Geotechnical Engineering

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Geotechnical Investigation

Proposed Multi-Storey Building Complex
1009 Trim Road
Ottawa, Ontario

Prepared For

Starwood Group Inc.

September 9, 2020

Report: PG5336-1 Revision 1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Starwood Group Inc. (Starwood) to carry out a geotechnical investigation for the proposed multi-storey building complex to be located at 1009 Trim Road, in the City of Ottawa (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objective of the current this geotechnical investigation was to:

☐ Determine the subsoil and groundwater conditions at this site by means of test holes.

☐ Provide geotechnical recommendations pertaining to design of the proposed development including construction considerations which may affect the design.

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

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of this present investigation.

2.0 Proposed Development

Based on available information, the proposed complex will be constructed in 2 phases. The first phase will consists of 2 multi-storey residential towers. It is understood that both towers will be constructed over an underground parking podium extending 2 levels under finished grade. The second phase will consist of a third tower located east of phase 1. The parking garage will extend beyond the footprint of each towers and cover the majority of the site. The development will also include associated asphalt covered parking areas, access lanes and landscaped areas. It is further anticipated that the site will be municipally serviced.

3.0 Method of Investigation

Field Program

A previous field program was carried out by others in 2016. At that time a total of 6 boreholes and 4 test pits were advanced to a maximum depth of 47.9 m below the existing grade. These locations of these test holes are illustrated on Drawing PG5336-1 - Test Hole Location Plan included in Appendix 2.

The field program for the current investigation was carried out on June 29 to July 2, 2020 and consisted of a total of 4 boreholes drilled and sampled to a maximum depth of 15.9 m below the existing grade. A dynamic cone penetration test (DCPT) was carried out at two boreholes (BH 3 and BH 4) to determine inferred bedrock depth which ranged from 34.0 to 41.8 m below the existing grade. The borehole locations for the current investigation were determined in the field by Paterson personnel taking into consideration existing borehole coverage and existing site features. The locations of the boreholes are illustrated on Drawing PG5336-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were put down using a track-mounted auger drill rig operated by a two person crew. All fieldwork was conducted under the full-time supervision of personnel from Paterson’s geotechnical division under the direction of a senior engineer. The testing procedure for boreholes consisted of augering to the required depths and at the selected locations and sampling the overburden.

Sampling and In Situ Testing

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

A Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split spoon samples. The SPT results are 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 sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

The thickness of the overburden was evaluated during the course of the investigation by a dynamic cone penetration test (DCPT) at all borehole locations. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at its tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

Undrained shear strength testing was carried out at regular depth intervals in cohesive soils. This testing was done in general accordance with ASTM D2573-08 - Standard Test Method for Field Vane Shear Test in Cohesive Soil. Reference should be made to the Soil Profile and Test Data Sheets provided in Appendix 1.

The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1.

Sample Storage

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

3.2 Field Survey

The test hole locations were determined by Paterson field personnel. The test hole locations and ground surface elevations at the test hole locations reference a geodetic datum. The test holes by others also reference a geodetic datum. The location of the test holes and the ground surface elevation at each test hole location, if available, are presented on Drawing PG5336-1 - Test Hole Location Plan included in Appendix 2.

3.3 Laboratory Testing

Soil samples recovered from the subject site were visually examined in our laboratory to review the field logs. All samples will be stored in the laboratory for a period of one month after the issuance of this report. They will then be discarded unless we are otherwise directed.

3.4 Analytical Testing

One soil sample was 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. If available, the results are presented in Appendix 1 and are discussed further in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The majority of the subject site is gravel covered with large boulders. Small to medium sized trees are present on the property boundaries of the subject site that border Trim Road and Inlet Private. The southern portion of the site is relatively flat and slightly above grade from Inlet Private. The site slopes towards the Ottawa river to the north, following Trim Road. An approximately 2 m high pile of boulders was observed at the northwestern portion of the site. The ground surface within the subject site slopes down gradually towards the northern portion of the site. The northern portion of the site is wet land from the Ottawa River. The site is bordered to the north by the Ottawa River, to the east by vacant treed land, to the west by Trim Road, and to the south by Inlet Private.

4.2 Subsurface Profile

Overburden

Generally, the subsurface profile at the test hole locations consists of topsoil underlain by a fill consisting of silty sand mixed with clay and/or gravel. Fill consisting of boulders and blast rock were also noted on site. A very stiff brown silty clay deposit was encountered under the fill layer. The brown silty clay was underlain by a stiff grey silty clay layer. Practical refusal to DCPT was encountered in BH3 and BH4 between 34.0 and 41.8 m below existing grade. Specific details of the soil profile at each test hole location are presented Appendix 1.

Bedrock

Based on available geological mapping, the subject site is located in an area where the bedrock consists of interbedded limestone and dolomite of the Gull River formation. The overburden drift thickness is estimated to be between 20 to 35 m.

4.3 Groundwater

The groundwater level readings are presented in Table 1. It is important to note that groundwater level readings from piezometers and monitoring wells could be influenced by surface water infiltrating the backfilled boreholes within low permeability soils, such as at the subject site. Groundwater conditions can also be estimated based on the observed colour, moisture levels and consistency of the recovered soil samples. Based on Paterson's review of the recovered soil samples, the long-term groundwater level is expected to be at a depth ranging between 4 to 5 m below existing ground surface.

Table 1 - Summary of Groundwater Levels

Borehole Number	Ground Surface Elev. (m)	Measured Groundwater Level		Recording Date
		Depth (m)	Elevation (m)	
BH1-20	46.87	4.72	42.15	July 17, 2020
BH2-20	47.73	4.51	43.22	July 17, 2020
BH3-20	49.31	4.93	44.38	July 17, 2020
MW16-1	47.30	3.29 1.5	44.01 45.80	July 17, 2020 April 7, 2016
MW16-2	47.20	2.83 5.50	44.37 41.70	July 17, 2020 April 7, 2016
MW16-3	48.80	4.10 5.02	44.70 43.78	July 17, 2020 April 7, 2016
MW16-4	47.10	2.83 2.0	44.27 45.1	July 17, 2020 April 7, 2016
MW16-5	43.6	4.80	38.80	April 7, 2016
MW16-6	43.00	1.10 0.7	41.90 42.30	July 17, 2020 April 7, 2016

Note: Ground surface elevations at the test hole locations are referenced to a geodetic datum.

5.0 Discussion

5.1 Geotechnical Assessment

Foundation Design Considerations

From a geotechnical perspective, the subject site is suitable for the proposed high-rise buildings. It is expected that the proposed high-rise buildings will be founded on end bearing piled foundations extending to the bedrock surface. It is also expected that the underground parking structure beyond the towers' extent will be founded on conventional spread footings placed on an undisturbed, very stiff to stiff silty clay bearing surface.

A control joint between the piled foundation and the underground parking foundation can be considered to avoid differential settlement. The structural design will dictate if this is required.

Permissible Grade Raise

Due to the presence of a silty clay layer, the subject site is subjected to a permissible grade restriction. Our permissible grade raise recommendations are discussed in Subsection 5.3.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and fill, such as those containing organic or deleterious materials, should be stripped from under any buildings and other settlement sensitive structures.

Fill Placement

Fill placed for grading beneath the building area should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill material should be tested and approved prior to delivery to the site. The fill should be placed in maximum 300 mm thick lifts and compacted to 98% of the material's standard Proctor maximum dry density (SPMDD).

Site-excavated soil can be placed as general landscaping fill where settlement is a minor concern of the ground surface. These materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be placed to increase the subgrade level for areas to be paved, the fill should be compacted in maximum 300 mm thick lifts and to a minimum density of 95% of the respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for placement as backfill against foundation walls due to the frost heave potential of the site excavated soils below settlement sensitive areas, such as concrete sidewalks and exterior concrete entrance areas.

Fill used for grading beneath the base and subbase layers of paved areas should consist, unless otherwise specified, of clean imported granular fill, such as OPSS Granular A, Granular B Type II or select subgrade material. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the paved areas should be compacted to at least 95% of its SPMDD.

5.3 Foundation Design

Conventional Shallow Footings

Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, placed over an undisturbed, very stiff brown silty clay bearing surface can be designed using bearing resistance value at serviceability limit states (SLS) of **200 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **300 kPa**. A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance values at ULS.

Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, placed over an undisturbed, stiff grey silty clay bearing surface can be designed using bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **250 kPa**. A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance values at ULS.

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, have been removed prior to the placement of concrete for footings.

For the parking garage, the bearing resistance value given for footings at SLS will be subjected to potential post construction total and differential settlements of 20 and 10 mm, respectively.

Footings on Lean Concrete

Where the underside of footings is located within the existing fill layer, consideration should be given to lower the footings to a native bearing surface.

Alternatively, footings can be placed over lean concrete in-filled trenches extending from design underside of footing level to the native bearing surface. The bearing surface surface should be reviewed and approved by the geotechnical consultant at the time of excavation. The near vertical, zero entry trench should extend at least 300 mm beyond the outside face of the footing and be in-filled with minimum 15 MPa lean concrete. It should be noted that the zero-entry trenches would be excavated through silty sand and therefore, the sidewalls could become unstable. Precautions should be taken during construction to ensure personnel and equipment are kept away from the top of the trenches (see Subsection 6.3).

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Above the groundwater level, adequate lateral support is provided to a stiff silty clay when a plane extending down and out from the bottom edge of the footing at a minimum of 1H:1V passes only through in situ soil or engineered fill.

Piled Foundation

It is expected that the main buildings will be constructed over concrete filled steel pipe piles driven to refusal on the bedrock surface.

For deep foundations, concrete-filled steel pipe piles are generally utilized in the Ottawa area. Applicable pile resistance at SLS values and factored pile resistance at ULS values are given in Table 1. A resistance factor of 0.4 has been incorporated into the factored ULS values. Note that these are all geotechnical axial resistance values.

The geotechnical pile resistance values were estimated using the Hiley dynamic formula, to be confirmed during pile installation with a program of dynamic monitoring. For this project, the dynamic monitoring of two (2) to four (4) piles would be recommended. This is considered to be the minimum monitoring program, as the piles under shear walls may be required to be driven using the maximum recommended driving energy to achieve the greatest factored resistance at ULS values. Re-striking of all piles at least once will also be required after at least 48 hours have elapsed since initial driving.

Table 2 - Pile Foundation Design Data

Pile Outside Diameter (mm)	Pile Wall Thickness (mm)	Geotechnical Axial Resistance		Final Set (blows/ 12 mm)	Transferred Hammer Energy (kJ)
		SLS (kN)	Factored at ULS (kN)		
245	9	925	1110	6	27
245	11	1050	1260	6	31
245	13	1200	1440	6	35

Permissible Grade Raise Recommendations

The grade raise restriction for the subject site was determined to be **2 m** above original ground surface.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Site Class D** for the proposed foundations considered at this site, as per Table 4.1.8.4.A of the OBC 2012.

Further to the above, it should be noted that liquefaction potential is assessed as part of the seismic design considerations. The silty clay deposit encountered at the subject site has been encountered during numerous geotechnical investigations completed by Paterson across the greater Ottawa area. Based on our experience, and supported by multiple laboratory testing results, this material would typically be considered highly plastic with a plasticity index (PI) greater than 20. Figure 6.15 of the Canadian Foundation Manual (2006) provides criteria for liquefaction assessment of fine-grained soils from Bray et al. (2004) as shown in Figure 1 below.

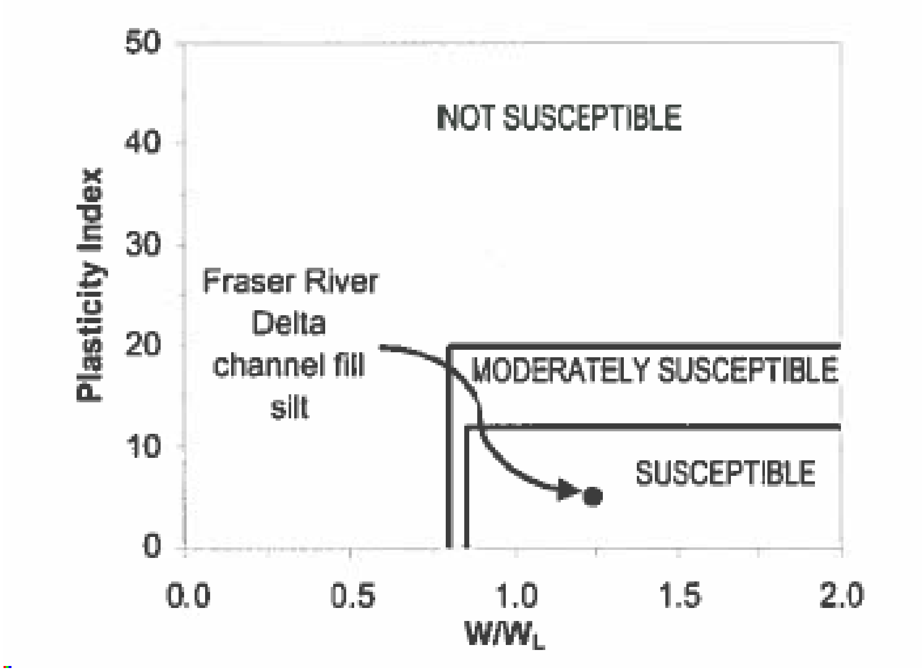


Figure 1 - Bray et al. (2004) criteria for liquefaction assessment of fine-grained soils

Based on the Atterberg Limits testing results conducted on the representative soils samples at the subject site resulting in Plasticity Index (PI) above 20 in conjunction with the site specific shear wave velocity test results, the underlying soils at the subject site not considered susceptible to liquefaction or subsequent 'earth flows' from a geotechnical perspective.

5.5 Basement Slab

The basement areas for the proposed project will be mostly parking and the recommended pavement structure noted in Subsection 5.7 will be applicable. However, if storage or other uses of the lower level where a concrete floor slab will be constructed, the upper 200 mm of sub-slab fill is recommended to consist of 19 mm clear crushed stone. The upper 200 mm of sub-slab fill is recommended to consist of OPSS Granular A crushed stone for slab on grade construction. All backfill material within the footprint of the proposed building(s) should be placed in maximum 300 mm thick loose layers and compacted to a minimum of 98% of the SPMDD.

Any soft areas should be removed and backfilled with appropriate backfill material prior to placing any fill. OPSS Granular A or Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. All backfill material within the footprint of the proposed building(s) should be placed in maximum 300 mm thick loose layers and compacted to a minimum of 98% of the SPMDD.

In consideration of the groundwater conditions encountered at the time of the current and previous fieldwork, a subfloor drainage system, consisting of lines of perforated drainage pipe subdrains connected to a positive outlet, should be provided in the clear stone under the lower basement floor (discussed in Subsection 6.1).

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 structures. 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. 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 Ottawa area is 0.32g 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 Pavement Design

Car only parking, access lanes, heavy truck parking areas, local and collector roadways are anticipated at this site. The proposed pavement structures are shown in Tables 2 and 3.

Table 3 - 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 or fill	

Table 4 - Recommended Pavement Structure - Access Lanes

Thickness mm	Material Description
40	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course** - HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil, select subgrade material or OPSS Granular B Type I or II material placed over in situ soil or fill	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

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 Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% 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.

Where silty clay is encountered at subgrade level, consideration should be given to installing subdrains during the pavement construction. These drains should be constructed according to City of Ottawa specifications. The drains should be connected to a positive outlet. The subgrade surface should be crowned to promote water flow to the drainage lines. The subdrains will help drain the pavement structure, especially in early Spring when the subgrade is saturated and weaker and, therefore, more susceptible to permanent deformation.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage/Flood Proofing

Based on the available information, the lower parking level will be located below the 100 year flood level. To limit long-term groundwater infiltration, it is recommended that a flood proofing system be designed for the proposed building. The system should consist of a water suppression system to lessen the infiltration volumes and manage discharge. Also, a perimeter foundation drainage system will be required as a secondary system to account for any groundwater which breaches the primary groundwater infiltration control system.

The groundwater infiltration control system should extend above the 1:100 year flood level and the following is suggested for preliminary design purposes:

❑ Pour a concrete mud slab at the base of the excavation to create a horizontal hydraulic barrier. Typically, the minimum thickness of the concrete mud slab is 150 mm.
❑ Place a composite drainage layer, such as Delta Drain 6000 or equivalent, over the foundation wall(as a secondary system). The composite drainage layer should extend from finished grade to underside of footing level.
❑ Place a suitable waterproofing membrane on the drainage layer, such as a bentomat liner system or equivalent. The membrane liner should extend down to footing level. The membrane liner should tie into the concrete mud slab.
❑ Pour foundation wall against the composite drainage system.

It is recommended that the composite drainage system (such as Delta Drain 6000 or equivalent) extend down to the footing level. It is recommended that 150 mm diameter sleeves at 3-6 m centres be cast in the footing or at the foundation wall/footing interface to allow the infiltration of water to flow to the interior perimeter drainage pipe. The perimeter drainage pipe and underfloor drainage system should direct water to sump pit(s) within the lower basement area.

It is important to note that the building's sump pit and elevator pit be considered for waterproofing in a similar fashion. A detail can be provided by Paterson once the design drawings are available for the elevator and sump pits.

Underfloor Drainage

It is anticipated that underfloor drainage will be required to control water infiltration. For design purposes, we recommend that 150 mm diameter perforated pipes be placed at 6 m centres. The 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

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials compacted in lifts as per Subsection 5.2 for areas where frost susceptible structures, such as the site access lane, are to be located. A frost taper should also be provided at the transition between the building face and the native, silty clay subgrade for the access lane.

The greater part of the site excavated materials will be frost susceptible and, as such, are acceptable for foundation wall backfill within landscaped finished areas only.

6.2 Protection of Footings 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 alone should be provided in this regard.

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.

The parking garage may require protection against frost action depending on the founding depth. Unheated structures, such as the access ramp wall footings, may be required to be insulated against the deleterious effect of frost action. A minimum of 2.1 m of soil cover alone, or a minimum of 0.6 m of soil cover, in conjunction with foundation insulation, should be provided.

6.3 Excavation Side Slopes

Temporary Side Slopes

The temporary excavation side slopes anticipated should either be excavated to acceptable slopes or retained by shoring systems from the beginning of the excavation until the structure is backfilled.

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 groundwater level. The subsurface soil is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should maintain safe working distance 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.

A trench box is recommended to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations should not remain open for extended periods of time.

Temporary Shoring

Temporary shoring may be required for the overburden soil to complete the required excavations where insufficient room is available for open cut methods. The shoring requirements designed by a structural engineer specializing in those works will depend on the depth of the excavation, the proximity of the adjacent structures and the elevation of the adjacent building foundations and underground services. The design and implementation of these temporary systems will be the responsibility of the excavation contractor and their design team. Inspections and approval of the temporary system will also be the responsibility of the designer. Geotechnical information provided below is to assist the designer in completing a suitable and safe shoring system. The designer should take into account the impact of a significant precipitation event and designate design measures to ensure that a precipitation will not negatively impact the shoring system or soils supported by the system. Any changes to the approved shoring design system should be reported immediately to the owner’s structural design prior to implementation.

The temporary system could consist of soldier pile and lagging system or interlocking steel sheet piling. Any additional loading due to street traffic, construction equipment, adjacent structures and facilities, etc., should be included to the earth pressures described below. These systems could be cantilevered, anchored or braced. Generally, it is expected that the shoring systems will be provided with tie-back rock anchors to ensure their stability. The shoring system is recommended to be adequately supported to resist toe failure and inspected to ensure that the sheet piles extend well below the excavation base. It should be noted if consideration is being given to utilizing a raker style support for the shoring system that lateral movements can occur and the structural engineer should ensure that the design selected minimizes these movements to tolerable levels.

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

Table 5 - 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
Dry Unit Weight (γ), kN/m^3	20
Effective Unit Weight (γ), kN/m^3	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 calculated above the groundwater level while the effective unit weight should be calculated below the groundwater level.

The hydrostatic groundwater pressure should be included to the earth pressure distribution wherever the effective unit weight are calculated for earth pressures. If the groundwater level is lowered, the dry unit weight for the soil/bedrock should be calculated full weight, with no hydrostatic groundwater pressure component. For design purposes, the minimum factor of safety of 1.5 should be calculated.

6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications & Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa. A minimum of 150 mm of OPSS Granular A should be placed for bedding for sewer or water pipes when placed on soil subgrade. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to a minimum of 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 and compacted to 95% of the material's 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 SPMDD.

To reduce long term lowering of the groundwater level at this site, clay seals should be provided in the service trenches. The seals should be at least 1.5 m long and should extend from trench wall to trench wall. Generally, the seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compatible brown silty clay placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the material's SPMDD. The clay seals should be placed at the site boundaries and at stratigic locations at no more than 60 m intervals in the service trenches.

6.5 Groundwater Control

Groundwater Control for Building Construction

It is anticipated that groundwater infiltration into the excavations should be low through the sides of the excavation and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations. The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

A temporary Ministry of the Environment, Conservation and Parks (MECP) Catergory 3 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.

Long-term Groundwater Control

The recommendations for the proposed building long-term groundwater control are presented in Subsection 6.1. Any groundwater encountered along the building perimeter or sub-slab drainage system will be directed to the proposed building cistern/sump pit. Provided the proposed groundwater infiltration control system is properly implemented and approved by the geotechnical consultant at the time of construction, the groundwater flow should be low (i.e.- less than 30,000 L/day per building) with peak periods noted after rain events. A more accurate estimate can be provided at the time of construction, once groundwater infiltration levels are observed. The groundwater flow should be controllable using conventional open sumps.

Impacts on Neighbouring Structures

Based on observations, the long term groundwater level is anticipated at depths below 4-5 m. A local groundwater lowering is anticipated under short-term conditions due to construction of the proposed building. The extent of any significant groundwater lowering should occur within a limited range of the subject site due to the minimal temporary groundwater lowering.

The neighbouring structures are expected to be founded within the brown silty clay crust bearing surface. No issues are expected, with respect to groundwater lowering, that would cause long term damage to adjacent structures surrounding the proposed building.

6.6 Winter Construction

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

The subsurface conditions mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the installation of straw, propane heaters and tarpaulins or other suitable means. 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.

The 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.

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 samples 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 an aggressive to highly aggressive corrosive environment.

7.0 Recommendations

For the foundation design data provided herein to be applicable that a materials testing and observation services program is required to be completed. The following aspects be performed by the geotechnical consultant:

- ☐ Review of the site master grading plan, once available.
- ☐ Observation of all bearing surfaces prior to the placement of concrete.
- ☐ Sampling and testing of the concrete and fill materials.
- ☐ Observation of the placement of the foundation insulation, if applicable.
- ☐ 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.
- ☐ Observation and review of placement of waterproofing and groundwater control system.
- ☐ Field density tests to determine the level of compaction achieved.
- ☐ Sampling and testing of the bituminous concrete including mix design reviews.

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

8.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review the grading plan once available. Also, our recommendations should be reviewed when the project drawings and specifications are complete.

A soils 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 that we be notified immediately in order to permit reassessment of our recommendations.

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 Starwood or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Joey R. Villeneuve, M.A.Sc., P.Eng., ing

David J. Gilbert, P.Eng.

LICENSED PROFESSIONAL ENGINEER
Sept. 9, 2020
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Report Distribution

❑ Starwood Group Inc.
❑ Paterson Group

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

TEST HOLE LOGS BY OTHERS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building Complex - 1009 Trim Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

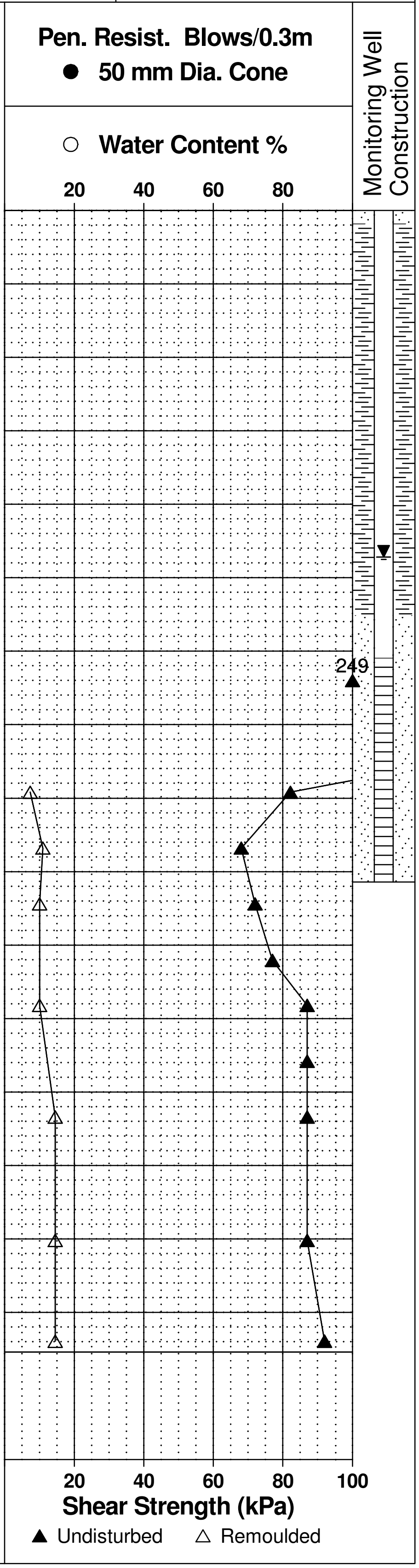
DATE June 29, 2020

FILE NO. PG5336

HOLE NO. BH 1-20

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty sand with gravel, crushed stone, trace cobbles, boulders and blast rock — 1.12	AU	1		
	SS	2	57	50+
FILL: Brown/black silty clay with gravel, trace sand, brick, occasional cobbles and boulders — 2.13	SS	3	58	11
FILL: Brown/black sand with crushed stone, shale fragments, some clay, occasional cobbles and boulders — 3.05	SS	4	50	38
	SS	5	79	14
FILL: Grey-brown silty clay, some sand, gravel, trace cobbles, plastic, organics — 6.10	SS	6	75	17
	SS	7	50	P
	SS	8	54	P
Hard to very stiff, brown **SILTY CLAY** - stiff and grey by 8.3m depth	SS	9	88	
	SS	10	92	
	SS	11	83	
	SS	12	100	
	SS	13	100	
— 15.54	SS	14	50	P
End of Borehole (GWL @ 4.72m - July 17, 2020)				

DEPTH (m)	ELEV. (m)
0	46.87
1	45.87
2	44.87
3	43.87
4	42.87
5	41.87
6	40.87
7	39.87
8	38.87
9	37.87
10	36.87
11	35.87
12	34.87
13	33.87
14	32.87
15	31.87

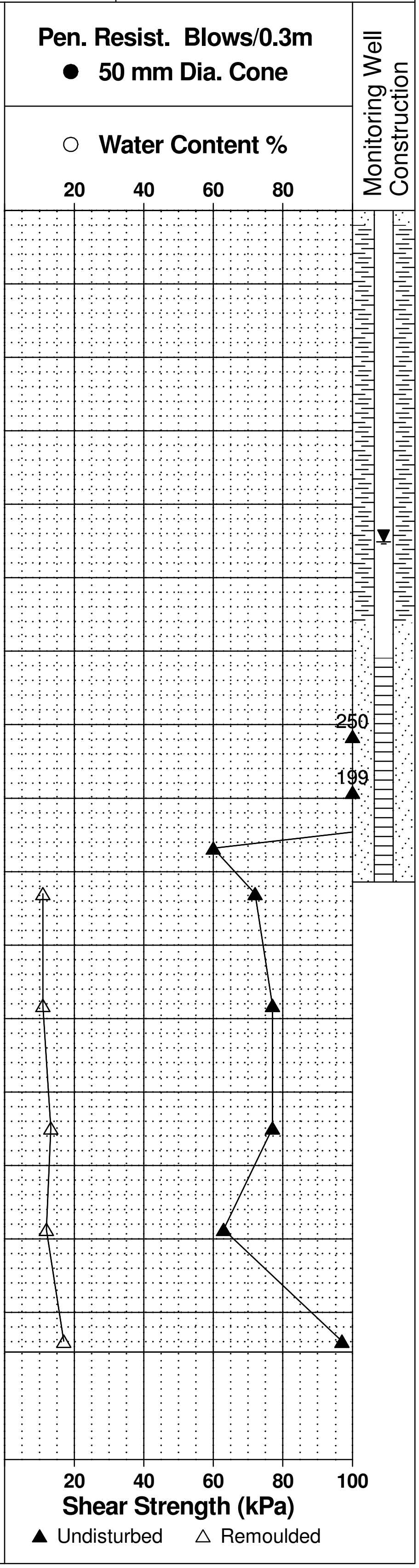


SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building Complex - 1009 Trim Road
Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY Track-Mount Power Auger
DATE June 30, 2020
FILE NO. PG5336
HOLE NO. BH 2-20

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	47.73
FILL: Brown silty sand with crushed stone, trace organics, occasional boulders and blast rock	AU	1				
	SS	2	10	13	1	46.73
1.37						
FILL: Brown to grey silty clay, some sand and crushed stone, occasional boulders - some wood from 3.8 to 4.1m depth	SS	3	42	18	2	45.73
	SS	4	50	7	3	44.73
	SS	5	50	43		
	SS	6	17	18	4	43.73
	SS	7	33	3	5	42.73
	SS	8	17	3		
6.10					6	41.73
Hard to very stiff, brown **SILTY CLAY** - stiff and grey by 8.2m depth	SS	9	100	9		
	SS	10	75	P	7	40.73
	SS	11	100	P	8	39.73
	SS	12	100	P	9	38.73
					10	37.73
					11	36.73
					12	35.73
	SS	13	100	P	13	34.73
					14	33.73
					15	32.73
15.54						
End of Borehole (GWL @ 4.51m - July 17, 2020)						



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building Complex - 1009 Trim Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Track-Mount Power Auger

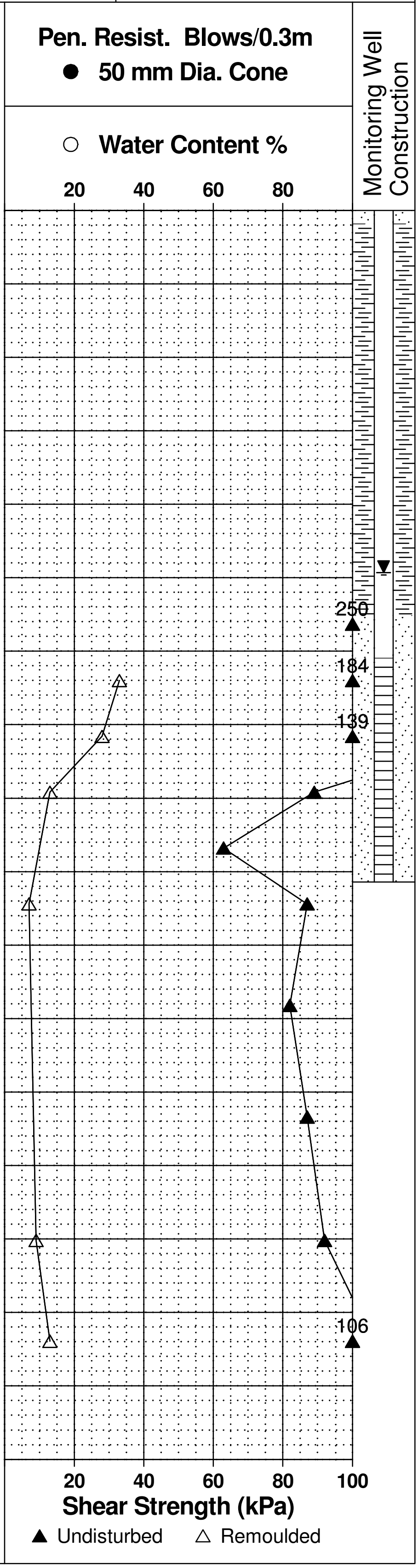
DATE July 2, 2020

FILE NO. PG5336

HOLE NO. BH 3-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
FILL: Brown silty sand with crushed stone, occasional cobbles, boulders and blast rock		AU	1		
		SS	2	33	50+
1.52					
FILL: Brown sity clay, trace sand, gravel and wood		SS	3	0	10
		SS	4	58	3
		SS	5	83	18
3.96					
Hard to very stiff, brown **SILTY CLAY**		SS	6	75	19
		SS	7	92	16
		SS	8	92	P
		SS	9	92	P
		SS	10	96	P
		SS	11	92	P
- stiff and grey by 8.4m depth		SS	12	96	P
		SS	13	100	P
		SS	14	96	P
15.54					
Dynamic Cone Penetration Test commenced at 15.54m depth. Cone pushed to 31.7m depth.					

DEPTH (m)	ELEV. (m)
0	49.31
1	48.31
2	47.31
3	46.31
4	45.31
5	44.31
6	43.31
7	42.31
8	41.31
9	40.31
10	39.31
11	38.31
12	37.31
13	36.31
14	35.31
15	34.31
16	33.31
17	32.31



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SOIL PROFILE AND TEST DATA

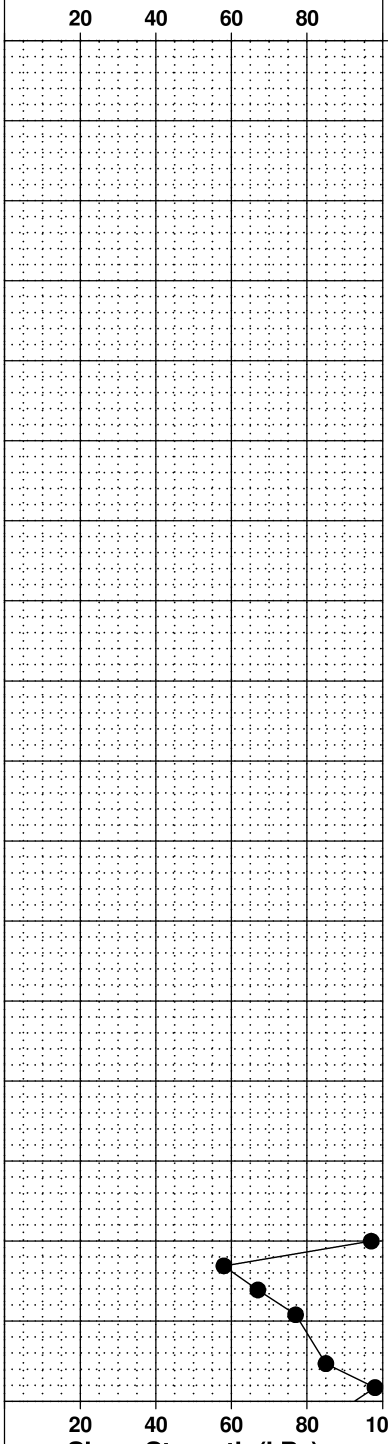
Geotechnical Investigation
Prop. Multi-Storey Building Complex - 1009 Trim Road
Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY Track-Mount Power Auger
DATE July 2, 2020
FILE NO. PG5336
HOLE NO. BH 3-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
GROUND SURFACE		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
						17	32.31
						18	31.31
						19	30.31
						20	29.31
						21	28.31
						22	27.31
						23	26.31
						24	25.31
						25	24.31
						26	23.31
						27	22.31
						28	21.31
						29	20.31
						30	19.31
						31	18.31
						32	17.31
						33	16.31
						34	15.31

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

○ Water Content %



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Monitoring Well Construction

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building Complex - 1009 Trim Road
Ottawa, Ontario

DATUM Geodetic

REMARKS

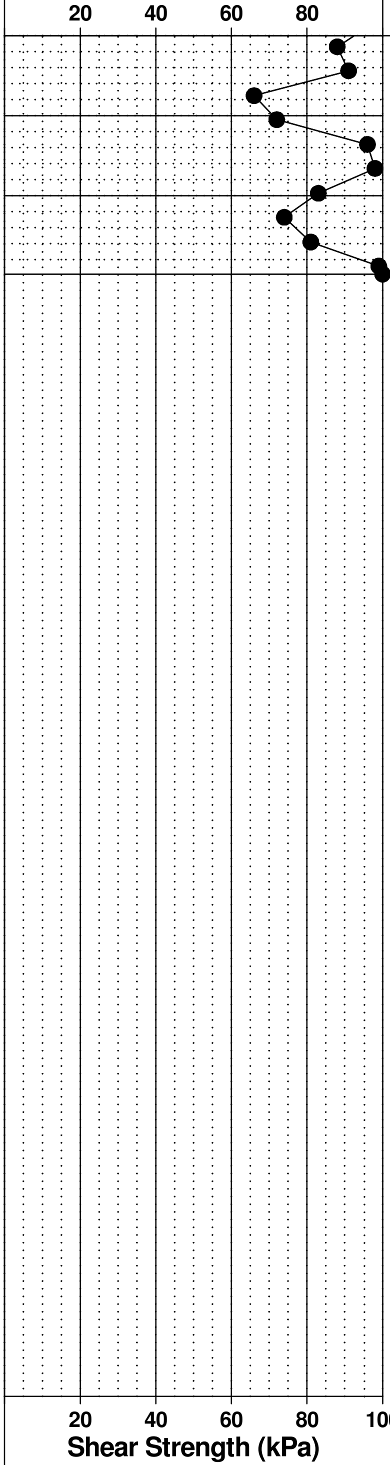
BORINGS BY Track-Mount Power Auger

DATE July 2, 2020

FILE NO. PG5336

HOLE NO. BH 3-20

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 %	Monitoring Well Construction
GROUND SURFACE						34	15.31		
						35	14.31		
						36	13.31		
36.98									
End of Borehole Practical DCPT refusal at 36.98m depth. (GWL @ 4.93m - July 17, 2020)									



▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building Complex - 1009 Trim Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5336

REMARKS

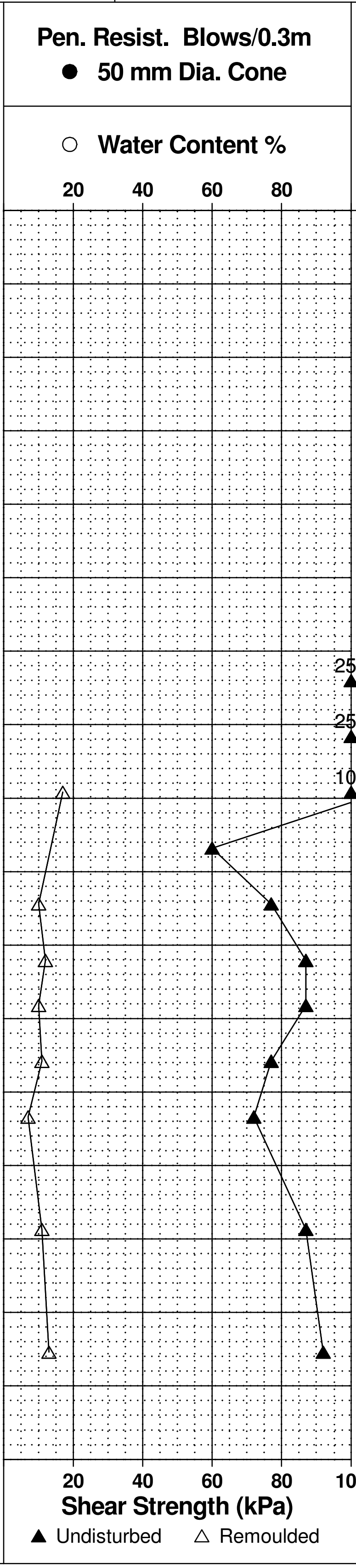
HOLE NO. BH 4-20

BORINGS BY Track-Mount Power Auger

DATE June 30, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
FILL: Brown silty sand, some gravel, trace organics, cobbles and boulders (0.60)	▨	AU	1		
FILL: Brown sand with crushed stone (0.76)	▨	SS	2	33	14
FILL: Grey-brown silty clay, trace sand, gravel and topsoil - trace wood by 5.2m depth (5.69)	▨	SS	3	4	9
		SS	4	75	5
		SS	5	29	P
		SS	6	92	7
		SS	7	62	4
		SS	8	88	6
Hard to very stiff, brown **SILTY CLAY** - stiff and grey by 8.7m depth (15.85)	▨	SS	9	100	P
		SS	10	100	P
		SS	11	100	P
		SS	12	100	P
		SS	13	83	P
		SS	14	100	P
		SS	15	100	P
Dynamic Cone Penetration Test commenced at 15.85m depth. Cone pushed to 41.1m depth.					

DEPTH (m)	ELEV. (m)
0	48.90
1	47.90
2	46.90
3	45.90
4	44.90
5	43.90
6	42.90
7	41.90
8	40.90
9	39.90
10	38.90
11	37.90
12	36.90
13	35.90
14	34.90
15	33.90
16	32.90
17	31.90



Monitoring Well Construction

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building Complex - 1009 Trim Road
Ottawa, Ontario

DATUM Geodetic

FILE NO. **PG5336**

REMARKS

HOLE NO. **BH 4-20**

BORINGS BY Track-Mount Power Auger

DATE June 30, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Monitoring Well Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE									
						17	31.90		
						18	30.90		
						19	29.90		
						20	28.90		
						21	27.90		
						22	26.90		
						23	25.90		
						24	24.90		
						25	23.90		
						26	22.90		
						27	21.90		
						28	20.90		
						29	19.90		
						30	18.90		
						31	17.90		
						32	16.90		
						33	15.90		
						34	14.90		

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building Complex - 1009 Trim Road
Ottawa, Ontario

DATUM Geodetic

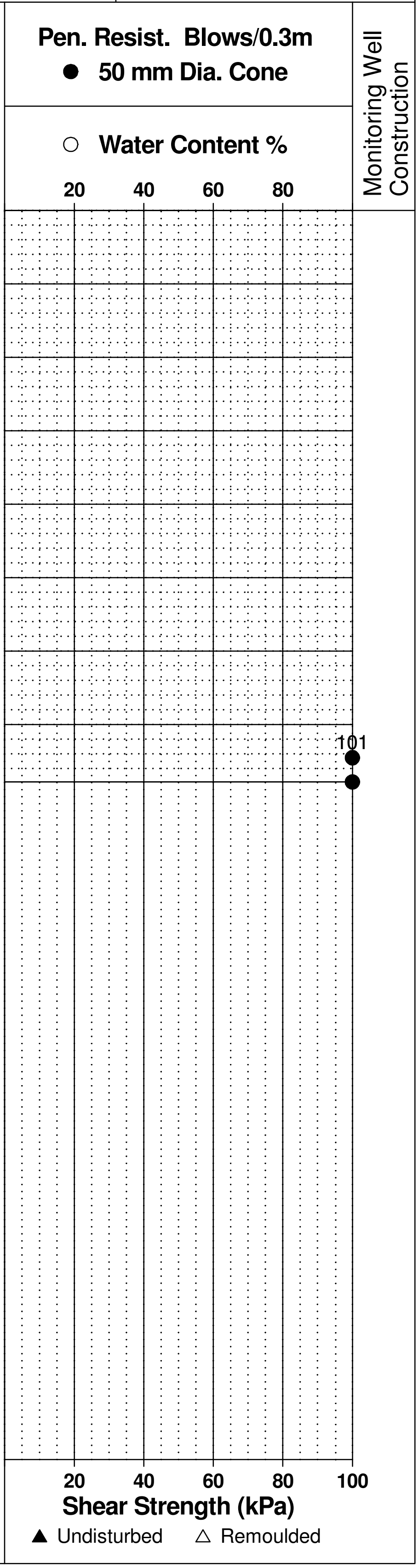
FILE NO. PG5336

REMARKS

HOLE NO. BH 4-20

BORINGS BY Track-Mount Power Auger **DATE** June 30, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
						34	14.90
						35	13.90
						36	12.90
						37	11.90
						38	10.90
						39	9.90
						40	8.90
						41	7.90
41.78							
End of Borehole Practical DCPT refusal at 41.78m depth.							



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 relative strength of cohesionless soils is the compactness condition, 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. An SPT N value of “P” denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	‘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 shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

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, S_t, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity: $S_t < 2$
Medium Sensitivity: $2 < S_t < 4$
Sensitive: $4 < S_t < 8$
Extra Sensitive: $8 < S_t < 16$
Quick Clay: $S_t > 16$

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 NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, 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, generally recovered using a piston sampler
G - "Grab" sample from test pit or surface materials
AU - Auger sample or bulk sample
WS - Wash sample
RC - Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC% - Natural water content or water content of sample, %
LL - Liquid Limit, % (water content above which soil behaves as a liquid)
PL - Plastic Limit, % (water content above which soil behaves plastically)
PI - Plasticity Index, % (difference between LL and PL)

Dxx - Grain size at which xx% of the soil, by weight, is of finer grain sizes
These grain size descriptions are not used below 0.075 mm grain size
D10 - Grain size at which 10% of the soil is finer (effective grain size)
D60 - Grain size at which 60% of the soil is finer

Cc - Concavity coefficient = $(D30)^2$ / (D10 x 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)

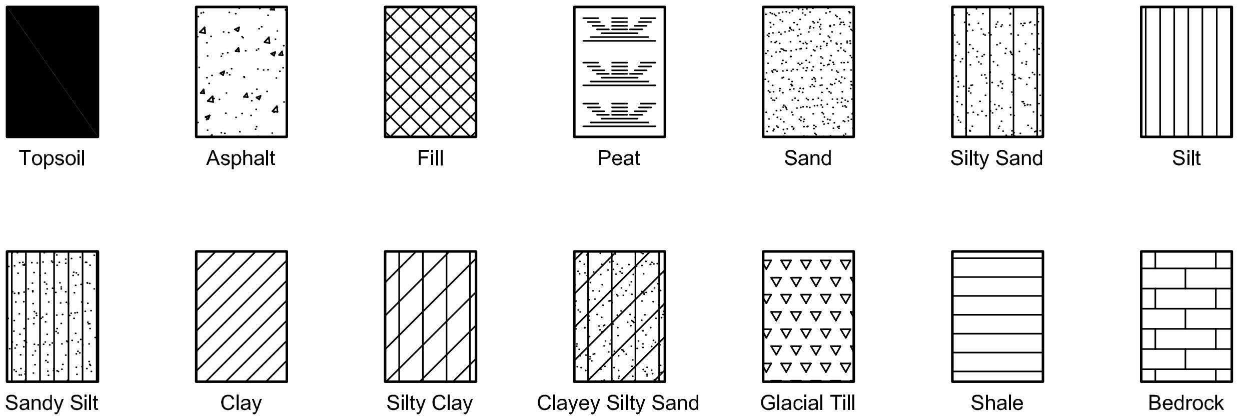
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

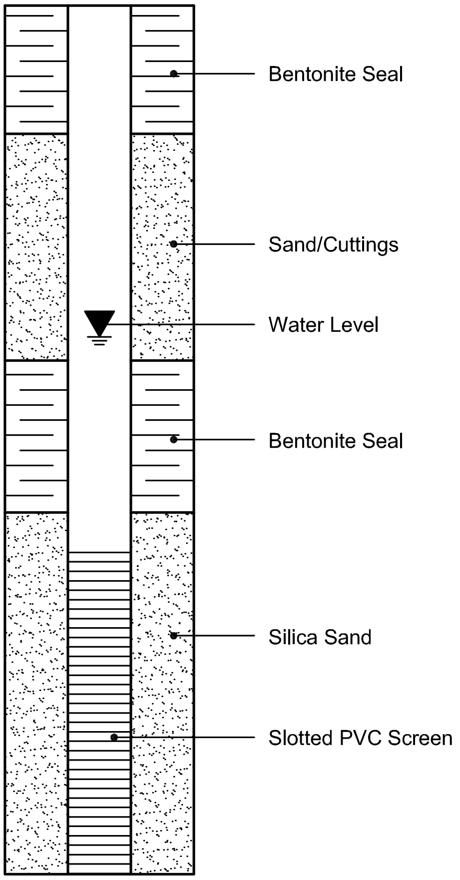
SYMBOLS AND TERMS (continued)

STRATA PLOT

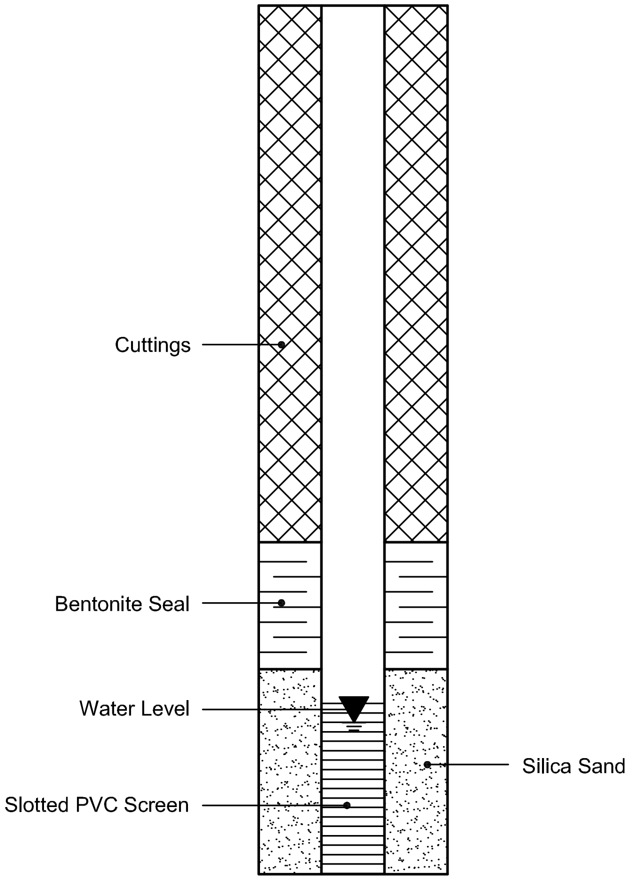


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



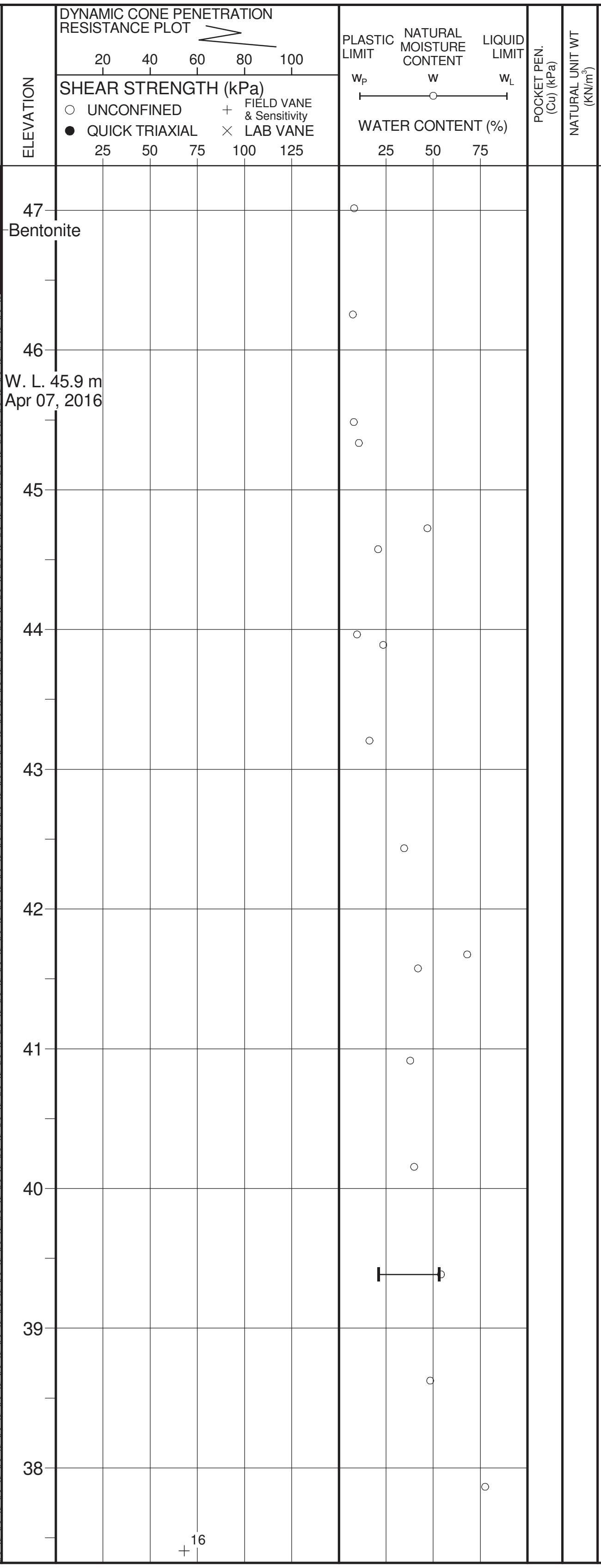
LOG OF BOREHOLE MW16-1

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 5038380 E 462237

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter: 76 mm

Project No.: 161-03361-00
Date Started: 3/24/2016
Supervisor:
Reviewer:

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
47.3						
0.0	**CRUSHED SAND AND GRAVEL** trace to some silt, trace to some clay, grey, wet, compact (FILL)	1	SS	28	Bentonite	
	- loose below 0.75 m	2	SS	5		
					W. L. 45.9 m Apr 07, 2016	
45.5 1.8	**CLAYEY SILT** some sand, some gravel, dark brown, moist, loose to compact (FILL)	3A 3B	SS	10		
44.7 2.7	**SILTY SAND** some gravel,brown, moist (FILL)	4 4B	SS	8		19 56 (25)
44.3 3.1	**SAND AND GRAVEL** brown, mosit (FILL)					
44.1 3.2	**CLAYEY SILT** some sand, trace gravel, grey-brown, wet, loose to compact (FILL)	5A 5B	SS	19		
	- Shale Fragments below 3.8 m	6	SS	8		
	- very loose below 4.8 m in depth	7	SS	2		
42.0 5.3	**SILTY SAND ORGANIC SOIL** trace wood, light brown, wet					
41.8 5.5	**CLAYEY SILT**: trace gravel, grey-brown, wet (FILL)	8A 8B	SS	2		
41.2 6.1	**SILTY CLAY** brown-grey, wet, very stiff (WEATHERED CRUST)	9	SS	19		
		10	SS	20		
	- stiff	11	SS	4		0 0 40 60
38.9 8.4	**SILTY CLAY** grey, wet, stiff	12	SS	2		
		13	SS	WH		
			VANE			



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GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▽

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

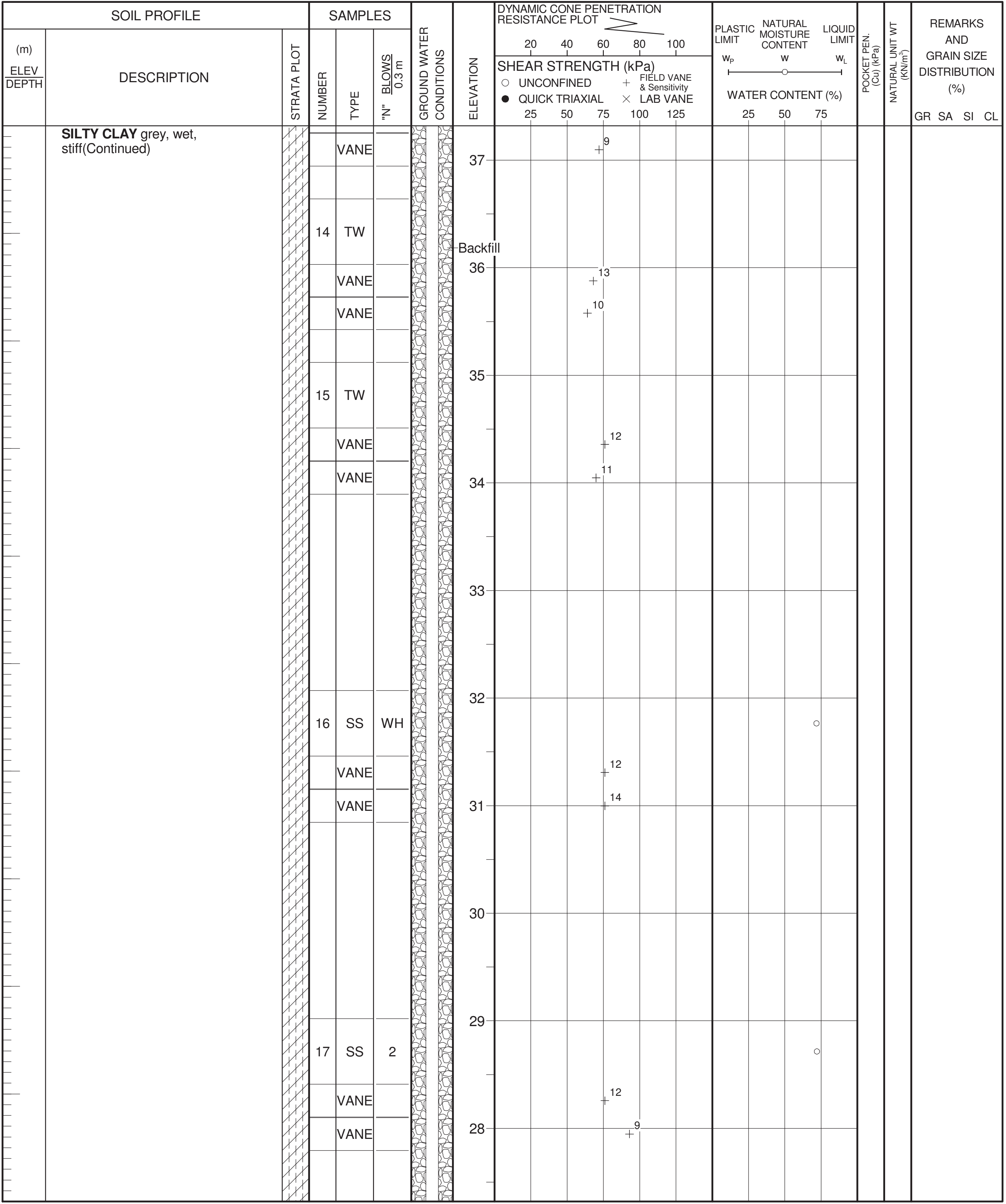
WSP SOIL LOG - OTTAWA GEOTECHNICAL BH LOGS - 1009 TRIM ROAD, OTTAWA, ONTARIO.GPJ SPL.GDT 5/5/16

LOG OF BOREHOLE MW16-1

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 5038380 E 462237

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter: 76 mm

Project No.: 161-03361-00
Date Started: 3/24/2016
Supervisor:
Reviewer:



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GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▼

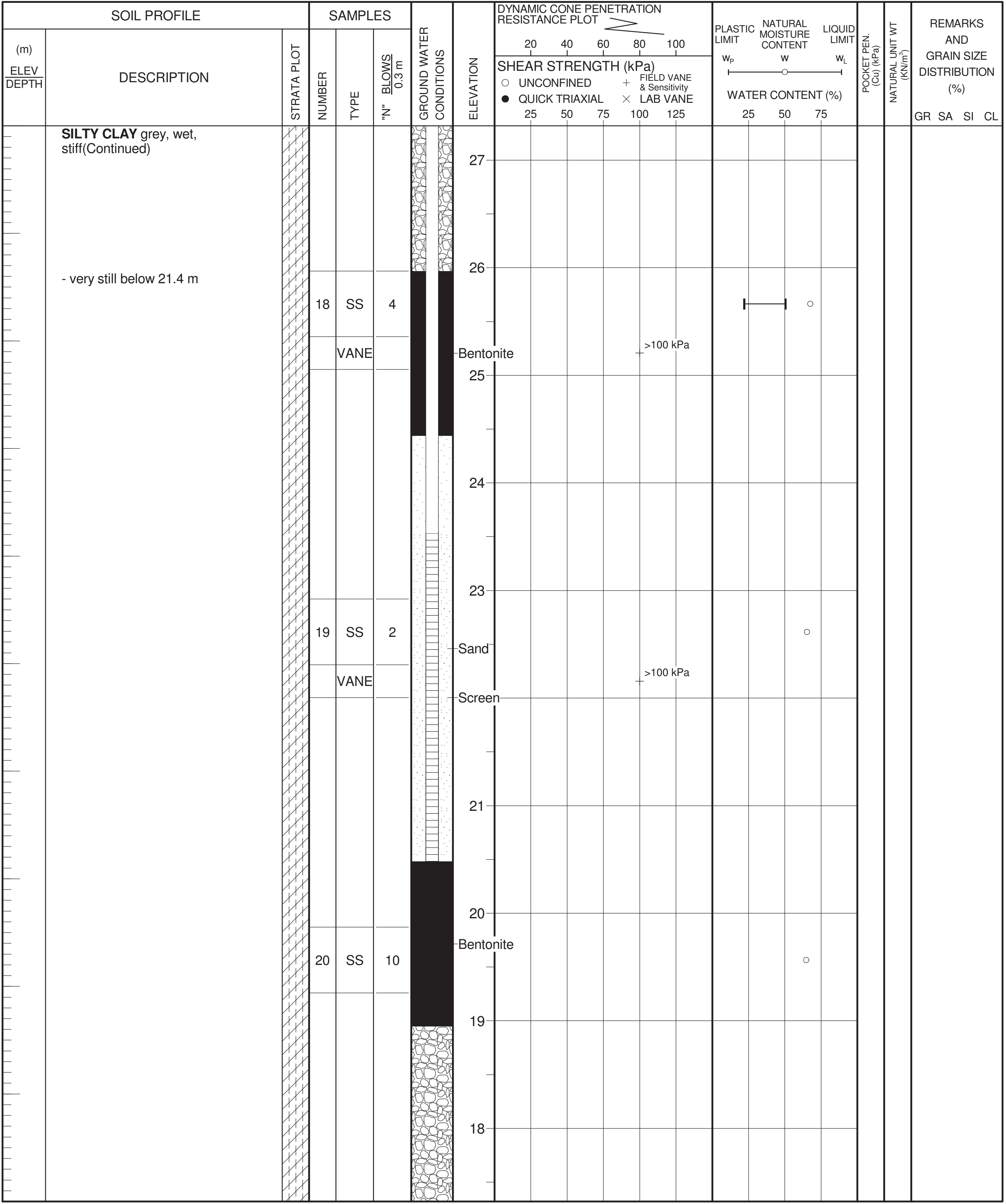
GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE MW16-1

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 5038380 E 462237

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter: 76 mm

Project No.: 161-03361-00
Date Started: 3/24/2016
Supervisor:
Reviewer:



Description	Number	Type	"N" Blows/0.3 m
SILTY CLAY grey, wet, stiff(Continued)			
- very still below 21.4 m	18	SS	4
		VANE	
	19	SS	2
		VANE	
	20	SS	10

Continued Next Page

GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▽

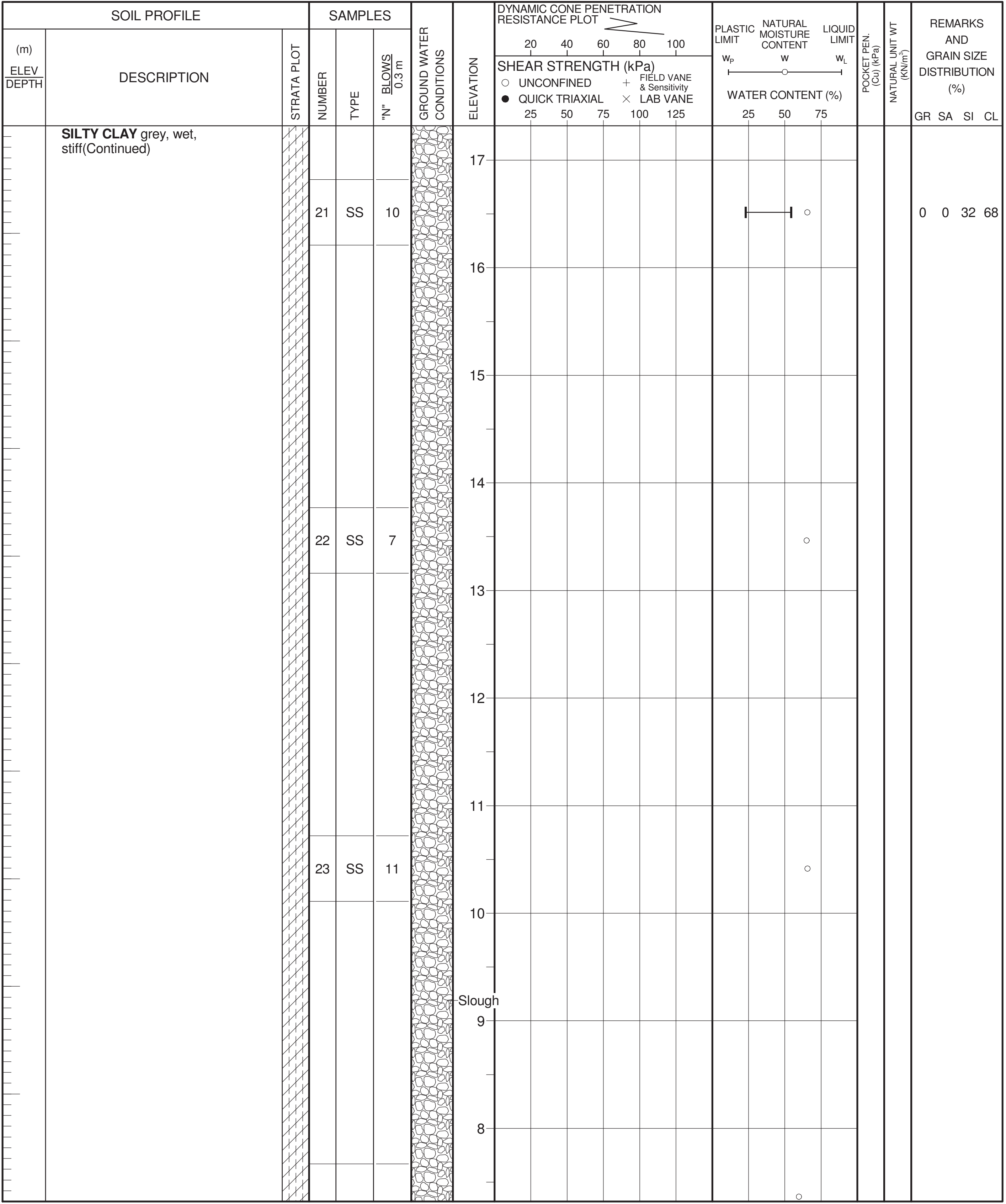
GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE MW16-1

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 5038380 E 462237

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter: 76 mm

Project No.: 161-03361-00
Date Started: 3/24/2016
Supervisor:
Reviewer:



SILTY CLAY grey, wet, stiff(Continued)

Number	Type	"N" Blows/0.3 m	GR	SA	SI	CL
21	SS	10	0	0	32	68
22	SS	7				
23	SS	11				

Continued Next Page

GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

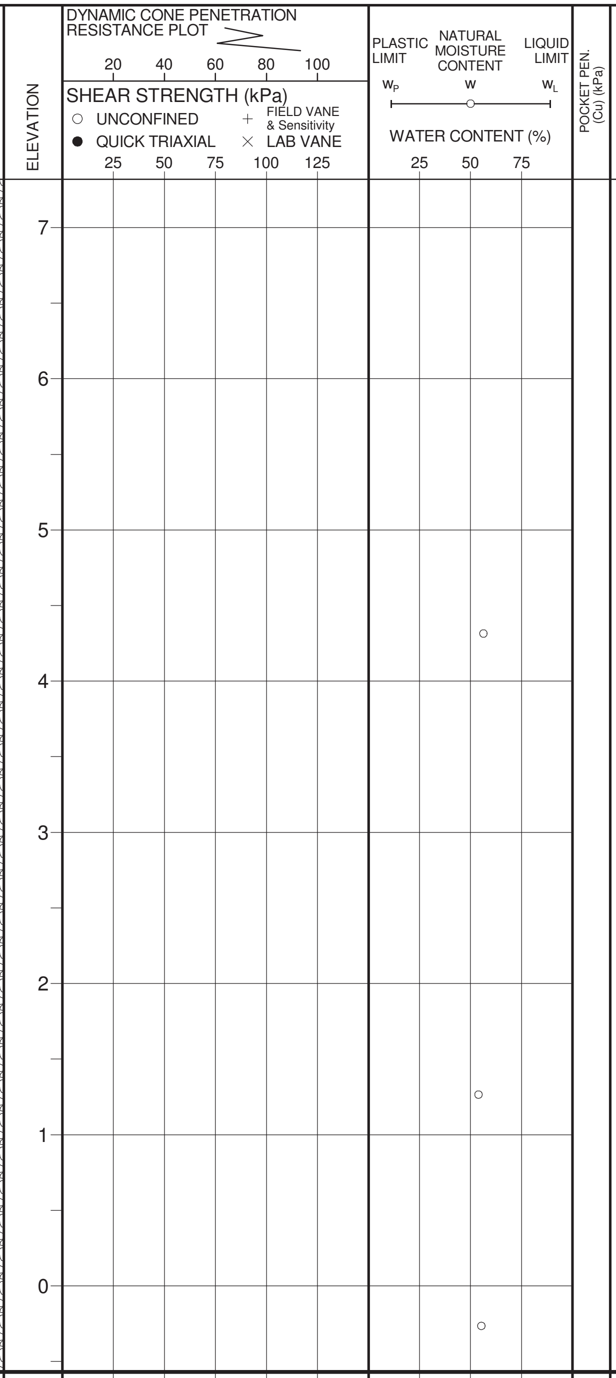
LOG OF BOREHOLE MW16-1

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 5038380 E 462237

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter: 76 mm

Project No.: 161-03361-00
Date Started: 3/24/2016
Supervisor:
Reviewer:

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			
	SILTY CLAY grey, wet, stiff(Continued)		24	SS	13			
			25	SS	12			
			26	SS	14			
			27	SS	14			
-0.6 47.9	**END OF BOREHOLE**							



1) Borehole terminated at 47.9 m below the existing ground surface.
2) 31 mm monitoring well installed at 26.8 m below the existing ground surface.
3) Date Groundwater Depth

Date	Groundwater Depth
4/7/2016	1.5 m

GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▽

GRAPH NOTES + ³, × ³: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE MW16-2

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462330 E 5038430

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/22/2016
Supervisor:
Reviewer:

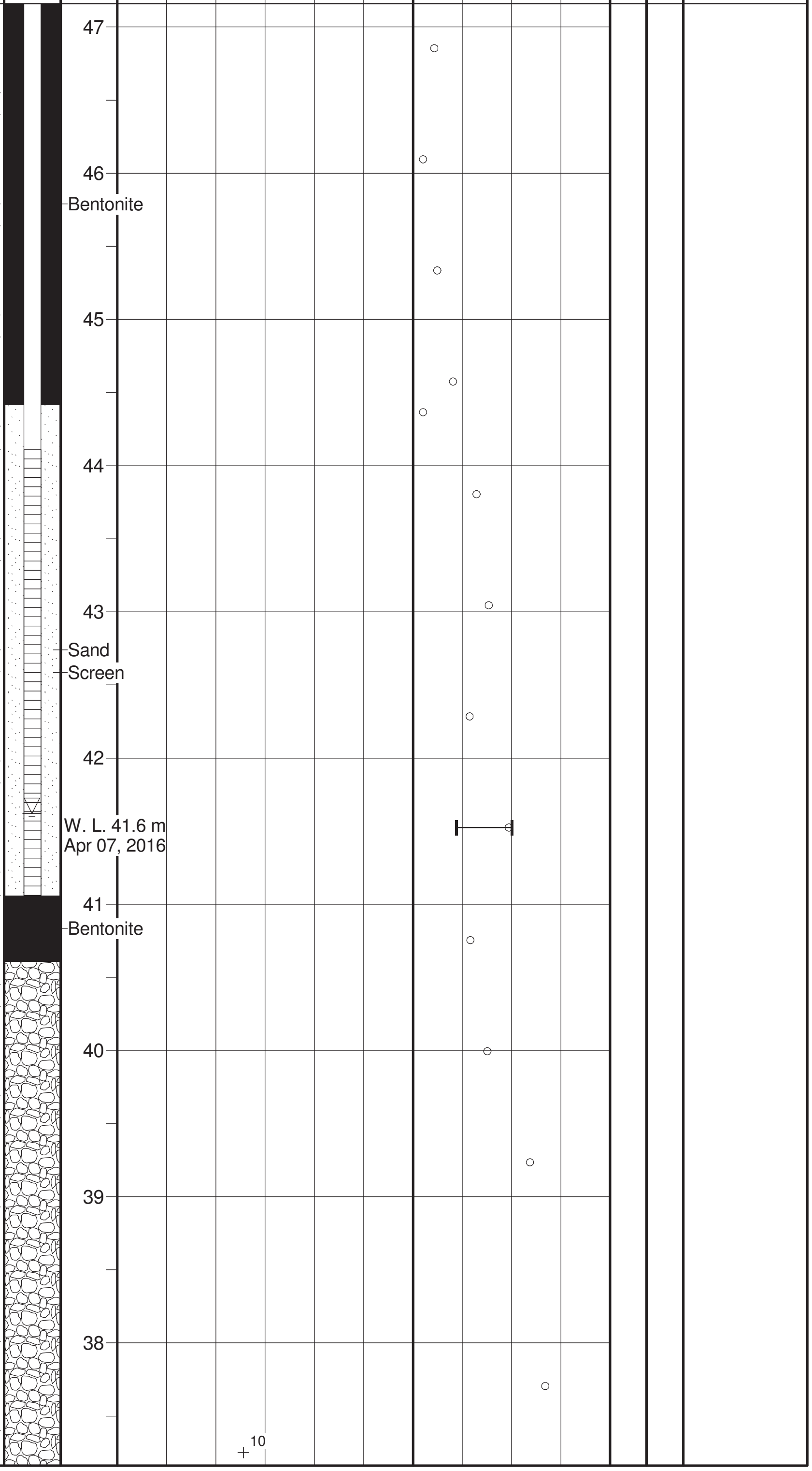
SOIL PROFILE

ELEV (m)	DEPTH (m)	DESCRIPTION
47.2	0.0	**CRUSHED SAND AND GRAVEL** trace to some silt, trace to some clay, grey, compact to very dense (FILL) - grey
44.5	2.7	**GRAVEL**: black, mosit (FILL)
44.3	2.9	**SILTY CLAY**: grey brown, firm to very stiff, moist to wet, (WEATHERED CRUST)
39.5	7.6	**SILTY CLAY**: grey, wet, stiff

SAMPLES

NUMBER	TYPE	"N" BLOWS 0.3 m
1	SS	12
2	SS	50/ 150 mm
3	SS	11
4A	SS	11
4B		
5	SS	12
6	SS	10
7	SS	16
8	SS	6
9	SS	21
10	SS	12
11	SS	2
12	SS	1
	VANE	

GROUND WATER CONDITIONS | ELEVATION | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 | SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125 | PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 25 50 75 | POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (KN/m³) | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL



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GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▽

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

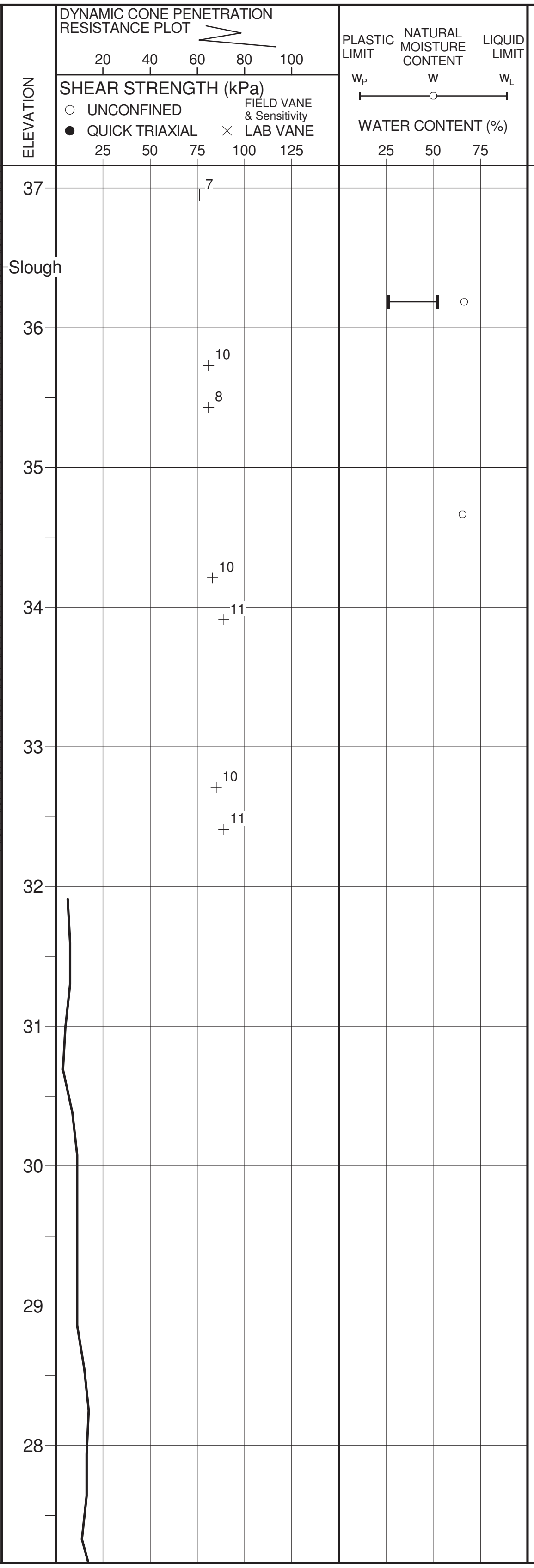
LOG OF BOREHOLE MW16-2

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462330 E 5038430

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/22/2016
Supervisor:
Reviewer:

(m) ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION	FIELD VANE & Sensitivity	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY: grey, wet, stiff(Continued)		VANE			37	7	
					Slough			
		13	SS	WH		36		0 0 48 52
			VANE				10	
			VANE				8	
		14	SS	WH		35		
			VANE				10	
			VANE			34	11	
			VANE			33	10	
			VANE				11	
32.3 14.9	**SILTY CLAY**(Inferred based on DCPT results)					32		
						31		
						30		
						29		
						28		



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GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▼

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

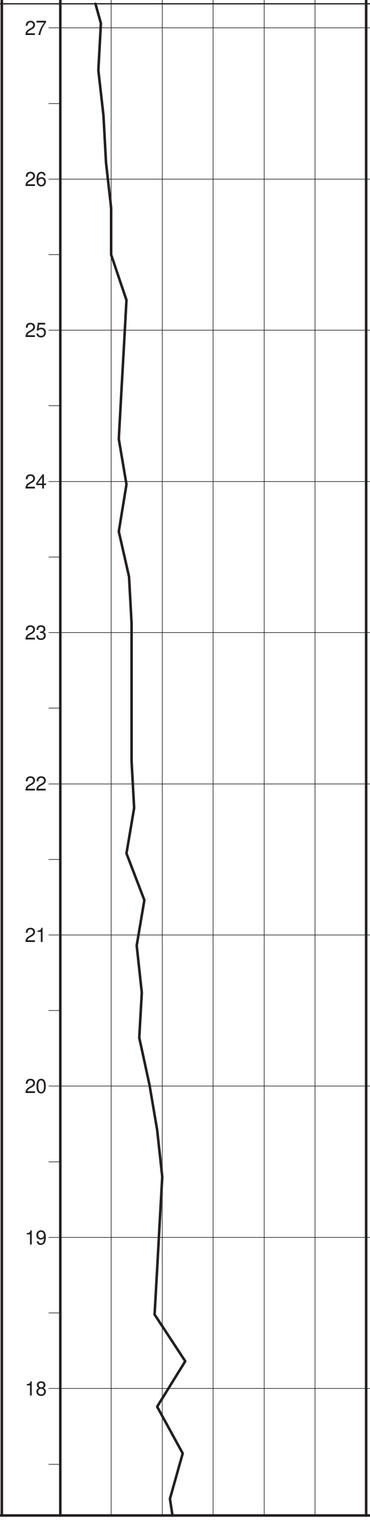
LOG OF BOREHOLE MW16-2

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462330 E 5038430

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/22/2016
Supervisor:
Reviewer:

SOIL PROFILE			SAMPLES									
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 25 50 75	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY(Inferred based on DCPT results)(Continued)											



WSP SOIL LOG - OTTAWA GEOTECHNICAL BH LOGS - 1009 TRIM ROAD, OTTAWA, ONTARIO.GPJ SPL.GDT 5/5/16

Continued Next Page

GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▽

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

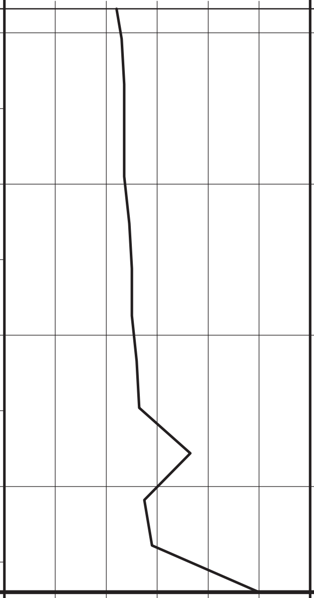
LOG OF BOREHOLE MW16-2

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462330 E 5038430

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/22/2016
Supervisor:
Reviewer:

SOIL PROFILE			SAMPLES										
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 25 50 75	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY(Inferred based on DCPT results)(Continued)						17 16 15 14					
13.3 33.9	**END OF BOREHOLE** 1) Augering 14.9 m below the existing ground surface, switch to DCPT. 2) Borehole dry at completion of augering. 3) DCPT refusal at 33.9 m below the existing ground surface. 4) 31 mm monitoring well installed at 6.1 m below the existing ground surface. 5) Date Groundwater Depth 4/7/2016 5.5 m											



WSP SOIL LOG - OTTAWA GEOTECHNICAL BH LOGS - 1009 TRIM ROAD, OTTAWA, ONTARIO.GPJ SPL.GDT 5/5/16

GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▽

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

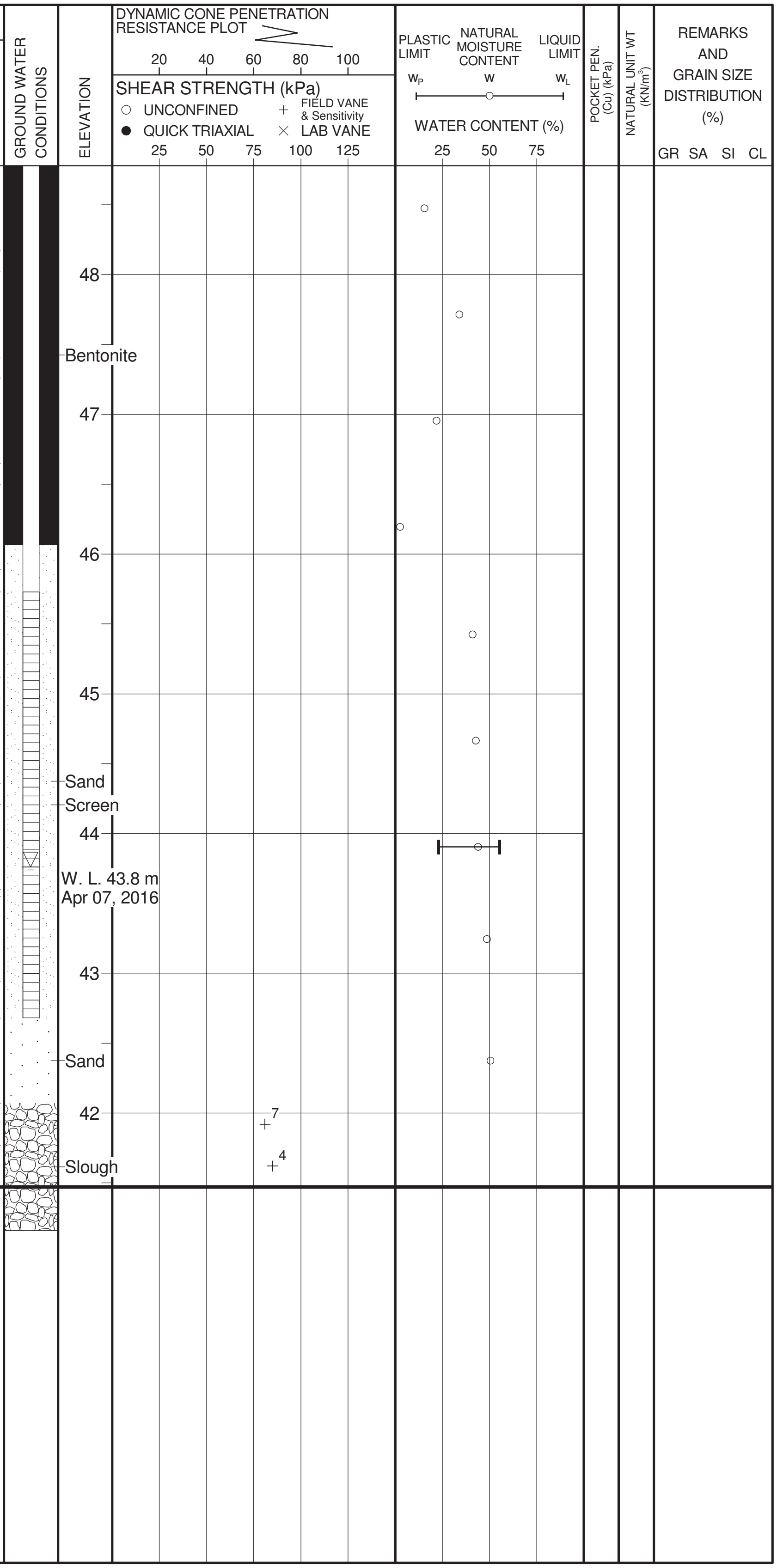
LOG OF BOREHOLE MW16-3

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462249 E 5038342

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/22/2016
Supervisor:
Reviewer:

SOIL PROFILE		SAMPLES		
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m
48.8				
0.0	**CRUSHED SAND AND GRAVEL** trace to some silt, trace to some clay, grey, compact to very dense (FILL)	1	SS	14
		2	SS	
		3	SS	6
		4	SS	15
45.7 3.1	**SILTY CLAY**: grey, moist, firm to stiff	5	SS	9
44.8 4.0	**SILTY CLAY**: grey, moist, firm to stiff	6	SS	8
		7	SS	7
		8	SS	4
		9	SS	3
			VANE	
			VANE	
41.5 7.3	**END OF BOREHOLE**			



1) Borehole terminated at 7.62 m below the existing ground surface.
2) Borehole dry at the completion of augering.
3) 31 mm monitoring well installed at 6.1 m below the existing ground surface.
4) Date Groundwater Depth

Date	Groundwater Depth
4/7/2016	5.02 m

WSP SOIL LOG - OTTAWA GEOTECHNICAL BH LOGS - 1009 TRIM ROAD, OTTAWA, ONTARIO.GPJ SPL.GDT 5/5/16

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

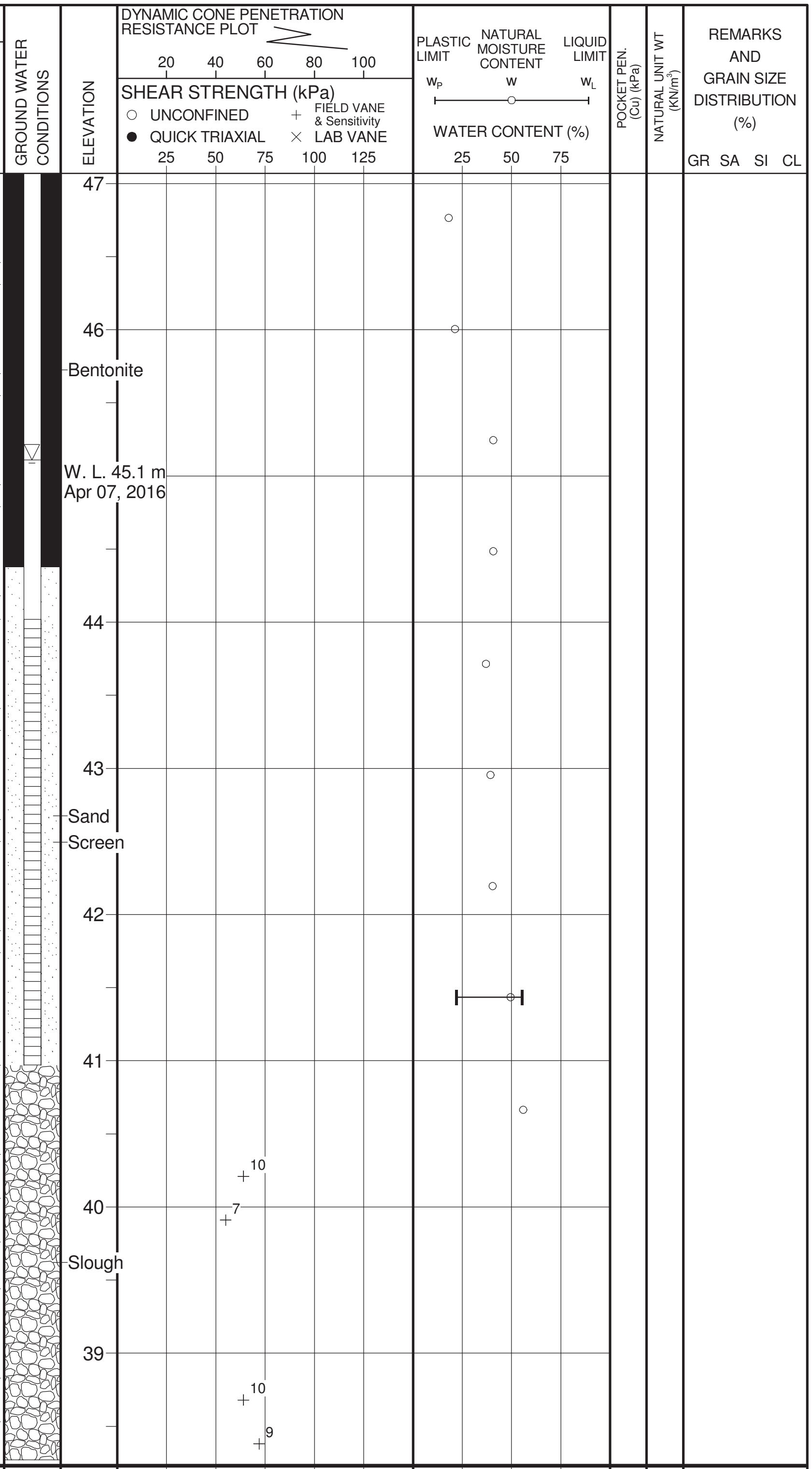
LOG OF BOREHOLE MW16-4

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462344 E 5038407

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/22/2016
Supervisor:
Reviewer:

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m
47.1				
0.0	**CRUSHED SAND AND GRAVEL** trace to some silt, trace to some clay, grey, loose to very loose (FILL)	1	SS	6
		2	SS	3
45.6 1.5	**SILTY CLAY**: brown, moist, stiff to stiff very (WEATHERED CRUST) 1.5 m - 2.1 m : trace to some organics	3	SS	WH
		4	SS	7
		5	SS	15
		6	SS	13
		7	SS	8
	- becoming wet below 5.2 m	8	SS	5
41.0 6.1	**SILTY CLAY**: grey, moist, stiff to stiff very	9	SS	3
			VANE	
			VANE	
		10	TW	
			VANE	
			VANE	
38.2 8.8	**END OF BOREHOLE** 1) Borehole terminated at 8.8 m below the existing ground surface. 2) Seepage noted upon completion of borehole at 7.8 m below the existing ground surface. 3) 31 mm monitoring well installed at			



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GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▼

GRAPH NOTES
$+^3, \times^3$: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE MW16-4

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462344 E 5038407

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/22/2016
Supervisor:
Reviewer:

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 25 50 75	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION					
	6.1 m below the existing ground surface. 4) Date Groundwater Depth 4/7/2016 2.0 m											

GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▽

GRAPH NOTES

$+^3, \times^3$: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

LOG OF BOREHOLE MW16-5

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462379 E 5038450

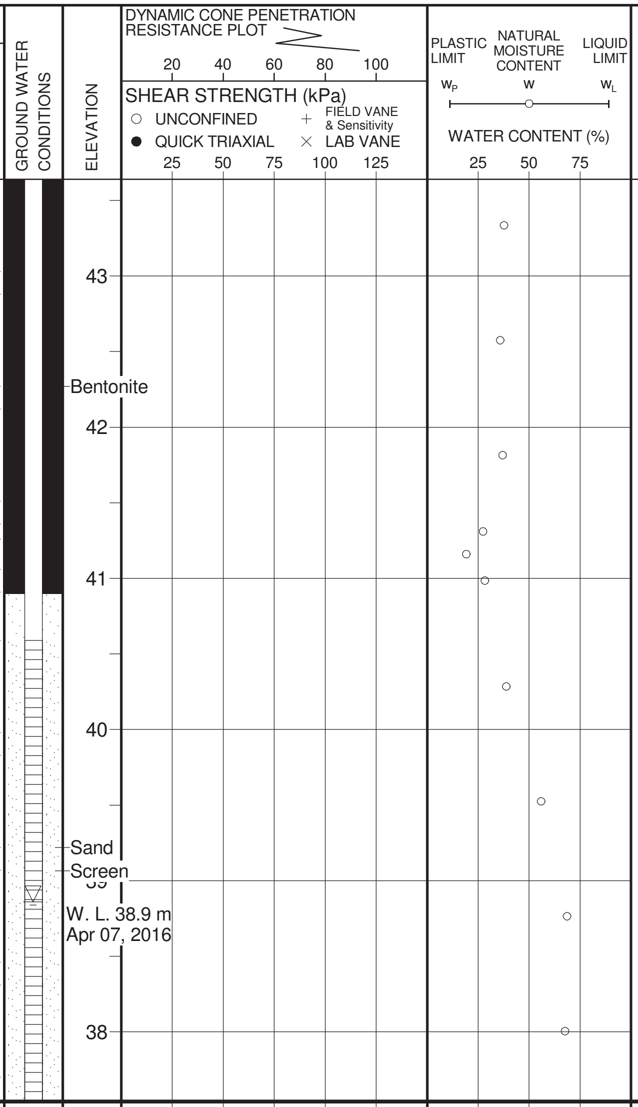
DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/22/2016
Supervisor:
Reviewer:

SOIL PROFILE		SAMPLES			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m			
43.6							
0.0	**SILTY CLAY** brown-grey, moist, soft to firm (FILL)	1	SS	2			
		2	SS	6			
42.1 1.5	**SILTY CLAY** some organic deposits, brown-grey, moist, stiff	3	SS	5			
41.3 2.4	**SILTY SAND** grey-brown, moist	4A	SS	21			
		4B		21			
41.0 2.6	**SILTY CLAY**: grey brown, wet, stiff to very stiff (WEATHERED CRUST)	4C		21			
		5	SS	15			
		6	SS	5			
39.1 4.6	**SILTY CLAY**: grey, wet, stiff	7	SS	2			
		8	SS	1			
37.5 6.1	**END OF BOREHOLE**						

1) Borehole terminated at 6.1 m below the existing ground surface.
2) 31 mm monitoring well installed at 6.1 m below the existing ground surface.
3) Date Groundwater Depth

Date	Groundwater Depth
4/7/2016	4.8 m



GROUNDWATER ELEVATIONS

Shallow/ Single Installation ∇ ▼ Deep/Dual Installation ∇ ∇

GRAPH NOTES +3, ×3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

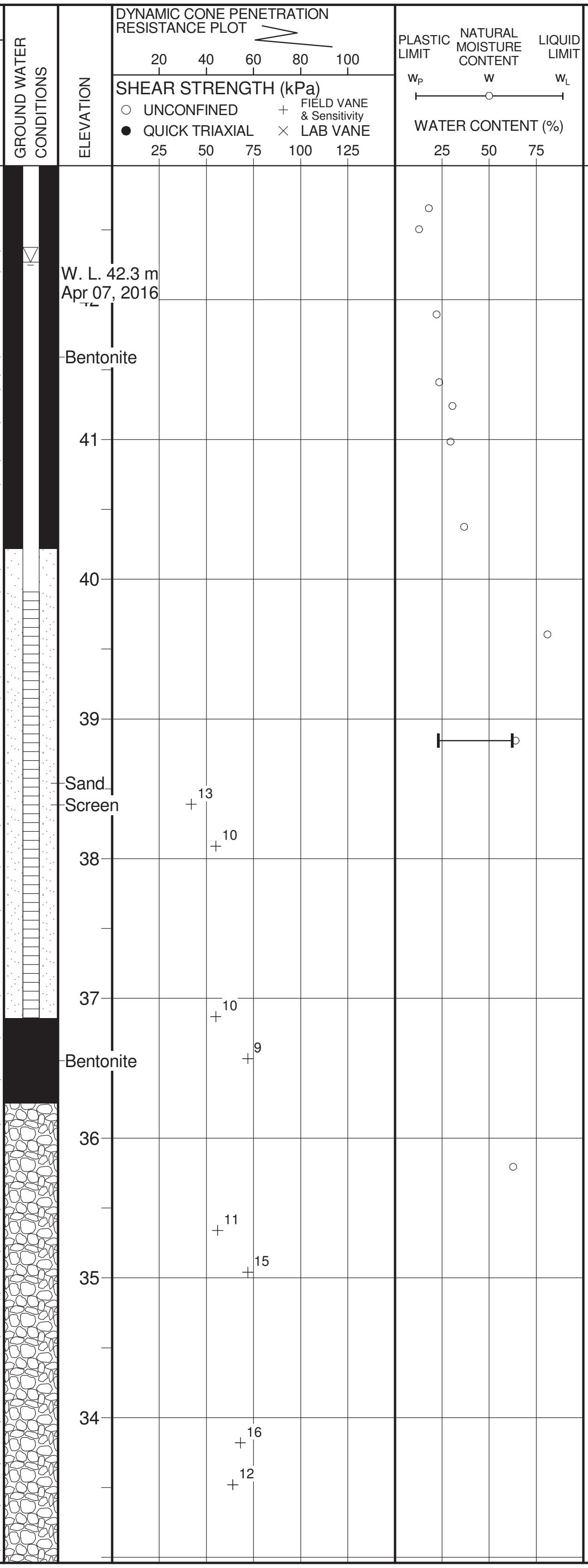
LOG OF BOREHOLE MW16-6

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462225 E 5038410

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/23/2016
Supervisor:
Reviewer:

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS / 0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
43.0					
42.9 0.0	**TOPSOIL - 20 mm** **CRUSHED SAND AND GRAVEL** trace silt, brown, wet, compact (FILL)	1A 1B	SS	28	39 52 (9)
42.2 0.8	**CLAYEY SILT** some sand, trace gravel, trace brick, dark brown, moist, compact (FILL)	2	SS	10	
41.4 1.6	**SANDY SILT** trace gravel, dark brown, moist, loose (FILL)	3A 3B	SS		
41.1 1.8	**SILTY CLAY**: trace to some gravel, trace to some sand, brown, moist, firm (FILL)	3C			
		4A	SS		
39.9 3.1	**SILTY CLAY**: grey brown, moist, stiff (WEATHERED CRUST)	5	SS	7	
39.2 3.8	**SILTY CLAY**: grey, wet, stiff	6	SS	WH	0 0 26 74
			VANE		
			VANE		
		A	TW		
			VANE		
			VANE		
		7	SS	WH	
			VANE		
			VANE		
		B	TW		
			VANE		
			VANE		



POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (KN/m³)

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GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▽

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

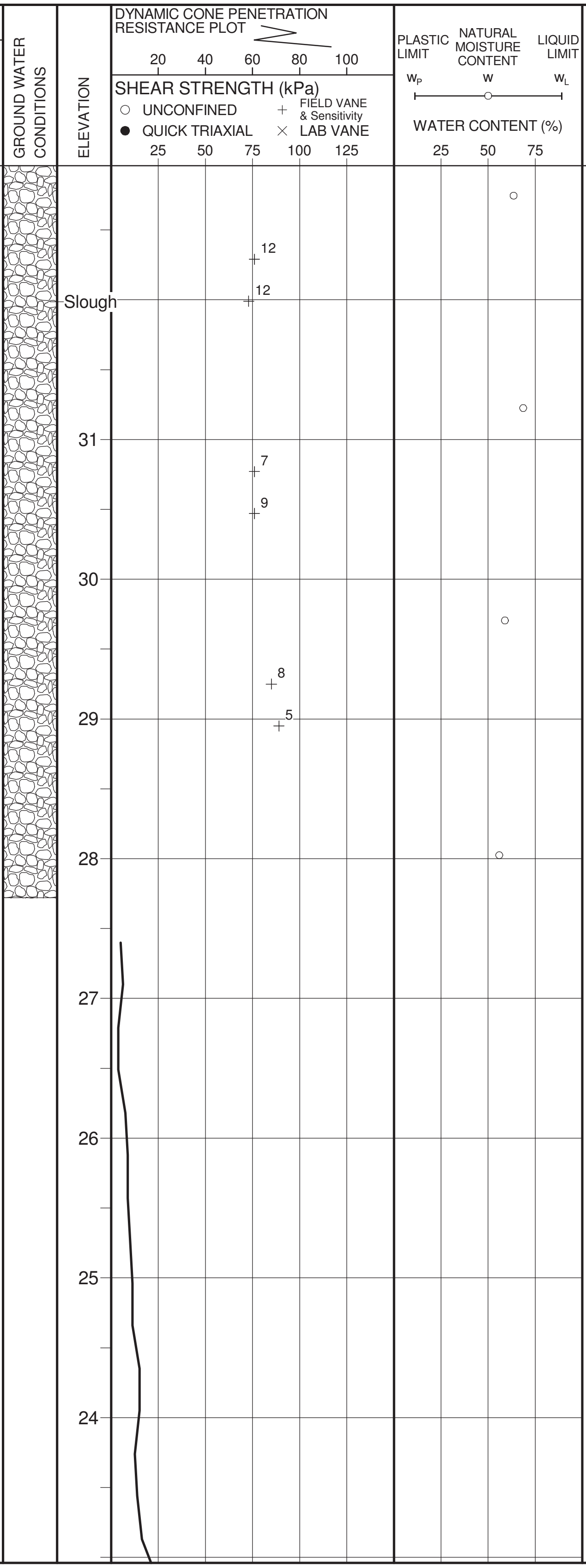
LOG OF BOREHOLE MW16-6

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462225 E 5038410

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/23/2016
Supervisor:
Reviewer:

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m
	SILTY CLAY: grey, wet, stiff(Continued)	8	SS	WH
			VANE	
			VANE	
		9	SS	WH
			VANE	
			VANE	
		10	SS	WH
			VANE	
			VANE	
		11	SS	4
27.7 15.2	**SILTY CLAY**: grey, wet, stiff (Inferred based on DCPT results)			



POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Continued Next Page

GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▽

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

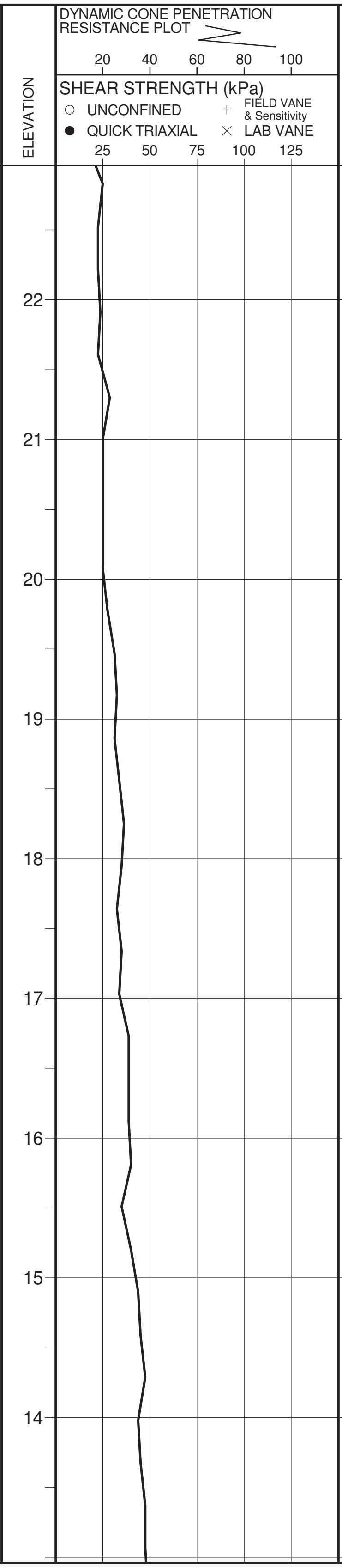
LOG OF BOREHOLE MW16-6

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462225 E 5038410

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/23/2016
Supervisor:
Reviewer:

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS / 0.3 m			w_P w w_L WATER CONTENT (%) 25 50 75			GR SA SI CL
	SILTY CLAY: grey, wet, stiff (Inferred based on DCPT results)(Continued)										



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GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼   Deep/Dual Installation ▽ ▼

GRAPH NOTES
$+^3, \times^3$: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

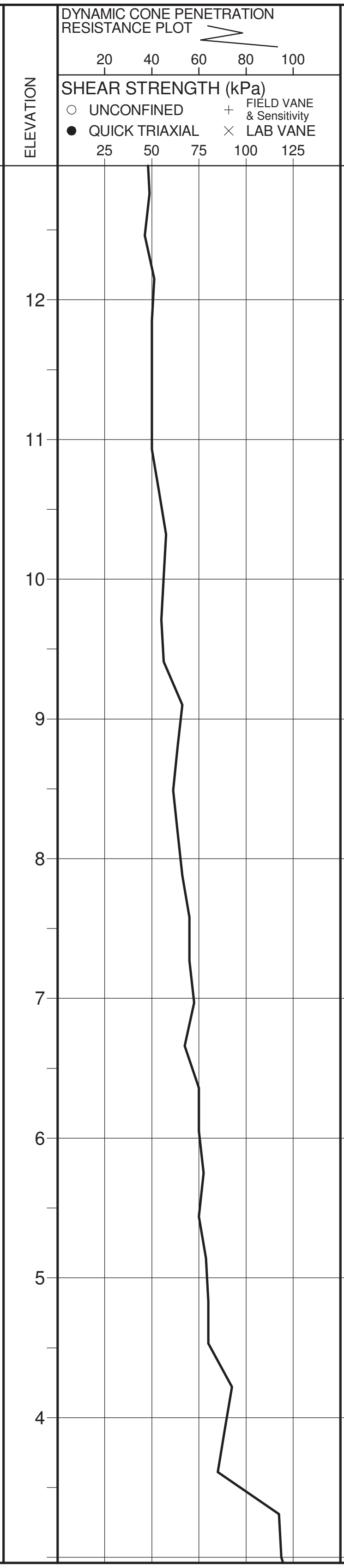
LOG OF BOREHOLE MW16-6

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462225 E 5038410

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/23/2016
Supervisor:
Reviewer:

SOIL PROFILE			SAMPLES									
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100) SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE (25, 50, 75, 100, 125)	PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L WATER CONTENT (%) (25, 50, 75)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY: grey, wet, stiff (Inferred based on DCPT results)(Continued)	▨										



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GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▽

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE MW16-6

Project: Geotechnical Investigation
Client: Grandmaître Family
Project Location: Part Lot 30, Concession 1, Parts 1 & 2, Cumberland, ON
Datum: Approximate
BH Location: See borehole location plan N 462225 E 5038410

DRILLING DATA
Rig Type:
Method: Hollow Stem Auger
Borehole Diameter: 203 mm
Core Diameter:

Project No.: 161-03361-00
Date Started: 3/23/2016
Supervisor:
Reviewer:

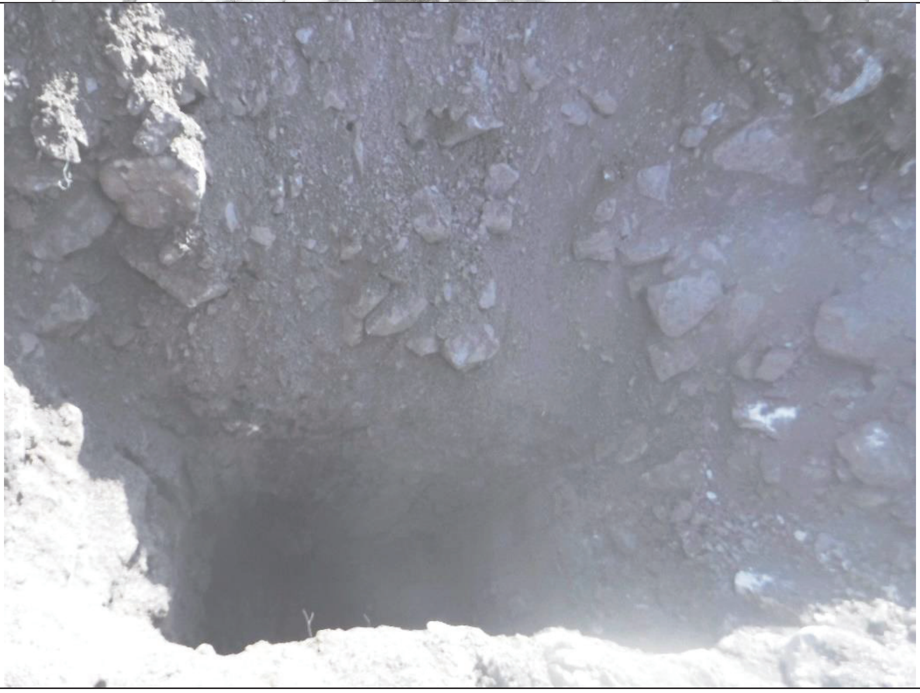
SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 25 50 75	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (KN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION					
2.7												
40.3	**END OF BOREHOLE** 1) End of augering at 15.2 m below the existing ground surface. Switch to DCPT. 2) Seepage noted at the bottom of borehole upon completion of augering. 3) DCPT refusal at 40.3 m below the existing ground surface. 4) 31 mm monitoring well installed at 6.1 m below the existing ground surface. 5) Date Groundwater Depth -- 4/7/2016 0.7 m											

GROUNDWATER ELEVATIONS

Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▽

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε =3% Strain at Failure

TEST PIT NUMBER (ELEVATION)	**DEPTH (METRES)**	**DESCRIPTION**		
TP 16-4 (47.3 m)	0.0 – 1.8 1.8 – 4.0 4.0 – 6.4 6.4 – 7.3 7.3	Crushed Sand and Gravel with boulders/cobbles, grey, moist (FILL) Silty Sand and Gravel, some clay to clayey, brown, moist (FILL) Silty Clay, trace to some gravel, trace roots, grey-brown, moist (FILL) Organic Soil mixed with roots, black, moist End of Test Pit		
Sample	Depth	% Gravel	% Sand	% Fines
1	0 – 0.6 m	84	15	1



APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG5336-1 - TEST HOLE LOCATION PLAN

FIGURE 1

KEY PLAN

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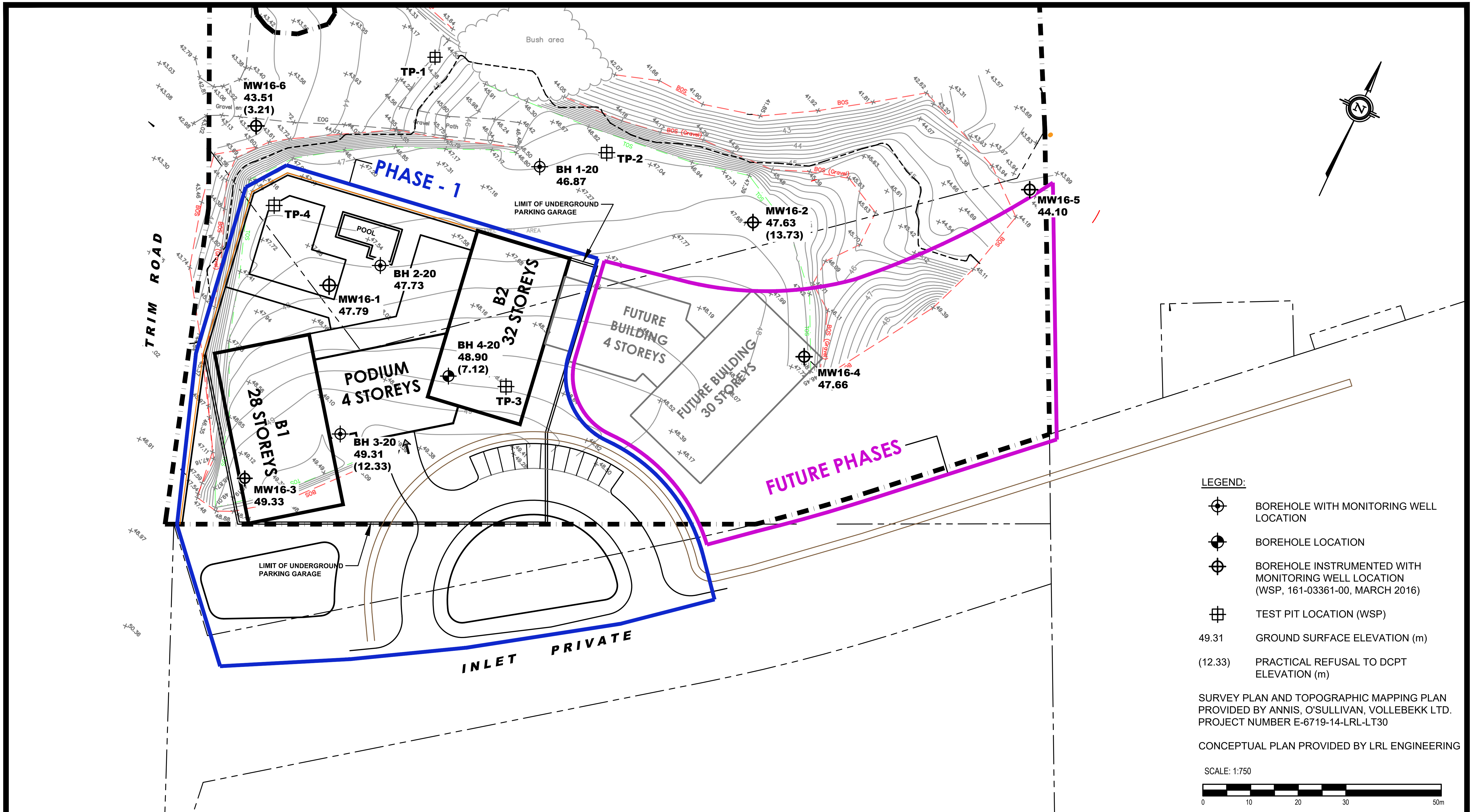

LEGEND:

⌖	BOREHOLE WITH MONITORING WELL LOCATION
⌖	BOREHOLE LOCATION
⌖	BOREHOLE INSTRUMENTED WITH MONITORING WELL LOCATION (WSP, 161-03361-00, MARCH 2016)
⊞	TEST PIT LOCATION (WSP)
49.31	GROUND SURFACE ELEVATION (m)
(12.33)	PRACTICAL REFUSAL TO DCPT ELEVATION (m)

SURVEY PLAN AND TOPOGRAPHIC MAPPING PLAN PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD. PROJECT NUMBER E-6719-14-LRL-LT30

CONCEPTUAL PLAN PROVIDED BY LRL ENGINEERING

SCALE: 1:750

0 10 20 30 50m

patersongroup
consulting engineers

154 Colonnade Road South
Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL
3	UPDATED TO LATEST CONCEPTUAL PLAN	09/02/2020	RG
2	NEW BOREHOLES ADDED	07/07/2020	RG
1	UPDATED TO LATEST CONCEPTUAL PLAN	05/14/2020	RG

STARWOOD GROUP INC
GEOTECHNICAL INVESTIGATION
PROPOSED MULTI-STOREY BUILDING COMPLEX - 1009 TRIM ROAD
OTTAWA, ONTARIO

Title:
TEST HOLE LOCATION PLAN

Scale: 1:750
Date: 04/2020
Drawn by: RCG
Report No.: PG5336-1
Checked by: RG
Dwg. No.: PG5336-1
Approved by: DJG
Revision No.: 3

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