PATERSON GROUP

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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Appendices

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.

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 underlaying 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.

Table 1 – Summary of Groundwater Levels Readings

Borehole Number	Ground Surface Elevation (m)	Measured Groundwater Level		Date Recorded
		Depth (m)	Elevation (m)	
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	

Note: 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.

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

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

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

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^3.

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^3, 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)
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)

An additional pressure having a magnitude equal to $K_o \cdot q$ 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 (ΔP_{AE}).

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

$a_c = (1.45 - a_{max}/g)a_{max}$
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m) g = gravity, 9.81 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

$P_o = 0.5\ K_o\ \gamma\ H^2$, where $K_o = 0.5$ 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.

Table 2 - Parameters used in Rock Anchor Review

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^3
Apex angle of failure cone	60^o
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.

Table 3 - Recommended Rock Anchor Lengths - Grouted Rock Anchor

Diameter of Drill Hole (mm)	Anchor Lengths (m)			Factored Tensile Resistance (kN)
	Bonded Length	Unbonded Length	Total Length	
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:

Table 4 - Recommended Pavement Structure - Car-Only Parking Areas (Podium Deck)

Thickness (mm)	Material Description
50	**Wear Course** - HL-3 or Superpave 12.5 Asphaltic Concrete
200**	**Base** - OPSS Granular A Crushed Stone
See Below*	**Thermal Break*** - Rigid insulation (See Paragraph Below)
n/a	**Waterproofing Membrane and IKO Protection Board**
SUBGRADE – 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.	

Table 5 - Recommended Pavement Structure – Access Lane, Fire Truck Lane, Ramp and Heavy Truck Parking Areas (Podium Deck)

Thickness (mm)	Material Description
40	**Wear Course** - HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Wear Course** - HL-8 or Superpave 19.0 Asphaltic Concrete
300**	**Base** - OPSS Granular A Crushed Stone
See Below*	**Thermal Break*** - Rigid insulation (See Paragraph Below)
n/a	**Waterproofing Membrane and IKO Protection Board**
SUBGRADE – 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.

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

Table 7 - Recommended Pavement Structure – Access Lanes and Heavy Truck Parking Areas	
Thickness (mm)	**Material Description**
40	**Wear Course** - HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course** - HL-8 or Superpave 19 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
450	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - 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.

Table 8 - Soil Parameters

Parameters	Values
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/m3	21
Submerged Unit Weight , kN/m3	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.

LICENSED PROFESSIONAL ENGINEER
Dec.16, 2022
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

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

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

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	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	69.17
Asphaltic concrete (0.10)						
FILL: Brown silty sand with gravel and crushed stone (1.07)	AU	1				
	SS	2	25	10	1	68.17
FILL: Topsoil and organics, some wood, trace clay (2.44)	SS	3	75	4	2	67.17
GLACIAL TILL: Loose to dense, grey silty clay to clayey silt with sand, trace gravel - sand and gravel increasing with depth - cobbles and boulders by 4.0m depth (4.98)	SS	4	71	3		
	SS	5	75	4	3	66.17
	RC	1	49	N/A	4	65.17
BEDROCK: Fair to excellent quality shale with limestone interbedding	RC	2	100	61	5	64.17
	RC	3	100	71	6	63.17
	RC	4	100	90	7	62.17
	RC	5	100	100	8	61.17
					9	60.17
					10	59.17
					11	58.17

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

○ Water Content %

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

Monitoring Well Construction

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9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

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

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BORINGS BY CME-55 Low Clearance Drill

DATE September 2, 2022

FILE NO. PG5216

HOLE NO. BH 1-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						11	58.17
		RC	6	100	92		
						12	57.17
		RC	7	100	95		
						13	56.17
						14	55.17
		RC	8	100	87		
BEDROCK: Excellent quality shale with limestone interbedding						15	54.17
		RC	9	100	97		
						16	53.17
						17	52.17
		RC	10	100	92		
						18	51.17
		RC	11	100	100		
						19	50.17
19.61							
End of Borehole							
(GWL @ 3.38m - Sept. 15, 2022)							

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

○ Water Content %

20 40 60 80

Monitoring Well Construction

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed High-Rise Development
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DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE September 6, 2022

FILE NO. PG5216

HOLE NO. BH 2-22

SOIL DESCRIPTION (GROUND SURFACE)	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
Asphaltic concrete	0.10				
FILL: Crushed stone with gravel, trace clay and concrete, occasional cobbles and boulders	1.45	SS	1	33	26
		SS	2	100	50+
FILL: Brown silty clay with topsoil and gravel, occasional cobbles	2.21	SS	3	67	20
GLACIAL TILL: Compact to loose, brown to grey silty clay with sand, gravel, cobbles and boulders	4.60	SS	4	92	25
		SS	5	75	37
		SS	6	75	28
BEDROCK: Very poor quality, weathered shale	6.99	SS	7	23	50+
		SS	8	100	50+
		SS	9	50	50+
		SS	10	100	50+
BEDROCK: Good to excellent quality shale with limestone interbedding		RC	1	100	79
		RC	2	100	98
		RC	3	100	81

DEPTH (m)	ELEV. (m)
0	69.26
1	68.26
2	67.26
3	66.26
4	65.26
5	64.26
6	63.26
7	62.26
8	61.26
9	60.26
10	59.26
11	58.26

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

○ Water Content %
20 40 60 80

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

Monitoring Well Construction

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SOIL PROFILE AND TEST DATA

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

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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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 7, 2022

FILE NO. PG5216

HOLE NO. BH 3-22

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	67.83
FILL: Brown silty sand, some gravel and topsoil (to 0.69)	AU	1				
FILL: Brown silty sand with clay, some gravel, topsoil, occasional cobbles	SS	2	83	22	1	66.83
- clay content increasing with depth (to 2.44)	SS	3	92	31	2	65.83
GLACIAL TILL: Compact to dense, grey silty sand to sandy silt with clay and gravel	SS	4	62	11		
- cobbles and boulders by 3.1m depth	SS	5	42	24	3	64.83
- some shale fragments by 4.5m depth	SS	6	67	46	4	63.83
(to 4.62)	SS	7	100	50+		
					5	62.83
BEDROCK: Good to excellent quality shale with limestone interbedding	RC	1	92	80	6	61.83
	RC	2	100	86	7	60.83
	RC	3	100	97	8	59.83
- vertical fracture from 9.4 to 10.4m depth	RC	4	100	92	9	58.83
					10	57.83
					11	56.83

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

○ Water Content %

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

Monitoring Well Construction

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9 Auriga Drive, Ottawa, Ontario K2E 7T9

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 7, 2022

FILE NO. PG5216

HOLE NO. BH 3-22

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

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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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 4-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	67.96
TOPSOIL 0.05							
FILL: Brown silty sand with gravel and crushed stone 0.69		AU	1				
Compact to dense, brown **SILTY SAND,** trace gravel		SS	2	58	24	1	66.96
- some clay by 1.7m depth 1.98		SS	3	83	44	2	65.96
GLACIAL TILL: 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		
		SS	6	60	38	4	63.96
4.62		SS	7	0	50+		
BEDROCK: Fair to excellent quality shale with limestone interbedding		RC	1	100	72	5	62.96
- vertical fracture from 4.8 to 5.1m depth						6	61.96
		RC	2	100	81	7	60.96
		RC	3	100	98	8	59.96
						9	58.96
		RC	4	100	98	10	57.96
						11	56.96

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

○ Water Content %
20 40 60 80

Monitoring Well Construction

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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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 TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						11	56.96
BEDROCK: 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	98	17	50.96
						18	49.96
19.68						19	48.96
End of Borehole							
(GWL @ 2.31m - Sept. 15, 2022)							

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

○ Water Content %

20 40 60 80

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

Monitoring Well Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

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	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	68.18
TOPSOIL	0.05						
FILL: Brown to black silty sand with gravel and crushed stone, trace clay	0.69	AU	1				
FILL: Grey silty sand to sandy silt, trace topsoil	1.22	SS	2	83	20	1	67.18
FILL: Brown silty clay, some sand, trace gravel and topsoil	1.45						
GLACIAL TILL: Dark brown silty clay with sand, gravel, cobbles and boulders		SS	3	75	31	2	66.18
- dark grey to black by 2.2m depth		SS	4	92	17	3	65.18
- some shale fragments by 3.35m depth	3.66	SS	5	67	21		
End of Borehole							

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

○ Water Content %

20 40 60 80

Monitoring Well Construction

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

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9 Auriga Drive, Ottawa, Ontario K2E 7T9

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	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.05				
FILL: Brown silty sand with gravel	0.69	AU	1		
Compact, brown **SILTY SAND**	1.75	SS	2	83	12
GLACIAL TILL: Dark grey to black silty clay with sand, gravel, cobbles and shale fragments	2.13	SS	3	92	8
End of Borehole					

DEPTH (m)	ELEV. (m)
0	68.52
1	67.52
2	66.52

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

○ Water Content %

20 40 60 80

Monitoring Well Construction

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

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

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 TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Monitoring Well Construction
GROUND SURFACE						0	68.53		
TOPSOIL 0.05									
Compact, brown **SILTY SAND** 0.76		AU	1						
Compact, brow **SILTY SAND to SANDY SILT** 1.45		SS	2	88	16	1	67.53		
GLACIAL TILL: 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

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

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	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	68.28
TOPSOIL	0.08						
FILL: Brown silty sand with clay, gravel and crushed stone	0.69	AU	1				
FILL: Brown silty sand with clay, topsoil, trace gravel	1.78	SS	2	83	9	1	67.28
GLACIAL TILL: Dark brown silty clay with sand, gravel, cobbles and shale fragments	2.13	SS	3	83	17	2	66.28
End of Borehole							

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

○ Water Content %

20 40 60 80

Monitoring Well Construction

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

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

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 9-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	68.30
TOPSOIL 0.10							
FILL: Brown sity sand with gravel and crushed stone, trace clay and topsoil 0.99		AU	1				
Compact, brown **SILTY SAND to SANDY SILT,** trace shale fragments 1.45		SS	2	83	11	1	67.30
GLACIAL TILL: Dark brown silty clay with sand, gravel, cobbles, some shale fragments 2.13		SS	3	75	23	2	66.30
End of Borehole							

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

○ Water Content %

20 40 60 80

Monitoring Well Construction

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

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

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. BH10-22

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

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

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9 Auriga Drive, Ottawa, Ontario K2E 7T9

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	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	69.17
Asphaltic concrete	0.05						
FILL: Brown silty sand with crushed stone and gravel	0.69	AU	1				
FILL: Brown silty sand, trace clay, gravel, crushed stone	1.45	SS	2	75	12	1	68.17
FILL: Brown silty clay, some sand, trace gravel, topsoil and wood	2.59	SS	3	88	9	2	67.17
Compact, brown **SANDY SILT,** trace clay	2.90	SS	4	88	17		
End of Borehole							

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

○ Water Content %

20 40 60 80

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

Monitoring Well Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

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

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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9 Auriga Drive, Ottawa, Ontario K2E 7T9

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 TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Monitoring Well Construction
GROUND SURFACE						0	68.88		
Asphaltic concrete 0.08									
FILL: Brown silty sand with crushed stone and gravel 0.69									
FILL: Grey-brown silty clay with sand, some topsoil and gravel 1.45		SS	1	75	6	1	67.88		
GLACIAL TILL: 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
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

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

DATUM Geodetic

FILE NO. PG5216

REMARKS

HOLE NO. BH13-22

BORINGS BY CME-55 Low Clearance Drill **DATE** September 8, 2022

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	68.86
Asphaltic concrete 0.08							
FILL: Brown silty sand, some gravel, trace brick and plastic 0.99		AU	1				
		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 2.44							
Compact, brown **SILTY SAND,** trace clay 2.90		SS	4	75	22		
End of Borehole							

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

○ Water Content %

20 40 60 80

Monitoring Well Construction

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

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

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	Depth to base (m)	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							0	69.32
TOPSOIL	0.10							
FILL: Brown silty sand	0.76		AU	1				
FILL: Brown silty sand, trace organics, brick	2.59		SS	2	100	50+	1	68.32
			SS	3	58	17	2	67.32
Compact, brown **SILTY SAND to SANDY SILT,** trace clay	2.90		SS	4	83	21		
End of Borehole								

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

○ Water Content %

20 40 60 80

Monitoring Well Construction

20 40 60 80 100

Shear Strength (kPa)

▲ 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.

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

SAMPLE TYPES

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

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

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

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
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

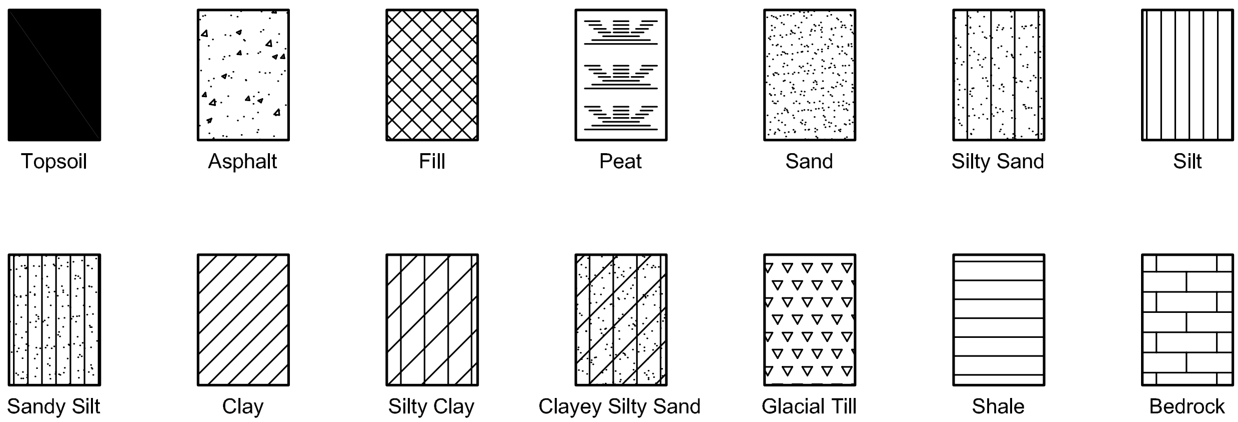
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void 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.

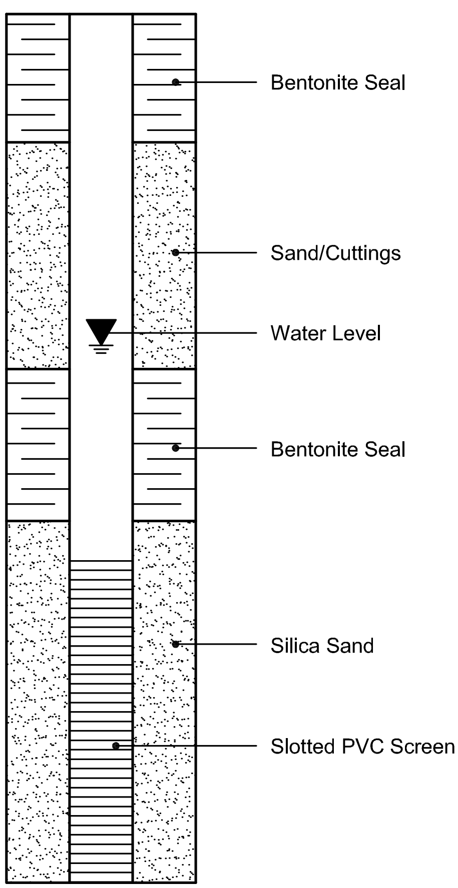
SYMBOLS AND TERMS (continued)

STRATA PLOT

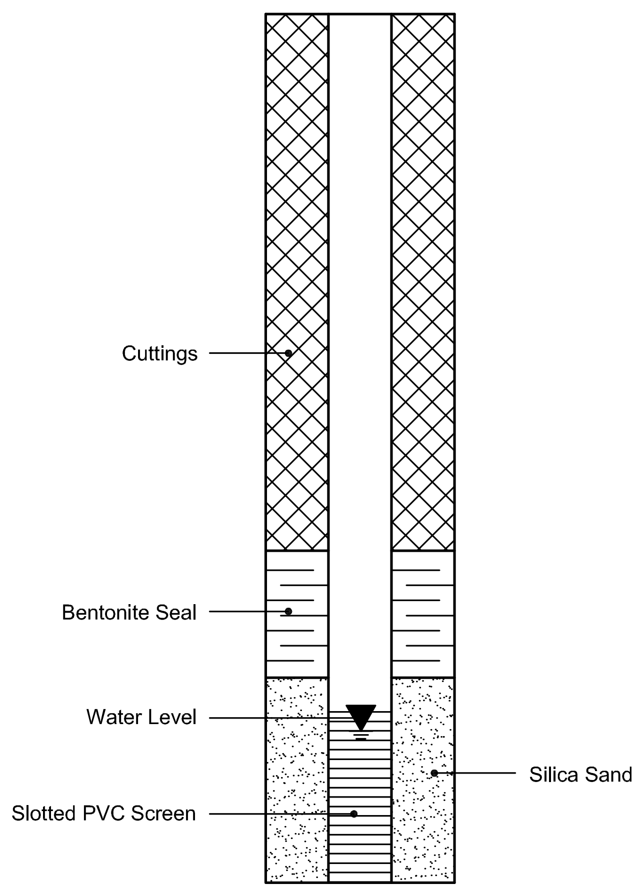


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



BOREHOLE REPORT

Borehole No. MW-1-21

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 : 450263.5
Y : 5030050.1
Z : 68.04

- WATER LEVEL
Date : 2021-07-29
Depth (m) : 2.022

Location plan :

Borehole type : Auger 200mm
Core bit size :
Hammer type :
Energy ratio :
Date (start) : 2021-07-14
Date (finish) : 2021-07-14

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

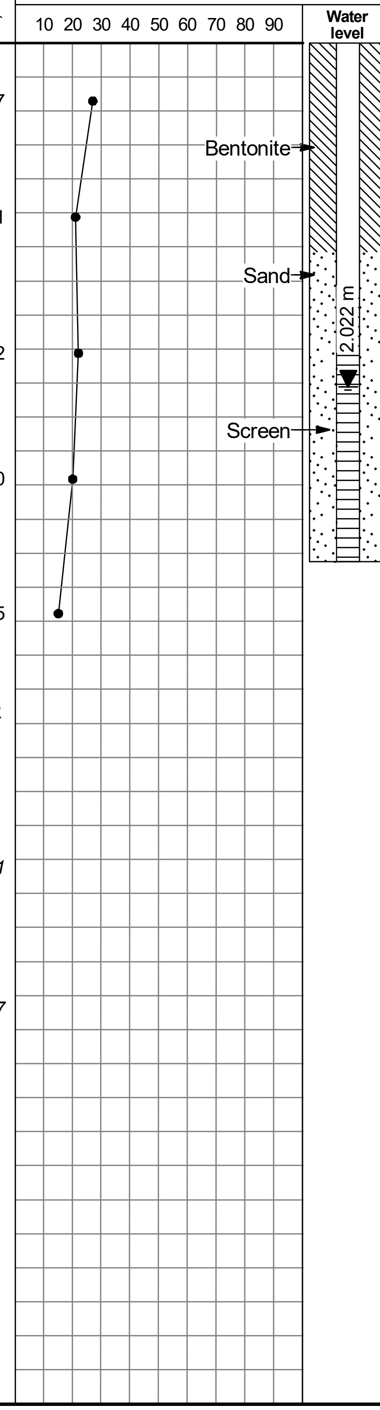
DRAFT

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

TESTS RESULTS
○ Water content (%)
W_P W_L Atterberg limits (%)
● "N" Standard penetration test value
▲ "N_C" Dynamic penetration test value
△ C_u (Field, kPa)
□ C_u (Lab, kPa)

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	68.04	Ground surface						
		TOPSOIL	SS-1A			0.4		
0.08	67.97	FILL, Sandy GRAVEL, grey, moist, compact	SS-1B	75	GSA	0.5	2-13 14-21	27
0.18	67.86	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; 4.75 m, vertical fracture	RC-1	94	UCS = 16.6 MPa			*51*
		5.44 m, becoming good quality	RC-2	100				*87*
5.92	62.12	End of borehole						



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 :

Borehole type : Auger 200mm
Core bit size :
Hammer type :
Energy ratio :
Date (start) : 2021-07-14
Date (finish) : 2021-07-14

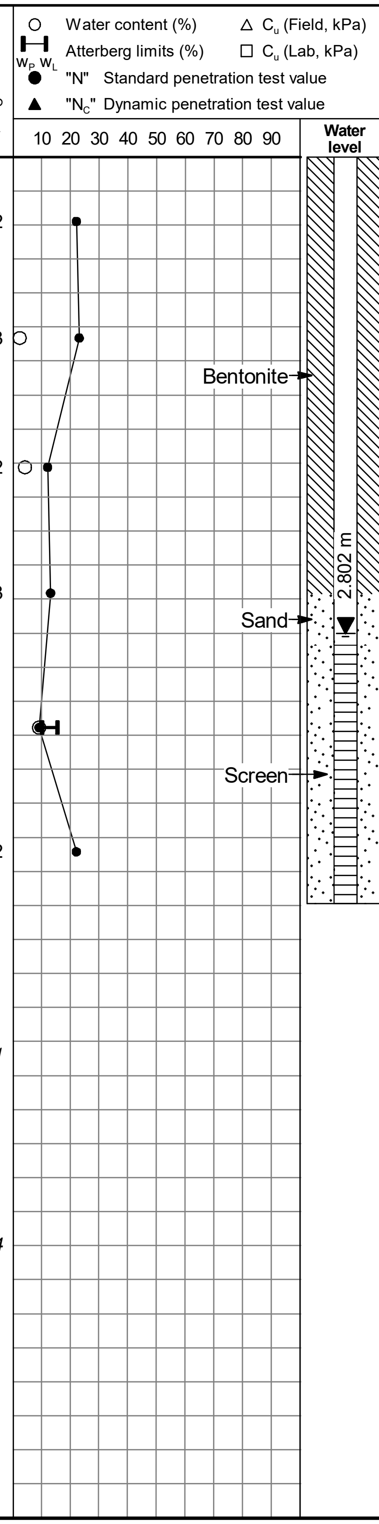
SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

DRAFT

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	68.76	Ground surface						
		TOPSOIL						
0.13	68.63	FILL, SAND and GRAVEL, trace silt, brown, moist, compact contains rootlets	SS-1	79		0.1	6-6-16-43	22
0.76	68.00	SAND, trace silt, brown, moist	SS-2	91	w CA	0	7-12 11-10	23
			SS-3	71	w	0	4-6-6-6	12
2.29	66.47	Silty SAND (TILL), some gravel and clay, moist to wet, dark grey, loose to compact	SS-4	54	CA	0	3-5-8-7	13
			SS-5	91	GSA W_L-W_P w	0	3-4-5-9	9
			SS-6	79		0	2-8-14-37	22
4.57	64.19	SHALE with limestone interbeds, highly weathered to fresh, black with grey bands, fair quality; 5.44 m, clay seam; 5.56 m, vertical fracture	RC-1	98				*51*
		6.20 m, vertical fracture	RC-2	100	UCS = 15.4 MPa			*44*
6.80	61.96	End of borehole						



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 :

Borehole type :	Auger 200mm
Core bit size :	
Hammer type :	
Energy ratio :	
Date (start) :	2021-07-16
Date (finish) :	2021-07-16

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

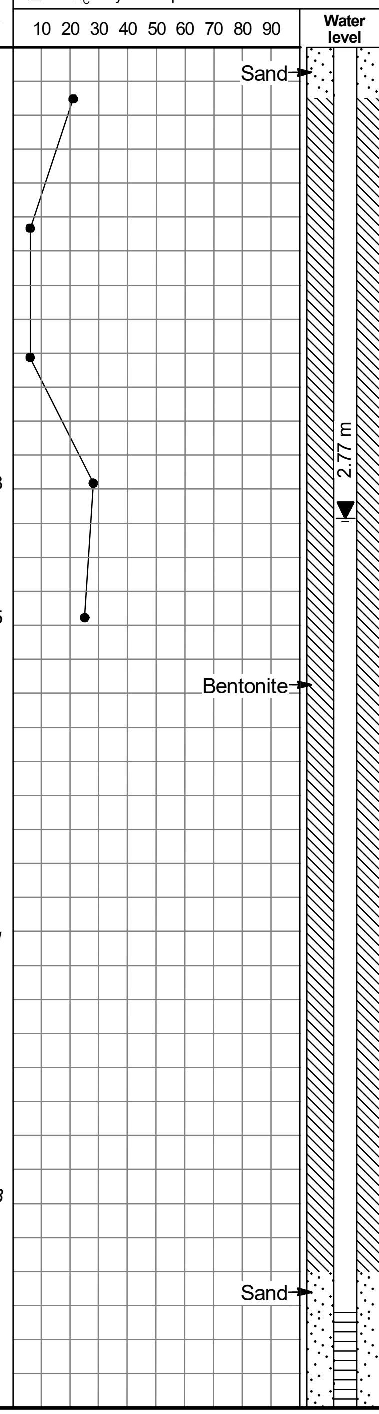
DRAFT

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

TESTS RESULTS legend: ○ Water content (%); △ C_u (Field, kPa); W_P W_L Atterberg limits (%); □ C_u (Lab, kPa); ● "N" Standard penetration test value; ▲ "N_C" Dynamic penetration test value

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	68.74	Ground surface						
0.04	68.70	ASPHALT						
		FILL, SAND and GRAVEL, trace silt, grey, compact, moist	SS-1	41		7.7	15-15-6-9	21
0.86	67.88	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		
1.52	67.22	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
2.29	66.45	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
			SS-5	92		17.6	9-8-17-20	25
		Spoon refusal	SS-6	0			50	R
4.11	64.63	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*
			RC-2	100				*71*
		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	GEODETIC COORDINATES (MTM, NAD-83) (m)	- WATER LEVEL
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION	X : 450313.6	Date : 2021-07-29
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	Y : 5030060.2	Depth (m) : 2.77
DESCRIBED BY:	J. SCOTT VERIFIED BY: S. SOLEIMANI/ A. FIORILLI	Z : 68.74	Location plan :

Borehole type : Auger 200mm
Core bit size :
Hammer type :
Energy ratio :
Date (start) : 2021-07-16
Date (finish) : 2021-07-16

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

DRAFT

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

Water content (%) / Atterberg limits (%) W_P W_L / "N" Standard penetration test value / "N_C" Dynamic penetration test value / C_u (Field, kPa) / C_u (Lab, kPa)

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_C or RQD	Water level
8.00	60.74		Ground surface								
					RC-4	100	UCS = 13.5 MPa			88	Screen
					RC-5	100				98	
					RC-6	77				45	
12.01	56.73		End of borehole								

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

SAMPLE TYPE
SS(E) - Split Spoon (Environment)
RC(E) - Rock diamond core
AU(E) - Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E) - Grab sample

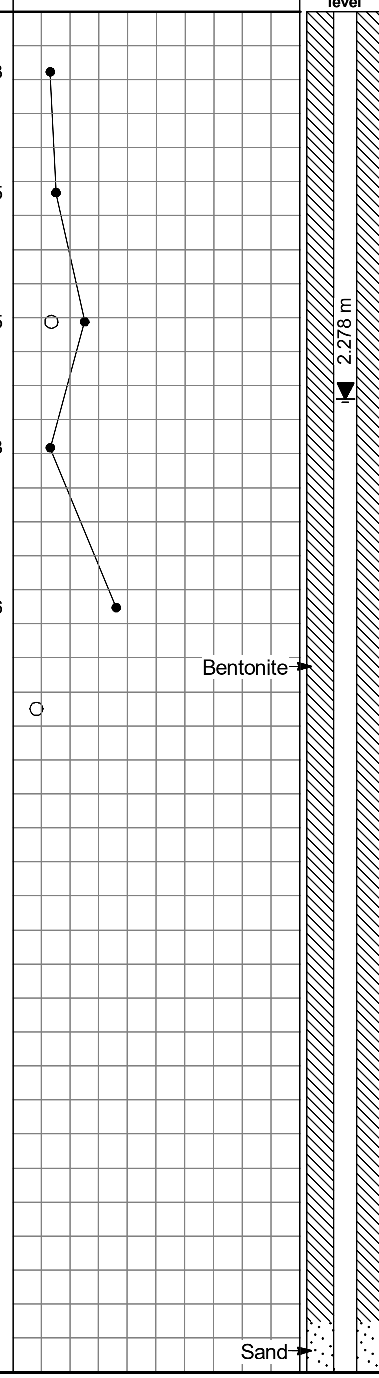
DRAFT

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

TESTS RESULTS legend: ○ Water content (%); △ C_u (Field, kPa); W_P W_L Atterberg limits (%); □ C_u (Lab, kPa); ● "N" Standard penetration test value; ▲ "N_C" Dynamic penetration test value

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	68.10	Ground surface						
		TOPSOIL						
0.10	68.00	FILL, Gravelly SAND, some silt, brown, dry, compact	SS-1	58	CA	0	1-4-9-24	13
			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
2.29	65.81	Clayey silty SAND (TILL), some gravel, dark brown, moist, compact	SS-4	79		0.1	7-7-6-8	13
3.20	64.90	Silty SAND (TILL), trace gravel and clay, grey, wet, dense	SS-5	75	GSA	0.1	11-13 23-30	36
			SS-6	42	w	0.1	18-50/13cm	R
			SS-7	0			50/13cm	R
5.99	62.11	Highly weathered, fractured SHALE						
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



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

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

DRAFT

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

TESTS RESULTS legend:
Water content (%)
Atterberg limits (%) (W_P W_L)
"N" Standard penetration test value
"N_C" Dynamic penetration test value
C_u (Field, kPa)
C_u (Lab, kPa)

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_C or RQD	10 20 30 40 50 60 70 80 90	Water level
8.00	60.10		Ground surface									
					RC-2	100				78		
9.0												Screen
					RC-3	100				64		
10.0			10.49 m, becoming good to excellent quality									
11.0					RC-4	100	UCS = 17.7 MPa			90		
12.0												
12.07	56.03		End of borehole									
13.0												
14.0												
15.0												

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 :

Borehole type :	Auger 200mm
Core bit size :	
Hammer type :	
Energy ratio :	
Date (start) :	2021-07-15
Date (finish) :	2021-07-15

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

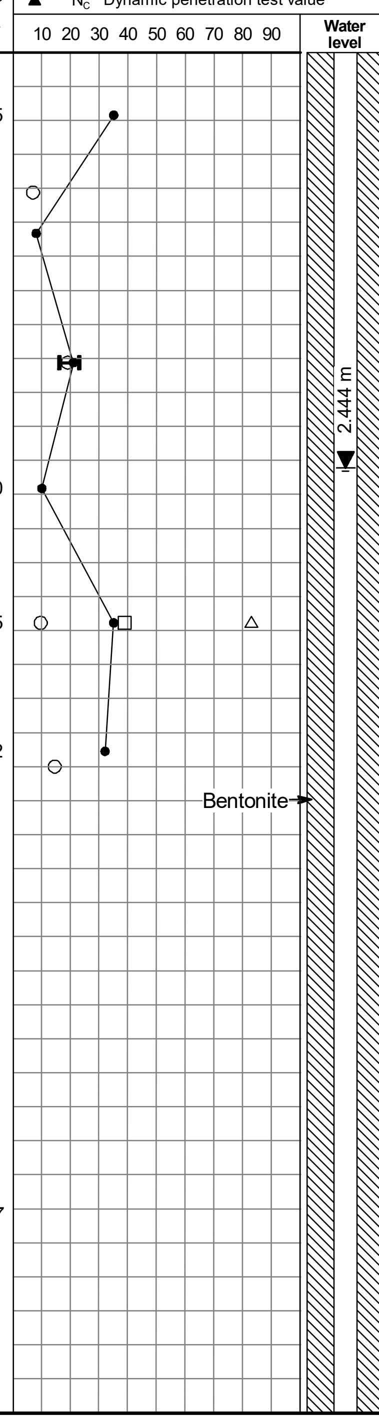
DRAFT

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

TESTS RESULTS
○ Water content (%)
W_P W_L Atterberg limits (%)
● "N" Standard penetration test value
▲ "N_C" Dynamic penetration test value
△ C_u (Field, kPa)
□ C_u (Lab, kPa)

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	68.54	Ground surface						
		TOPSOIL						
0.13	68.41	FILL, SAND and GRAVEL, trace silt, grey, moist	SS-1A	96		0	5-21	35
0.41	68.13	FILL, Silty SAND, trace gravel, brown, moist	SS-1B		CA	0	14-11	
			SS-2A	75	w	0	4-3-5-4	8
0.89	67.65	Clayey SILT, trace sand and gavel, dark grey, moist, firm	SS-2B		CA	0		
		1.52 m, becoming very stiff and wet	SS-3	79	W_L-W_P w	0	3-9-12-7	21
2.29	66.25	Silty CLAY (TILL), some sand and gravel, brown to grey, moist, stiff to very stiff Contains cobbles and boulders	SS-4	96		0	5-5-5-6	10
			SS-5	100	w	0	4-13 22-6	35
			SS-6A	92		0	7-10	32
3.99	64.55	Silty SAND (TILL), some gravel, dark grey, wet, dense Contains cobbles and boulders	SS-6B		w	0	22-15	
			SS-7	54		0	--	
5.18	63.36	SHALE with limestone interbeds, weathered to fresh, dark grey thinly bedded, very poor quality	RC-1	74				*0*
		6.07 m, clay seam						
		6.80 m, vertical fracture	RC-2	100				*47*



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

BOREHOLE REPORT

Borehole No. MW-5-21

CLIENT:	CANDEREL	GEODETIC COORDINATES (MTM, NAD-83) (m)	- WATER LEVEL
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION	X : 450282.2	Date : 2021-07-29
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	Y : 5030037.9	Depth (m) : 2.444
DESCRIBED BY:	J. SCOTT VERIFIED BY: S. SOLEIMANI/ A. FIORILLI	Z : 68.54	Location plan :

Borehole type : Auger 200mm
Core bit size :
Hammer type :
Energy ratio :
Date (start) : 2021-07-15
Date (finish) : 2021-07-15

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

DRAFT

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

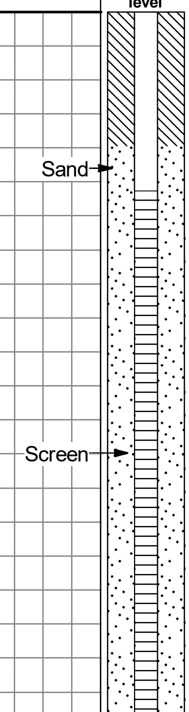
TESTS RESULTS legend: ○ Water content (%); △ C_u (Field, kPa); W_P W_L Atterberg limits (%); □ C_u (Lab, kPa); ● "N" Standard penetration test value; ▲ "N_C" Dynamic penetration test value

Scale: 10 20 30 40 50 60 70 80 90

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_C or RQD
8.00	60.54		Ground surface							
					RC-3	100				75
					RC-4	100	UCS = 16.7 MPa			48
			9.85 m, clay seam							
					RC-5	100				76
12.14	56.40		End of borehole							

Depth scale: 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0

Water level



BOREHOLE REPORT

Borehole No. MW-6-21

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 : 450311.0
Y : 5030037.1
Z : 69.11

▼ - WATER LEVEL
Date : 2021-07-29
Depth (m) : 2.523

Location plan :

Borehole type : Auger 200mm
Core bit size :
Hammer type :
Energy ratio :
Date (start) : 2021-07-16
Date (finish) : 2021-07-16

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

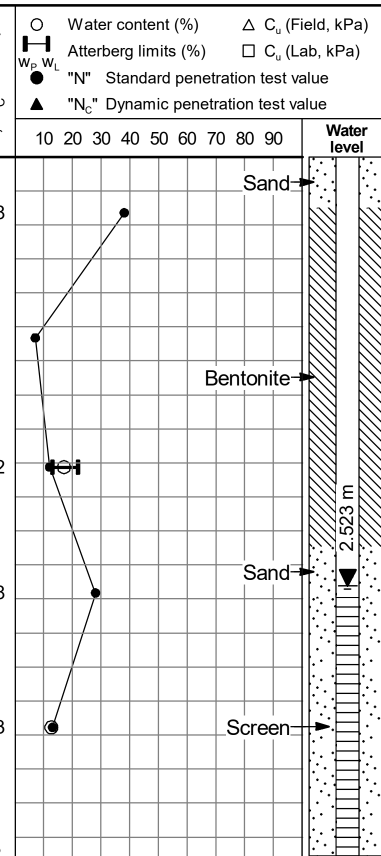
DRAFT

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	69.11	Ground surface						
0.05	69.06	ASPHALT						
		FILL, SAND and GRAVEL, grey, dry, dense	SS-1	20		3	4-16 22-29	38
			SS-2	29	CA	10.3	2-3-4-4	7
1.52	67.59	Silty CLAY (TILL), trace gravel, brown, moist, stiff	SS-3	71	W_L-W_P w	3.4	4-4-8-10	12
1.83	67.28	SAND and GRAVEL (TILL), grey, moist to wet, compact						
			SS-4	92	CA	8.7	33-21-7-6	28
3.05	66.06	Clayey silty SAND (TILL), grey, moist to wet, compact	SS-5	83	w	4.8	5-5-8-3	13
3.81	65.30	SAND and GRAVEL (TILL), grey, wet, dense to very dense	SS-6	33		5.9	21 50/13cm	R
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*
		6.17 m, becoming excellent quality	RC-2	97				*97*
6.91	62.20	End of borehole						

TESTS RESULTS



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

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

DRAFT

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

STRATIGRAPHY

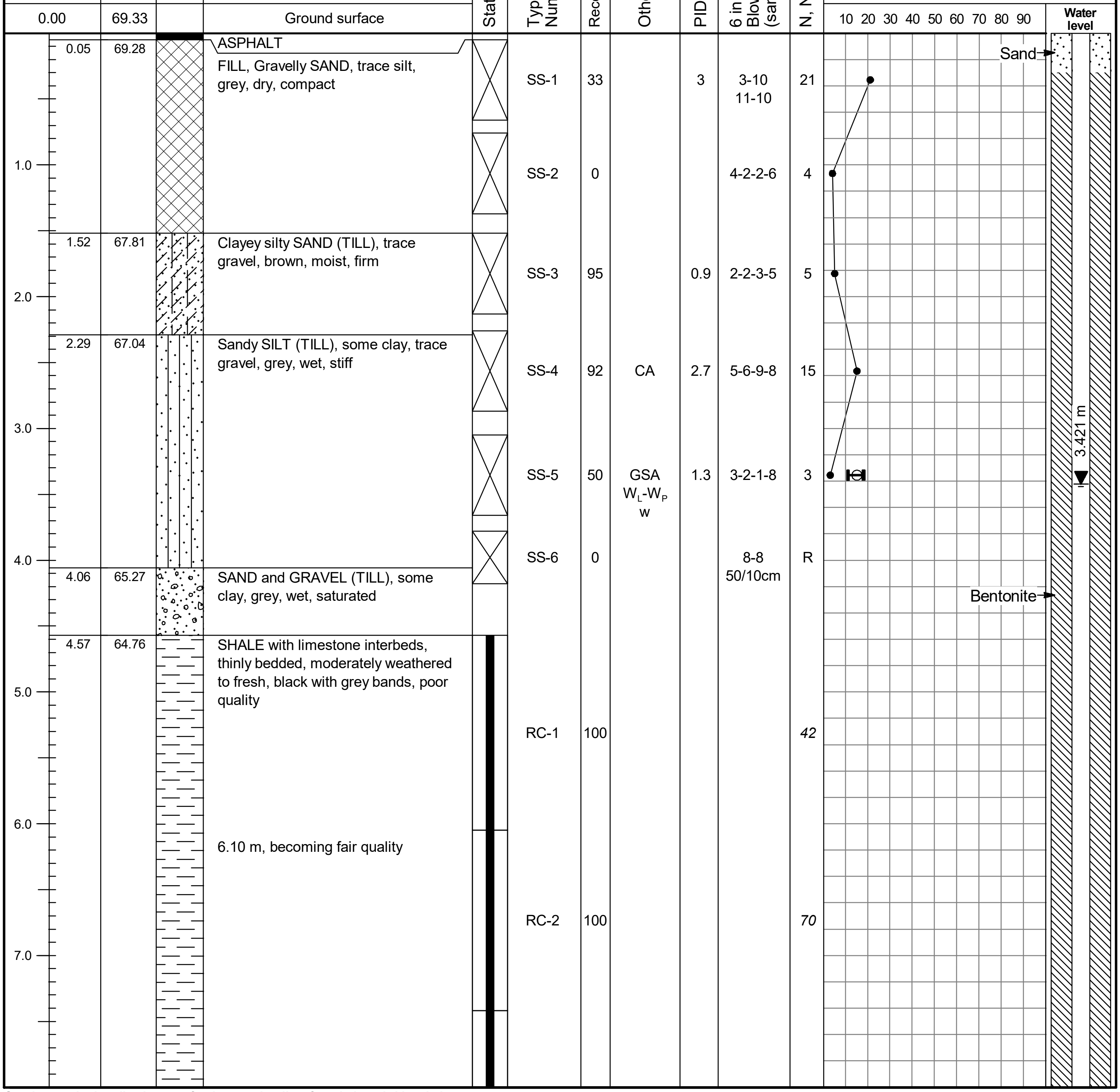
Depth (m)	Elevation (m)	Description
0.00	69.33	Ground surface
0.05	69.28	ASPHALT FILL, Gravelly SAND, trace silt, grey, dry, compact
1.52	67.81	Clayey silty SAND (TILL), trace gravel, brown, moist, firm
2.29	67.04	Sandy SILT (TILL), some clay, trace gravel, grey, wet, stiff
4.06	65.27	SAND and GRAVEL (TILL), some clay, grey, wet, saturated
4.57	64.76	SHALE with limestone interbeds, thinly bedded, moderately weathered to fresh, black with grey bands, poor quality 6.10 m, becoming fair quality

SAMPLE

Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
SS-1	33		3	3-10 11-10	21
SS-2	0			4-2-2-6	4
SS-3	95		0.9	2-2-3-5	5
SS-4	92	CA	2.7	5-6-9-8	15
SS-5	50	GSA W_L-W_P w	1.3	3-2-1-8	3
SS-6	0			8-8 50/10cm	R
RC-1	100				*42*
RC-2	100				*70*

TESTS RESULTS

○ Water content (%) △ C_u (Field, kPa)
W_P W_L Atterberg limits (%) □ C_u (Lab, kPa)
● "N" Standard penetration test value
▲ "N_C" Dynamic penetration test value



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

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

DRAFT

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

TESTS RESULTS legend: ○ Water content (%); △ C_u (Field, kPa); W_P W_L Atterberg limits (%); □ C_u (Lab, kPa); ● "N" Standard penetration test value; ▲ "N_C" Dynamic penetration test value

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_C or RQD	Water level
8.00	61.33		Ground surface								
				Diamond drilling	RC-3	100				71	Sand
				Diamond drilling	RC-4	100				52	Screen
			10.5 m, becoming excellent quality	Diamond drilling	RC-5	100				95	
12.03	57.30		End of borehole								

Monitoring Well: MW18-01

Project:	Phase II ESA	**Drilling method:**	Geoprobe 7822DT (Direct Push)
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	100.56 m RTD
Number:	122170233	**Top of casing elevation:**	100.47 m RTD
Field investigator:	C. Jolicoeur	**Easting:**	5030067
Contractor:	Strata Drilling Group	**Northing:**	450284

SUBSURFACE PROFILE | SAMPLE DETAILS | INSTALLATION DETAILS

Depth (m BGS)	Elevation (m RTD)	Stratigraphic Description
	100.56	Ground Surface
0.00		SAND and GRAVEL (FILL)
0.53	100.03	SAND brown, medium grained, loose, dry
2.13	98.43	CLAY (TILL) dark brown, wet - damp
4.42	96.14	Refusal End of Borehole

Sample Number	Sample Type	Recovery	Lab Analyses	%LEL (Comb) / ppm (TOV)
1	DP	12"		<5 / 1.0
2		28"		<5 / 1.0
3	DP	17"		<5 / <0.02
4		17"	PHC F1-F4, PAH, VOC	<5 / 1.0
5	DP	26"	Metals	
6		26"		

Sample details recovery n/a noted for each DP interval.

Installation Details – Description:
- Flushmount protective cover with concrete seal
- 50 mm ID PVC pipe backfilled with bentonite
- Groundwater Level: 3.22 m BGS 20-Sep-18
- 50 mm ID slotted PVC pipe backfilled with silica sand

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

Stantec

Drawn By/Checked By: M. Ford

Monitoring Well: MW18-02

Project:	Phase II ESA	**Drilling method:**	Geoprobe 7822DT (Direct Push)
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	99.70 m RTD
Number:	122170233	**Top of casing elevation:**	99.56 m RTD
Field investigator:	C. Jolicoeur	**Easting:**	5030061
Contractor:	Strata Drilling Group	**Northing:**	450263

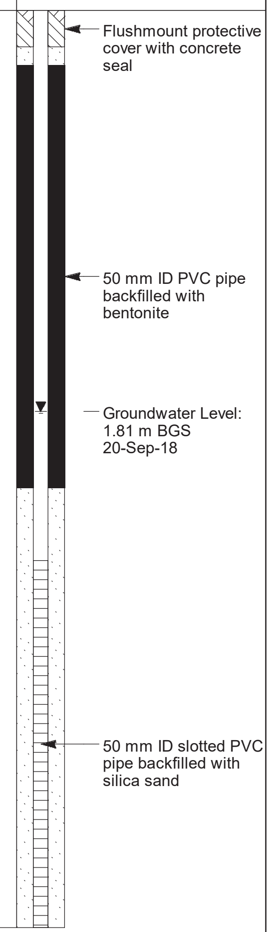
SUBSURFACE PROFILE

Stratigraphic Description	Elevation (m RTD) / Depth (m BGS)
Ground Surface	99.70
TOPSOIL with gravel	0.00 / 99.39
SILT brown, dry	0.30 / 99.16
CLAY (TILL) brown to dark brown, dry	0.53 / 97.56
SILTY CLAY light brown, dry	2.13 / 96.95
CLAY (TILL) dark brown, wet	2.74 / 95.89
Refusal End of Borehole	3.81

SAMPLE DETAILS

Sample Number	Sample Type	Recovery	Lab Analyses	%LEL (Comb) / ppm (TOV)
1	DP	21"		<5 / 1.0
		n/a		
2		21"	Metals	<5 / <0.02
3	DP	24"	PAH	<5 / 1.0
		n/a		
4		24"		<5 / 1.0
5	DP	n/a 30"	PHC F1-F4, VOC	<5 / 1.0

INSTALLATION DETAILS



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

Drawn By/Checked By: M. Ford

Borehole: BH18-03

Project:	Phase II ESA	**Drilling method:**	Geoprobe 7822DT (Direct Push)
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	99.61 m RTD
Number:	122170233	**Top of casing elevation:**	n/a
Field investigator:	C. Jolicoeur	**Easting:**	5030038
Contractor:	Strata Drilling Group	**Northing:**	450262

SUBSURFACE PROFILE | SAMPLE DETAILS | INSTALLATION DETAILS

Stratigraphic Description	Elevation (m RTD) / Depth (m BGS)
Ground Surface	99.61
TOPSOIL with gravel	0.00
SAND brown, medium grained, loose, with clay lenses	99.31 0.30
CLAY (TILL) dark brown - 125 mm seam of sand - wet - with gravel	98.85 0.76
Refusal End of Borehole	95.50 4.11

Sample Number	Sample Type	Lab Analyses	%LEL Comb / ppm Comb ●	ppm TOV ○
1	DP	pH	15	1.0
2	DP		10	1.0
3	DP	VOC	125	7.0
4	DP	PHC F1-F4	15	2.0
5	DP	Metals	20	<0.02

%LEL Comb▲: 20 40 60 80
ppm: ○TOV ● Comb: 200 400 600 800

Depth (ft): 2, 4, 6, 8, 10, 12, 14, 16
Depth (m): 1, 2, 3, 4, 5

Installation Details – Diagram / Description: 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	**Drilling method:**	Geoprobe 7822DT (Direct Push)
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	100.46 m RTD
Number:	122170233	**Top of casing elevation:**	100.35 m RTD
Field investigator:	C. Jolicoeur	**Easting:**	5030026
Contractor:	Strata Drilling Group	**Northing:**	450291

SUBSURFACE PROFILE

Depth (ft)	Depth (m)	Graphic Log	Stratigraphic Description	Elevation (m RTD) / Depth (m BGS)
			Ground Surface	100.46
			SAND and GRAVEL (FILL)	0.00
			SAND brown, medium grained, dry	100.23 0.23
2				
			CLAY (TILL) dark brown	99.69 0.76
	1			
4				
6				
	2			
8				
10	3			
12			- wet	
	4			
14				
16			Refusal End of Borehole	95.58 4.88
	5			

SAMPLE DETAILS

%LEL Comb▲ 20 40 60 80; ppm ○TOV ●Comb 200 400 600 800

Sample Number	Sample Type	Recovery	Lab Analyses	Comb / TOV (ppm)
1	DP	20"		<5 / <0.02
		n/a		
2		20"	Metals	<5 / <0.02
3	DP	22"		85 / <0.02
		n/a		
4		22"	PHC F1-F4, VOC	40 / <0.02
5	DP			110 / <0.02
		n/a		
6			PAH	145 / <0.02
7	DP	n/a 12"		145 / <0.02

INSTALLATION DETAILS

Diagram — Description:

- Flushmount protective cover with concrete seal
- 50 mm ID PVC pipe backfilled with bentonite
- Groundwater Level: 2.01 m BGS 20-Sep-18
- 50 mm ID slotted PVC pipe backfilled with silica sand

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

Stantec

Drawn By/Checked By: M. Ford

Borehole: BH18-05

Project:	Phase II ESA	**Drilling method:**	Geoprobe 7822DT (Direct Push)
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	100.49 m RTD
Number:	122170233	**Top of casing elevation:**	n/a
Field investigator:	C. Jolicoeur	**Easting:**	5030048
Contractor:	Strata Drilling Group	**Northing:**	450300

SUBSURFACE PROFILE

Stratigraphic Description	Elevation (m RTD)	Depth (m BGS)
Ground Surface	100.49	
TOPSOIL with sand		0.00
CLAYEY SILT	100.03	0.46
SILT brown, dry; - moist	99.80	0.69
CLAY (TILL) dark brown, dry; - wet; - damp	98.20	2.29
End of Borehole	95.92	4.57

SAMPLE DETAILS

Sample Number	Sample Type	Recovery	Lab Analyses	Comb (ppm)	TOV (ppm)
1	DP	13"		<5	<0.02
		n/a			
2		13"		<5	<0.02
3	DP	24"		55	<0.02
		n/a			
4		24"	Metals	25	<0.02
5	DP	30"	PHC F1-F4, VOC	185	<0.02
		n/a			
6		30"	PAH	5	<0.02

INSTALLATION DETAILS

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

Drawn By/Checked By: M. Ford

Test Hole: TH18-1

Project:	Phase II ESA	**Drilling method:**	Hand Auger
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	101.74 m RTD
Number:	122170233	**Top of casing elevation:**	n/a
Field investigator:	C. Jolicoeur	**Easting:**	n/a
Contractor:	Stantec Consulting Ltd.	**Northing:**	n/a

SUBSURFACE PROFILE			SAMPLE DETAILS					INSTALLATION DETAILS
Depth (ft) (m)	Stratigraphic Description	Elevation (m RTD) Depth (m BGS)	Sample Number	Sample Type	Recovery	Lab Analyses	%LEL Comb (20 40 60 80); ppm TOV / Comb (200 400 600 800)	Description
	Ground Surface	101.74						
	TOPSOIL	0.00	1	HA	n/a	Metals, PHC F1-F4, PAH, VOC		Slough
	SAND (FILL) medium grained	101.28 0.46						
	End of Borehole	100.83 0.91						

Depth scale: (ft) 2, 4, 6, 8, 10, 12, 14, 16; (m) 1, 2, 3, 4, 5

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	**Drilling method:**	Hand Auger
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	101.96 m RTD
Number:	122170233	**Top of casing elevation:**	n/a
Field investigator:	C. Jolicoeur	**Easting:**	n/a
Contractor:	Stantec Consulting Ltd.	**Northing:**	n/a

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▲ 20 40 60 80 / ppm ○TOV ● Comb 200 400 600 800	Diagram	Description
		Ground Surface	101.96							
		TOPSOIL	0.00	1	HA	n/a	Metals, PHC F1 - F4, PAH, VOC			Slough
		SAND (FILL) medium grained	101.50 0.46							
		End of Borehole	101.05 0.91							

Depth scale: (ft) 2, 4, 6, 8, 10, 12, 14, 16; (m) 1, 2, 3, 4, 5

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

Stantec

Drawn By/Checked By: M. Ford

Test Hole: TH18-3

Project:	Phase II ESA	**Drilling method:**	Hand Auger
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	102.07 m RTD
Number:	122170233	**Top of casing elevation:**	n/a
Field investigator:	C. Jolicoeur	**Easting:**	n/a
Contractor:	Stantec Consulting Ltd.	**Northing:**	n/a

SUBSURFACE PROFILE			SAMPLE DETAILS					INSTALLATION DETAILS
Stratigraphic Description	Elevation (m RTD) Depth (m BGS)		Sample Number	Sample Type	Recovery	Lab Analyses	%LEL Comb▲ 20 40 60 80 / ppm ○TOV ● Comb 200 400 600 800	Description
Ground Surface	102.07							
TOPSOIL	101.61	0.00	1	HA	n/a	Metals, PHC F1-F4. PAH, VOC		Slough
SAND (FILL) medium grained	101.15	0.46						
End of Borehole		0.91						

Depth scale: (ft) 2, 4, 6, 8, 10, 12, 14, 16; (m) 1, 2, 3, 4, 5

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

Stantec

Drawn By/Checked By: M. Ford

PARACEL LABORATORIES LTD.

Certificate of Analysis

Report Date: 14-Sep-2022

Client: Paterson Group Consulting Engineers

Order Date: 8-Sep-2022

Client PO: 55731

Project Description: PG5216

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

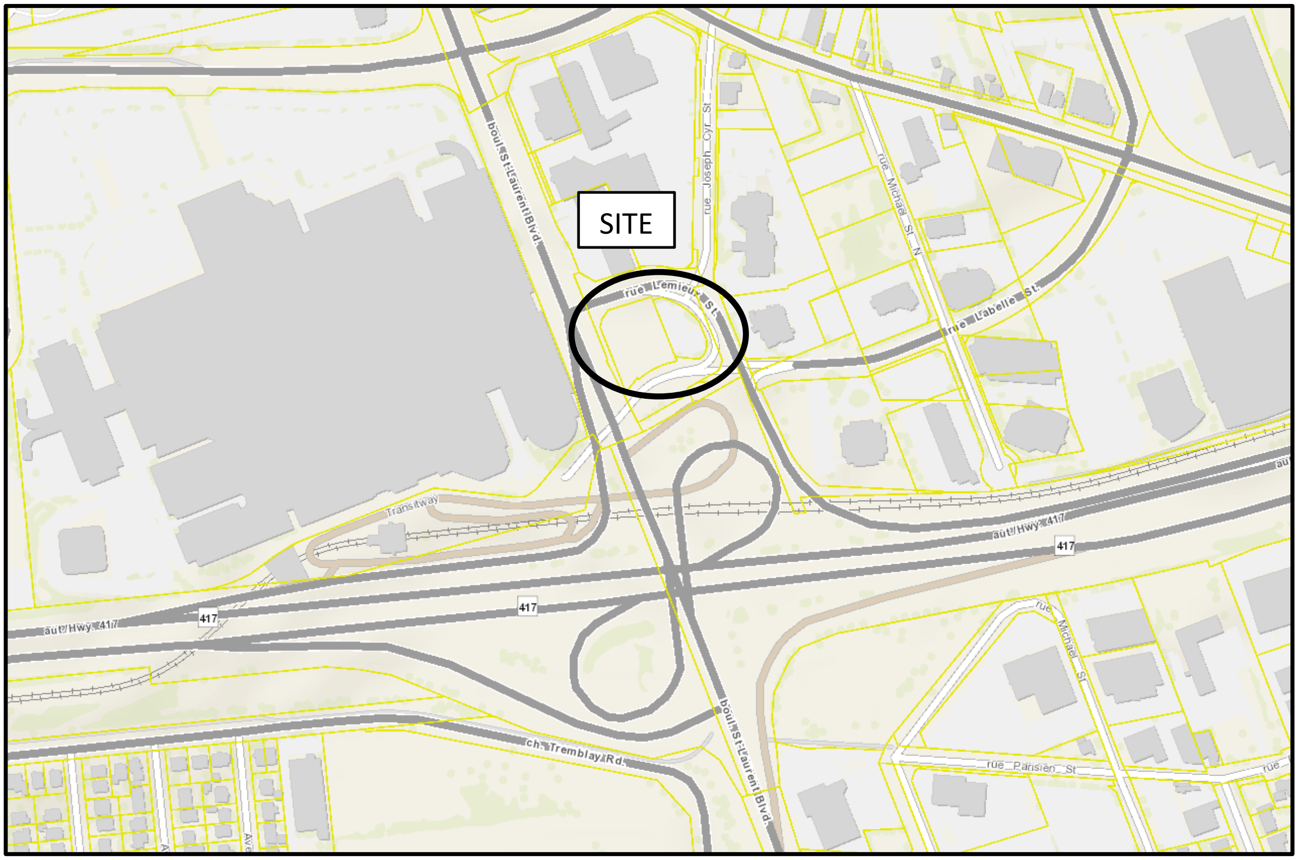


FIGURE 1

KEY PLAN

PATERSON GROUP

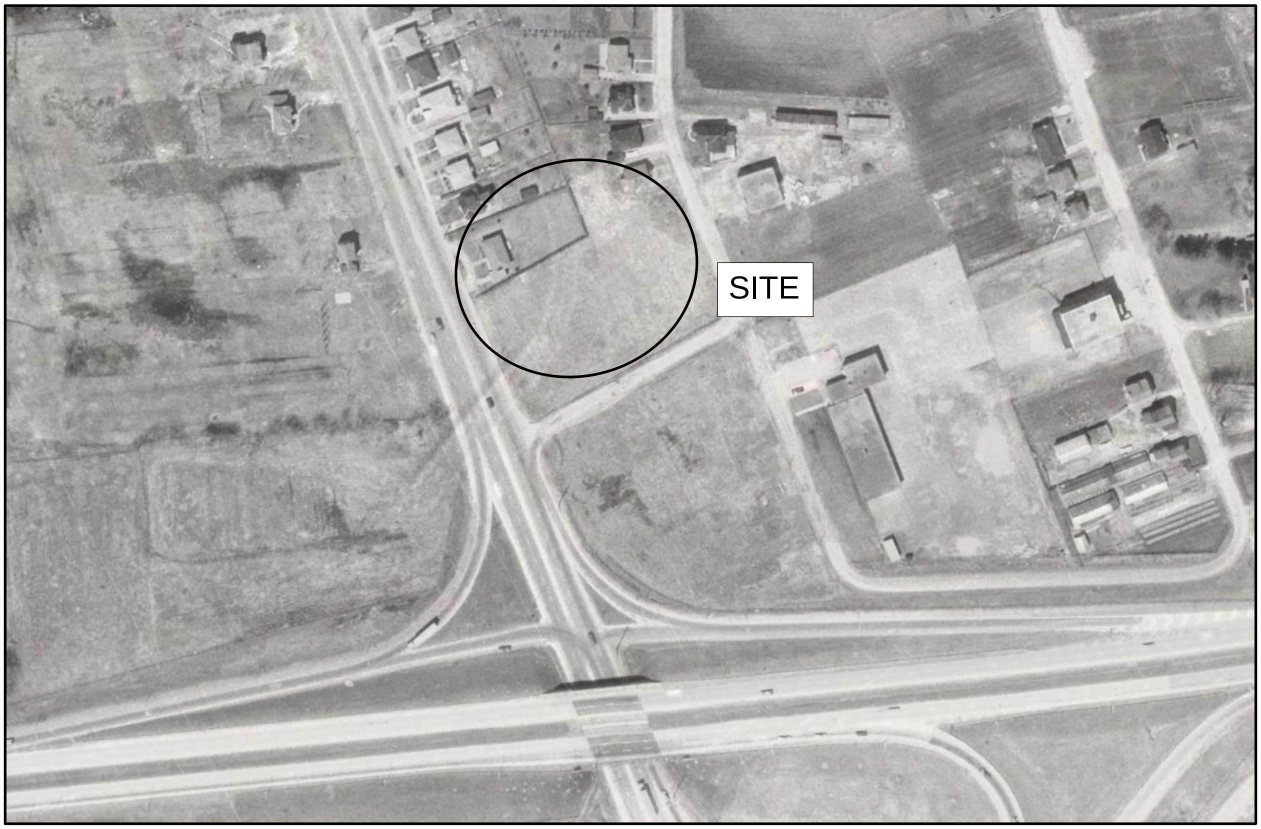


FIGURE 2

Aerial Photograph - 1965

PATERSON GROUP

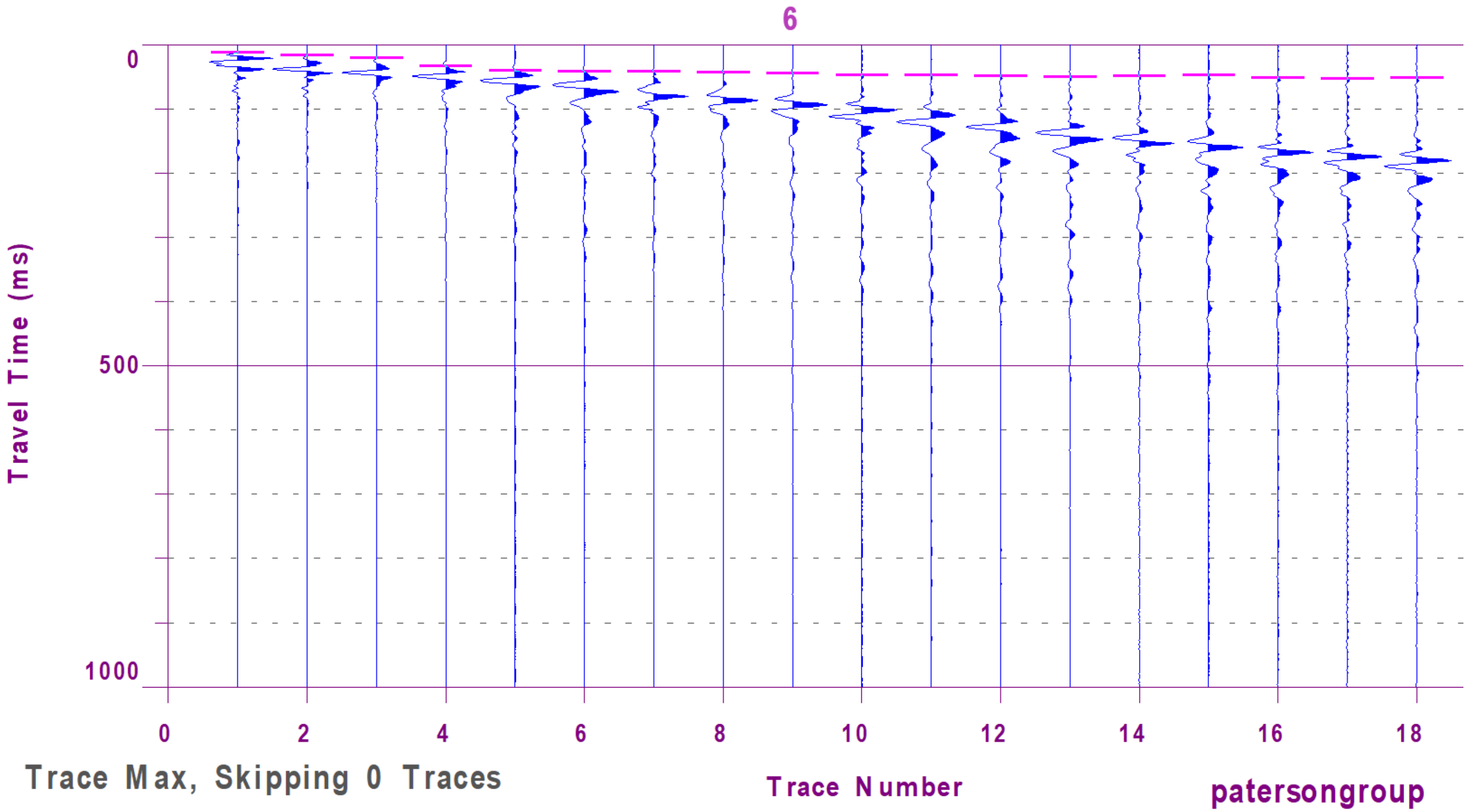


Figure 3 – Shear Wave Velocity Profile at Shot Location -3 m

PATERSON GROUP

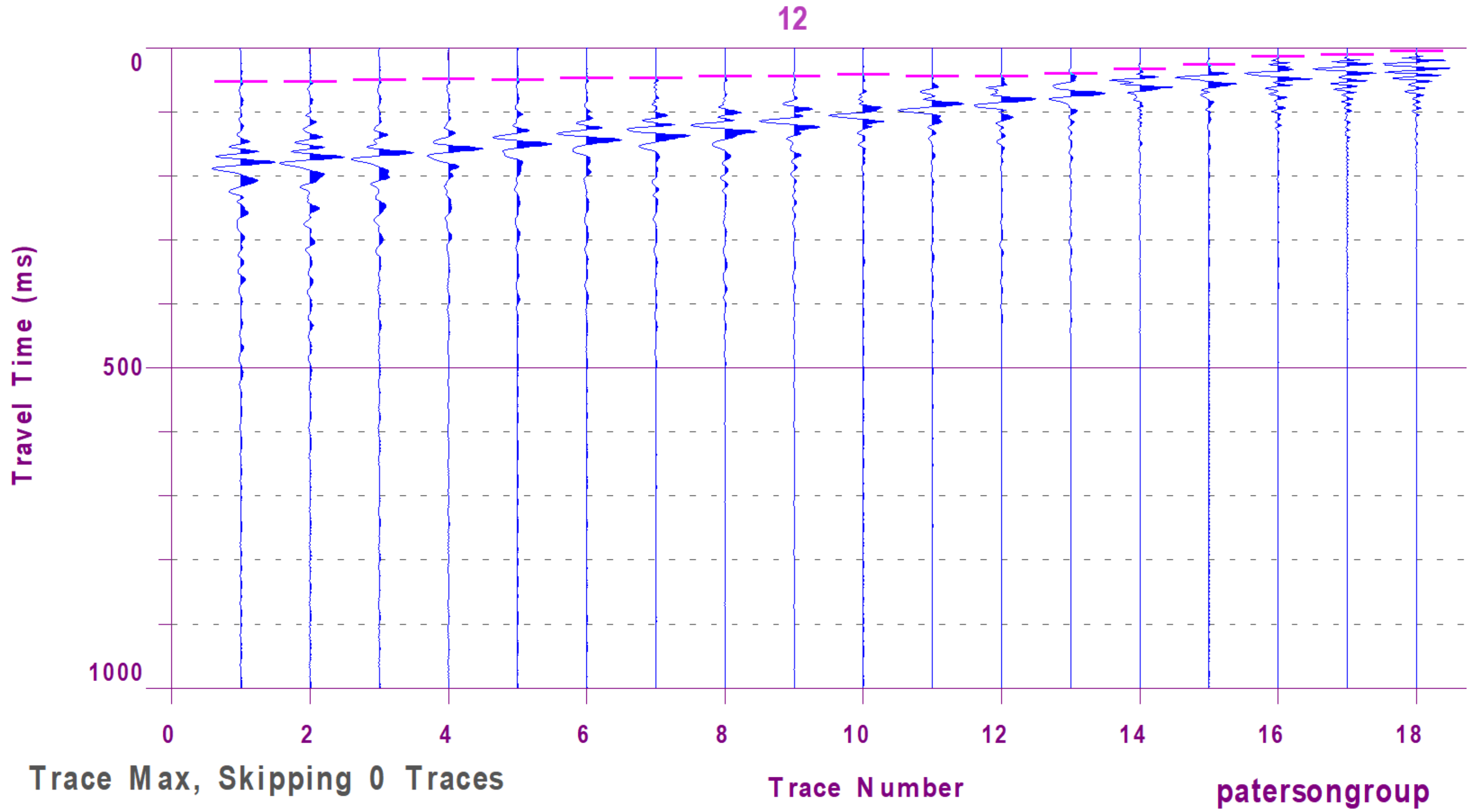
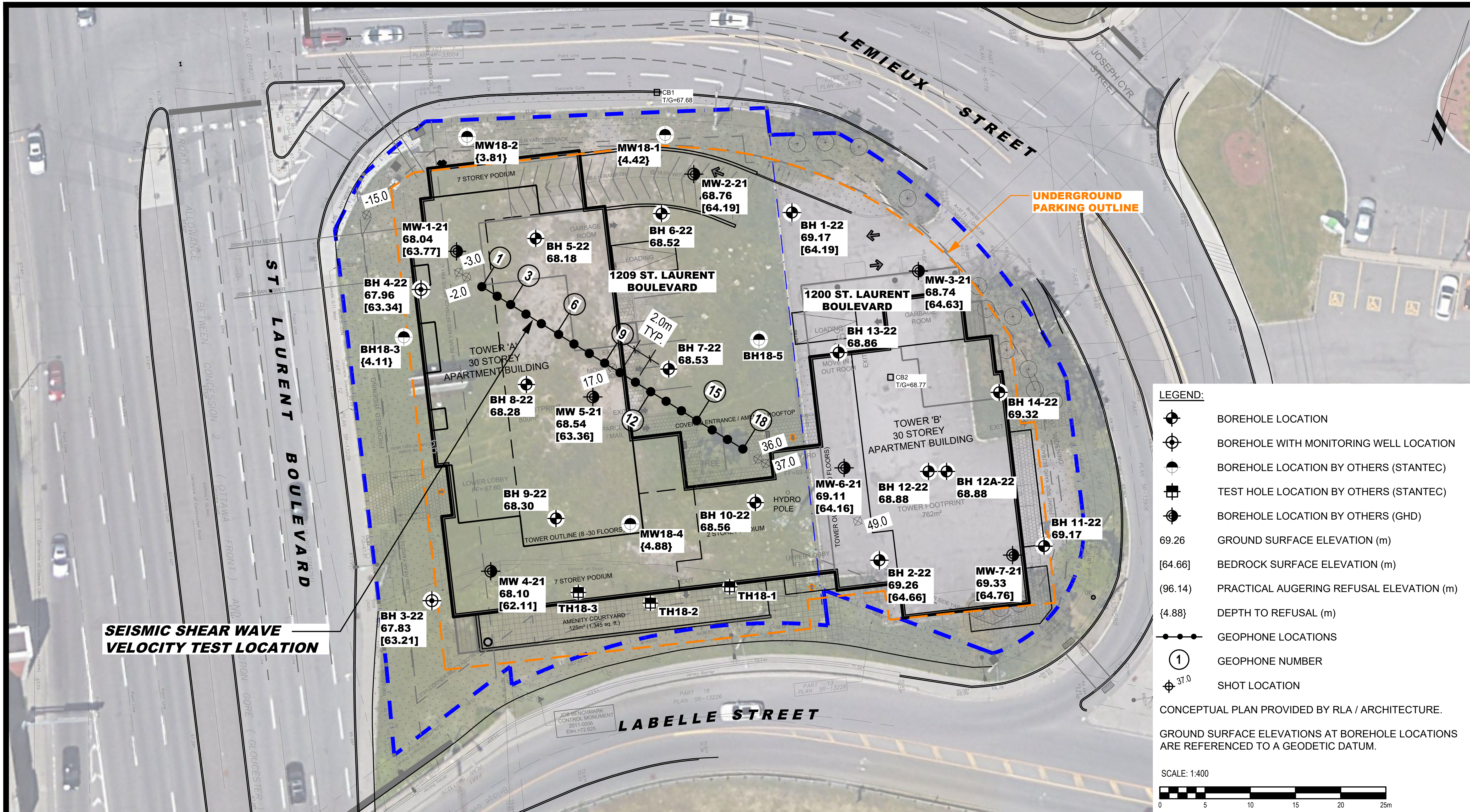


Figure 4 – Shear Wave Velocity Profile at Shot Location 2 m



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
- 1 GEOPHONE NUMBER
- 37.0 SHOT LOCATION

CONCEPTUAL PLAN PROVIDED BY RLA / ARCHITECTURE.

GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS ARE REFERENCED TO A GEODETIC DATUM.

SCALE: 1:400

0 5 10 15 20 25m

PATERSON GROUP

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

Title:

TEST HOLE LOCATION PLAN

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

p:\autocad drawings\geotechnical\pg52xx\pg5216\pg5216-1-test hole location plan (rev.01).dwg

11x17