

# **Geotechnical Investigation**

## **Proposed High-Rise Development**

1209 St. Laurent Boulevard  
Ottawa, Ontario

Prepared for 1209 St. Laurent Limited Partnership

Report PG5216-2 Revision 3 dated December 16, 2022

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## 1.0 Introduction

Paterson Group (Paterson) was commissioned by 1209 St. Laurent Limited Partnership to conduct a geotechnical investigation for a proposed high-rise development to be located at 1209 St. Laurent Boulevard in the City of Ottawa (refer to Figure 1 - Key Plan presented in Appendix 2).

The objectives of the geotechnical investigation were to:

- ❑ Determine the subsoil and groundwater conditions at this site by means of boreholes.
- ❑ Provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect its design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. The report contains the geotechnical findings and includes recommendations pertaining to the design and construction of the subject development as understood at the time of writing this report.

## 2.0 Proposed Development

Based on available drawings and information provided by the client, it is understood that the proposed development will consist of two thirty-storey towers with a seven-storey podium, two-storey podium link, and a 4-level sloped underground parking structure. Associated access lanes and landscaped areas are also anticipated for the proposed development. It is further anticipated that the proposed buildings will be municipally serviced.

## **3.0 Method of Investigation**

### **3.1 Field Investigation**

#### **Field Program**

The field program for the current geotechnical investigation was conducted between September 2 and 8, 2022 and consisted of advancing four (4) boreholes (BH 1-22 to BH 4-22) to a maximum depth of 19.7 m below the existing ground surface, including bedrock coring. A further eleven (11) boreholes (BH 5-22 to BH 14-22) were completed by Paterson on September 8, 2022, advanced to a maximum depth of 3.7 m below the existing ground surface, for environmental purposes and will be addressed in a separate report.

Previous geotechnical investigations were completed by others in September 2018 and July 2021. During the September 2018 investigation a total of five (5) boreholes and three (3) hand auger holes were advanced to maximum depths of 4.9 m and 0.9 m, respectively, below existing ground surface. During the July 2021 investigation a total of seven (7) boreholes were advanced to a maximum depth of 12.1 m below existing ground surface.

The test hole locations were determined in the field by Paterson personnel and distributed in a manner to provide general coverage of the proposed development taking into consideration site features and underground utilities. The test hole locations are presented on Drawing PG5216-2 - Test Hole Location Plan included in Appendix 2.

The test holes were completed using a track-mounted drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The drilling procedure consisted of drilling to the required depth at the selected location and sampling the overburden.

#### **Sampling and In Situ Testing**

Soil samples from the boreholes were recovered from the auger flights or a 50 mm diameter split-spoon sampler. All soil samples were classified on site, placed in sealed plastic bags and transported to the laboratory for further review. The depths at which the auger and split spoon samples were recovered from the test holes are presented as AU and SS, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

Standard Penetration Testing (SPT) was conducted and recorded as “N” values on the Soil Profile and Test Data sheets. The “N” value is the number of blows required to drive the split-spoon sample 300 mm into the soil after a 150 mm initial penetration with a 63.5 kg hammer falling from a height of 760 mm.

Rock samples were recovered from four boreholes drilled during the current investigation (BH 1-22, BH 2-22, BH 3-22, and BH 4-22) using a core barrel and diamond drilling techniques. The bedrock samples were classified on site, placed in hard cardboard core boxes and transported to Paterson’s laboratory. The depths at which rock core samples were recovered from the boreholes are presented as RC on the Soil Profile and Test Data sheets in Appendix 1.

The recovery value and a Rock Quality Designation (RQD) value were calculated for each drilled section of bedrock and are presented on the borehole logs. The recovery value is the length of the bedrock sample recovered over the length of the drilled section. The RQD value is the total length of intact rock pieces longer than 100 mm over the length of the core run. The values indicate the bedrock quality.

Subsurface conditions observed in the test holes were recorded in detail in the field. Reference should be made to the Soil Profile and Test Data sheets presented in Appendix 1 for specific details of the soil profile encountered at the test hole locations.

## **Groundwater**

Boreholes BH 1-22, BH 2-22, BH 3-22, and BH 4-22 were fitted with 51 mm diameter PVC groundwater monitoring wells. Typical monitoring well construction details are described below:

- 1.5 m of slotted 51 mm diameter PVC screen at the base of the boreholes.
- 51 mm diameter PVC riser pipe from the top of the screen to the ground surface.
- No. 3 silica sand backfill within annular space around screen.
- 300 mm thick bentonite hole plug directly above PVC slotted screen.
- Clean backfill from top of bentonite plug to the ground surface.

The groundwater observations are discussed in Subsection 4.3 and presented in the Soil Profile and Test Data sheets in Appendix 1.

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## **Sample Storage**

All samples from the investigation will be stored in the laboratory for a period of one month after issuance of this report. The samples will then be discarded unless directed otherwise.

## **3.2 Field Survey**

The test hole locations were selected by Paterson to provide general coverage of the current phase of the development taking into consideration existing site features and underground utilities. The test hole locations and ground surface elevation at each test hole location were surveyed by Paterson using a high precision GPS unit and referenced to a geodetic datum. The location of the test holes and ground surface elevation at each test hole location are presented on Drawing PG5216-2 - Test Hole Location Plan in Appendix 2.

## **3.3 Laboratory Testing**

The soil and rock samples recovered from the subject site were visually examined in our laboratory to review the results of the field logging. All test results are included in Appendix 1 and further discussed in Subsection 4.2 of the current report.

## **3.4 Analytical Testing**

One (1) soil sample were submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was submitted to determine the concentration of sulphate and chloride, the resistivity and the pH of the sample. The results are presented in Appendix 1 and are discussed further in Subsection 6.7.

## **4.0 Observations**

### **4.1 Surface Conditions**

The subject site is currently vacant, and grass covered with some mature trees present near the site boundary with an asphaltic concrete parking area located within the east position of the site. The site is bordered to the west by St. Laurent Boulevard and further by the St. Laurent Shopping Centre, and to the south by an access ramp and overpass leading to the St. Laurent Shopping Centre. The site is bordered by Lemieux Street and further by commercial developments to the east and north.

Based on historic aerial images obtained from Geo Ottawa, the subject site was formerly occupied by at least two single family residential dwellings as recent as 1965. Reference should be made to Figure 2 in Appendix 2.

The majority of the subject site is relatively flat and at grade with surrounding roadways at an approximate geodetic elevation of 68 to 69 m. There is a relatively steep slope present along the south boundary of the site at the access ramp and overpass abutment. The slope increases in height towards the west at approximate geodetic elevations of 69 to 72 m.

### **4.2 Subsurface Profile**

#### **Overburden**

Generally, the soil profile at the test hole locations within the site for the current geotechnical investigation consists of a 100 mm thick layer of asphaltic concrete or a topsoil layer overlying an approximately 0.6 to 2.4 m thick layer of fill. Fill was observed at surface at the location of borehole BH 3-22. The fill layer was generally observed to consist of brown silty sand or silty clay with varying amounts of crushed stone, organic material, cobbles, and boulders.

A 2.2 to 2.6 m thick deposit of loose to dense glacial till was encountered underlying the fill layer in all boreholes with the exception of BH 4-22, where an approximately 1.3 m thick deposit of compact to dense silty sand was encountered overlaying the glacial till. The glacial till was generally observed to consist of brown to grey silty clay to clayey silt, or silty sand to sandy silt with gravel, cobbles, and boulders. The content of cobbles and boulders in the glacial till deposit was generally observed to increase with depth.



## Bedrock

A shale bedrock with limestone interbedding was encountered at all borehole locations at depths ranging between 4.6 to 5.0 m below the existing ground surface, the bedrock was cored to a maximum depth of 19.7 m below the existing ground surface. Generally, the bedrock was observed to consist of an approximately 1.5 to 2.0 m weathered zone of fair quality which transitioned to excellent quality with depth. A 2.4 m thick layer of very poor-quality weathered bedrock was encountered at the location of borehole BH 2-22. Vertical fractures were encountered within borehole BH 3-22 at depths of 9.4 m to 10.4 m and 11.4 to 11.8 m, and within borehole BH 4-22 at a depth of 4.8 to 5.1 m below the existing ground surface. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profile encountered at borehole location.

Based on available geological mapping, the subject site is underlain by shale of the Billings formation with a drift thickness of 0 to 5 m.

## 4.3 Groundwater

The groundwater levels were recorded within the monitoring wells installed within the four boreholes during the current investigation on September 15, 2022. The recorded groundwater levels are presented in Table 1 below and are further noted on the Soil Profile and Test Data sheets in Appendix 1.

<b>Table 1 – Summary of Groundwater Levels Readings</b>				
<b>Borehole Number</b>	<b>Ground Surface Elevation (m)</b>	<b>Measured Groundwater Level</b>		<b>Date Recorded</b>
		<b>Depth (m)</b>	<b>Elevation (m)</b>	
BH 1-22	69.17	3.38	65.79	September 15, 2022
BH 2-22	69.26	3.36	65.90	
BH 3-22	67.83	2.41	65.42	
BH 4-22	67.96	2.31	65.65	
<b>Note:</b> The ground surface elevation at each borehole location was surveyed using a handheld GPS using a geodetic datum.				

Groundwater conditions can also be estimated based on the observed colour and consistency of the recovered soil samples. Based on these observations, it is estimated that the long-term groundwater can be expected between **2.5 and 3.5 m** depth below existing ground surface within the glacial till layer. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

## **5.0 Discussion**

### **5.1 Geotechnical Assessment**

Based on the results of the geotechnical investigation, the subject site is considered suitable for the proposed development. The proposed high-rise development will be founded on conventional spread footings placed on a clean, surface sounded bedrock bearing surface.

It should be noted that the Billings formation shale is potentially susceptible to expansive behaviour. Upon being exposed to air and moisture, the Billings formation shale may readily decompose into thin flakes along the bedding planes.

Where vertical side slopes are excavated in the weathered shale bedrock, bedrock stabilization will be required. Specifically, horizontal rock anchors, shotcrete and/or chain link fencing may be required at specific locations.

The above and other considerations are further discussed in the following sections.

### **5.2 Site Grading and Preparation**

#### **Stripping Depth**

It is expected that all overburden materials will be excavated to the bedrock surface for the entire building footprint to accommodate the five levels of underground parking.

#### **Expansive Shale**

To reduce the long-term deterioration of the shale, exposure of the bedrock surface to oxygen and moisture should be kept as low as possible. The bedrock surface within the proposed building footprint should be protected from excessive dewatering and exposure to ambient air. It is recommended that a minimum 50 mm thick concrete mud slab be placed on the exposed bedrock surface within a 48-hour period of being exposed. As an alternative to the mud slab, keeping the shale surface covered with granular backfill is also acceptable.

## **Bedrock Removal**

As noted above, bedrock removal will be required for the construction of the underground parking structure. Bedrock removal can be accomplished by hoe ramming where only a small quantity of bedrock needs to be removed. Sound bedrock may be removed by line drilling and controlled blasting and/or hoe ramming.

Prior to considering blasting operations, the blasting effects on the existing services, buildings, and other structures should be addressed. A pre-blast or pre-construction survey of the existing structures located in the proximity of the blasting operations should be carried out prior to commencing site.

As a general guideline, peak particle velocities (measured at the structures) should not exceed 25 mm/s during the blasting program to reduce the risks of damage to the existing surrounding structures. The blasting operations should be planned and conducted under the supervision of a licensed professional engineer who is also an experienced blasting consultant.

Excavation side slopes in sound bedrock can be carried out using near vertical sidewalls. A minimum 1 m horizontal ledge should be left between the bottom of the overburden excavation and the top of the bedrock surface to provide an area to allow for potential sloughing. The 1 m horizontal ledge set back can be eliminated with the implementation of a shoring program consisting of soldier piles extending to the bedrock surface.

## **Vibration Considerations**

Construction operations could be the cause of vibrations, and possibly, sources of nuisance to the community. Therefore, means to reduce the vibration levels as much as possible should be incorporated in the construction operations to maintain a cooperative environment with the residents.

The following construction equipment could be the source of vibrations: piling equipment, hoe ram, compactor, dozer, crane, truck traffic, etc. The construction of the shoring system will require the use of this type of equipment. Vibrations, whether it is caused by blasting operations or by construction operations, could be the cause or the source of detrimental vibrations on the adjoining buildings and structures. Therefore, it is recommended that all vibrations be limited.

Two parameters determine the permissible vibrations, the maximum peak particle velocity, and the frequency. For low frequency vibrations, the maximum allowable peak particle velocity is less than that for high frequency vibrations. As a guideline, the peak particle velocity should be less than 15 mm/s between frequencies of 4 to 12 Hz, and 50 mm/s above a frequency of 40 Hz (interpolate between 12 and 40 Hz). These guidelines are for current construction standards. These guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, a pre-construction survey is recommended to minimize the risks of claims during or following the construction of the proposed building.

### **Bedrock Excavation Face Reinforcement**

A bedrock stabilization system consisting of a combination of horizontal rock anchors and/or chain link fencing connected to the excavation face may be required at specific locations to prevent bedrock pop-outs. This system is usually considered where bedrock fractures are conducive to the failure of the bedrock surface. The requirement for horizontal rock anchors and other bedrock stabilization methods will be evaluated during the excavation operations at the time of construction.

### **Fill Placement**

If fill placement is required for grading beneath the proposed building to support the floor slab, unless otherwise specified, should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill should be approved prior to delivery to the site. The granular material should be placed in lifts no greater than 300 mm thick and compacted with suitable compaction equipment for the lift thickness. Fill placed beneath the buildings should be compacted to a minimum of 98% of the material's standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil could be placed as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in thin lifts and at a minimum compacted by the heavy equipment tracks to minimize voids. If these materials are to build up the subgrade level for areas to be paved, the material should be compacted in thin lifts to a minimum density of 95% of the SPMDD.

Non-specified existing fill and site-excavated soil are not suitable as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

## 5.3 Foundation Design

### Bearing Resistance Values

Footings placed on the concrete mud slab overlaying a clean, surface sounded shale bedrock surface can be designed using a factored bearing resistance value at ultimate limit states (ULS) of **3,000 kPa**, incorporating a geotechnical resistance factor of 0.5. Footings bearing on an acceptable bedrock bearing surface and designed using the bearing resistance values provided herein will be subjected to negligible potential post-construction total and differential settlements.

A clean, surface-sounded bedrock bearing surface should be free of loose materials, and have no near surface seams, voids, fissures or open joints which can be detected from surface sounding with a rock hammer.

### Lateral Support

Adequate lateral support is provided to a sound bedrock bearing medium when a plane extending horizontally and vertically from the footing perimeter at a minimum of 1H:6V (or shallower) passing through sound bedrock or a material of the same or higher capacity as the bedrock, such as concrete.

## 5.4 Design for Earthquakes

Seismic shear wave velocity testing was completed for the subject site to accurately determine the applicable seismic site classification for the proposed building in accordance with Table 4.1.8.4.A of the Ontario Building Code 2012. The shear wave velocity testing was completed by Paterson personnel. The results of the shear wave velocity test are provided on Figures 3 and 4, which are presented in Appendix 2 of this report.

### Field Program

The seismic array testing location was placed as presented in Drawing PG5216-2 - Test Hole Location Plan, attached to the present report. Paterson field personnel placed 18 horizontal 2.4 Hz. geophones mounted to the surface by means of two 75 mm ground spikes attached to the geophone land case. The geophones were spaced at 2 m intervals and connected by a geophone spread cable to a Geode 24 Channel seismograph.

The seismograph was also connected to a computer laptop and a hammer trigger switch attached to a 12-pound dead blow hammer. The hammer trigger switch sends a start signal to the seismograph. The hammer is used to strike an I-Beam seated into the ground surface, which creates a polarized shear wave. The hammer shots are repeated between four (4) to eight (8) times at each shot location to improve signal to noise ratio. The shot locations were 15, 3 and 2 m away from the first and last geophone and at the centre of the seismic array.

### Data Processing and Interpretation

Interpretation for the shear wave velocity results were completed by Paterson personnel. Shear wave velocity measurement was made using reflection/refraction methods. The interpretation is performed by recovering arrival times from direct and refracted waves.

The interpretation is repeated at each shot location to provide an average shear wave velocity,  $V_{s30}$ , of the upper 30 m profile, immediately below the foundation of the building. The layer intercept times, velocities from different layers and critical distances are interpreted from the shear wave records to compute the bedrock depth at each location.

The bedrock velocity was interpreted using the main refractor wave velocity, which is considered a conservative estimate of the bedrock velocity due to the increasing quality of the bedrock with depth. It should be noted that as bedrock quality increases, the bedrock shear wave velocity also increases.

Based on the results of our testing, the average overburden shear wave velocity is **320 m/s** while the bedrock shear wave velocity is **2,114 m/s**. It is understood that the overburden will be completely removed as part of the proposed building and footings will be placed directly on the bedrock surface.

The  $V_{s30}$  was calculated using the standard equation for average shear wave velocity provided in the OBC 2012 and as presented below.

$$V_{s30} = \frac{\text{Depth}_{of\ interest} (m)}{\left( \frac{\text{Depth}_{Layer1} (m)}{V_{s_{Layer1}} (m/s)} + \frac{\text{Depth}_{Layer2} (m)}{V_{s_{Layer2}} (m/s)} \right)}$$

$$V_{s30} = \frac{30\ m}{\left( \frac{30\ m}{2,114\ m/s} \right)}$$

$$V_{s30} = 2,114\ m/s$$

Based on the results of the shear wave velocity testing, the average shear wave velocity  $V_{s30}$ , is 2,114 m/s. Therefore, a **Site Class A** is applicable for the design of proposed building bearing on bedrock, as per Table 4.1.8.4.A of the OBC 2012. The soils underlying the subject site are not susceptible to liquefaction.

## 5.5 Basement Floor Slab

The mud slab overlaying the bedrock surface will be considered an acceptable subgrade surface on which to commence backfilling for floor slab construction. OPSS Granular B Type II or Granular A is recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill consist 19 mm clear crushed stone. In consideration of the groundwater conditions encountered during the investigation, a subfloor drainage system, consisting of lines of perforated drainage pipe with a gravity connection to the building sump pit(s), should be provided under the lower basement floor.

All granular backfill material within the proposed building footprint should be placed in maximum 300 mm thick loose lifts and compacted to at least 98% of its SPMDD.

## 5.6 Basement Wall

There are several combinations of backfill materials and retained soils that could be applicable for the basement walls of the subject structure. However, the conditions can be well-represented by assuming the retained soil consists of a material with an angle of internal friction of 30 degrees and a bulk (drained) unit weight of 20 kN/m<sup>3</sup>.

However, undrained conditions are anticipated (i.e. below the groundwater level). Therefore, the applicable effective (undrained) unit weight of the retained soil can be taken as 13 kN/m<sup>3</sup>, where applicable. A hydrostatic pressure should be added to the total static earth pressure when using the effective unit weight.

### Lateral Earth Pressures

The static horizontal earth pressure ( $p_o$ ) can be calculated using a triangular earth pressure distribution equal to  $K_o \cdot \gamma \cdot H$  where:

$K_o$  = at-rest earth pressure coefficient of the applicable retained soil (0.5)

$\gamma$  = unit weight of fill of the applicable retained soil (kN/m<sup>3</sup>)

$H$  = height of the wall (m)



An additional pressure having a magnitude equal to  $K_0 \cdot q$  and acting on the entire height of the wall should be added to the above diagram for any surcharge loading,  $q$  (kPa), that may be placed at ground surface adjacent to the wall. The surcharge pressure will only be applicable for static analyses and should not be used in conjunction with the seismic loading case.

Actual earth pressures could be higher than the “at-rest” case if care is not exercised during the compaction of the backfill materials to maintain a minimum separation of 0.3 m from the walls with the compaction equipment.

### Seismic Earth Pressures

The total seismic force ( $P_{AE}$ ) includes both the earth force component ( $P_o$ ) and the seismic component ( $\Delta P_{AE}$ ).

The seismic earth force ( $\Delta P_{AE}$ ) can be calculated using  $0.375 \cdot a_c \cdot \gamma \cdot H^2/g$  where:

$$a_c = (1.45 - a_{max}/g) a_{max}$$

$$\gamma = \text{unit weight of fill of the applicable retained soil (kN/m}^3\text{)}$$

$$H = \text{height of the wall (m)} \quad g = \text{gravity, } 9.81 \text{ m/s}^2$$

The peak ground acceleration, ( $a_{max}$ ), for the site area is 0.32 g according to OBC 2012. Note that the vertical seismic coefficient is assumed to be zero.

The earth force component ( $P_o$ ) under seismic conditions can be calculated using

$$P_o = 0.5 K_0 \gamma H^2, \text{ where } K_0 = 0.5 \text{ for the soil conditions noted above.}$$

The total earth force ( $P_{AE}$ ) is considered to act at a height,  $h$  (m), from the base of the wall, where:

$$h = \{P_o \cdot (H/3) + \Delta P_{AE} \cdot (0.6 \cdot H)\} / P_{AE}$$

The earth forces calculated are unfactored. For the ULS case, the earth loads should be factored as live loads, as per OBC 2012.



## 5.7 Rock Anchor Design

The geotechnical design of grouted rock anchors in sedimentary bedrock is based upon two possible failure modes. The anchor can fail either by shear failure along the grout/rock interface or a 60 to 90 degrees pullout of rock cone with the apex of the cone near the middle of the bonded length of the anchor. Interaction may develop between the failure cones of anchors that are relatively close to one another resulting in a total group capacity smaller than the sum of the load capacity of each individual anchor.

A third failure mode of shear failure along the grout/steel interface should be reviewed by the structural engineer to ensure all typical failure modes have been reviewed.

The anchor should be provided with a bonded length at the base of the anchor which will provide the anchor capacity, as well an unbonded length between the rock surface and the top of the bonded length.

Permanent anchors should be provided with corrosion protection. As a minimum, the entire drill hole should be filled with cementitious grout. The free anchor length is provided by installing a plastic sleeve to act as a bond break, with the sleeve filled with grout or a corrosion inhibiting mastic. Double corrosion protection can be provided with factory assembled systems, such as those available from Dywidag Systems International or Williams Form Engineering Corp. Recognizing the importance of the anchors for the long term performance of the foundation of the proposed building, the rock anchors for this project are recommended to be provided with double corrosion protection.

### Grout to Rock Bond

The Canadian Foundation Engineering Manual recommends a maximum allowable grout to rock bond stress (for sound rock) of 1/30 of the unconfined compressive strength (UCS) of either the grout or rock (but less than 1.3 MPa) for an anchor of minimum length (depth) of 3 m. Generally, the UCS of shale ranges between about 40 and 50 MPa, which is stronger than most routine grouts. A factored tensile grout to rock bond resistance value at ULS of **1.0 MPa**, incorporating a resistance factor of 0.4, can be calculated. A minimum grout strength of 40 MPa is recommended.

## Rock Cone Uplift

The rock anchor capacity depends on the dimensions of the rock anchors and the anchorage system configuration. Based on available bedrock information, a **Rock Mass Rating (RMR) of 44** was assigned to the bedrock, and Hoek and Brown parameters (**m and s**) were taken as **0.128 and 0.00009**, respectively.

## Recommended Grouted Rock Anchor Parameters

Preliminary parameters used to calculate grouted rock anchor lengths are provided in Table 2. It is recommended that additional boreholes be extended into the underlying bedrock surface beyond the founding level of the proposed multi-storey structure to evaluate the quality of the bedrock and confirm the preliminary parameters provided in Table 2.

<b>Table 2 - Parameters used in Rock Anchor Review</b>	
Grout to Rock Bond Strength - Factored at ULS	1.0 MPa
Compressive Strength - Grout	40 MPa
Rock Mass Rating (RMR) – Fair to Excellent quality Shale Hoek and Brown parameters	44 m=0.128 and s=0.00009
Unconfined compressive strength - Shale	40 MPa
Unit weight - Submerged Bedrock	15 kN/m <sup>3</sup>
Apex angle of failure cone	60°
Apex of failure cone	mid-point of fixed anchor length

The fixed anchor length will depend on the diameter of the drill holes. Recommended anchor lengths are provided in Table 3. The factored tensile resistance values provided are based on a single anchor with no group influence effects.

<b>Table 3 - Recommended Rock Anchor Lengths - Grouted Rock Anchor</b>				
<b>Diameter of Drill Hole (mm)</b>	<b>Anchor Lengths (m)</b>			<b>Factored Tensile Resistance (kN)</b>
	<b>Bonded Length</b>	<b>Unbonded Length</b>	<b>Total Length</b>	
75	3.0	1.8	4.8	450
	3.6	2.0	5.6	600
	4.3	2.1	6.4	750
	5.3	2.2	7.5	1000
125	3.5	1.6	5.1	600
	3.8	2.0	5.8	750
	4.1	2.6	6.7	1000
	4.8	2.7	7.5	1250

It is recommended that the anchor drill hole diameter be within 1.5 to 2 times the rock anchor tendon diameter and the anchor drill holes be inspected by geotechnical personnel and should be flushed clean prior to grouting. The use of a grout tube to place grout from the bottom up in the anchor holes is further recommended.

The geotechnical capacity of each rock anchor should be proof tested at the time of construction. More information on testing can be provided upon request. Compressive strength testing is recommended to be completed for the rock anchor grout. A set of grout cubes should be tested for each day grout is prepared.

## **5.8 Pavement Structure**

### **Pavement Structure over Podium Deck**

It is anticipated that the podium deck structure will be provided car only parking areas, access lanes, fire truck lanes and loading areas. Based on the concrete slab subgrade, the pavement structure indicated in the following page may be considered for design purposes:

<b>Table 4 - Recommended Pavement Structure - Car-Only Parking Areas (Podium Deck)</b>	
<b>Thickness (mm)</b>	<b>Material Description</b>
50	<b>Wear Course</b> - HL-3 or Superpave 12.5 Asphaltic Concrete
200**	<b>Base</b> - OPSS Granular A Crushed Stone
See Below*	<b>Thermal Break*</b> - Rigid insulation (See Paragraph Below)
n/a	<b>Waterproofing Membrane and IKO Protection Board</b>
<b>SUBGRADE</b> – Reinforced Concrete Podium Deck	
*If specified by others, not required from a geotechnical perspective	
**Thickness is dependent on grade of insulation as noted in paragraphs below.	

<b>Table 5 - Recommended Pavement Structure – Access Lane, Fire Truck Lane, Ramp and Heavy Truck Parking Areas (Podium Deck)</b>	
<b>Thickness (mm)</b>	<b>Material Description</b>
40	<b>Wear Course</b> - HL-3 or Superpave 12.5 Asphaltic Concrete
50	<b>Wear Course</b> - HL-8 or Superpave 19.0 Asphaltic Concrete
300**	<b>Base</b> - OPSS Granular A Crushed Stone
See Below*	<b>Thermal Break*</b> - Rigid insulation (See Paragraph Below)
n/a	<b>Waterproofing Membrane and IKO Protection Board</b>
<b>SUBGRADE</b> – Reinforced Concrete Podium Deck	
*If specified by others, not required from a geotechnical perspective	
**Thickness is dependent on grade of insulation as noted in paragraphs below.	

The transition between the pavement structure over the podium deck subgrade and soil subgrade beyond the footprint of the podium deck is recommended to be transitioned to match the pavement structures provided in the following section. For this transition, a 5H:1V is recommended between the two subgrade surfaces. Further, the base layer thickness should be increased to a minimum thickness of 500 mm below the top of the podium slab a minimum of 1.5 m from the face of the foundation wall prior to providing the recommended taper.

Should the proposed podium deck be specified to be provided a thermal break by the use of a layer of rigid insulation below the pavement structure, its placement within the pavement structure is recommended to be as per the above-noted tables. The layer of rigid insulation is recommended to consist of a DOW Chemical High-Load 100 (HI-100), High-Load 60 (HI-60) or High Load (HI-40). The pavement structures base layer thickness will be dependant on the grade of insulation considered for this project and should be reassessed by the geotechnical consultant once pertinent design details have been prepared.

The higher grades of insulation have more resistance to deformation under wheel-loading and require less granular cover to avoid being crushing by vehicular loading. It should be noted that SM (Styrofoam) rigid insulation is not considered suitable for this application.

### **Pavement Structure over Overburden**

Car only parking areas, access lanes, and heavy traffic access areas are expected at this site. The subgrade material is anticipated to consist of native soil. The proposed pavement structures are presented in Tables 4 and 5.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type I or II material.

<b>Table 6 - Recommended Pavement Structure – Car Only Parking Areas</b>	
<b>Thickness (mm)</b>	<b>Material Description</b>
50	<b>Wear Course</b> - HL 3 or Superpave 12.5 Asphaltic Concrete
150	<b>BASE</b> - OPSS Granular A Crushed Stone
300	<b>SUBBASE</b> - OPSS Granular B Type II
<b>SUBGRADE</b> - Either fill, in-situ soil, or OPSS Granular B Type I or II material placed over in-situ soil, bedrock or concrete fill.	

<b>Table 7 - Recommended Pavement Structure – Access Lanes and Heavy Truck Parking Areas</b>	
<b>Thickness (mm)</b>	<b>Material Description</b>
40	<b>Wear Course</b> - HL-3 or Superpave 12.5 Asphaltic Concrete
50	<b>Binder Course</b> - HL-8 or Superpave 19 Asphaltic Concrete
150	<b>BASE</b> - OPSS Granular A Crushed Stone
450	<b>SUBBASE</b> - OPSS Granular B Type II
<b>SUBGRADE</b> - Either fill, in-situ soil, or OPSS Granular B Type I or II material placed over in-situ soil, bedrock or concrete fill.	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project. The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material's SPMDD using suitable compaction equipment.

## **Pavement Structure Drainage**

Satisfactory performance of the pavement structure is largely dependent on keeping the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity.

## **5.9 Potential Exposed Bedrock**

Based on the subsurface conditions within the vicinity of the proposed towers' location, the majority of the bedrock core recovery within the cored boreholes (BH 1-22, BH 2-22, BH 3-22, and BH 4-22) was 49 % to 100 % indicating poor to excellent quality shale with limestone interbedding, with localized poor quality zones at the top of the bedrock surface. Therefore, the proposed bedrock excavation face can be left exposed for architectural purposes, provided any loose rock pieces have been removed.

Removal of loose rock pieces can be done by a pressure washing program under the supervision of Paterson personnel. The exposed, cleaned, bedrock excavation face shall be inspected and approved by Paterson to confirm that all loose rock fragments have been removed.

During excavation, Paterson shall also review the exposed bedrock face to determine if any additional bedrock stabilization measures are required. A bedrock stabilization system could be required for the upper portion of the exposed bedrock face during construction to ensure worker safety. Alternatively, pressure washing could be done to ensure that a bedrock face, free of loose materials, is present during construction.

It should be noted that groundwater infiltration from the exposed bedrock face could occur over long-term conditions. Therefore, a groundwater collection system may be required at the basement slab level to maintain the water within the stormwater drainage system. The groundwater collection system for the exposed bedrock face is expected to consist of a perforated drainage pipe running below an opening in the lowest floor slab and connected to the sub-floor drainage system.

Furthermore, given the potential expansive nature of the Billings shale, the exposed shale bedrock surface may degrade over time and require periodic maintenance which could include scaling and/or shotcrete finishing.

## 6.0 Design and Construction Precautions

### 6.1 Foundation Drainage and Backfill

#### Foundation Drainage System

To manage and control groundwater infiltration over the long term, the following system is recommended to be installed for the exterior foundation walls and underfloor drainage:

- ❑ The minimum 50 mm thick concrete mud slab will create a horizontal hydraulic barrier to lessen the water infiltration at the base of the excavation.
- ❑ A composite drainage layer (such as Delta Drain 6000 or approved equivalent) will be placed from finished grade to the top of the footing level, against the foundation wall. It is recommended that 150 mm diameter sleeves be placed at 3 m centres, cast in the foundation wall at the footing interface to allow the infiltration of water to flow to an interior perimeter drainage pipe. The perimeter drainage pipe should direct water to the sump pit(s) within the lower basement area.

#### Underfloor Drainage

Underfloor drainage will be required to control water infiltration below the lowest underground parking level slab that breaches the horizontal hydraulic barrier (minimum 100 mm thick concrete mud slab). For design purposes, it's recommended that a 150 mm diameter perforated pipe be placed at 6 m centers. The final spacing of the underfloor drainage system should be confirmed at the time of completing the excavation when water infiltration can be better assessed.

#### Foundation Backfill

Where required, backfill against the exterior sides of the foundation walls should consist of free draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a drainage geocomposite, such as Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I or OPSS Granular A granular material, should otherwise be used for this purpose.

## 6.2 Protection Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effects of frost action. A minimum of 1.5 m of soil cover, or a minimum of 0.6 m of soil cover in conjunction with foundation insulation, should be provided.

Exterior unheated footings, such as those for isolated exterior piers, are more prone to deleterious movement associated with frost action than the exterior walls of the structure proper and require additional protection, such as soil cover of 2.1 m or a combination of soil cover and foundation insulation.

It is expected that the foundations will generally not require protection against frost action due to the founding depth. However, unheated structures, such as the access ramp, may require insulation against the deleterious effect of frost action.

## 6.3 Excavation

It is expected that temporary shoring will be required due to the proposed founding depth for the underground parking structure. Furthermore, it is expected that the foundation walls will be blind poured against the vertical bedrock face and shoring system.

### **Excavation Side Slopes for Servicing and Shallow Excavations**

The subsoil at this site is considered to be mainly a Type 2 and Type 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects. The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below the groundwater level.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by “cut and cover” methods and excavations will not be left open for extended periods of time.



## **Temporary Shoring**

Temporary shoring will be required due to the depth of the excavation, the proximity of the adjacent structures and underground services. Due to the glacial till deposit and the excavation below the bedrock surface, it is assumed that the temporary shoring will consist of drilled soldier piles and timber lagging system. Temporary shoring will be required to support the overburden for the entire perimeter of the excavation.

The design and approval of the shoring system will be the responsibility of the shoring contractor and the shoring designer hired by the shoring contractor. It is the responsibility of the shoring contractor to ensure that the temporary shoring is in compliance with safety requirements, designed to avoid any damage to adjacent structures and include dewatering control measures. In the event that subsurface conditions differ from the approved design during the actual installation, it is the responsibility of the shoring contractor to commission the required experts to re-assess the design and implement the required changes. Furthermore, the design of the temporary shoring system should take into consideration, a full hydrostatic condition which can occur during significant precipitation events.

For design purposes, the temporary system will most likely consist of a drilled soldier pile and timber lagging system. Drilled soldier piles will be required to penetrate through expected occasional boulders and bedrock. These systems can be anchored or braced. Generally, it is expected that the shoring system will be provided with tie-back anchors to ensure their stability and greater safety.

## **Typical Geotechnical Parameters**

Generally, it is expected that the shoring systems will be provided with tie-back anchors to ensure their stability.

The geotechnical design of grouted anchors is based upon two possible failure modes. The anchor can fail either by shear failure along the grout interface or by pullout of a 60 to 90 degree cone with the apex of the cone near the middle of the bonded length of the anchor.

The earth pressures acting on the shoring system may be calculated using the following parameters.

<b>Table 8 - Soil Parameters</b>	
<b>Parameters</b>	<b>Values</b>
Active Earth Pressure Coefficient ( $K_a$ )	0.33
Passive Earth Pressure Coefficient ( $K_p$ )	3
At-Rest Earth Pressure Coefficient ( $K_o$ )	0.5
Unit Weight , kN/m <sup>3</sup>	21
Submerged Unit Weight , kN/m <sup>3</sup>	13

The active earth pressure should be calculated where wall movements are permissible while the at-rest pressure should be calculated if no movement is permissible.

The dry unit weight should be used above the groundwater level while the effective unit weight should be used below the groundwater level.

The hydrostatic groundwater pressure should be added to the earth pressure distribution wherever the effective unit weights are used for earth pressure calculations. If the groundwater level is lowered, the dry unit weight for the soil should be used full weight, with no hydrostatic groundwater pressure component.

For design purposes, the minimum factor of safety of 1.5 should be calculated.

### **Soldier Pile and Lagging System**

The active earth pressure acting on a soldier pile and lagging shoring system can be calculated using a rectangular earth pressure distribution with a maximum pressure of  $0.65 \cdot K \cdot \gamma \cdot H$  for strutted or anchored shoring, or a triangular earth pressure distribution with a maximum value of  $K \cdot \gamma \cdot H$  for a cantilever shoring system.  $H$  is the height of the excavation.

The active earth pressure should be used where wall movements are permissible while the at-rest pressure should be used if no movement is permissible. The total unit weight should be used above the groundwater level while the submerged unit weight should be used below the groundwater level.

The hydrostatic groundwater pressure should be added to the earth pressure distribution wherever the submerged unit weights are used for earth pressure calculations should the level on the groundwater not be lowered below the bottom of the excavation. If the groundwater level is lowered, the total unit weight for the soil should be used full weight, with no hydrostatic groundwater pressure component.

## **Adjacent Overpass Abutment**

Based on design drawings provided by the client, the underside of footing elevation of the abutment at the site is 65.8 m, based on the results of the geotechnical investigation, it is anticipated that the abutment is founded on the glacial till deposit, approximately 2.6 m above the bedrock surface.

Due to the proximity and founding conditions of the bridge abutment located at the south boundary of the site, the temporary shoring system must be designed to support the load. It should be noted that if the bridge abutment lateral support zone conflicts with the location of the foundation wall for the proposed building, the proposed building's foundation walls will be designed to support any lateral loads imposed by the bridge abutment. The subject development will not negatively impact the existing bridge abutment.

It should be noted that the drawings provided by the client are not as-built drawings, actual field conditions need to be verified prior to construction by completing test pits at the location of the abutment.

## **6.4 Pipe Bedding and Backfill**

At least 150 mm of OPSS Granular A should be placed for bedding for sewer or water pipes when placed on soil/bedrock subgrade. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe, should consist of OPSS Granular A (concrete or PSM PVC pipes) or sand (concrete pipe). The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to a minimum of 95% of the SPMDD.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce the potential differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

## **6.5 Groundwater Control**

### **Groundwater Control for Building Construction**

The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source.

It is anticipated that pumping from open sumps will be sufficient to control the groundwater influx through the sides of the excavations.

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes, being pumped during the construction phase, between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

It should be noted that Paterson completed hydraulic conductivity testing within the monitoring wells installed at the subject site, the results will be provided in a separate hydrogeological report.

### **Long-term Groundwater Control**

Our recommendations for the proposed building's long-term groundwater control are presented in Subsection 6.1. Provided the proposed foundation drainage system is properly implemented and approved by the geotechnical consultant at the time of construction, it is expected that groundwater flow will be low (less than 50,000 L/day) which includes higher volumes during peak periods noted after rain events. A more accurate estimate can be provided at the time of construction, once groundwater infiltration levels are observed. It is anticipated that the groundwater flow will be controllable using conventional open sumps.

## **6.6 Winter Construction**

Precautions must be taken if winter construction is considered for this project.

The excavations may be completed in proximity of existing structures which could be adversely affected due to the freezing conditions. In particular, it should be recognized that where a shoring system is used, the soil behind the shoring system will be subjected to freezing conditions which could result in heaving of the structure(s) placed within or above frozen soil. Provisions should be made in the contract document to protect the walls of the excavations from freezing, if applicable.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters and tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

Trench excavations and pavement construction are also difficult activities to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Precautions should be taken if such activities are to be carried out during freezing conditions. Additional information could be provided, if required.

## **6.7 Corrosion Potential and Sulphate**

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a non-aggressive to slightly aggressive corrosive environment.

## 7.0 Recommendations

It is a requirement for the foundation design data provided herein to be applicable that a materials testing and observation services program including the following aspects be performed by the geotechnical consultant.

- Review of the geotechnical aspects of the excavating contractor's shoring design, prior to construction.
- Review the proposed protection system for the potentially expansive shales.
- Review proposed foundation drainage design and installation.
- Observation of all bearing surfaces prior to the placement of concrete.
- Sampling and testing of the concrete and fill materials used.
- Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- Observation of all subgrades prior to backfilling and follow-up field density tests to determine the level of compaction achieved.
- Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued, upon request, following the completion of a satisfactory materials testing and observation program by the geotechnical consultant.

All excess soils, with the exception of engineered crushed stone fill, generated by construction activities that will be transported on-site or off-site should be handled as per **Ontario Regulation 406/19: On-Site and Excess Soil Management**.

## 8.0 Statement of Limitations

The recommendations provided in this report are in accordance with our present understanding of the project. We request permission to review our recommendations when the drawings and specifications are completed.

A geotechnical investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request immediate notification to permit reassessment of our recommendations.

The recommendations provided herein should only be used by the design professionals associated with this project. They are not intended for contractors bidding on or undertaking the work. The latter should evaluate the factual information provided in this report and determine its suitability and completeness for their intended construction schedule and methods. Additional testing may be required for their purposes.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than 1209 St. Laurent Limited Partnership or their agents is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

### Paterson Group Inc.



Nicole R.L. Patey, B.Eng.



David J. Gilbert, P.Eng.

### Report Distribution:

- 1209 St. Laurent Limited Partnership (1 copy)
- Paterson Group (1 copy)

# APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

SOIL PROFILE AND TEST DATA SHEETS BY OTHERS

ANALYTICAL TESTING RESULTS



## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Proposed High-Rise Development  
1200-1209 St. Laurent Blvd., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 2, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH 1-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %					
								20	40	60	80		
<b>GROUND SURFACE</b>													
Asphaltic concrete	0.10					0	69.17						
<b>FILL:</b> Brown silty sand with gravel and crushed stone		AU	1										
	1.07	SS	2	25	10	1	68.17						
<b>FILL:</b> Topsoil and organics, some wood, trace clay		SS	3	75	4	2	67.17						
	2.44	SS	4	71	3	3	66.17						
<b>GLACIAL TILL:</b> Loose to dense, grey silty clay to clayey silt with sand, trace gravel		SS	5	75	4	4	65.17						
- sand and gravel increasing with depth		RC	1	49	N/A	5	64.17						
- cobbles and boulders by 4.0m depth	4.98	RC	2	100	61	6	63.17						
		RC	3	100	71	7	62.17						
<b>BEDROCK:</b> Fair to excellent quality shale with limestone interbedding		RC	4	100	90	8	61.17						
		RC	5	100	100	9	60.17						
						10	59.17						
						11	58.17						
								20	40	60	80	100	
								<b>Shear Strength (kPa)</b>					
								▲ Undisturbed    △ Remoulded					

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Proposed High-Rise Development  
1200-1209 St. Laurent Blvd., Ottawa, Ontario

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FILE NO.  
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HOLE NO.  
**BH 1-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction		
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80			
GROUND SURFACE						11	58.17							
<b>BEDROCK:</b> Excellent quality shale with limestone interbedding		RC	6	100	92	12	57.17							
		RC	7	100	95	13	56.17							
		RC	8	100	87	14	55.17							
		RC	9	100	97	15	54.17							
		RC	10	100	92	16	53.17							
		RC	11	100	100	17	52.17							
							18	51.17						
							19	50.17						
		End of Borehole					19.61							
		(GWL @ 3.38m - Sept. 15, 2022)												

20 40 60 80 100  
**Shear Strength (kPa)**  
▲ Undisturbed    △ Remoulded

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 6, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH 2-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %					
								20	40	60	80		
<b>GROUND SURFACE</b>													
Asphaltic concrete	0.10					0	69.26						
<b>FILL:</b> Crushed stone with gravel, trace clay and concrete, occasional cobbles and boulders		SS	1	33	26								
		SS	2	100	50+	1	68.26						
<b>FILL:</b> Brown silty clay with topsoil and gravel, occasional cobbles	1.45												
		SS	3	67	20	2	67.26						
<b>GLACIAL TILL:</b> Compact to loose, brown to grey silty clay with sand, gravel, cobbles and boulders	2.21												
		SS	4	92	25	3	66.26						
		SS	5	75	37	4	65.26						
		SS	6	75	28	4	65.26						
<b>BEDROCK:</b> Very poor quality, weathered shale	4.60												
		SS	7	23	50+	5	64.26						
		SS	8	100	50+	6	63.26						
		SS	9	50	50+	6	63.26						
<b>BEDROCK:</b> Good to excellent quality shale with limestone interbedding	6.99												
		SS	10	100	50+	7	62.26						
		RC	1	100	79	8	61.26						
	RC	2	100	98	9	60.26							
	RC	3	100	81	10	59.26							
						11	58.26						
								20	40	60	80	100	
								<b>Shear Strength (kPa)</b>					
								▲ Undisturbed    △ Remoulded					

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Proposed High-Rise Development  
1200-1209 St. Laurent Blvd., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 6, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH 2-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %				
GROUND SURFACE							20	40	60	80		
<b>BEDROCK:</b> Good to excellent quality shale with limestone interbedding		RC	4	100	98	11	58.26					
		RC	5	100	100	12	57.26					
		RC	6	100	91	13	56.26					
		RC	7	100	97	14	55.26					
		RC	8	100	100	15	54.26					
		RC	9	100	100	16	53.26					
		RC	8	100	100	17	52.26					
		RC	9	100	100	18	51.26					
		RC	9	100	100	19	50.26					
End of Borehole (GWL @ 3.36m - Sept. 15, 2022)	19.71											
							20	40	60	80	100	
							<b>Shear Strength (kPa)</b>					
							▲ Undisturbed    △ Remoulded					

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 7, 2022

FILE NO.  
PG5216

HOLE NO.  
BH 3-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %					
								20	40	60	80		
<b>GROUND SURFACE</b>						0	67.83						
<b>FILL:</b> Brown silty sand, some gravel and topsoil		AU	1										
0.69													
<b>FILL:</b> Brown silty sand with clay, some gravel, topsoil, occasional cobbles		SS	2	83	22	1	66.83						
- clay content increasing with depth		SS	3	92	31	2	65.83						
2.44													
<b>GLACIAL TILL:</b> Compact to dense, grey silty sand to sandy silt with clay and gravel		SS	4	62	11	3	64.83						
- cobbles and boulders by 3.1m depth		SS	5	42	24	4	63.83						
- some shale fragments by 4.5m depth		SS	6	67	46	5	62.83						
4.62													
		RC	1	92	80	6	61.83						
<b>BEDROCK:</b> Good to excellent quality shale with limestone interbedding		RC	2	100	86	7	60.83						
		RC	3	100	97	8	59.83						
		RC	4	100	92	9	58.83						
- vertical fracture from 9.4 to 10.4m depth		RC	4	100	92	10	57.83						
						11	56.83						
								20	40	60	80	100	
								<b>Shear Strength (kPa)</b>					
								▲ Undisturbed    △ Remoulded					

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 7, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH 3-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80		
GROUND SURFACE						11	56.83						
<b>BEDROCK:</b> Good to excellent quality shale with limestone interbedding  - vertical fracture from 11.4 to 11.8m depth		RC	5	100	80	12	55.83						
		RC	6	100	100	13	54.83						
		RC	7	100	100	14	53.83						
		RC	8	100	97	15	52.83						
		RC	9	100	100	16	51.83						
		RC	10	100	100	17	50.83						
						18	49.83						
						19	48.83						
						19.74							
End of Borehole (GWL @ 2.41m - Sept. 15, 2022)													

20 40 60 80 100  
**Shear Strength (kPa)**  
▲ Undisturbed    △ Remoulded

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH 4-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80	
<b>GROUND SURFACE</b>												
<b>TOPSOIL</b>	0.05					0	67.96					
<b>FILL:</b> Brown silty sand with gravel and crushed stone	0.69	AU	1									
Compact to dense, brown <b>SILTY SAND</b> , trace gravel		SS	2	58	24	1	66.96					
- some clay by 1.7m depth		SS	3	83	44	2	65.96					
<b>GLACIAL TILL:</b> Compact to dense, brown silty clay with sand, gravel, cobbles and boulders		SS	4	50	23	3	64.96					
- dark grey by 3.0m depth		SS	5	33	38	4	63.96					
		SS	6	60	38	4	63.96					
	4.62	SS	7	0	50+	5	62.96					
<b>BEDROCK:</b> Fair to excellent quality shale with limestone interbedding		RC	1	100	72	6	61.96					
- vertical fracture from 4.8 to 5.1m depth		RC	2	100	81	7	60.96					
		RC	3	100	98	8	59.96					
		RC	4	100	98	9	58.96					
		RC	4	100	98	10	57.96					
						11	56.96					
								20	40	60	80	100
								<b>Shear Strength (kPa)</b>				
								▲ Undisturbed    △ Remoulded				

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Proposed High-Rise Development  
1200-1209 St. Laurent Blvd., Ottawa, Ontario

9 Auriga Drive, Ottawa, Ontario K2E 7T9

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH 4-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction		
		TYPE	NUMBER	RECOVERY	N VALUE or RQD			○ Water Content %						
								20	40	60	80			
GROUND SURFACE						11	56.96							
<b>BEDROCK:</b> Excellent quality shale with limestone interbedding		RC	5	100	98	12	55.96							
		RC	6	100	98	13	54.96							
		RC	7	100	100	14	53.96							
		RC	8	100	100	15	52.96							
		RC	9	100	100	16	51.96							
		RC	10	100	100	17	50.96							
						18	49.96							
						19	48.96							
	End of Borehole													
(GWL @ 2.31m - Sept. 15, 2022)														

19.68

20 40 60 80 100  
Shear Strength (kPa)  
▲ Undisturbed     △ Remoulded



## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
 Proposed High-Rise Development  
 1200-1209 St. Laurent Blvd., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH 5-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %					
								20	40	60	80		
<b>GROUND SURFACE</b>													
<b>TOPSOIL</b>	0.05					0	68.18						
<b>FILL:</b> Brown to black silty sand with gravel and crushed stone, trace clay	0.69	AU	1										
<b>FILL:</b> Grey silty sand to sandy silt, trace topsoil	1.22	SS	2	83	20	1	67.18						
<b>FILL:</b> Brown silty clay, some sand, trace gravel and topsoil	1.45	SS	3	75	31	2	66.18						
<b>GLACIAL TILL:</b> Dark brown silty clay with sand, gravel, cobbles and boulders		SS	4	92	17								
- dark grey to black by 2.2m depth		SS	5	67	21	3	65.18						
- some shale fragments by 3.35m depth	3.66												
End of Borehole													

20 40 60 80 100  
**Shear Strength (kPa)**  
 ▲ Undisturbed    △ Remoulded

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Proposed High-Rise Development  
1200-1209 St. Laurent Blvd., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH 6-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80	
GROUND SURFACE												
TOPSOIL	0.05					0	68.52					
FILL: Brown silty sand with gravel	0.69	AU	1									
Compact, brown SILTY SAND		SS	2	83	12	1	67.52					
GLACIAL TILL: Dark grey to black silty clay with sand, gravel, cobbles and shale fragments	1.75	SS	3	92	8	2	66.52					
End of Borehole	2.13											
								20	40	60	80	100
								<b>Shear Strength (kPa)</b>				
								▲ Undisturbed    △ Remoulded				

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Proposed High-Rise Development  
1200-1209 St. Laurent Blvd., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH 7-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80	
<b>GROUND SURFACE</b>												
<b>TOPSOIL</b>	0.05					0	68.53					
Compact, brown <b>SILTY SAND</b>	0.76	AU	1									
Compact, brown <b>SILTY SAND to SANDY SILT</b>	1.45	SS	2	88	16	1	67.53					
<b>GLACIAL TILL:</b> Dark brown silty clay with sand, gravel, cobbles and boulders	2.13	SS	3	75	16	2	66.53					
End of Borehole												

20 40 60 80 100  
**Shear Strength (kPa)**  
▲ Undisturbed    △ Remoulded

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Proposed High-Rise Development  
1200-1209 St. Laurent Blvd., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
PG5216

HOLE NO.  
BH 8-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %					
GROUND SURFACE								20	40	60	80		
TOPSOIL	0.08					0	68.28						
FILL: Brown silty sand with clay, gravel and crushed stone	0.69	AU	1										
FILL: Brown silty sand with clay, topsoil, trace gravel		SS	2	83	9	1	67.28						
GLACIAL TILL: Dark brown silty clay with sand, gravel, cobbles and shale fragments	1.78	SS	3	83	17	2	66.28						
End of Borehole	2.13												

20 40 60 80 100  
Shear Strength (kPa)  
▲ Undisturbed    △ Remoulded

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH 9-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %					
								20	40	60	80		
<b>GROUND SURFACE</b>													
<b>TOPSOIL</b>	0.10					0	68.30						
<b>FILL:</b> Brown silty sand with gravel and crushed stone, trace clay and topsoil		AU	1										
	0.99												
Compact, brown <b>SILTY SAND to SANDY SILT</b> , trace shale fragments		SS	2	83	11	1	67.30						
	1.45												
<b>GLACIAL TILL:</b> Dark brown silty clay with sand, gravel, cobbles, some shale fragments		SS	3	75	23	2	66.30						
	2.13												
End of Borehole													

20 40 60 80 100  
**Shear Strength (kPa)**  
▲ Undisturbed    △ Remoulded

DATUM Geodetic




REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH10-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %				
20	40					60	80					
<b>GROUND SURFACE</b>												
<b>TOPSOIL</b>	0.08					0	68.56					
FILL: Brown silty sand, trace gravel		AU	1									
FILL: Brown silty sand with clay, some topsoil	0.84					1	67.56					
		SS	2	92	11							
FILL: Brown silty sand with clay, some topsoil	1.45											
		SS	3	83	19	2	66.56					
<b>GLACIAL TILL:</b> Dark brown silty clay, some sand, gravel, cobbles, trace shale fragments	2.13											
End of Borehole												

20 40 60 80 100  
**Shear Strength (kPa)**  
▲ Undisturbed    △ Remoulded

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Proposed High-Rise Development  
1200-1209 St. Laurent Blvd., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH11-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80	
<b>GROUND SURFACE</b>												
Asphaltic concrete	0.05					0	69.17					
<b>FILL:</b> Brown silty sand with crushed stone and gravel	0.69	AU	1									
<b>FILL:</b> Brown silty sand, trace clay, gravel, crushed stone	1.45	SS	2	75	12	1	68.17					
<b>FILL:</b> Brown silty clay, some sand, trace gravel, topsoil and wood	2.59	SS	3	88	9	2	67.17					
Compact, brown <b>SANDY SILT</b> , trace clay	2.90	SS	4	88	17							
End of Borehole												

20 40 60 80 100  
**Shear Strength (kPa)**  
▲ Undisturbed    △ Remoulded

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
 Proposed High-Rise Development  
 1200-1209 St. Laurent Blvd., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH12-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %					
								20	40	60	80		
<b>GROUND SURFACE</b>													
Asphaltic concrete	0.08					0	68.88						
<b>FILL:</b> Brown silty sand with crushed stone and gravel	0.69	AU	1										
<b>FILL:</b> Grey-brown silty clay with sand, some topsoil and gravel	1.45	SS	2	50	6	1	67.88						
<b>GLACIAL TILL:</b> Dark brown silty clay, some sand, gravel, cobbles, trace shale fragments	1.55	SS	3	100	50+								
End of Borehole													

20 40 60 80 100  
**Shear Strength (kPa)**  
 ▲ Undisturbed    △ Remoulded



## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Proposed High-Rise Development  
1200-1209 St. Laurent Blvd., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH12A-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80	
<b>GROUND SURFACE</b>												
Asphaltic concrete	0.08					0	68.88					
<b>FILL:</b> Brown silty sand with crushed stone and gravel	0.69											
<b>FILL:</b> Grey-brown silty clay with sand, some topsoil and gravel	1.45	SS	1	75	6	1	67.88					
<b>GLACIAL TILL:</b> Dark brown silty clay, some sand, gravel, cobbles, trace shale fragments	2.13	SS	2	83	10	2	66.88					
End of Borehole												

		20	40	60	80	100
<b>Water Content %</b> ○						
<b>Shear Strength (kPa)</b> ▲ Undisturbed    △ Remoulded						

DATUM Geodetic


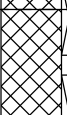



REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH13-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			○ Water Content %					
GROUND SURFACE								20	40	60	80		
Asphaltic concrete FILL: Brown silty sand, some gravel, trace brick and plastic		AU	1			0	68.86						
	0.08												
	0.99	SS	2	83	9	1	67.86						
FILL: Grey sandy silt to silty sand with topsoil													
	2.06	SS	3	67	6	2	66.86						
FILL: Grey-brown silty clay, some topsoil													
	2.21												
TOPSOIL		SS	4	75	22								
	2.44												
Compact, brown SILTY SAND, trace clay													
	2.90												
End of Borehole													

20 40 60 80 100  
Shear Strength (kPa)  
▲ Undisturbed    △ Remoulded

## SOIL PROFILE AND TEST DATA

Geotechnical Investigation  
Proposed High-Rise Development  
1200-1209 St. Laurent Blvd., Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 8, 2022

FILE NO.  
**PG5216**

HOLE NO.  
**BH14-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Monitoring Well Construction
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80	
<b>GROUND SURFACE</b>												
TOPSOIL	0.10					0	69.32					
FILL: Brown silty sand	0.76	AU	1									
FILL: Brown silty sand, trace organics, brick		SS	2	100	50+	1	68.32					
		SS	3	58	17	2	67.32					
Compact, brown <b>SILTY SAND to SANDY SILT</b> , trace clay	2.59	SS	4	83	21							
End of Borehole	2.90											
								20	40	60	80	100
								<b>Shear Strength (kPa)</b>				
								▲ Undisturbed    △ Remoulded				

# 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 the 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 be 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.

<b>RQD %</b>	<b>ROCK QUALITY</b>
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 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 = $(D_{30})^2 / (D_{10} \times D_{60})$
Cu	-	Uniformity coefficient = $D_{60} / D_{10}$

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  $Cu > 6$

Sands 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.
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## SYMBOLS AND TERMS (continued)

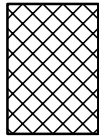
### STRATA PLOT



Topsoil



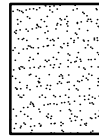
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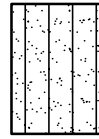
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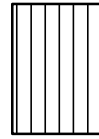
Peat



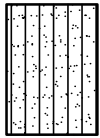
Sand



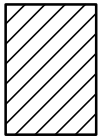
Silty Sand



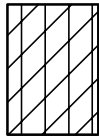
Silt



Sandy Silt



Clay



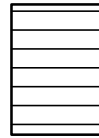
Silty Clay



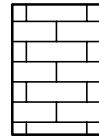
Clayey Silty Sand



Glacial Till



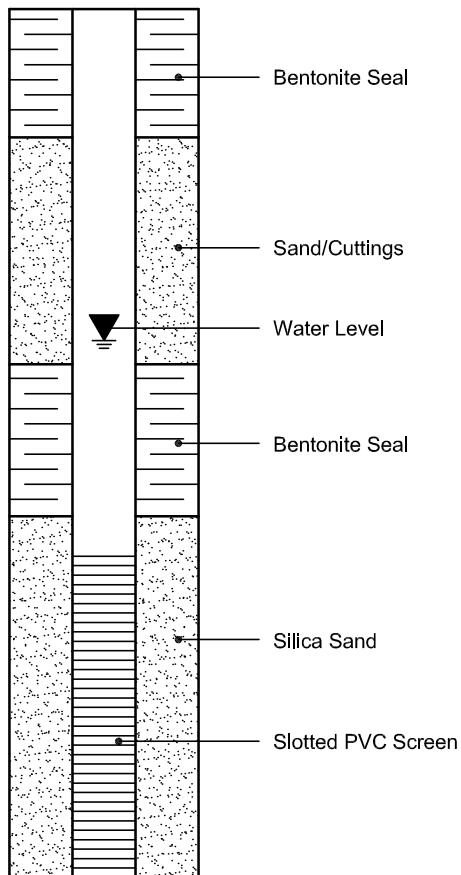
Shale



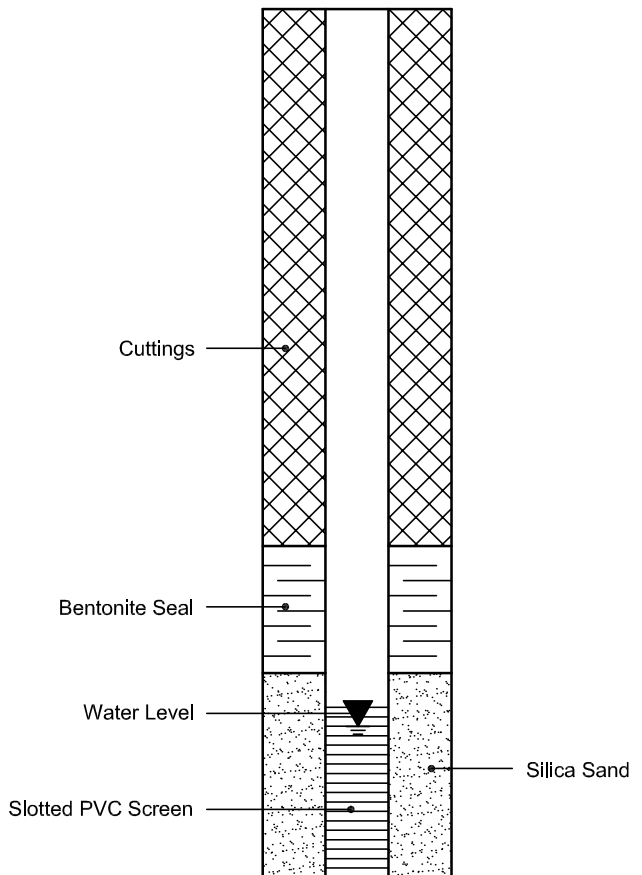
Bedrock

### MONITORING WELL AND PIEZOMETER CONSTRUCTION

#### MONITORING WELL CONSTRUCTION



#### PIEZOMETER CONSTRUCTION





# BOREHOLE REPORT

**Borehole No. MW-1-21**

<p>CLIENT: CANDEREL                  PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION                  LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO                  DESCRIBED BY: J. SCOTT      VERIFIED BY: S. SOLEIMANI/ A. FIORILLI</p>	<p>GEODETIC COORDINATES (MTM, NAD-83) (m)                  X : 450263.5                  Y : 5030050.1                  Z : 68.04</p>	<p>▼ - WATER LEVEL                  Date : 2021-07-29                  Depth (m) : 2.022</p> <p>Location plan :</p>
<p>Borehole type : Auger 200mm                  Core bit size :                  Hammer type :                  Energy ratio :                  Date (start) : 2021-07-14                  Date (finish) : 2021-07-14</p>	<p><b>SAMPLE TYPE</b></p> <p>SS(E)- Split Spoon (Environment)                  RC(E)- Rock diamond core                  AU(E)- Auger                  TEE - Sampling Tube Environment                  ST - Shelby tube                  GS(E)- Grab sample</p>	<p><b>SAMPLE STATE</b></p> <p>☒ Remoulded                  ☒ Intact                  ◻ Diamond drilling                  ◼ Lost</p>
DRAFT		
<p><b>TEST SYMBOL</b></p> <p>GSA: grain size analysis                  CA: chemical analysis                  W<sub>L</sub>: liquid limit                  W<sub>P</sub>: plastic limit                  w : water content                  C<sub>u</sub>: undrained shear strength                  S<sub>r</sub>: sensitivity                  Dup: duplicate sample</p>		

STRATIGRAPHY				SAMPLE						TESTS RESULTS										
Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N <sub>c</sub> or RQD	○ Water content (%)    Δ C <sub>u</sub> (Field, kPa) ▭ Atterberg limits (%)    □ C <sub>u</sub> (Lab, kPa) ● "N" Standard penetration test value ▲ "N <sub>c</sub> " Dynamic penetration test value									
0.00	68.04		Ground surface								10 20 30 40 50 60 70 80 90									
0.08	67.97		TOPSOIL		SS-1A			0.4												
0.18	67.86		FILL, Sandy GRAVEL, grey, moist, compact		SS-1B	75	GSA	0.5	2-13 14-21	27										
			FILL, Silty SAND, some gravel, brown, moist, compact		SS-2A		CA	0.1												
0.91	67.13		SAND, trace silt, brown, moist, compact		SS-2B	54	CA	0	10-10 11-9	21										
1.52	66.52		Clayey silty SAND (TILL), some gravel, dark brown, moist to wet, compact		SS-3	58		0.2	3-7-15-11	22										
2.26	65.78		contains cobbles and boulders		SS-4	63		0.2	8-11-9-8	20										
					SS-5	33		0.2	8-10-5-3	15										
					SS-6	0			11 50/11cm	R										
4.27	63.77		SHALE with limestone interbeds, slightly weathered to fresh, black with grey bands, fair quality		RC-1	94	UCS = 16.6 MPa			51										
			4.75 m, vertical fracture																	
			5.44 m, becoming good quality		RC-2	100				87										
6.0	5.92		End of borehole																	

See the attached explicative note for the complete list of symbols and abbreviations





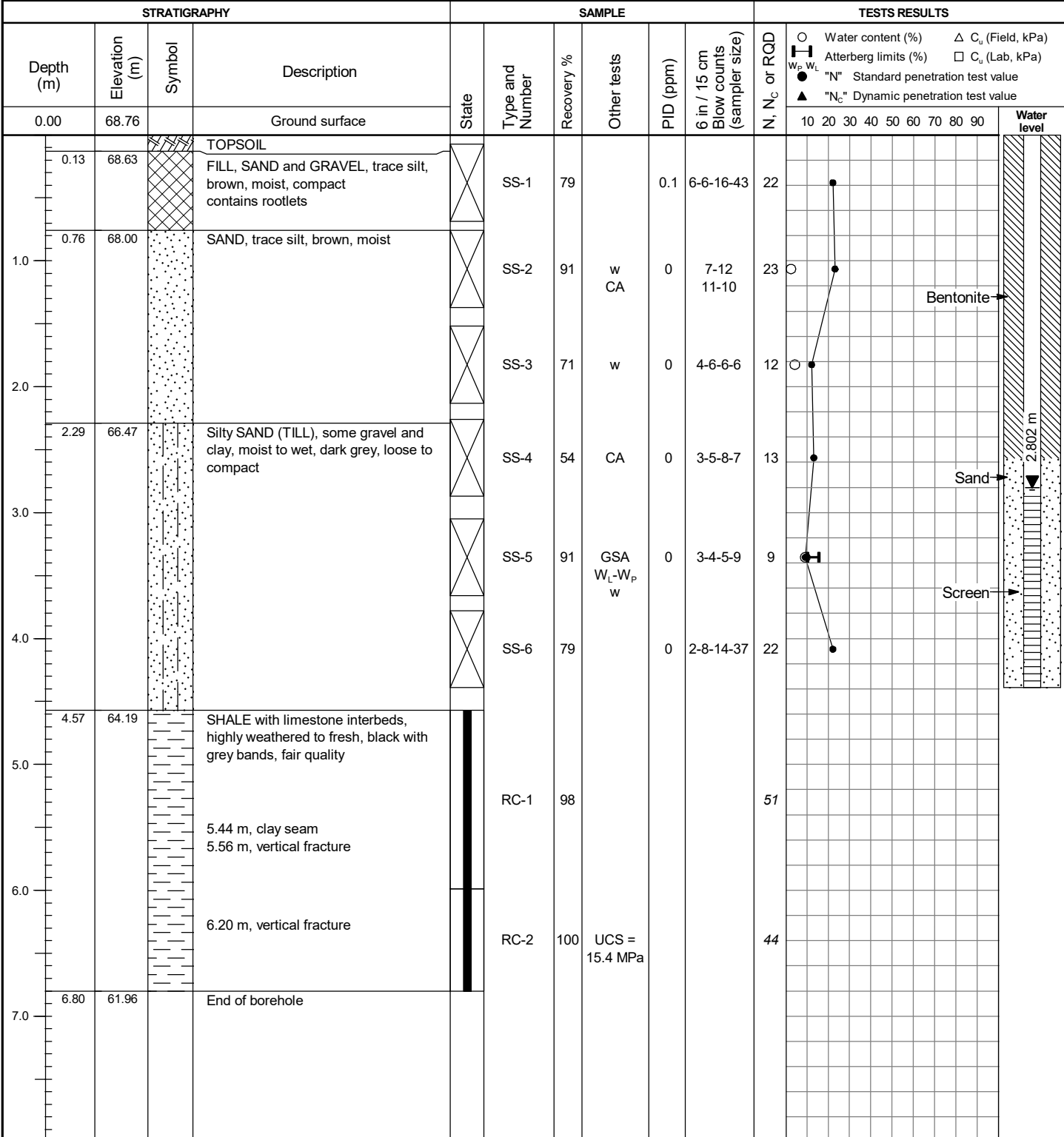
# BOREHOLE REPORT

**Borehole No. MW-2-21**

CLIENT: CANDEREL PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO DESCRIBED BY: J. SCOTT      VERIFIED BY: S. SOLEIMANI/ A. FIORILLI	GEODETIC COORDINATES (MTM, NAD-83) (m) X : 450287.0 Y : 5030064.5 Z : 68.76	▼ - WATER LEVEL Date : 2021-07-29 Depth (m) : 2.802 Location plan :
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Borehole type : Auger 200mm Core bit size : Hammer type : Energy ratio : Date (start) : 2021-07-14 Date (finish) : 2021-07-14	<b>SAMPLE TYPE</b>	SS(E)- Split Spoon (Environment) RC(E)- Rock diamond core AU(E)- Auger TEE - Sampling Tube Environment ST - Shelby tube GS(E)- Grab sample	<b>SAMPLE STATE</b>	<input checked="" type="checkbox"/> Remoulded <input checked="" type="checkbox"/> Intact <input type="checkbox"/> Diamond drilling <input checked="" type="checkbox"/> Lost	<b>TEST SYMBOL</b>	GSA: grain size analysis CA: chemical analysis W <sub>L</sub> : liquid limit W <sub>P</sub> : plastic limit w : water content C <sub>u</sub> : undrained shear strength S <sub>r</sub> : sensitivity Dup: duplicate sample
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DRAFT



See the attached explicative note for the complete list of symbols and abbreviations



# BOREHOLE REPORT

Borehole No. **MW-3-21**

CLIENT: CANDEREL	GEODETIC COORDINATES (MTM, NAD-83) (m)	▼ - WATER LEVEL Date : 2021-07-29 Depth (m) : 2.77
PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION	X : 450313.6 Y : 5030060.2 Z : 68.74	
LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	DESCRIPTED BY: J. SCOTT	VERIFIED BY: S. SOLEIMANI/ A. FIORILLI

Borehole type : Auger 200mm	<b>DRAFT</b>	SS(E)- Split Spoon (Environment)	<b>DRAFT</b>	☒ Remoulded
Core bit size :		RC(E)- Rock diamond core		☒ Intact
Hammer type :		AU(E)- Auger		☐ Diamond drilling
Energy ratio :		TEE - Sampling Tube Environment		■ Lost
Date (start) : 2021-07-16		ST - Shelby tube		
Date (finish) : 2021-07-16		GS(E)- Grab sample		

STRATIGRAPHY			SAMPLE					TESTS RESULTS			
Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N <sub>c</sub> or RQD	Water level
0.00	68.74		Ground surface								
0.04	68.70	ASPHALT	ASPHALT								
			FILL, SAND and GRAVEL, trace silt, grey, compact, moist		SS-1	41		7.7	15-15-6-9	21	
1.0	0.86		FILL, Sandy SILT to silty SAND, grey, moist to wet, loose		SS-2A	75	CA	7.2	3-3-3-5	6	
					SS-2B			6.3			
2.0	1.52		Clayey silt to silty CLAY (TILL), some gravel and sand, greenish-grey to brown, stiff		SS-3	38	GSA	0.5	1-3-3-6	6	
3.0	2.29		Silty SAND (TILL), some gravel and clay, brown, compact to very dense Contains cobbles and boulders		SS-4	100		1.8	4-10 18-15	28	
4.0			Spoon refusal		SS-5	92		17.6	9-8-17-20	25	
					SS-6	0			50	R	
5.0	4.11		SHALE with limestone interbeds, highly weathered to fresh, dark grey thinly bedded, very poor quality 4.30 m, vertical fracture 4.50 m, becoming fair quality		RC-1	77				0	
6.0					RC-2	100				71	
7.0			6.00 m, becoming excellent to good quality		RC-3	100				98	

See the attached explicative note for the complete list of symbols and abbreviations



# BOREHOLE REPORT

**Borehole No. MW-3-21**

CLIENT: CANDEREL PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO DESCRIBED BY: J. SCOTT      VERIFIED BY: S. SOLEIMANI/ A. FIORILLI	GEODETIC COORDINATES (MTM, NAD-83) (m) X : 450313.6 Y : 5030060.2 Z : 68.74	▼ - WATER LEVEL Date : 2021-07-29 Depth (m) : 2.77 Location plan :
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Borehole type : Auger 200mm Core bit size : Hammer type : Energy ratio : Date (start) : 2021-07-16 Date (finish) : 2021-07-16	<b>SAMPLE TYPE</b>	SS(E)- Split Spoon (Environment) RC(E)- Rock diamond core AU(E)- Auger TEE - Sampling Tube Environment ST - Shelby tube GS(E)- Grab sample	<b>SAMPLE STATE</b>	<input checked="" type="checkbox"/> Remoulded <input checked="" type="checkbox"/> Intact <input type="checkbox"/> Diamond drilling <input checked="" type="checkbox"/> Lost	<b>TEST SYMBOL</b>	GSA: grain size analysis CA: chemical analysis W <sub>L</sub> : liquid limit W <sub>P</sub> : plastic limit w : water content C <sub>u</sub> : undrained shear strength S <sub>r</sub> : sensitivity Dup: duplicate sample
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DRAFT

STRATIGRAPHY				SAMPLE						TESTS RESULTS										
Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N <sub>c</sub> or RQD	○ Water content (%)      Δ C <sub>u</sub> (Field, kPa) □ Atterberg limits (%)      □ C <sub>u</sub> (Lab, kPa) ● "N" Standard penetration test value ▲ "N <sub>c</sub> " Dynamic penetration test value									
8.00	60.74		Ground surface								W <sub>P</sub> W <sub>L</sub> 10 20 30 40 50 60 70 80 90      Water level									
					RC-4	100	UCS = 13.5 MPa			88										
					RC-5	100				98										
					RC-6	77				45										
12.0	12.01	56.73	End of borehole																	
13.0																				
14.0																				
15.0																				

See the attached explicative note for the complete list of symbols and abbreviations



# BOREHOLE REPORT

Borehole No. **MW-4-21**

CLIENT: CANDEREL	GEODETIC COORDINATES (MTM, NAD-83) (m)	▼ - WATER LEVEL Date : 2021-07-29 Depth (m) : 2.278
PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION	X : 450275.7 Y : 5030016.5 Z : 68.10	
LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	DESCRIBED BY: J. SCOTT	VERIFIED BY: S. SOLEIMANI/ A. FIORILLI

Borehole type : Auger 200mm	DRAFT	SS(E)- Split Spoon (Environment)	☒ Remoulded
Core bit size :		RC(E)- Rock diamond core	☒ Intact
Hammer type :		AU(E)- Auger	☐ Diamond drilling
Energy ratio :		TEE - Sampling Tube Environment	■ Lost
Date (start) : 2021-07-15		ST - Shelby tube	
Date (finish) : 2021-07-15		GS(E)- Grab sample	

STRATIGRAPHY				SAMPLE					TESTS RESULTS											
Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N <sub>c</sub> or RQD	○ Water content (%)    △ C <sub>u</sub> (Field, kPa) □ Atterberg limits (%)    □ C <sub>u</sub> (Lab, kPa) ● "N" Standard penetration test value ▲ "N <sub>c</sub> " Dynamic penetration test value									
0.00	68.10		Ground surface								10 20 30 40 50 60 70 80 90    Water level									
0.10	68.00	☒	TOPSOIL																	
		☒	FILL, Gravelly SAND, some silt, brown, dry, compact	☒	SS-1	58	CA	0	1-4-9-24	13										
1.0		☒		☒	SS-2	0			10-8-7-18	15										
1.52	66.58	☒	FILL, Silty CLAY, some sand, trace gravel, brown, moist, stiff	☒	SS-3	92	w	0.1	12-12 13-24	25										
2.0		☒		☒	SS-4	79		0.1	7-7-6-8	13										
2.29	65.81	☒	Clayey silty SAND (TILL), some gravel, dark brown, moist, compact	☒	SS-5	75	GSA	0.1	11-13 23-30	36										
3.0		☒		☒	SS-6	42	w	0.1	18-50/13cm	R										
3.20	64.90	☒	Silty SAND (TILL), trace gravel and clay, grey, wet, dense	☒	SS-7	0			50/13cm	R										
4.0		☒		☒							Bentonite									
5.0		☒		☒																
5.99	62.11	☒	Highly weathered, fractured SHALE	☒																
7.0		☒		☒																
7.44	60.66	☒	SHALE with limestone interbeds, weathered to fresh, dark grey to black bands, fair quality 7.77 m, clay seam	☒	RC-1	100				0										
		☒		☒							Sand									

See the attached explicative note for the complete list of symbols and abbreviations



# BOREHOLE REPORT

**Borehole No. MW-4-21**

CLIENT: CANDEREL PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO DESCRIBED BY: J. SCOTT      VERIFIED BY: S. SOLEIMANI/ A. FIORILLI	GEODETIC COORDINATES (MTM, NAD-83) (m) X : 450275.7 Y : 5030016.5 Z : 68.10	▼ - WATER LEVEL Date : 2021-07-29 Depth (m) : 2.278 Location plan :
Borehole type : Auger 200mm Core bit size : Hammer type : Energy ratio : Date (start) : 2021-07-15 Date (finish) : 2021-07-15	<b>SAMPLE TYPE</b> SS(E)- Split Spoon (Environment) RC(E)- Rock diamond core AU(E)- Auger TEE - Sampling Tube Environment ST - Shelby tube GS(E)- Grab sample	<b>SAMPLE STATE</b> <input checked="" type="checkbox"/> Remoulded <input checked="" type="checkbox"/> Intact <input type="checkbox"/> Diamond drilling <input type="checkbox"/> Lost
DRAFT		
<b>TEST SYMBOL</b> GSA: grain size analysis CA: chemical analysis W <sub>L</sub> : liquid limit W <sub>P</sub> : plastic limit w : water content C <sub>u</sub> : undrained shear strength S <sub>r</sub> : sensitivity Dup: duplicate sample		

STRATIGRAPHY				SAMPLE						TESTS RESULTS										
Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N <sub>c</sub> or RQD	○ Water content (%)      Δ C <sub>u</sub> (Field, kPa) Atterberg limits (%)      □ C <sub>u</sub> (Lab, kPa) "N" Standard penetration test value ▲ "N <sub>c</sub> " Dynamic penetration test value									
8.00	60.10		Ground surface								10	20	30	40	50	60	70	80	90	Water level
			10.49 m, becoming good to excellent quality		RC-2	100				78										Screen
					RC-3	100				64										
					RC-4	100	UCS = 17.7 MPa			90										
12.0	12.07	56.03	End of borehole																	
13.0																				
14.0																				
15.0																				

See the attached explicative note for the complete list of symbols and abbreviations



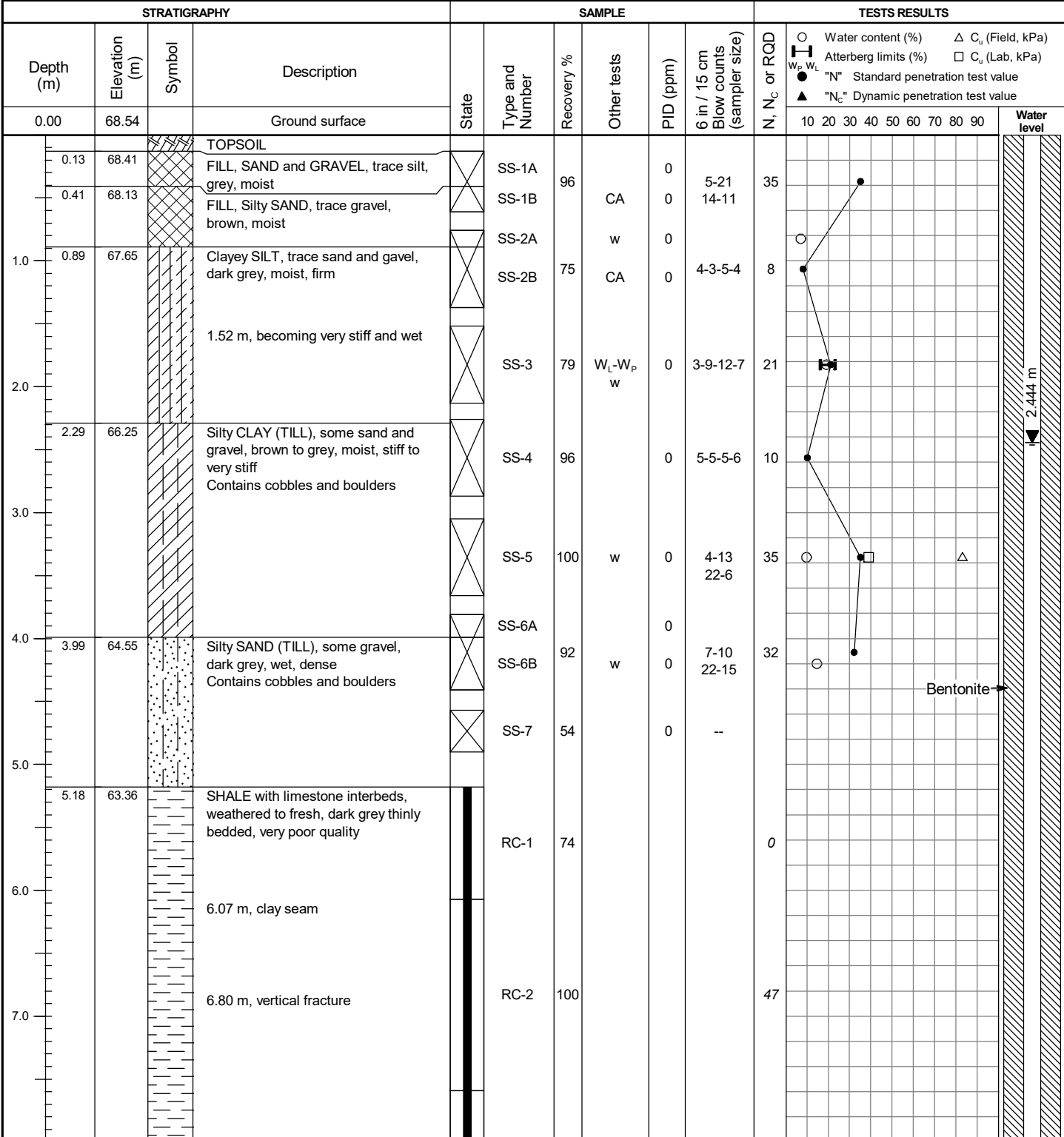
# BOREHOLE REPORT

**Borehole No. MW-5-21**

<p>CLIENT: CANDEREL                  PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION                  LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO                  DESCRIBED BY: J. SCOTT      VERIFIED BY: S. SOLEIMANI/ A. FIORILLI</p>	<p>GEODETIC COORDINATES (MTM, NAD-83) (m)                  X : 450282.2                  Y : 5030037.9                  Z : 68.54</p>	<p>▼ - WATER LEVEL                  Date : 2021-07-29                  Depth (m) : 2.444</p> <p>Location plan :</p>
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<p>Borehole type : Auger 200mm                  Core bit size :                  Hammer type :                  Energy ratio :                  Date (start) : 2021-07-15                  Date (finish) : 2021-07-15</p>	<p><b>SAMPLE TYPE</b></p>	<p>SS(E)- Split Spoon (Environment)                  RC(E)- Rock diamond core                  AU(E)- Auger                  TEE - Sampling Tube Environment                  ST - Shelby tube                  GS(E)- Grab sample</p>	<p><b>SAMPLE STATE</b></p>	<p>☒ Remoulded                  ☒ Intact                  ◻ Diamond drilling                  ◼ Lost</p>	<p><b>TEST SYMBOL</b></p>	<p>GSA: grain size analysis                  CA: chemical analysis                  W<sub>L</sub>: liquid limit                  W<sub>P</sub>: plastic limit                  w : water content                  C<sub>u</sub>: undrained shear strength                  S<sub>r</sub>: sensitivity                  Dup: duplicate sample</p>
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DRAFT



See the attached explicative note for the complete list of symbols and abbreviations



# BOREHOLE REPORT

**Borehole No. MW-5-21**

CLIENT: CANDEREL PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO DESCRIBED BY: J. SCOTT      VERIFIED BY: S. SOLEIMANI/ A. FIORILLI	GEODETIC COORDINATES (MTM, NAD-83) (m) X : 450282.2 Y : 5030037.9 Z : 68.54	▼ - WATER LEVEL Date : 2021-07-29 Depth (m) : 2.444 Location plan :
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Borehole type : Auger 200mm Core bit size : Hammer type : Energy ratio : Date (start) : 2021-07-15 Date (finish) : 2021-07-15	<b>SAMPLE TYPE</b>	SS(E)- Split Spoon (Environment) RC(E)- Rock diamond core AU(E)- Auger TEE - Sampling Tube Environment ST - Shelby tube GS(E)- Grab sample	<b>SAMPLE STATE</b>	<input checked="" type="checkbox"/> Remoulded <input checked="" type="checkbox"/> Intact <input type="checkbox"/> Diamond drilling <input type="checkbox"/> Lost	<b>TEST SYMBOL</b>	GSA: grain size analysis CA: chemical analysis W <sub>L</sub> : liquid limit W <sub>P</sub> : plastic limit w : water content C <sub>u</sub> : undrained shear strength S <sub>r</sub> : sensitivity Dup: duplicate sample
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DRAFT

STRATIGRAPHY				SAMPLE						TESTS RESULTS										
Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N <sub>c</sub> or RQD	○ Water content (%)      Δ C <sub>u</sub> (Field, kPa) □ Atterberg limits (%)      □ C <sub>u</sub> (Lab, kPa) ● "N" Standard penetration test value ▲ "N <sub>c</sub> " Dynamic penetration test value									
8.00	60.54		Ground surface								W <sub>P</sub> , W <sub>L</sub> 10 20 30 40 50 60 70 80 90      Water level									
			9.85 m, clay seam		RC-3	100				75										
					RC-4	100	UCS = 16.7 MPa			48										
					RC-5	100				76										
12.14	56.40		End of borehole																	
13.0																				
14.0																				
15.0																				

See the attached explicative note for the complete list of symbols and abbreviations



# BOREHOLE REPORT

Borehole No. **MW-6-21**

CLIENT: CANDEREL	GEODETIC COORDINATES (MTM, NAD-83) (m)	▼ - WATER LEVEL Date : 2021-07-29 Depth (m) : 2.523
PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION	X : 450311.0 Y : 5030037.1 Z : 69.11	
LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	DESCRIBED BY: J. SCOTT	VERIFIED BY: S. SOLEIMANI/ A. FIORILLI

Borehole type : Auger 200mm	DRAFT	SS(E)- Split Spoon (Environment)	☒ Remoulded	<b>TEST SYMBOL</b> GSA: grain size analysis CA: chemical analysis W <sub>L</sub> : liquid limit W <sub>P</sub> : plastic limit w : water content C <sub>u</sub> : undrained shear strength S <sub>r</sub> : sensitivity Dup: duplicate sample
Core bit size :		RC(E)- Rock diamond core	☒ Intact	
Hammer type :		AU(E)- Auger	☐ Diamond drilling	
Energy ratio :		TEE - Sampling Tube Environment	■ Lost	
Date (start) : 2021-07-16		ST - Shelby tube		
Date (finish) : 2021-07-16		GS(E)- Grab sample		

STRATIGRAPHY				SAMPLE						TESTS RESULTS										
Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N <sub>c</sub> or RQD	○ Water content (%)    Δ C <sub>u</sub> (Field, kPa) □ Atterberg limits (%)    □ C <sub>u</sub> (Lab, kPa) ● "N" Standard penetration test value ▲ "N <sub>c</sub> " Dynamic penetration test value									
0.00	69.11		Ground surface								10 20 30 40 50 60 70 80 90    Water level									
0.05	69.06	ASPHALT									Sand									
		FILL, SAND and GRAVEL, grey, dry, dense		SS-1	20			3	4-16 22-29	38	Bentonite									
1.0											Sand									
1.52	67.59	Silty CLAY (TILL), trace gravel, brown, moist, stiff		SS-2	29		CA	10.3	2-3-4-4	7	Sand									
1.83	67.28	SAND and GRAVEL (TILL), grey, moist to wet, compact		SS-3	71		W <sub>L</sub> -W <sub>P</sub> w	3.4	4-4-8-10	12	Screen									
2.0											Sand									
3.05	66.06	Clayey silty SAND (TILL), grey, moist to wet, compact		SS-4	92		CA	8.7	33-21-7-6	28	Water level 2.523 m									
3.81	65.30	SAND and GRAVEL (TILL), grey, wet, dense to very dense		SS-5	83		w	4.8	5-5-8-3	13	Screen									
4.0											Sand									
5.0	4.95	64.16	SHALE with limestone interbeds, thinly bedded, highly weathered to fresh, black with grey bands, fair quality		RC-1	100	UCS = 15.5 MPa			51	Screen									
6.0			6.17 m, becoming excellent quality		RC-2	97				97	Screen									
7.0	6.91	62.20	End of borehole								Screen									

See the attached explicative note for the complete list of symbols and abbreviations





# BOREHOLE REPORT

**Borehole No. MW-7-21**

CLIENT: CANDEREL PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO DESCRIBED BY: J. SCOTT      VERIFIED BY: S. SOLEIMANI/ A. FIORILLI	GEODETIC COORDINATES (MTM, NAD-83) (m) X : 450331.5 Y : 5030032.3 Z : 69.33	▼ - WATER LEVEL Date : 2021-07-29 Depth (m) : 3.421 Location plan :
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Borehole type : Auger 200mm Core bit size : Hammer type : Energy ratio : Date (start) : 2021-07-16 Date (finish) : 2021-07-16	<b>SAMPLE TYPE</b>	SS(E)- Split Spoon (Environment) RC(E)- Rock diamond core AU(E)- Auger TEE - Sampling Tube Environment ST - Shelby tube GS(E)- Grab sample	<b>SAMPLE STATE</b>	<input checked="" type="checkbox"/> Remoulded <input checked="" type="checkbox"/> Intact <input type="checkbox"/> Diamond drilling <input checked="" type="checkbox"/> Lost	<b>TEST SYMBOL</b>	GSA: grain size analysis CA: chemical analysis W <sub>L</sub> : liquid limit W <sub>P</sub> : plastic limit w : water content C <sub>u</sub> : undrained shear strength S <sub>r</sub> : sensitivity Dup: duplicate sample
--	--------------------	---	---------------------	--	--------------------	---

DRAFT

STRATIGRAPHY				SAMPLE						TESTS RESULTS										
Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N <sub>c</sub> or RQD	○ Water content (%)      Δ C <sub>u</sub> (Field, kPa) □ Atterberg limits (%)      □ C <sub>u</sub> (Lab, kPa) ● "N" Standard penetration test value ▲ "N <sub>c</sub> " Dynamic penetration test value									
0.00	69.33		Ground surface								Water level									
0.05	69.28		ASPHALT								Sand									
			FILL, Gravelly SAND, trace silt, grey, dry, compact		SS-1	33		3	3-10 11-10	21										
1.0					SS-2	0			4-2-2-6	4										
1.52	67.81		Clayey silty SAND (TILL), trace gravel, brown, moist, firm		SS-3	95		0.9	2-2-3-5	5										
2.29	67.04		Sandy SILT (TILL), some clay, trace gravel, grey, wet, stiff		SS-4	92	CA	2.7	5-6-9-8	15										
3.0					SS-5	50	GSA W <sub>L</sub> -W <sub>P</sub> w	1.3	3-2-1-8	3										
4.0	65.27		SAND and GRAVEL (TILL), some clay, grey, wet, saturated		SS-6	0			8-8 50/10cm	R	Bentonite									
4.57	64.76		SHALE with limestone interbeds, thinly bedded, moderately weathered to fresh, black with grey bands, poor quality		RC-1	100				42										
6.0			6.10 m, becoming fair quality		RC-2	100				70										
7.0																				

See the attached explicative note for the complete list of symbols and abbreviations



# BOREHOLE REPORT

**Borehole No. MW-7-21**

CLIENT: CANDEREL PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO DESCRIBED BY: J. SCOTT	VERIFIED BY: S. SOLEIMANI/ A. FIORILLI	GEODETIC COORDINATES (MTM, NAD-83) (m) X : 450331.5 Y : 5030032.3 Z : 69.33	- WATER LEVEL Date : 2021-07-29 Depth (m) : 3.421 Location plan :
Borehole type : Auger 200mm Core bit size : Hammer type : Energy ratio : Date (start) : 2021-07-16 Date (finish) : 2021-07-16	<b>SAMPLE TYPE</b> SS(E)- Split Spoon (Environment) RC(E)- Rock diamond core AU(E)- Auger TEE - Sampling Tube Environment ST - Shelby tube GS(E)- Grab sample	<b>SAMPLE STATE</b> <input checked="" type="checkbox"/> Remoulded <input checked="" type="checkbox"/> Intact <input type="checkbox"/> Diamond drilling <input checked="" type="checkbox"/> Lost	<b>TEST SYMBOL</b> GSA: grain size analysis CA: chemical analysis W <sub>L</sub> : liquid limit W <sub>P</sub> : plastic limit w : water content C <sub>u</sub> : undrained shear strength S <sub>r</sub> : sensitivity Dup: duplicate sample

DRAFT

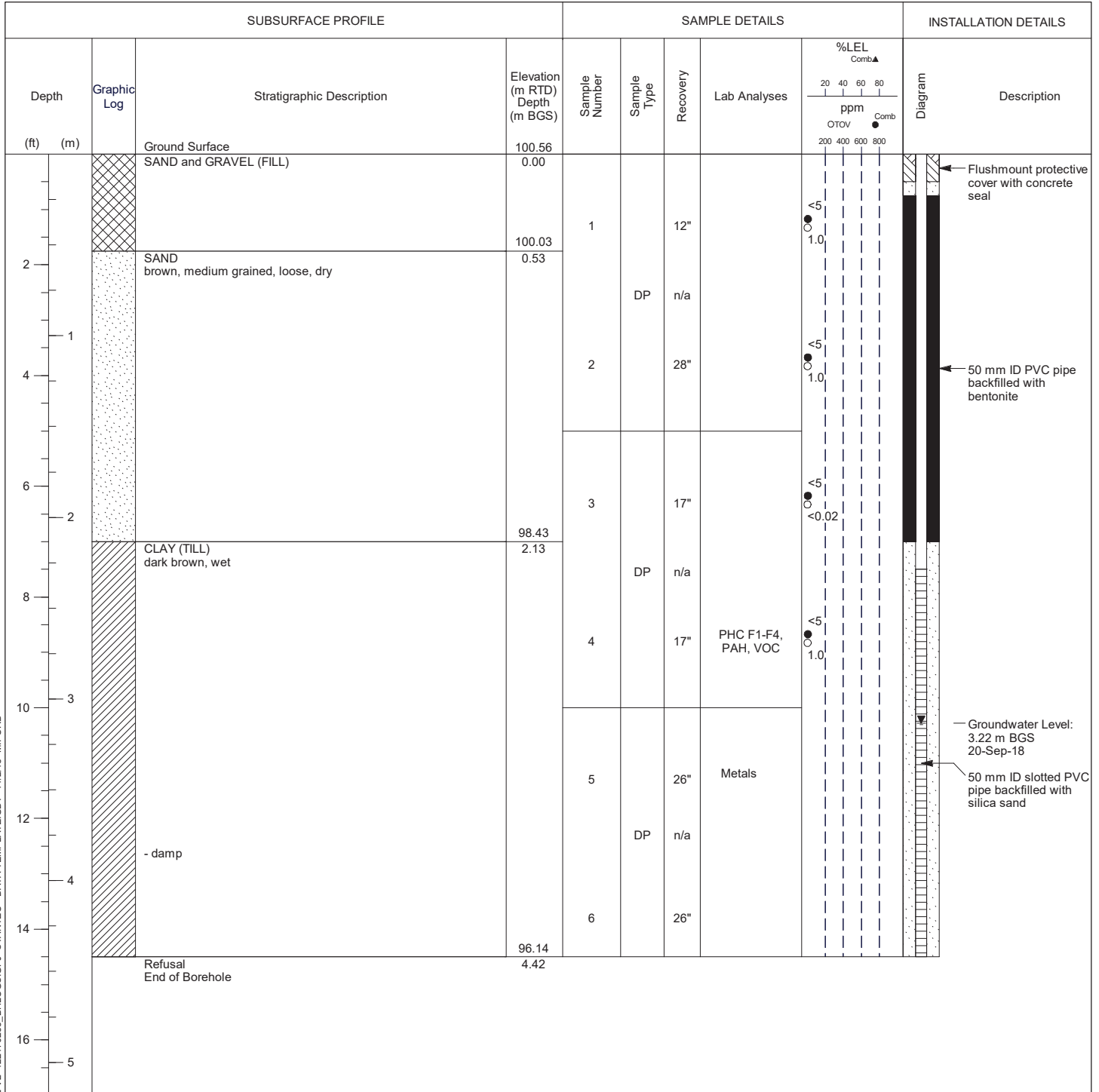
STRATIGRAPHY				SAMPLE						TESTS RESULTS											
Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N <sub>c</sub> or RQD	○ Water content (%)    Δ C <sub>u</sub> (Field, kPa) Atterberg limits (%)    □ C <sub>u</sub> (Lab, kPa) "N" Standard penetration test value ▲ "N <sub>c</sub> " Dynamic penetration test value										
8.00	61.33		Ground surface								10 20 30 40 50 60 70 80 90    Water level										
			10.5 m, becoming excellent quality		RC-3	100				71											
						RC-4	100				52										
						RC-5	100				95										
12.0	12.03	57.30	End of borehole																		
13.0																					
14.0																					
15.0																					

See the attached explicative note for the complete list of symbols and abbreviations

# Monitoring Well: MW18-01

**Project:** Phase II ESA  
**Client:** City of Ottawa  
**Location:** 1209 St. Laurent Boulevard, Ottawa, Ontario  
**Number:** 122170233  
**Field investigator:** C. Jolicoeur  
**Contractor:** Strata Drilling Group

**Drilling method:** Geoprobe 7822DT (Direct Push)  
**Date started/completed:** 13-Sep-2018  
**Ground surface elevation:** 100.56 m RTD  
**Top of casing elevation:** 100.47 m RTD  
**Easting:** 5030067  
**Northing:** 450284



Screen Interval: 2.29 - 4.42 m BGS  
 Sand Pack Interval: 2.13 - 4.42 m BGS  
 Well Seal Interval: 0.23 - 2.13 m BGS

**Notes:**  
 m BGS - metres below ground surface  
 DP - direct push sample  
 ppm - parts per million by volume  
 n/a - not available

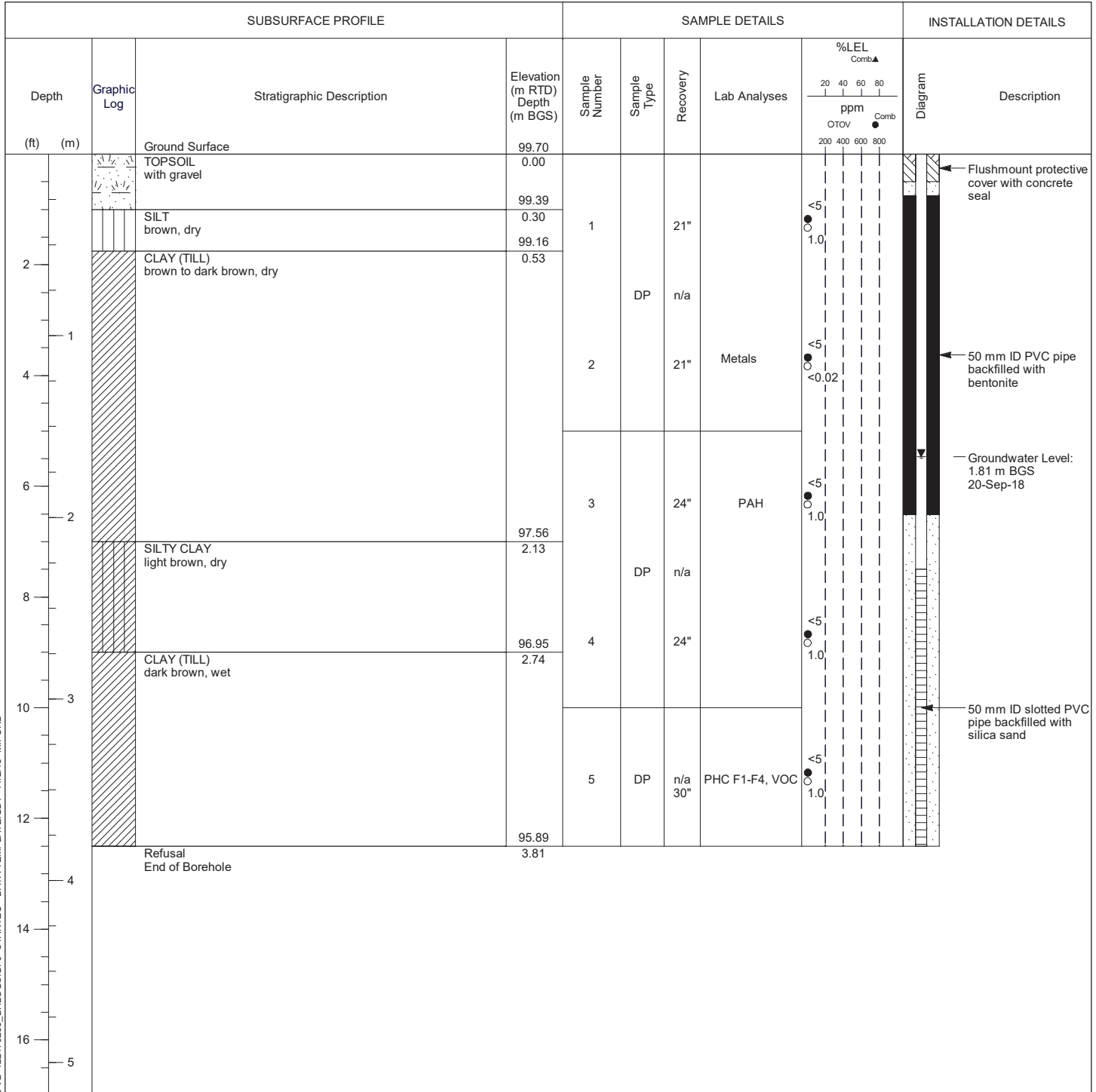
RTD - relative to datum  
 PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4  
 VOC - volatile organic compounds  
 PAH - polycyclic aromatic hydrocarbons



# Monitoring Well: MW18-02

**Project:** Phase II ESA  
**Client:** City of Ottawa  
**Location:** 1209 St. Laurent Boulevard, Ottawa, Ontario  
**Number:** 122170233  
**Field investigator:** C. Jolicoeur  
**Contractor:** Strata Drilling Group

**Drilling method:** Geoprobe 7822DT (Direct Push)  
**Date started/completed:** 13-Sep-2018  
**Ground surface elevation:** 99.70 m RTD  
**Top of casing elevation:** 99.56 m RTD  
**Easting:** 5030061  
**Northing:** 450263



Screen Interval: 2.29 - 3.81 m BGS  
 Sand Pack Interval: 1.98 - 3.81 m BGS  
 Well Seal Interval: 0.23 - 1.98 m BGS

**Notes:**  
 m BGS - metres below ground surface  
 DP - direct push sample  
 ppm - parts per million by volume  
 n/a - not available

RTD - relative to datum  
 PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4  
 VOC - volatile organic compounds  
 PAH - polycyclic aromatic hydrocarbons



# Borehole: BH18-03

**Project:** Phase II ESA  
**Client:** City of Ottawa  
**Location:** 1209 St. Laurent Boulevard, Ottawa, Ontario  
**Number:** 122170233  
**Field investigator:** C. Jolicoeur  
**Contractor:** Strata Drilling Group

**Drilling method:** Geoprobe 7822DT (Direct Push)  
**Date started/completed:** 13-Sep-2018  
**Ground surface elevation:** 99.61 m RTD  
**Top of casing elevation:** n/a  
**Easting:** 5030038  
**Northing:** 450262

SUBSURFACE PROFILE				SAMPLE DETAILS				INSTALLATION DETAILS		
Depth (ft) (m)	Graphic Log	Stratigraphic Description	Elevation (m RTD) Depth (m BGS)	Sample Number	Sample Type	Lab Analyses	%LEL Comb▲		Diagram	Description
							20	40		
		Ground Surface	99.61							
		TOPSOIL with gravel	0.00							
2		SAND brown, medium grained, loose, with clay lenses	99.31 0.30	1		pH	15	1.0		
4		CLAY (TILL) dark brown	98.85 0.76	2	DP		10	1.0		
6		- 125 mm seam of sand		3		VOC	125	7.0		
8		- wet		4	DP	PHC F1-F4	15	2.0		
10				5		Metals	20	<0.02		
14		- with gravel	95.50							
		Refusal End of Borehole	4.11							

← Backfilled with bentonite

**Notes:**  
 m BGS - metres below ground surface  
 DP - direct push sample  
 ppm - parts per million by volume  
 n/a - not available

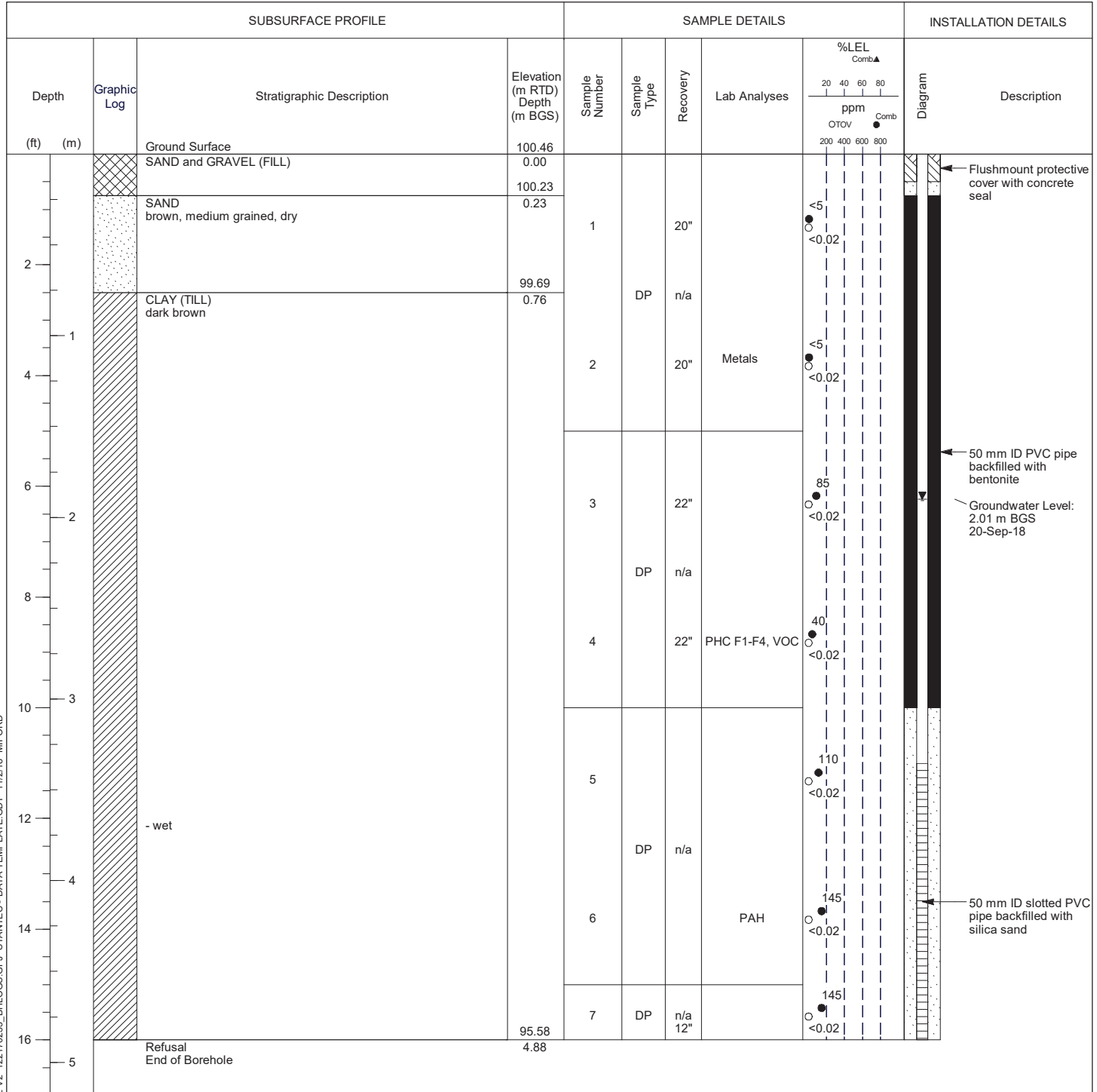
RTD - relative to datum  
 PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4  
 VOC - volatile organic compounds  
 PAH - polycyclic aromatic hydrocarbons



# Monitoring Well: MW18-04

**Project:** Phase II ESA  
**Client:** City of Ottawa  
**Location:** 1209 St. Laurent Boulevard, Ottawa, Ontario  
**Number:** 122170233  
**Field investigator:** C. Jolicoeur  
**Contractor:** Strata Drilling Group

**Drilling method:** Geoprobe 7822DT (Direct Push)  
**Date started/completed:** 13-Sep-2018  
**Ground surface elevation:** 100.46 m RTD  
**Top of casing elevation:** 100.35 m RTD  
**Easting:** 5030026  
**Northing:** 450291



Screen Interval: 3.35 - 4.88 m BGS  
 Sand Pack Interval: 3.05 - 4.88 m BGS  
 Well Seal Interval: 0.23 - 3.05 m BGS

**Notes:**  
 m BGS - metres below ground surface  
 DP - direct push sample  
 ppm - parts per million by volume  
 n/a - not available

RTD - relative to datum  
 PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4  
 VOC - volatile organic compounds  
 PAH - polycyclic aromatic hydrocarbons



# Borehole: BH18-05

**Project:** Phase II ESA  
**Client:** City of Ottawa  
**Location:** 1209 St. Laurent Boulevard, Ottawa, Ontario  
**Number:** 122170233  
**Field investigator:** C. Jolicoeur  
**Contractor:** Strata Drilling Group

**Drilling method:** Geoprobe 7822DT (Direct Push)  
**Date started/completed:** 13-Sep-2018  
**Ground surface elevation:** 100.49 m RTD  
**Top of casing elevation:** n/a  
**Easting:** 5030048  
**Northing:** 450300

SUBSURFACE PROFILE				SAMPLE DETAILS				INSTALLATION DETAILS			
Depth (ft) (m)	Graphic Log	Stratigraphic Description	Elevation (m RTD) Depth (m BGS)	Sample Number	Sample Type	Recovery	Lab Analyses	%LEL Comb▲		Diagram	Description
								20	40		
		Ground Surface	100.49								
		TOPSOIL with sand	0.00								
2		CLAYEY SILT	100.03 0.46	1		13"		<5	<0.02		
1		SILT brown, dry	99.80 0.69		DP	n/a					
4				2		13"		<5	<0.02		
6		- moist		3		24"		55	<0.02		
8		CLAY (TILL) dark brown, dry	98.20 2.29		DP	n/a					← Backfilled with bentonite
10				4		24"	Metals	25	<0.02		
12		- wet		5		30"	PHC F1-F4, VOC	185	<0.02		
14		- damp		6	DP	30"	PAH	5	<0.02		
16		End of Borehole	95.92 4.57								

**Notes:**  
 m BGS - metres below ground surface  
 DP - direct push sample  
 ppm - parts per million by volume  
 n/a - not available

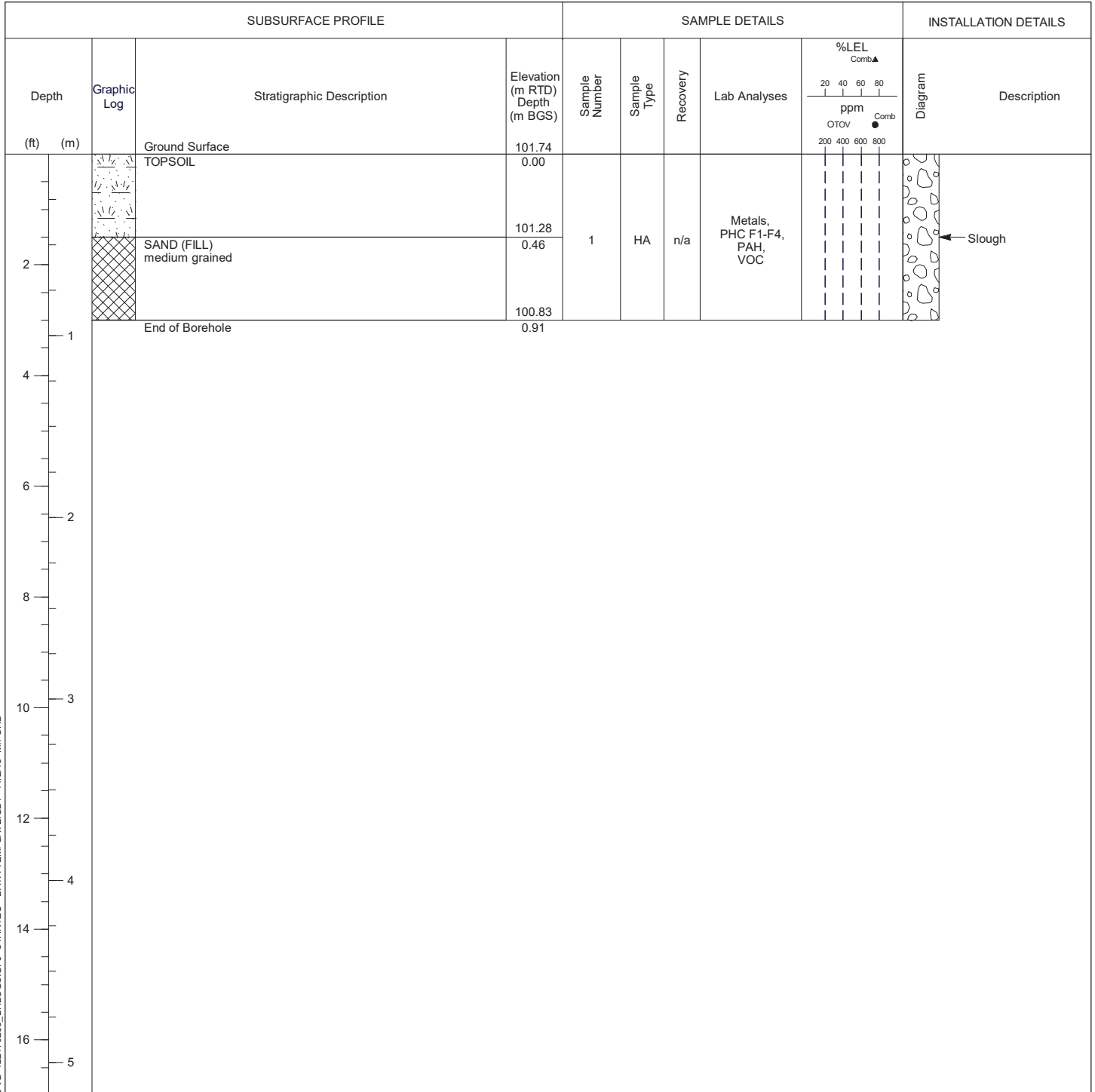
RTD - relative to datum  
 PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4  
 VOC - volatile organic compounds  
 PAH - polycyclic aromatic hydrocarbons



# Test Hole: TH18-1

**Project:** Phase II ESA  
**Client:** City of Ottawa  
**Location:** 1209 St. Laurent Boulevard, Ottawa, Ontario  
**Number:** 122170233  
**Field investigator:** C. Jolicoeur  
**Contractor:** Stantec Consulting Ltd.

**Drilling method:** Hand Auger  
**Date started/completed:** 13-Sep-2018  
**Ground surface elevation:** 101.74 m RTD  
**Top of casing elevation:** n/a  
**Easting:** n/a  
**Northing:** n/a



**Notes:**  
 m BGS - metres below ground surface  
 HA - hand auger sample  
 ppm - parts per million by volume  
 n/a - not available

RTD - relative to datum  
 PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4  
 VOC - volatile organic compounds  
 PAH - polycyclic aromatic hydrocarbons

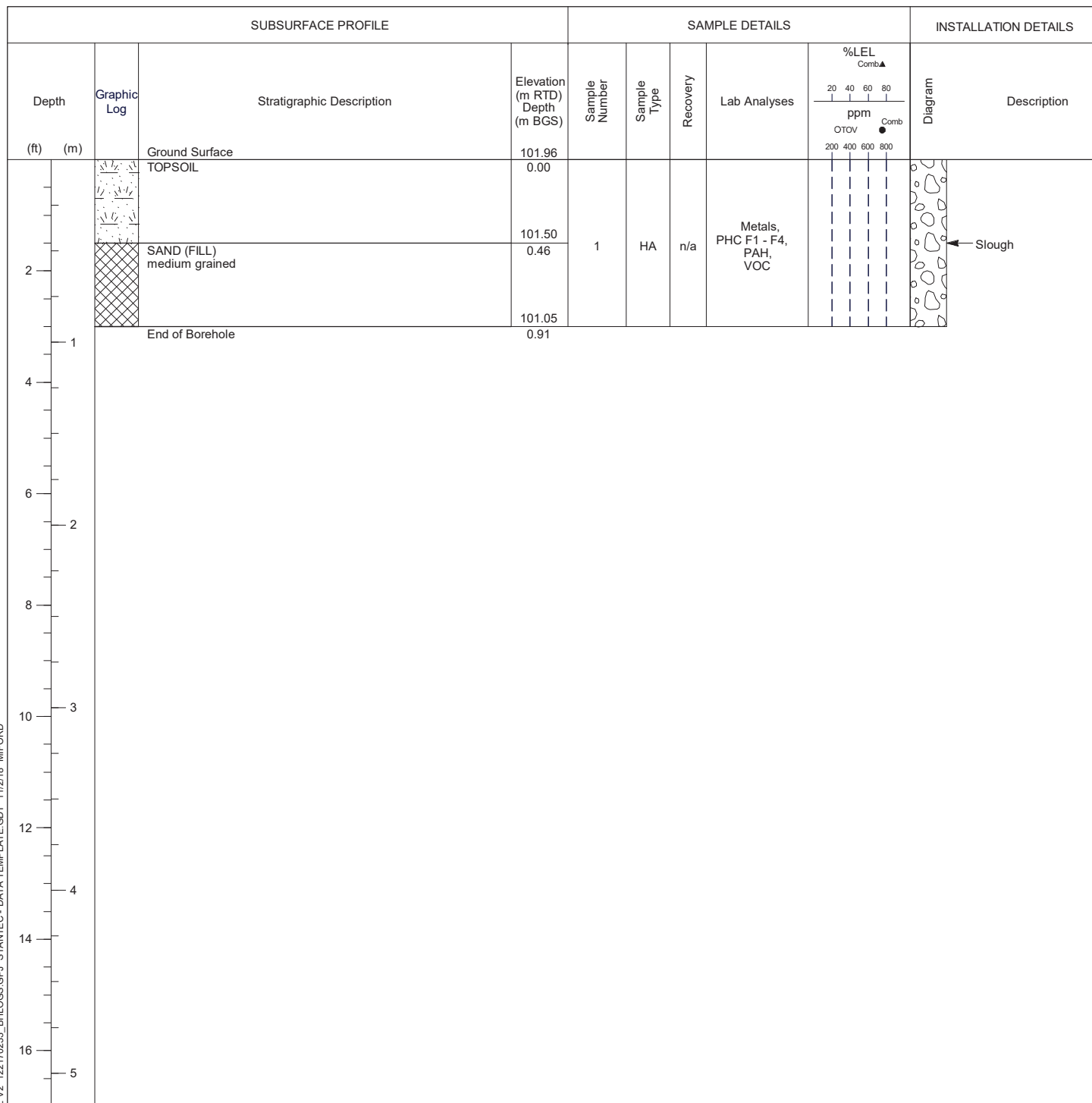




## Test Hole: TH18-2

**Project:** Phase II ESA  
**Client:** City of Ottawa  
**Location:** 1209 St. Laurent Boulevard, Ottawa, Ontario  
**Number:** 122170233  
**Field investigator:** C. Jolicoeur  
**Contractor:** Stantec Consulting Ltd.

**Drilling method:** Hand Auger  
**Date started/completed:** 13-Sep-2018  
**Ground surface elevation:** 101.96 m RTD  
**Top of casing elevation:** n/a  
**Easting:** n/a  
**Northing:** n/a



**Notes:**  
 m BGS - metres below ground surface  
 HA - hand auger sample  
 ppm - parts per million by volume  
 n/a - not available

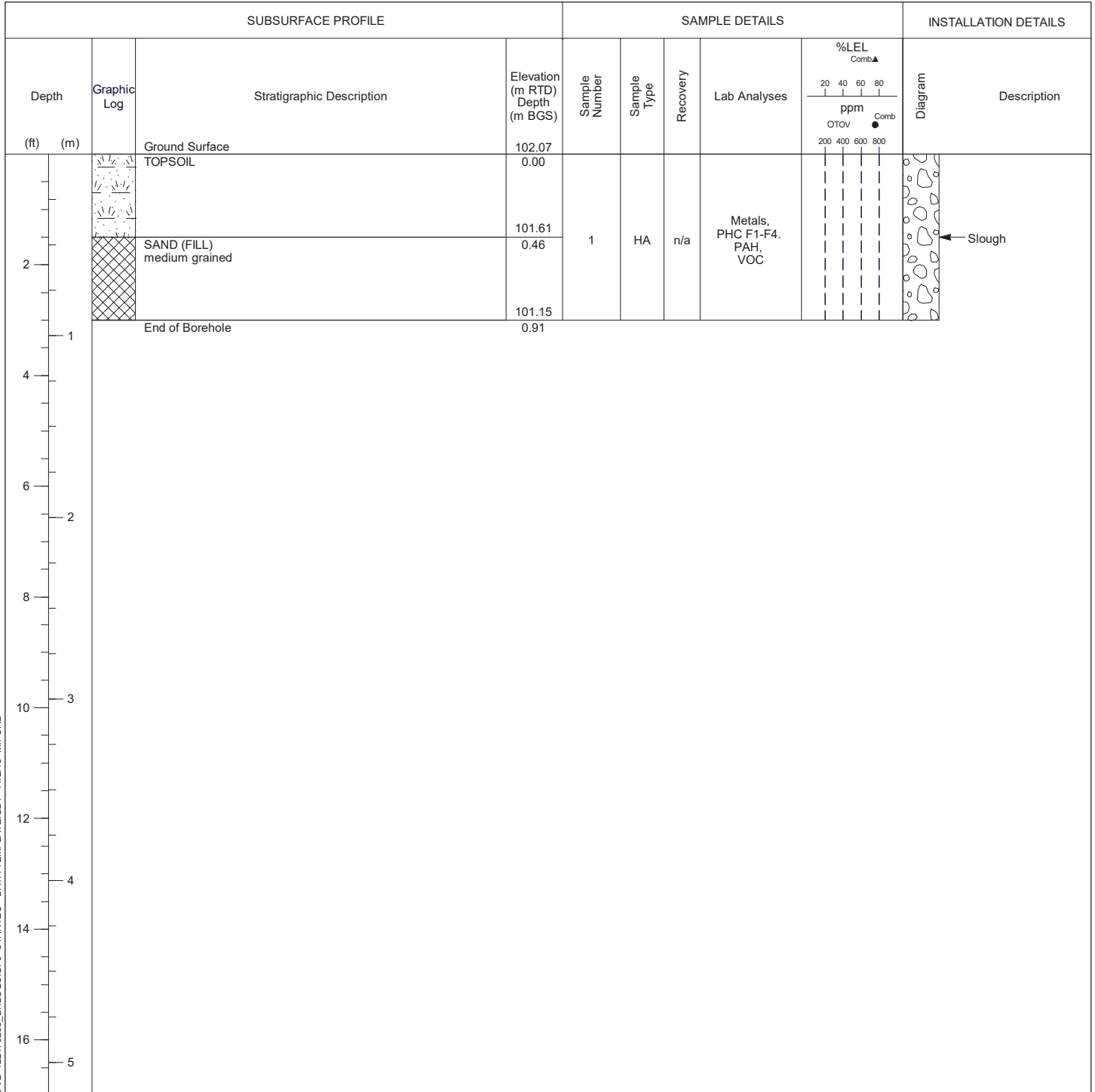
RTD - relative to datum  
 PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4  
 VOC - volatile organic compounds  
 PAH - polycyclic aromatic hydrocarbons



# Test Hole: TH18-3

**Project:** Phase II ESA  
**Client:** City of Ottawa  
**Location:** 1209 St. Laurent Boulevard, Ottawa, Ontario  
**Number:** 122170233  
**Field investigator:** C. Jolicoeur  
**Contractor:** Stantec Consulting Ltd.

**Drilling method:** Hand Auger  
**Date started/completed:** 13-Sep-2018  
**Ground surface elevation:** 102.07 m RTD  
**Top of casing elevation:** n/a  
**Easting:** n/a  
**Northing:** n/a



**Notes:**  
 m BGS - metres below ground surface  
 HA - hand auger sample  
 ppm - parts per million by volume  
 n/a - not available

RTD - relative to datum  
 PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4  
 VOC - volatile organic compounds  
 PAH - polycyclic aromatic hydrocarbons



Certificate of Analysis

Report Date: 14-Sep-2022

Client: Paterson Group Consulting Engineers

Order Date: 8-Sep-2022

Client PO: 55731

Project Description: PG5216

<b>Client ID:</b>	BH4-22 SS4	-	-	-	-
<b>Sample Date:</b>	07-Sep-22 09:00	-	-	-	-
<b>Sample ID:</b>	2237321-01	-	-	-	-
<b>Matrix:</b>	Soil	-	-	-	-
<b>MDL/Units</b>					

**Physical Characteristics**

% Solids	0.1 % by Wt.	88.4	-	-	-	-
----------	--------------	------	---	---	---	---

**General Inorganics**

pH	0.05 pH Units	8.39	-	-	-	-
Resistivity	0.1 Ohm.m	44.6	-	-	-	-

**Anions**

Chloride	5 ug/g	11	-	-	-	-
Sulphate	5 ug/g	84	-	-	-	-

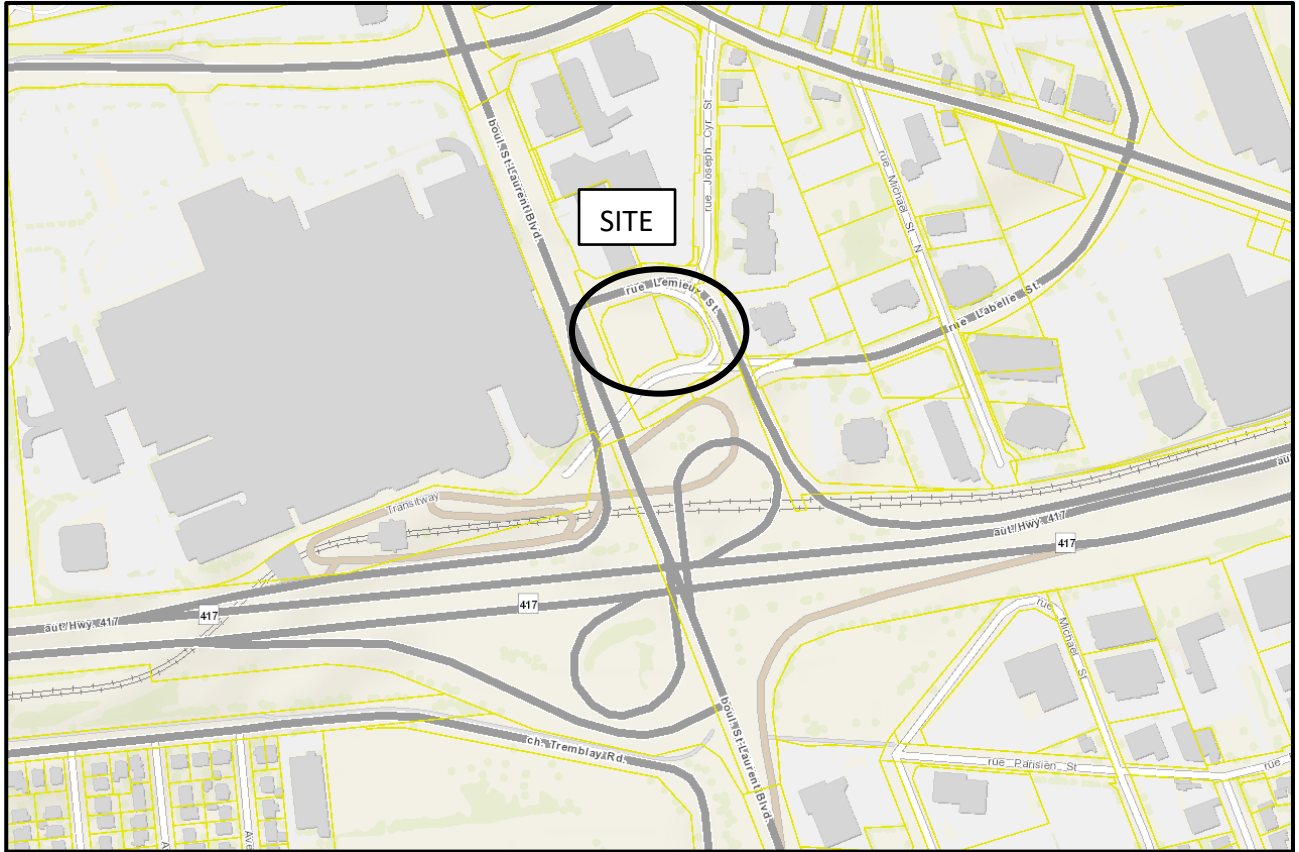
# APPENDIX 2

FIGURE 1 – KEY PLAN

FIGURE 2 – HISTORICAL IMAGE – 1965

FIGURES 3 & 4 – SEISMIC SHEAR WAVE VELOCITY PROFILES

DRAWING PG5216-2 – TEST HOLE LOCATION PLAN



# FIGURE 1

## KEY PLAN



## FIGURE 2

Aerial Photograph - 1965

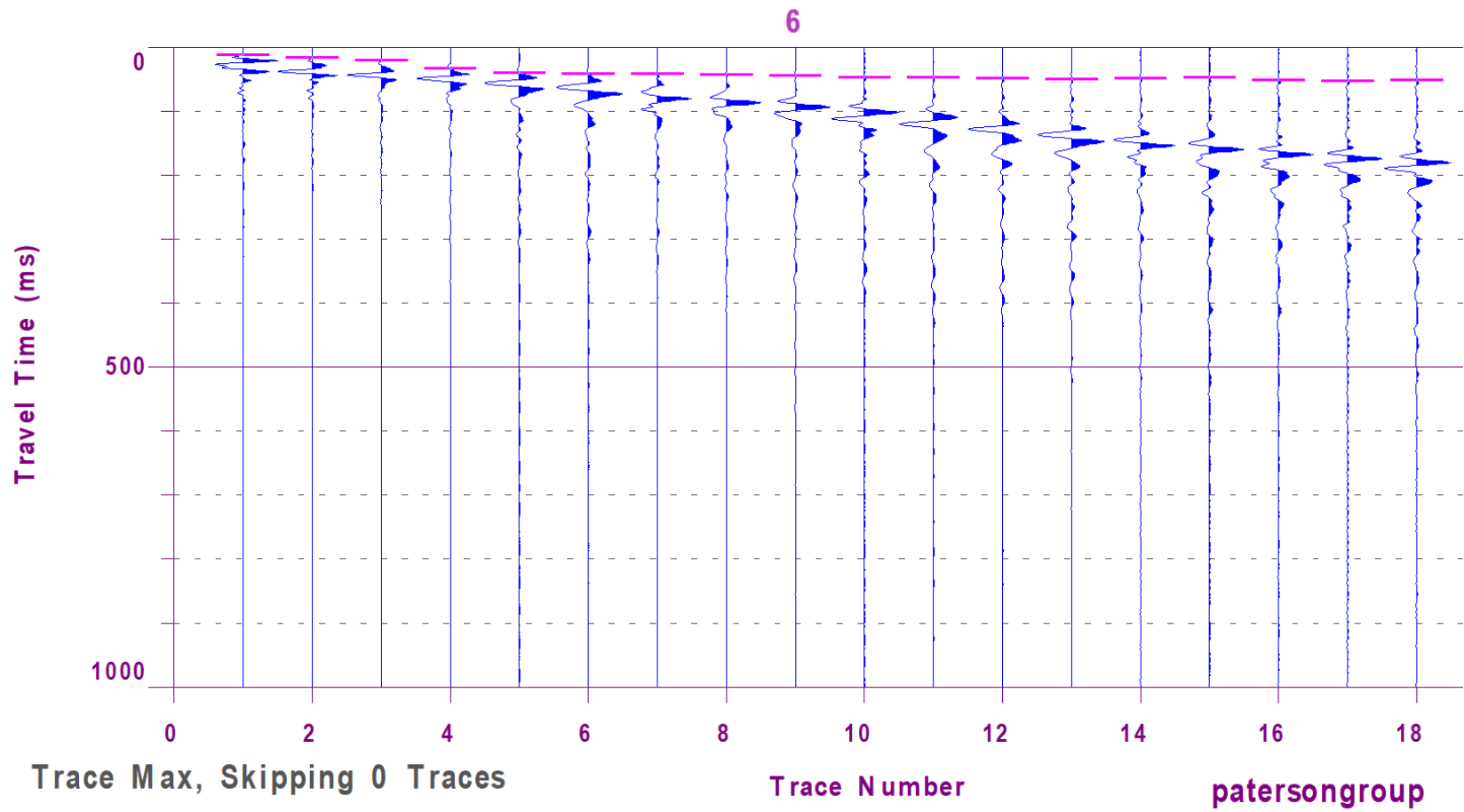


Figure 3 – Shear Wave Velocity Profile at Shot Location -3 m

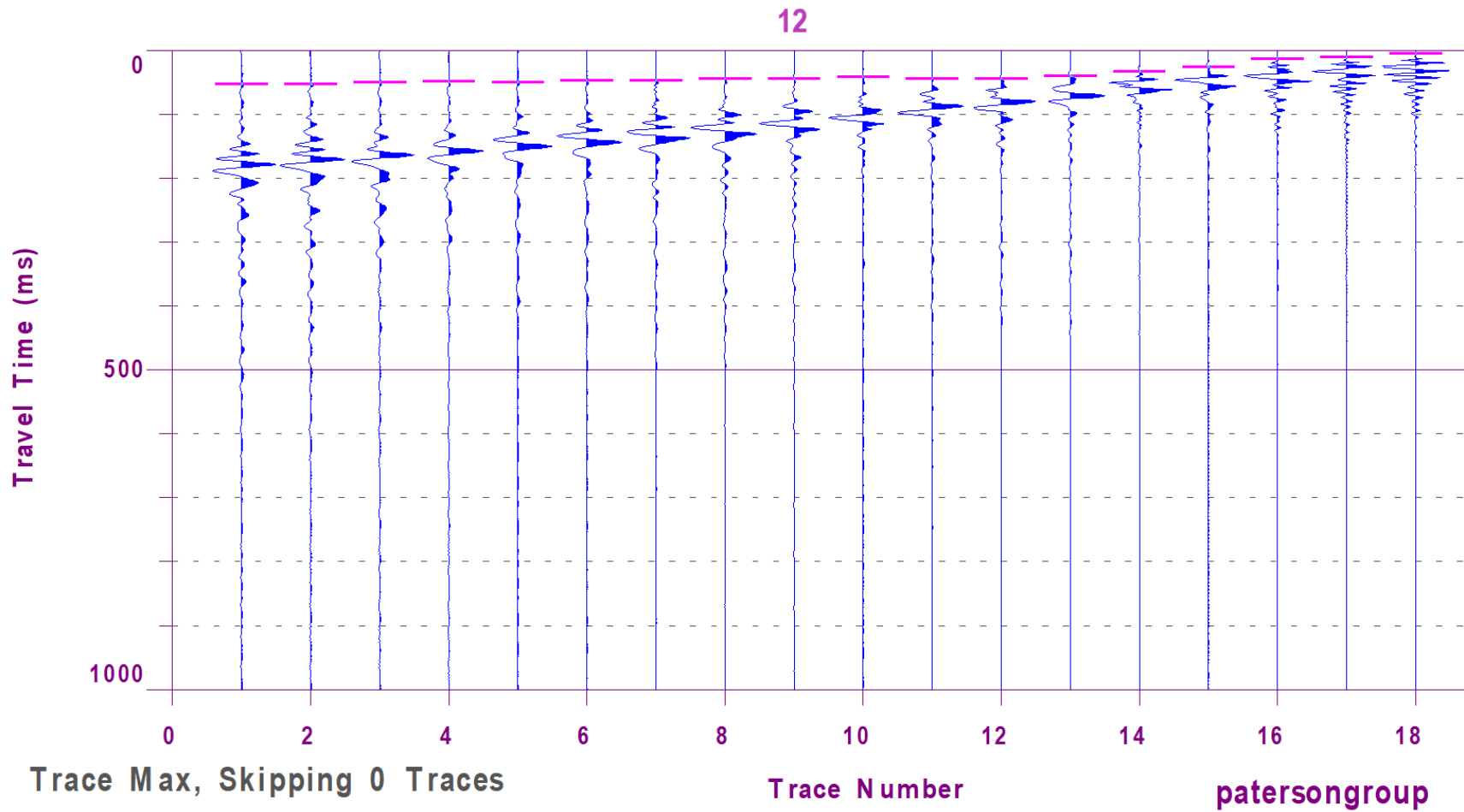
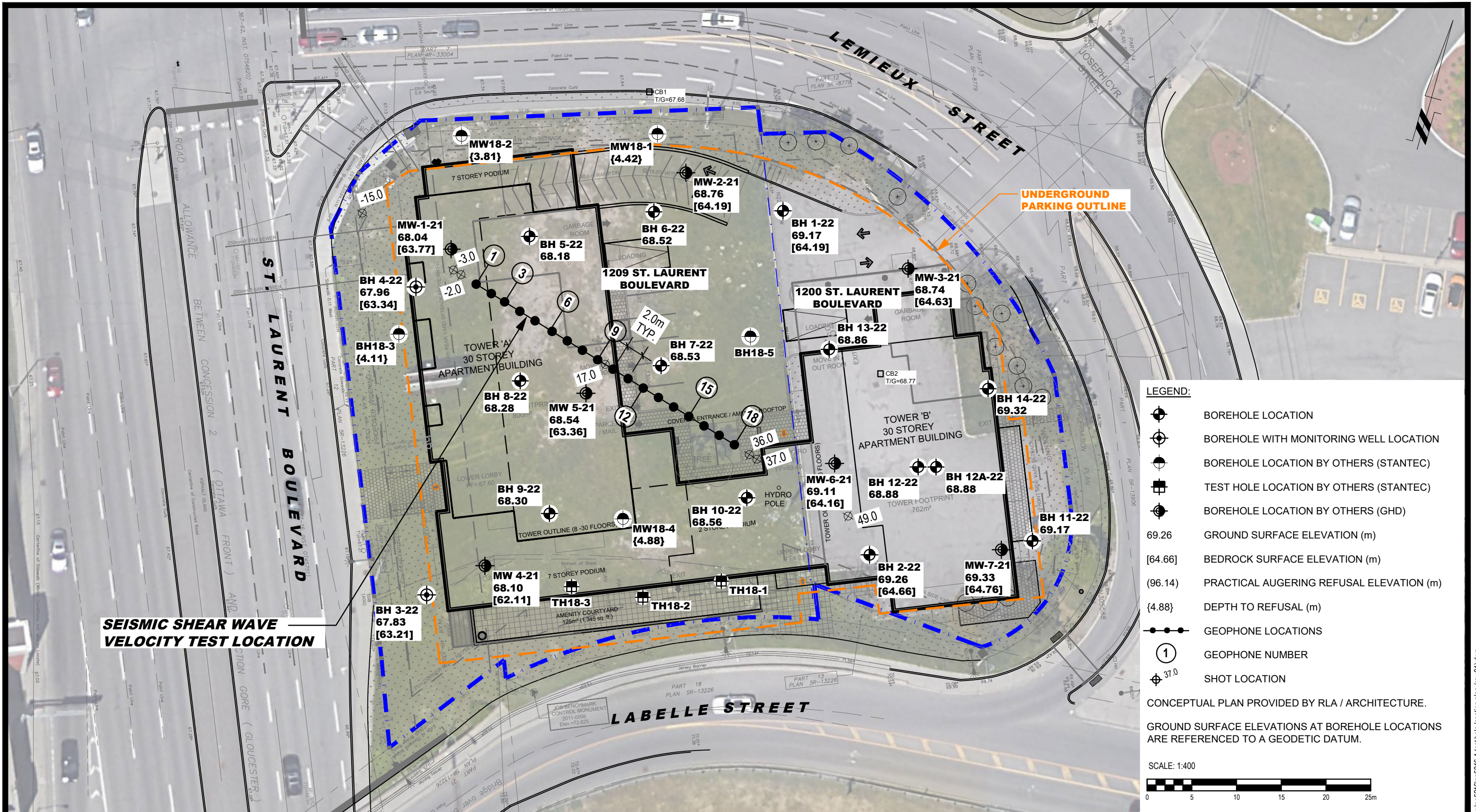


Figure 4 – Shear Wave Velocity Profile at Shot Location 2 m



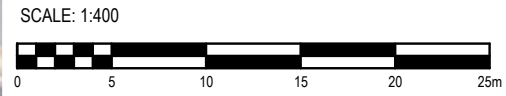


**SEISMIC SHEAR WAVE VELOCITY TEST LOCATION**

**UNDERGROUND PARKING OUTLINE**

- LEGEND:**
- BOREHOLE LOCATION
  - BOREHOLE WITH MONITORING WELL LOCATION
  - BOREHOLE LOCATION BY OTHERS (STANTEC)
  - TEST HOLE LOCATION BY OTHERS (STANTEC)
  - BOREHOLE LOCATION BY OTHERS (GHD)
  - 69.26 GROUND SURFACE ELEVATION (m)
  - [64.66] BEDROCK SURFACE ELEVATION (m)
  - (96.14) PRACTICAL AUGERING REFUSAL ELEVATION (m)
  - {4.88} DEPTH TO REFUSAL (m)
  - GEOPHONE LOCATIONS
  - GEOPHONE NUMBER
  - SHOT LOCATION

CONCEPTUAL PLAN PROVIDED BY RLA / ARCHITECTURE.  
GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS ARE REFERENCED TO A GEODETIC DATUM.



9 AURIGA DRIVE  
OTTAWA, ON  
K2E 7T9  
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
1	UPDATED TO NEW CONCEPTUAL PLAN	29/11/2022	NP

**CANDEREL GROUP**  
**GEOTECHNICAL INVESTIGATION**  
**PROPOSED HIGH-RISE DEVELOPMENT**  
**1200-1209 ST. LAURENT BOULEVARD**

OTTAWA, ONTARIO

**TEST HOLE LOCATION PLAN**

Scale:	1:400	Date:	10/2022
Drawn by:	YA	Report No.:	PG5216-2
Checked by:	NP	Dwg. No.:	<b>PG5216-2</b>
Approved by:	DJG	Revision No.:	1