MPa)	Bulk Modulus (MPa)
0.0	1	300	160	1900	0.30	49	127	106
1.0	2	350	160	1900	0.37	49	133	168
2.0	3	1000	230	1300	0.47	69	202	1208
3.0	4	1200	360	1700	0.45	220	639	2154
4.0	5	2100	900	2100	0.39	1701	4720	6993
5.0	6	3200	1100	2200	0.43	2662	7629	18979
6.0	7	3400	1100	2200	0.44	2662	7675	21883
7.0	8	3400	1100	2200	0.44	2662	7675	21883
8.0	9	3600	1500	2200	0.39	4950	13810	21912
9.0	10	3600	1500	2200	0.39	4950	13810	21912
10.0	11	3600	1500	2200	0.39	4950	13810	21912
11.0	12	3600	1500	2200	0.39	4950	13810	21912
12.0	12.6	3600	1500	2200	0.39	4950	13810	21912

Notes
1. Depth Presented relative to ground surface.
2. This Table to be analyzed in conjunction with the accompanying report.

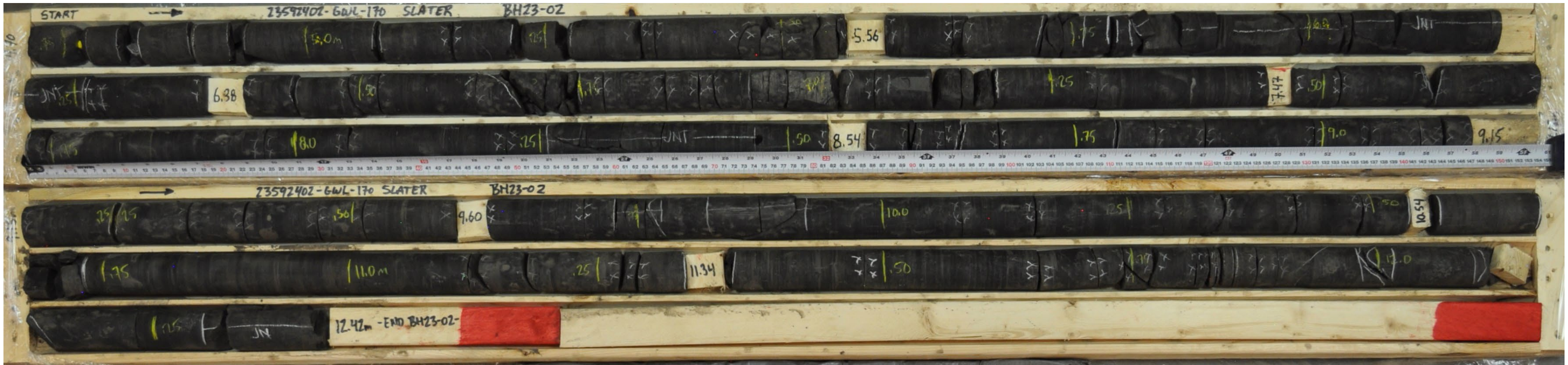


APPENDIX F

Rock Core Photos

BH23-02 (Dry)
Cored Length of 4.70 to 12.42 metres
Core Box 1 to 2 of 2

4.7 m



12.42 m

CLIENT	PROJECT
The Canada Life Assurance Company c/o GWL Realty Advisors Inc.	Geotechnical Investigation - 170 Slater Street, Ottawa, ON

CONSULTANT

YYY/MM/DD	2023-05-08
PREPARED	PAK
DESIGN	PAK
REVIEW	
APPROVED	

TITLE
COREHOLE BH23-02 (DRY)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
23592402			F-1

BH23-02 (Wet)
Cored Length of 4.70 to 12.42 metres
Core Box 1 to 2 of 2

4.7 m

12.42 m

CLIENT	PROJECT
The Canada Life Assurance Company c/o GWL Realty Advisors Inc.	Geotechnical Investigation - 170 Slater Street, Ottawa, ON

CONSULTANT: wsp

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TITLE

COREHOLE BH23-02 (WET)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
23592402			F-2

BH23-03 (Dry)
Cored Length of 4.07 to 13.59 metres
Core Box 1 to 3 of 3

4.07 m

13.59 m

CLIENT	PROJECT
The Canada Life Assurance Company c/o GWL Realty Advisors Inc.	Geotechnical Investigation - 170 Slater Street, Ottawa, ON

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YYY/MM/DD	2023-05-08
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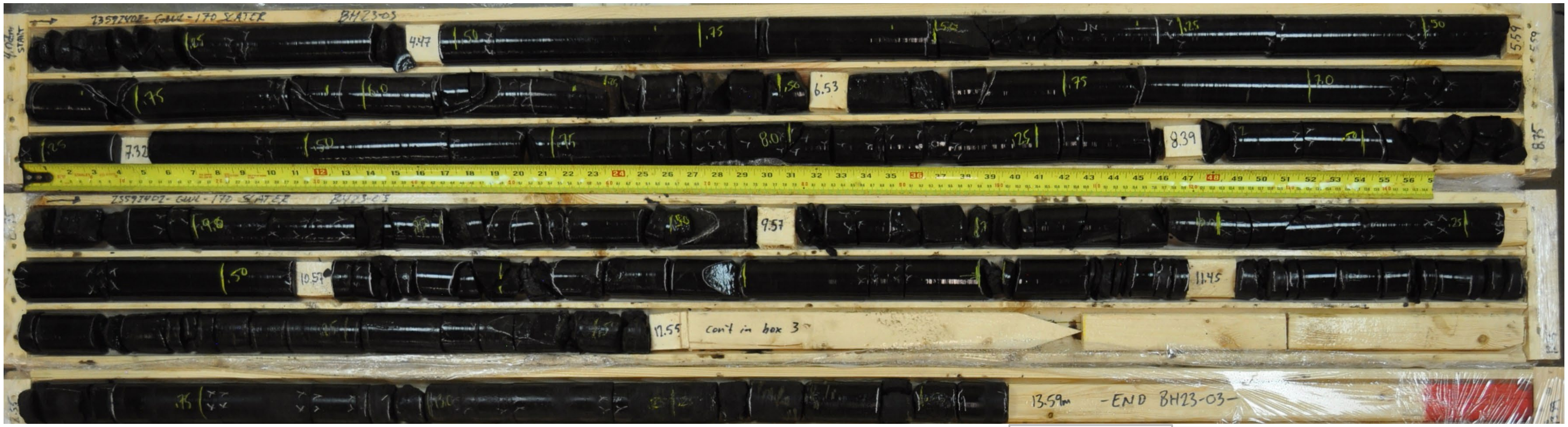
REVIEW	
APPROVED	

TITLE
COREHOLE BH23-03 (DRY)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
23592402		1	F-3

BH23-03 (Wet)
Cored Length of 4.07 to 13.59 metres
Core Box 1 to 3 of 3

4.07 m



13.59 m

CLIENT The Canada Life Assurance Company c/o GWL Realty Advisors Inc.	PROJECT Geotechnical Investigation - 170 Slater Street, Ottawa, ON

CONSULTANT

YYY/MM/DD	2023-05-08
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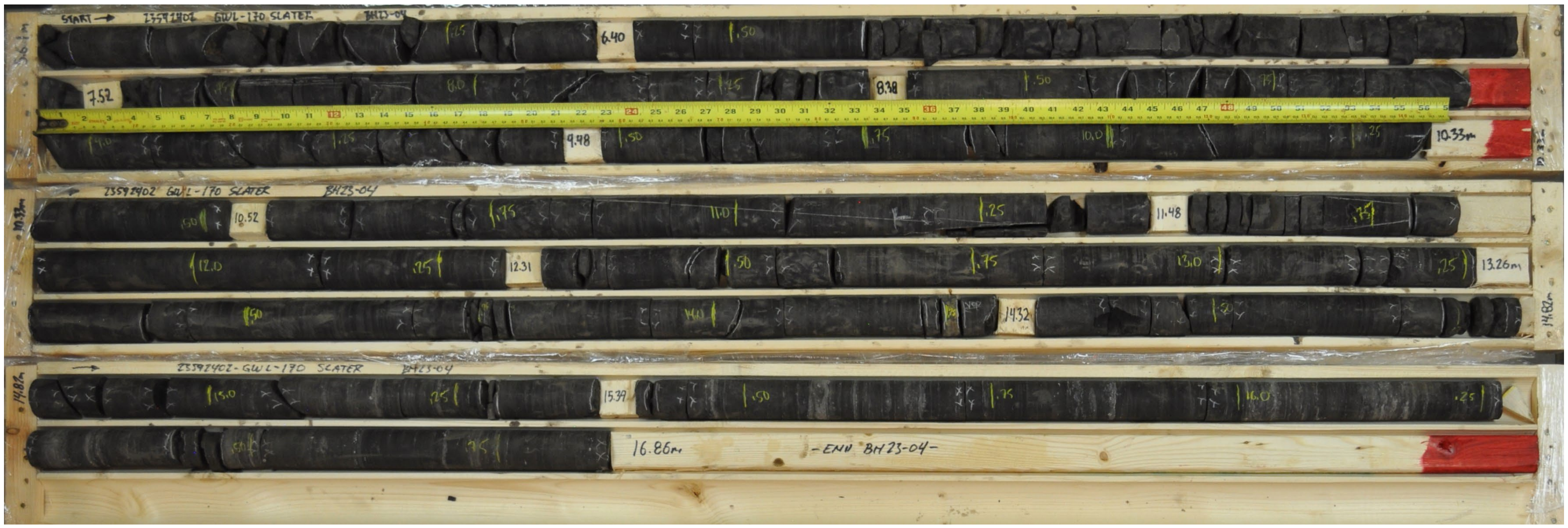
TITLE
COREHOLE BH23-03 (WET)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
23592402		1	F-4

BH23-04 (Dry)
Cored Length of 5.61 to 16.86 metres
Core Box 1 to 3 of 3

5.61m



16.86 m

CLIENT	PROJECT
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CONSULTANT: wsp

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DESIGN	PAK
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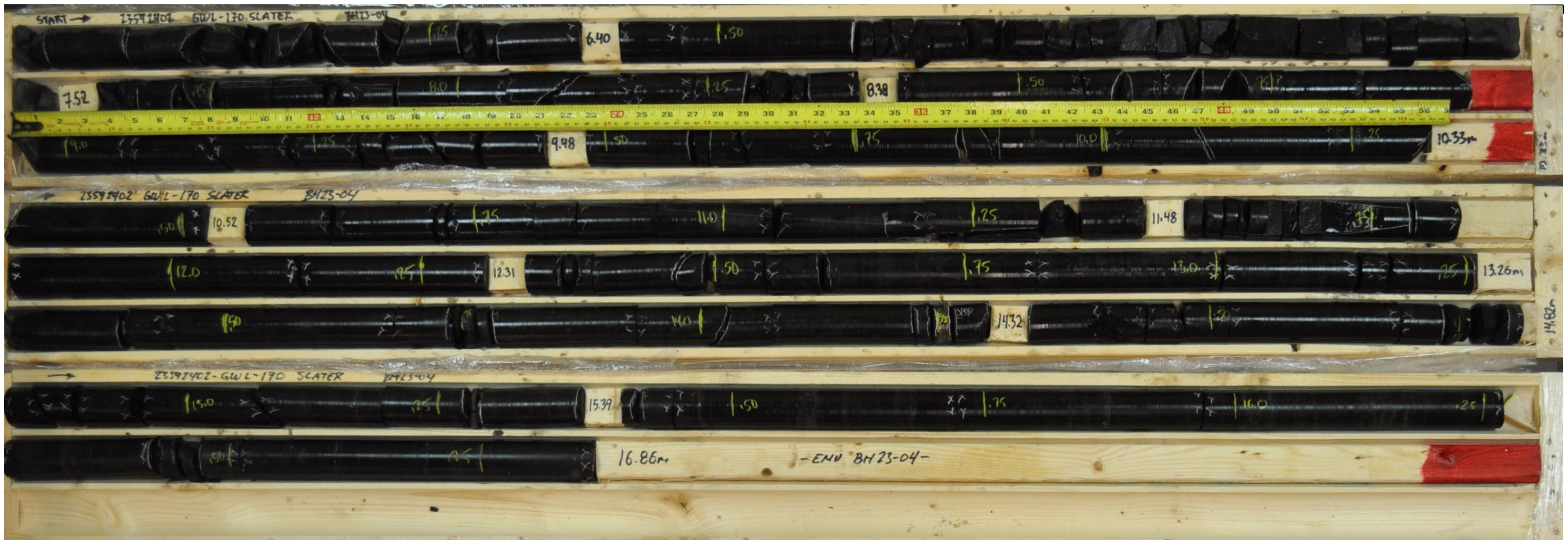
APPROVED	

TITLE
COREHOLE BH23-04 (DRY)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
23592402		1	F-5

BH23-04 (Wet)
Cored Length of 5.61 to 16.86 metres
Core Box 1 to 3 of 3

5.61m



16.86 m

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The Canada Life Assurance Company c/o GWL Realty Advisors Inc.

PROJECT
Geotechnical Investigation - 170 Slater Street, Ottawa, ON

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DESIGN	PAK
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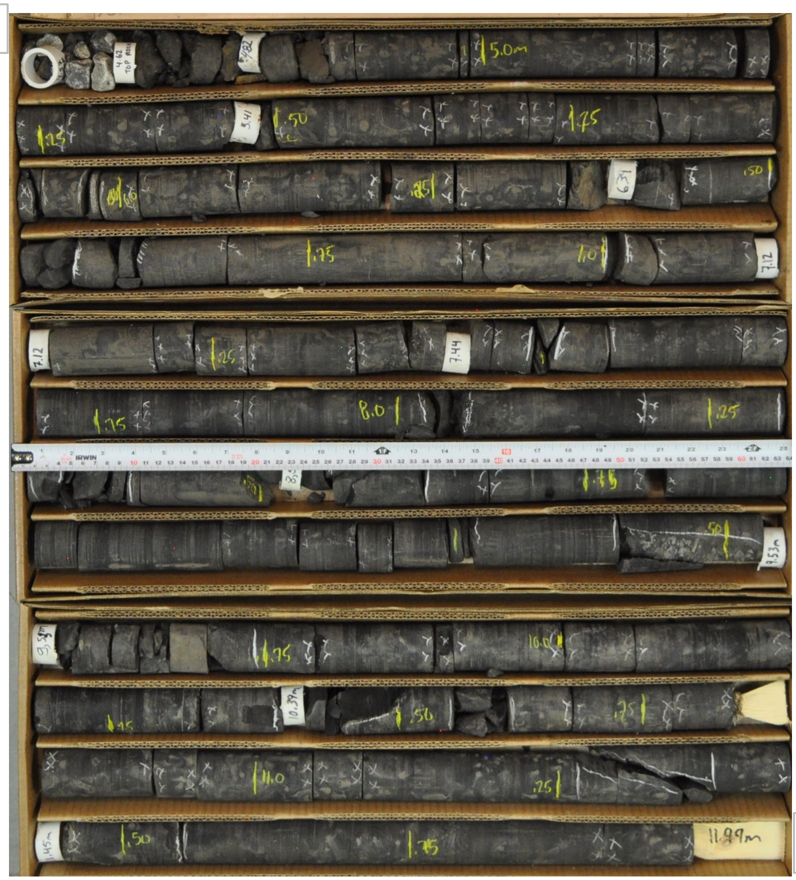
TITLE
COREHOLE BH23-04 (WET)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
23592402		1	F-6

BH23-05 (Dry)
Cored Length of 4.62 to 11.99 metres
Core Box 1 to 3 of 4

4.62 m



11.99m

CLIENT
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PROJECT
Geotechnical Investigation - 170 Slater Street, Ottawa, ON

CONSULTANT

YYY/MM/DD	2023-05-08
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DESIGN	PAK
REVIEW	
APPROVED	

TITLE
COREHOLE BH23-05 (DRY)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
23592402		1	F-7

Path: https://golderassociates.sharepoint.com/sites/170393/Project Files/5 Technical Work/Geotech/Rock Photos/Figure Core Photos Plate 23606896 - (3000) | File: Figure Core Photos Plate 23606896 - (3000)

BH23-05 (Wet)
Cored Length of 4.62 to 11.99 metres
Core Box 1 to 3 of 4

4.62 m

11.99 m

CLIENT
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PROJECT
Geotechnical Investigation - 170 Slater Street, Ottawa, ON

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YYY/MM/DD	2023-05-08
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DESIGN	PAK
REVIEW	
APPROVED	

TITLE
COREHOLE BH23-05 (WET)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
23592402		1	F-8

BH23-05 (Dry)
Cored Length of 11..99 to 16.49 metres
Core Box 4 to 4 of 4

11.99 m

16.49m

CLIENT
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PROJECT
Geotechnical Investigation - 170 Slater Street, Ottawa, ON

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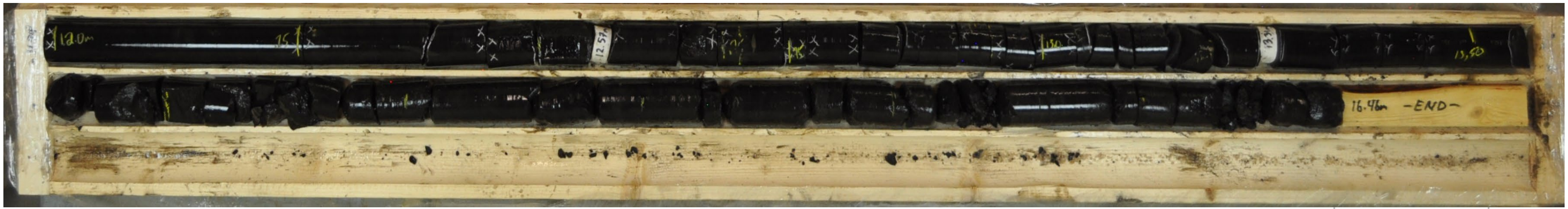
YYY/MM/DD	2023-05-08
PREPARED	PAK
DESIGN	PAK
REVIEW	
APPROVED	

TITLE
COREHOLE BH23-05 (DRY)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
23592402		1	F-9

BH23-05 (Wet)
Cored Length of 11.99 to 16.49 metres
Core Box 4 to 4 of 4

11.99 m



16.49 m

CLIENT
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PROJECT
Geotechnical Investigation - 170 Slater Street, Ottawa, ON

CONSULTANT

YYY/MM/DD	2023-05-08
PREPARED	PAK
DESIGN	PAK
REVIEW	
APPROVED	

TITLE
COREHOLE BH23-05 (WET)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
23592402		1	F-10

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APPENDIX G

Limitations

LIMITATIONS OF REPORT

This report was prepared pursuant to and in accordance with the master services agreement (the "MSA") dated May 2, 2019 between WSP Canada Inc. ("Consultant") and the other parties listed thereto, and the project specific agreement dated February 15, 2023 between Consultant and The Canada Life Assurance Company c/o GWL Realty Advisors Inc. The report was prepared by Consultant for the use of Owner and Manager (as those terms are defined under the MSA). In addition to the use of and reliance on this report by Owner and Manager, any person who has received a reliance letter for this report may use and rely on this report as if was prepared for such persons. Any use of or reliance on this report by any other person (i.e., a person other than any Owner Manager or otherwise permitted person) is the sole and exclusive responsibility of such other person. Consultant accepts no responsibility for damages, if any, suffered by such other person as a result of the use of or reliance on this report.

This report is based on the best information available to Consultant at the time of preparing this report after Consultant has used best industry practices, in the circumstances, to obtain information. To the extent that Consultant was required to rely on information from other persons, Consultant has verified such information to the extent reasonably possible in the circumstances. The material provided in this report reflects best industry judgement in light of the information available at the time of preparation of this report.

This limitations statement is considered an integral part of this report.

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