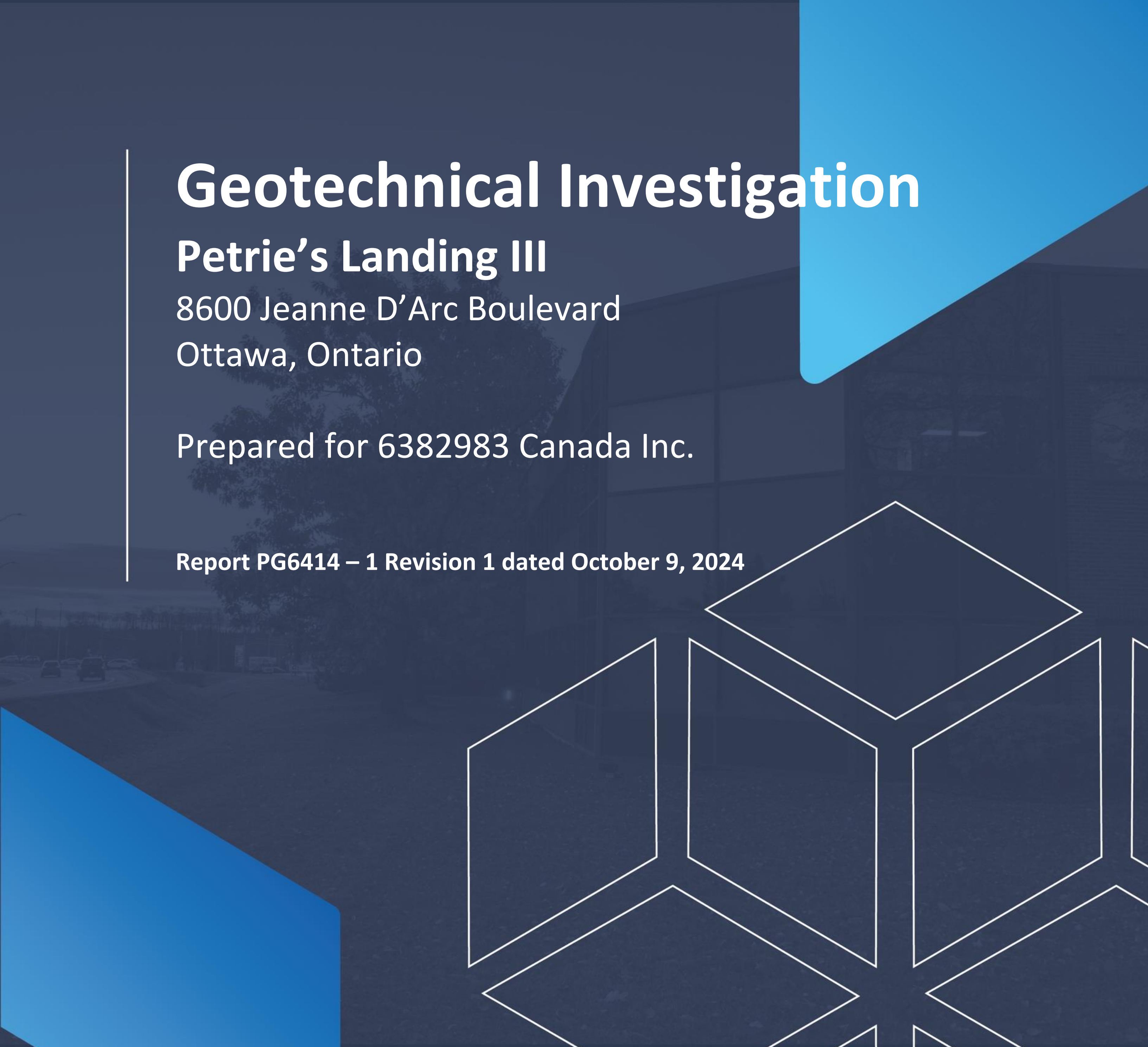


Geotechnical Investigation

Petrie’s Landing III

8600 Jeanne D’Arc Boulevard
Ottawa, Ontario

Prepared for 6382983 Canada Inc.

Report PG6414 – 1 Revision 1 dated October 9, 2024

Table of Contents

Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by 6382983 Canada Inc. to carry out a geotechnical investigation for the proposed multi-storey buildings to be located within the complex at 8600 Jeanne D'Arc Boulevard, 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 development will consist of fourteen (14) multi-storey residential and mixed use buildings. The development will also include associated asphaltic parking areas, access lanes and landscaped areas. It is assumed that the buildings will be constructed on top of 1 to 3 basement levels. It is further anticipated that the site will be fully municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the current investigation was carried out on October 20, 21, 24, 25 and 26, 2022 and consisted of a total of eleven (11) boreholes sampled to a maximum depth of 9.6 m below the existing grade throughout the subject site. A dynamic cone penetration test (DCPT) was carried out at nine (9) borehole.

Previous investigation was carried out on November 8, 2007 by Paterson and consisted of three (3) boreholes sampled to a maximum depth of 9.6 m. The borehole locations 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 PG6414-1 - 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.

Groundwater

Groundwater monitoring wells were installed in boreholes BH1-22, BH8-22 and BH10-22, and flexible standpipe piezometers were installed in all other boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program. All groundwater observations are noted on the Soil Profile and Test Data sheets presented in Appendix 1.

3.2 Field Survey

The test hole locations were selected by Paterson to provide general coverage of the proposed development taking into consideration the existing site features and underground utilities. The test hole locations and ground surface elevation at each test hole location were surveyed by Paterson with respect to a geodetic datum. The location of the test holes and ground surface elevation at each test hole location are presented on Drawing PG6414-1 – Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples were collected from the subject site during the investigation and were visually examined in our laboratory to review the results of the field logging. Seven (7) soil samples were submitted for Atterberg Limit testing, one (1) sample was submitted for Sieve Analysis and one (1) sample was submitted for Shrinkage. The test results are included in Appendix 1.

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

3.4 Analytical Testing

One (1) 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 6.8.

4.0 Observations

4.1 Surface Conditions

The majority of the subject site consist of vacant land with agricultural fields. The west portion of the site is covered with trees and vegetation following Taylor Creek. The ground surface within the subject site slopes gradually towards the north and northeast portion of the site. The site is bordered by a steep slope down to Taylor Creek along the west limit of the site. The site is bordered to the north by Jeanne D'Arc Boulevard, Highway 174 to the south and an institutional development to the east.

4.2 Subsurface Profile

Overburden

Generally, the subsurface profile at the test hole locations consists of topsoil underlain by a hard to very stiff brown silty clay deposit extending to depths of 2.3 m to 5.9 m below the existing grade. Shear strength ranging from 100 kPa to over 250 kPa were measured in the layer.

The brown silty clay was underlain by a firm to stiff grey silty clay deposit extending to depths of 20 m to 33 m below existing grade. Underlying the grey silty clay deposit is an inferred glacial till identified by DCPT testing. Practical refusal to DCPT was encountered in BH9-22 at 41 m depth 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 25 to 50 m.

4.3 Groundwater

Groundwater level readings were recorded on November 7, 2022 and are presented in Table 1 and on the Soil Profile and Test Data sheets in Appendix 1. It should be noted that surface water can become trapped within a backfilled borehole that can lead to higher than typical groundwater level observations. Additionally, groundwater levels are subject to seasonal fluctuations, therefore the groundwater levels could vary at the time of construction.

Long-term groundwater level can be estimated based on the observed color, moisture levels and consistency of the recovered soil samples. Based on these observations, the long-term groundwater is between 3.0 to 4.0 m in the areas of BH6-22 to BH9-22 and between 4.0 to 6.0 m in the areas of the remaining boreholes.

Table 1 - Summary of Groundwater Level Readings

Test Hole Number	Ground Surface Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Recording Date
BH1	53.07	1.59	51.48	November 13, 2007
BH2	52.31	2.7	49.61	November 13, 2007
BH3	49.65	1.53	48.12	November 13, 2007
BH1-22*	51.16	5.72	45.44	November 7, 2022
BH2-22	52.14	7.11	45.03	November 7, 2022
BH3-22	52.67	2.05	50.62	November 7, 2022
BH4-22	51.32	2.22	49.10	November 7, 2022
BH5-22	51.18	2.66	48.52	November 7, 2022
BH6-22	53.46	5.18	48.28	November 7, 2022
BH7-22	53.33	7.42	45.91	November 7, 2022
BH8-22*	53.04	3.20	49.84	November 7, 2022
BH9-22	52.77	3.65	49.12	November 7, 2022
BH10-22*	52.22	5.22	47.00	November 7, 2022
BH11-22	51.5	1.75	49.75	November 7, 2022

Note:
- The ground surface elevations are referenced to a geodetic datum.
- * Borehole with groundwater monitoring well

5.0 Discussion

5.1 Geotechnical Assessment

Foundation Design Considerations

From a geotechnical perspective, the subject site is suitable for the proposed multi-storey buildings. It is expected that the proposed buildings will be founded on piled foundations extending to the inferred glacial till or limestone bedrock surface. It is also expected that the underground parking will be founded on conventional spread footings or raft foundations placed on an undisturbed very stiff silty clay deposit 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.

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.

The above and other considerations are discussed in the following paragraphs.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing significant organic materials, should be stripped from under any buildings and other settlement sensitive structures. The existing fill material, where free of organic materials, should be reviewed by the geotechnical consultant at the time of construction to determine if the existing fill can be left in place below paved areas and below the slab granular fill layers.

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, hard to very stiff brown silty clay bearing surface can be designed using bearing resistance value at serviceability limit states (SLS) of **175 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **250 kPa**.

Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, placed over an undisturbed, firm to stiff grey silty clay bearing surface can be designed using bearing resistance value at serviceability limit states (SLS) of **125 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **200 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.

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.

Raft Foundation

If the bearing resistance values are not sufficient for shallow foundation, raft foundation can be considered. The following parameters may be used for raft design and will apply for an undisturbed soil bearing surface. An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings and approved by the geotechnical consultant.

Based on the following assumptions for a raft foundation, the proposed building can be designed with total and differential settlements of 25 and 15 mm, respectively.

For design purposes, it was assumed that the base of a raft foundation for a multi storey building would be located at a 6 to 7 m depth with one anticipated underground level.

The amount of settlement of the raft slab will be dependent on the sustained raft contact pressure. The bearing resistance value at SLS (contact pressure) of **175 kPa** will be considered acceptable. The loading conditions for the contact pressure are based on sustained loads, that are generally taken to be 100% Dead Load and 50% Live Load. The contact pressure provided considers the stress relief associated with the soil removal required for the proposed building.

The factored bearing resistance value at ULS can be taken as **125 kPa**. A geotechnical resistance factor of 0.5 was applied to the bearing resistance value at ULS.

The modulus of subgrade reaction was calculated to be **4.8 MPa/m** for a contact pressure of **175 kPa**. The design of the raft foundation is required to consider the relative stiffness of the reinforced concrete slab and the supporting bearing medium.

End Bearing Driven Piled Foundation

It is anticipated that the structures might require to be constructed over concrete filled steel pipe piles driven to refusal on the bedrock surface. The bedrock surface is estimated to be located at a depth ranging from 41 to 46 m in depth throughout the site. The piles will need to be driven through a dense layer of glacial till.

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 2. 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	1,000	1,250	6	27
245	11	1,150	1,450	6	31
245	13	1,300	1,600	6	35

The minimum recommended centre-to-centre pile spacing is 3 times the pile diameter. The closer the piles are spaced, however, the more potential that the driving of subsequent piles in a group could have influence on piles in the group that have already been driven. These effects, primarily consisting of uplift of previously driven piles, are checked as part of the field review of the pile driving operations.

Prior to the commencement of production pile driving, a limited number of indicator piles should be installed across the site. It is recommended that each indicator pile be dynamically load tested to evaluate pile stresses, hammer efficiency, pile load transfer, and end-of-driving criteria for end-bearing in the bedrock.

Drilled Shafts and Caissons

End bearing cast-in-place caissons can be used where supplemental axial resistance is required for structural design for the proposed building. The caisson should be installed by driving a temporary steel casing and excavating the soil through the casing. A minimum of 35 MPa concrete should be used to in fill the caissons. The caissons are to be structurally reinforced over their entire length.

Two conditions for drilled shafts are applicable for this site. The first alternative is a caisson installed on the sound bedrock augering through the weathered bedrock (end bearing). The compressive resistance for such piles is directly related to the compressive strength of the bedrock. It is recommended that the entire capacity be derived from the end bearing capacity.

The second alternative is a concrete caisson installed on the inferred glacial till. The compressive resistance for such piles is directly related to the point bearing resistance of the glacial till and the skin friction of the caisson.

Table 3 below presents the estimated capacity for different typical caisson sizes for a rock bearing caisson and glacial till bearing caisson.

Table 3 - Caisson Pile Capacities

Caisson Diameter		**Axial Capacity at ULS**		
inch	**mm**	**Rock Bearing (ULS)**	**Glacial Till Bearing (ULS)**	**Glacial Till Bearing (SLS)**
36	900	10,000	2,850	1,900
42	1,000	15,000	2,890	1,920
48	1,200	19,000	3,000	2,000
54	1,375	24,000	3,100	2,060
60	1,500	30,000	3,170	2,110

notes:
- Reinforced caisson when applicable
- 0.4 geotechnical factor applied to the shaft capacity
- Glacial till bearing piles must be installed a minimum of 6 m into the glacial till

The minimum recommended centre-to-centre pile spacing is 3 times the pile diameter. The closer the piles are spaced, however, the more potential that the installation of subsequent piles in a group could have influence on piles in the group that have already been driven. These effects, primarily consisting of uplift of previously installed piles.

Downdrag Considerations

Should grade raises occur at the site as part of the proposed development, downdrag loads should be considered on the piles or caissons. Based on the available subsurface information, it is expected that the deep foundations will be installed through approximately 20 to 33 m of very stiff to stiff silty clay. The silty clay generally has a cohesion of 200 kPa to 50 kPa. Assigning an adhesion factor of 0.5, the silty clay can be taken to have an ultimate adhesion of 100 kPa to 25 kPa against the sides of the piles or caissons.

The downdrag load is effectively applied to each pile at the location of the "neutral plane," where negative (i.e. downdrag) skin friction becomes positive shaft resistance. In the case of the end-bearing piles at this site, the neutral plane will be located near the bedrock surface.

The downdrag load is a structural capacity criterion and does not affect the geotechnical capacity of the piles or caissons. The structural axial capacity of the pile is governed by its structural strength at the neutral plane when subjected to the permanent load plus the downdrag load. Transient live load is not to be included. At or below the pile cap, the structural strength of the embedded pile or caisson is determined as a short column subjected to the permanent load plus the transient live load, but downdrag load is to be excluded.

At the depth of the neutral plane where the downdrag load is applied, the pile or caisson structure is well confined. The 4th edition of the Canadian Foundation Engineering Manual recommends that the allowable structural axial capacity of piles or caissons at the neutral plane, for resisting permanent load plus the downdrag load, can be determined by applying a factor of safety of 1.5 to the pile or caisson material strength (steel yield and concrete 28 day compressive strength).

Permissible Grade Raise Recommendations

Although no significant grade raises are expected for the subject development, the grade raise restriction for the subject site was calculated and is illustrated on Drawing PG6414-1 – Permissible Grade Raise Plan included in Appendix 2.

Should the option of deep foundation be retained for the entire structure, the permissible grade raise restriction will not be applicable to the building area. Furthermore, soil placed on top of podium structure is not considered in the grade raise restriction but should be considered in the design of the structural foundation. The remainder of the site will be subject to the grade raise restriction illustrated on Drawing PG6414-1 – Permissible Grade Raise Plan included in Appendix 2.

Generally, the potential long term settlement is evaluated based on the compressibility characteristics of the silty clay. These characteristics have been conservatively estimated based on the shear strength of the clay and the subsoil condition observed at the test pit locations. It should be noted that a post-development groundwater lowering of 0.5 m was applied to the permissible grade raise restriction

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class E** for the foundations considered. Due to the compactness of the silty clay deposit and the long term groundwater level, soils underlying the subject site are not susceptible to liquefaction. Refer to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

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:

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

For design purposes, it is recommended that the rigid pavement structure for the underground parking level consist of Category C2, 32 MPa concrete at 28 days with air entrainment of 5 to 8%. The recommended rigid pavement structure is further presented in Table 4 on the next page. The flexible pavement structure presented in Table 5 and Table 6 should be used for driveways and car only parking areas and at grade access lanes and heavy loading parking areas.

Table 4 - Recommended Rigid Pavement Structure - Lower Parking Level

Thickness (mm)	Material Description
150	**Exposure Class C2 - 32 MPa Concrete** (5 to 8% Air Entrainment)
300	**BASE** – OPSS Granular A Crushed Stone
SUBGRADE – Hard to firm silty clay, or OPSS Granular A or OPSS Granulart B Type **II** granular fill material placed over in situ soil.	

To control cracking due to shrinking of the concrete floor slab, it is recommended that strategically located saw cuts be used to create control joints within the concrete floor slab of the underground parking level. The control joints are generally recommended to be located at the center of the column lines and spaced at approximately 24 to 36 times the slab thickness (for example; a 0.15 m thick slab should have control joints spaced between 3.6 and 5.4 m).

The joints should be cut between 25 and 30% of the thickness of the concrete floor slab and completed as early as 4 hours after the concrete has been poured during warm temperatures and up to 12 hours during cooler temperatures.

Table 5 - Recommended Pavement Structure – Driveways 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 6 - 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	

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

A perimeter foundation drainage system is recommended to be provided for the proposed buildings. The system should consist of a 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 19 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

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 Miradrain G100N or Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose. Refer to the attached Figure 2- Foundation Drainage Detail, for specific details of the drainage recommendation.

Underfloor Drainage

Underfloor drainage may be required to control water infiltration. For design purposes, we recommend that 150 mm diameter perforated pipes be placed at 6 to 9 m centers. The spacing of the underfloor drainage system should be confirmed at the time of completing the excavation when water infiltration can be better assessed.

Elevator Pit Waterproofing

The elevator shaft exterior foundation walls should be waterproofed to avoid any infiltration into the elevator pit. It is recommended that a waterproofing membrane, such as Colphene Torch'n Stick (or approved other) be applied to the exterior of the elevator shaft foundation wall.

The Colphene Torch'n Stick waterproofing membrane should extend over the vertical portion of the raft slab and down to the top of the footing in accordance with the manufacturer's specifications. A continuous PVC waterstop such as Southern waterstop 14RCB or equivalent should be installed within the interface between the concrete base slab below the elevator shaft foundation walls.

The 150 mm diameter perforated corrugated pipe underfloor drainage should be placed along the perimeter of the exterior sidewalls and provided a gravity connection to the sump pump basin or the elevator sump pit.

The foundation wall of the elevator shaft and buildings sump pit should host a PVC sleeve to allow any water trapped within the interior side of the structures to be discharged to the associated sump pump. A minimum 100 mm diameter perforated, corrugated drainage pipe should extend from the sleeve towards the associated drainage system by gravity drainage and mechanical connection to the associated system. Also, the contractor should ensure that the opening is properly sealed to prevent water from entering the subject structure.

A protection board should be placed over the waterproofing membrane to protect the waterproofing membrane from damage during backfilling operations. The area between the pit structure and bedrock/soil excavation face can be in-filled with lean concrete, OPSS Granular A or Granular B Type II crushed stone.

It should be noted that a waterproofed concrete (with Xypex Additive, or equivalent) is optional for this waterproofing option. Refer to the attached Figure 3- Elevator Waterproofing Detail, for specific details of the waterproofing recommendation.

Adverse Effects from Dewatering on Adjacent Structures

The temporary dewatering program during construction will have a limited zone of influence of less than 10 m from the foundation perimeter and less than 5 m at post construction. The underlying native soil below the groundwater table at the subject site is a stiff silty clay deposit. The temporary dewatering of the silty clay deposit during the excavation and construction stage will not be susceptible to significant consolidation since the material is stiff to very stiff.

Implementation of the water suppression system recommended above is expected to limit the drawdown of the local groundwater table over the long term and in a limited area. Therefore, in our opinion, no adverse effects to nearby structures and infrastructure are expected over the long term.

6.2 Protection of Footings Against Frost Action

Perimeter footings, of heated structures are required to be insulated against the deleterious effect of frost action. A minimum of 1.5 m thick soil cover (or equivalent) should be provided in this regard.

A minimum of 2.1 m thick soil cover (or equivalent) should be provided for other exterior unheated footings.

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 7 - 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, sub bedding 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 strategic 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.

It is also proposed to use a pressure relief chamber to control groundwater infiltration. All construction time dewatering can be completed thought the pressure relief chamber described below. For short term and construction purposes no pumping limit is applicable from a geotehcnical perspective. It is expected that pumping will be stopped when sufficient dead load has been applied to the structure and the water suppression system can take over.

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.

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 a moderate to slightly aggressive environment.

6.8 Hydraulic Conductivity

Hydraulic conductivity testing was completed at select boreholes outfitted with monitoring wells screened within the overburden material. Falling head tests ("slug testing") were completed in accordance with ASTM Standard Test Method D4404 - Field Procedure for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers.

Following the completion of the slug testing, the test data was analyzed as per the method set out by Hvorslev (1951). Assumptions inherent in the Hvorslev method include a homogeneous and isotropic aquifer of infinite extent with zero-storage assumption, and a screen length significantly greater than the monitoring well diameter.

The assumption regarding aquifer storage is considered to be appropriate for groundwater flow through the overburden aquifer. The assumption regarding screen length and well diameter is considered to be met based on the screen lengths of 1.5 m and well diameter of 0.058 m.

While the idealized assumptions regarding aquifer extent, homogeneity, and isotropy are not strictly met in this case (or in any real-world situation), it has been our experience that the Hvorslev method produces effective point estimates of hydraulic conductivity in conditions similar to those encountered at the subject site.

The Hvorslev analysis is based on the line of best fit through the field data (hydraulic head recovery vs. time), plotted on a semi-logarithmic scale. In cases where the initial hydraulic head displacement is known with relative certainty, such as in this case where a physical slug has been introduced/removed, the line of best fit is considered to pass through the origin.

Results

Based on testing at the subject site, the hydraulic conductivity values for the silty clay varies from 5.79x10-9 to 9.96x10-8 m/s. The results from the hydraulic conductivity testing have been included in Appendix 1. An estimate on water infiltration can be made once more detail drawings are available.

6.9 Landscaping Considerations

Tree Planting Considerations

In accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines), Paterson completed a soils review of the site to determine applicable tree planting setbacks. Atterberg limits testing was completed for the recovered silty clay samples at selected locations throughout the subject site. The results of our testing are presented in Table 1 in Subsection 4.2.

Based on the results of the Atterberg limit testing mentioned above, the plasticity index was found to be greater than 40% in all the tested clay samples. Based on this, the clay is considered to be a clay of high potential for soil volume change.

Based on this, the setbacks would consist of 7.5 m for small (mature height up to 7.5 m) and medium size trees (mature tree height 7.5 to 14 m), provided the conditions noted below are met at the time of landscape design:

☐ A small tree must be provided with a minimum of 25 m^3 of available soils volume while a medium tree must be provided with a minimum of 30 m^3 of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

☐ The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.

☐ Grading surrounding the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree), as noted on the subdivision Grading Plan.

It is well documented in the literature, and is our experience, that fast-growing trees located near buildings founded on cohesive soils that shrink on drying can result in long-term differential settlements of the structures. Tree varieties that have the most pronounced effect on foundations are seen to consist of poplars, willows and some maples (i.e., Manitoba Maples) and, as such, they should not be considered in the landscaping design.

6.10 Slope Stability Analysis

Slope Conditions

Paterson completed a field review of the slope along the west portion of the site and along side of Taylor Creek. The slope was observed to be stable at a near incline of 3H:1V. The surface of the slope was well vegetated, covered with grass and mature tree. Taylor Creek was located along the slope. The path of the creek was noted to meander. Along the north portion of the site the creek was noted to be located over 40 m away from the bottom of the slope.

The creek flows under a concrete culvert under Jeanne D'Arc Boulevard. Blast stone and rip-rap stone material were observed to have been placed to protect against erosion next to the culvert and road embankment.

Some sign of erosion and scouring were observed along the path of the the creek towards the south.

Slope Stability Analysis

The slope stability analysis was modeled in SLIDE, a computer program which permits a two-dimensional slope stability analysis calculating several methods including the Bishop's method, which is a widely accepted slope analysis method. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to forces favoring failure. Theoretically, a factor of safety of 1.0 represents a condition where the slope is stable. However, due to intrinsic limitations of the calculation methods and the variability of the subsurface soil and groundwater conditions, a factor of safety greater than 1.0 is generally required for the failure risk to be considered acceptable. A minimum factor of safety of 1.5 is generally recommended for conditions where the slope failure would comprise permanent structures.

An analysis considering seismic loading was also completed. A horizontal acceleration of 0.16 g was considered for the sections for the seismic loading condition. A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading.

Six (6) slope cross-sections (Sections A, B, C, D, E and F) were studied as the worst case scenarios. The cross section locations are presented on Drawing PG6414-1 – Test Hole Location Plan in Appendix 2. It should be noted that details of the slope height and slope angle at the cross-section locations are presented in Figures 5A through 9B in Appendix 2 from the topographic data identified on Drawing PG6414-1 - Test Hole Location Plan in Appendix 2.

The effective strength soil parameters used for static analysis were chosen based on the subsoil information recovered during the geotechnical investigation. The effective strength soil parameters used for static analysis are presented in Table 8 on the following page.

Table 8 – Effective Stress Soil Parameters (Static Analysis)

Soil Layer	Unit Weight (kN/m^3)	Friction Angle (degrees)	Cohesion (kPa)
Topsoil	16	30	5
Brown Silty Clay	17	33	5
Grey Silty Clay	17	33	10
Glacial Till	20	38	5

The total strength parameters for seismic analysis were chosen based on the subsurface conditions observed in the test holes, and our general knowledge of the geology in the area. The strength parameters used for seismic analysis at the slope cross-sections are presented in Table 9 below.

Table 9 – Total Stress Soil Parameters (Seismic Analysis)

Soil Layer	Unit Weight (kN/m^3)	Friction Angle (degrees)	Cohesion (kPa)
Topsoil	16	30	5
Brown Silty Clay	17	-	100
Grey Silty Clay 1 (to a depth of 9.6 m)	17	-	50
Grey Silty Clay 2	17	-	60
Glacial Till	20	37	0

Stable Slope Allowance

The static analysis results for slope sections A, B, C, D, E and F are presented in Figures 4A, 5A, 6A, 7A, 8A and 9A, respectively, provided in Appendix 2. The factor of safety for the slopes was greater than 1.5 for slope sections B, E and F. A factor of safety less than 1.5 was noted for Section A, C and D, therefore, a slope stability setback would be required, if the existing slope were not re-graded as part of the proposed development. A stable slope setback of 4 m, 15 m and 4 m for Section A, C and Section D respectively would be required is the existing slope is not modified.

The results of the analyses with seismic loading are shown in Figures 4B, 5B, 6B, 7B, 8B and 9B presented in Appendix 2. The factor of safety for the slopes was greater than 1.1 for all slope sections. Based on these results, the slopes are considered to be stable under seismic loading. No further stable slope setback is required.

Toe Erosion and Erosion Access Allowance

The slopes were generally observed to be vegetated with trees and brush. Furthermore, flow from the creek in the watercourse at the base of the slopes was observed to be minimal at the time of inspection though, signs of active erosion were observed at the toe of the slopes. Considering the erosion observed at the toe of the slope, a toe erosion allowance of 7 m is recommended for slope section A, B, C, D and F.

It should be noted that toe erosion at slope section A was measured from the toe of the slope as allowed by the guidelines when the watercourse is located at 30 m or greater from the base of the slope. It is expected that failure of the slope due to toe erosion would occur along the flat plane adjacent to the watercourse. As such, the toe erosion for slope section A does not affect the required setback at section A.

The slope sections E and F was noted to have a factor of safety lower than 1.5 under static loading at the toe of the slope. The low factor of safety indicates a potential of minor surficial slope failure at the toe of the slope mainly caused be erosion. The potential slope failure is limited to the upper layer of soil and concentrated at the toe of the slope. Such failure will not affect the stability of the upper section of the slope. Given the lower factor of safety, an increased toe allowance of 8 m was utilized for slope section E. Due to the higher factor of safety and milder slope at section F, a toe allowance of 7 m is considered acceptable.

A 6 m erosion access allowance was applied from the top of stable slope for the slopes to allow for future maintenance of the slope.

To lower the erosion allowance setback, an erosion protection program consisting of covering the banks of the creek with rip rap and blast stone material can be completed. Note that the current setbacks are provided for the current conditions at the base of the slope. Paterson should prepare the erosion protection program and review its implementation in order to re-evaluate the erosion allowance setbacks.

Limit of Hazard Lands

The results of the slope stability assessment indicate that Limit of Hazard Lands setbacks of 10, 27, 28, 17, 14 and 13 m, as measured form the top of the slope, should be provided for any proposed structures at the subject site in the areas of Section A, B, C, D, E and F respectively, in order to provide a suitable factor of safety of 1.5 under static conditions and 1.1 under seismic conditions.

Furthermore, grade raise is not recommended in the limit of hazard lands. If any grading is recommended in the area, Paterson should review for any negative impact on the slope.

It is recommended that the existing vegetation and mature trees not be removed from the slope faces as the presence of the vegetation reduces surficial erosion activities. If the existing vegetation needs to be removed along the slope faces, it is recommended that a 100 to 150 mm of topsoil mixed with a hardy seed, or an erosional control blanket be placed across the exposed slope face.

7.0 Recommendations

For the foundation design data provided herein to be applicable that a material 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.

☐ Observe and review the installation of the drainage and waterproofing system.

☐ 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.

☐ 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 and our recommendations when the drawings and specifications are complete.

A geotechnical investigation of this nature is a limited sampling of a site. The recommendations are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around the test locations. The extent of the limited area depends on the soil, bedrock and groundwater conditions, as well the history of the site reflecting natural, construction, and other activities. Should any conditions at the site be encountered which differ from those at the test locations, we request notification immediately in order to permit reassessment of our recommendations.

The recommendations provided in this report are intended for the use of design professionals associated with this project. Contractors bidding on or undertaking the work should examine the factual information contained in this report and the site conditions, satisfy themselves as to the adequacy of the information provided for construction purposes, supplement the factual information if required, and develop their own interpretation of the factual information based on both their and their subcontractors construction methods, equipment capabilities and schedules.

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 6382983 Canada Inc. or their agent(s) is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
Oct. 9, 2024
J. R. VILLENEUVE
100504344
PROVINCE OF ONTARIO

Nicolas Seguin

Nicolas Seguin, EIT

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

Report Distribution:

- ☐ 6382983 Canada Inc. (Brigil Construction)
- ☐ Paterson Group Inc

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ATTERBERG TESTING RESULTS

GRAIN SIZE ANALYSIS RESULTS

SHRINKAGE ANALYSIS RESULTS

ANALYTICAL TESTING RESULTS

HYDRAULIC CONDUCTIVITY TESTING

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

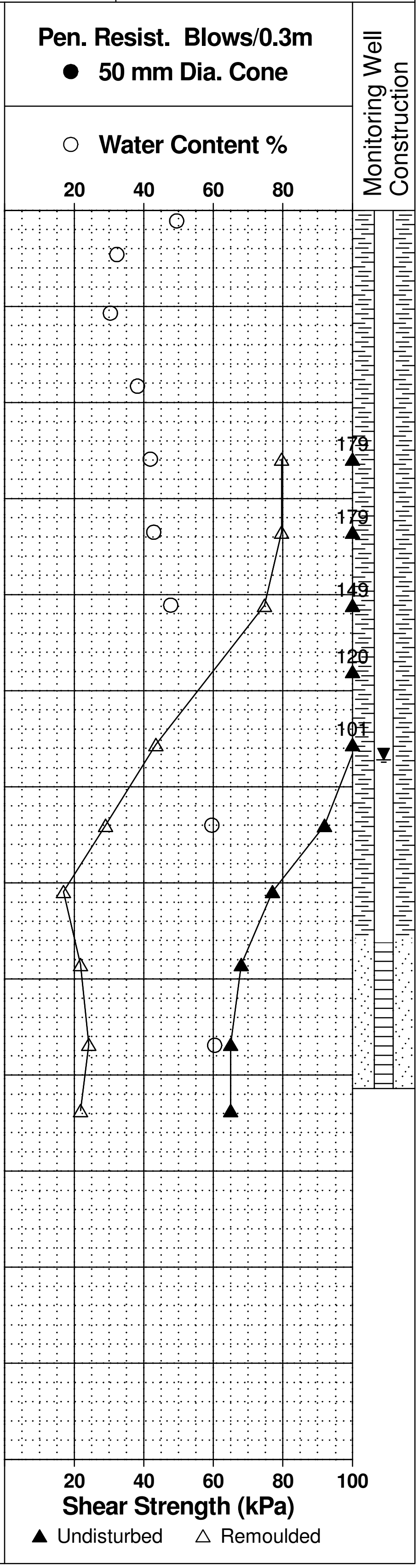
DATE October 20, 2022

FILE NO. PG6414

HOLE NO. BH 1-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.23		AU	1		
Hard to very stiff, brown **SILTY CLAY**		AU	2		
		SS	3	75	17
		SS	4	100	13
		SS	5	100	P
		SS	6	100	P
5.94		SS	7	100	P
Stiff, grey **SILTY CLAY**		SS	8	100	P
9.60		SS	9	100	P
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.6m depth.					

DEPTH (m)	ELEV. (m)
0	51.16
1	50.16
2	49.16
3	48.16
4	47.16
5	46.16
6	45.16
7	44.16
8	43.16
9	42.16
10	41.16
11	40.16
12	39.16
13	38.16



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

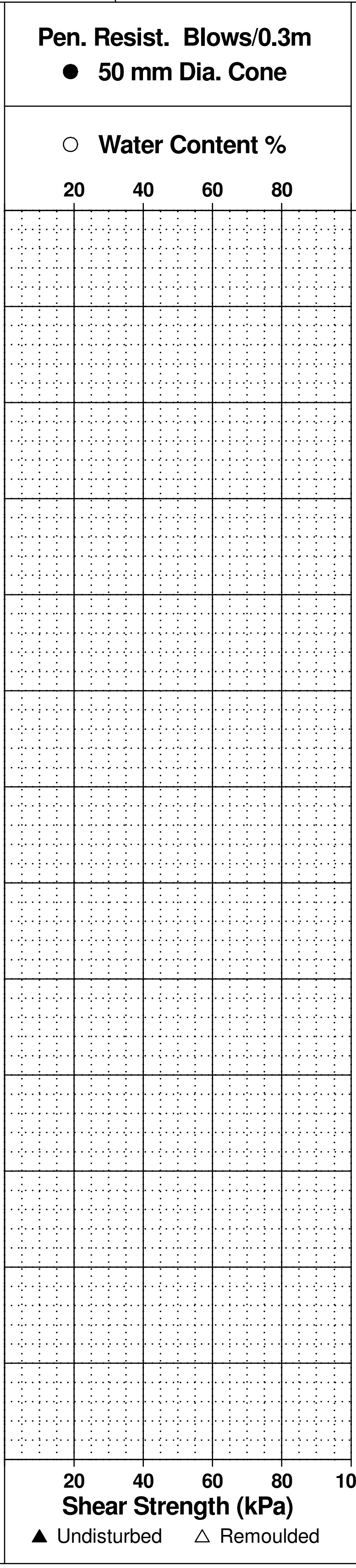
BORINGS BY CME-55 Low Clearance Drill

DATE October 20, 2022

FILE NO. **PG6414**

HOLE NO. **BH 1-22**

SOIL DESCRIPTION GROUND SURFACE	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Monitoring Well Construction
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.6m depth.						13	38.16	
						14	37.16	
						15	36.16	
						16	35.16	
						17	34.16	
						18	33.16	
						19	32.16	
						20	31.16	
						21	30.16	
						22	29.16	
						23	28.16	
						24	27.16	
						25	26.16	
						26	25.16	



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

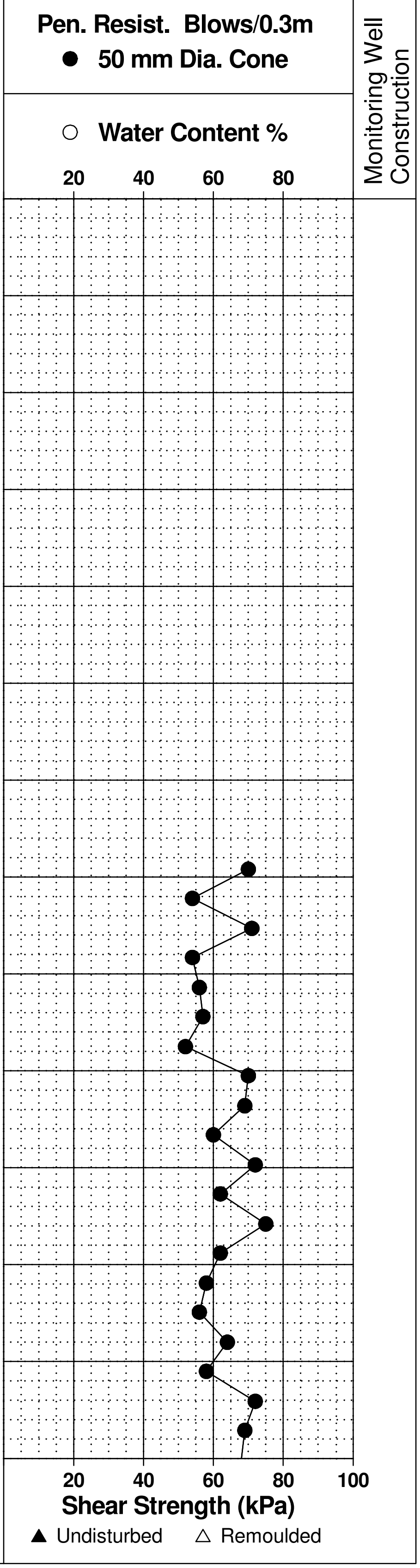
BORINGS BY CME-55 Low Clearance Drill

DATE October 20, 2022

FILE NO. PG6414

HOLE NO. BH 1-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
GROUND SURFACE		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.6m depth.						26	25.16
						27	24.16
						28	23.16
						29	22.16
						30	21.16
						31	20.16
						32	19.16
						33	18.16
						34	17.16
						35	16.16
						36	15.16
						37	14.16
						38	13.16
						39	12.16



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

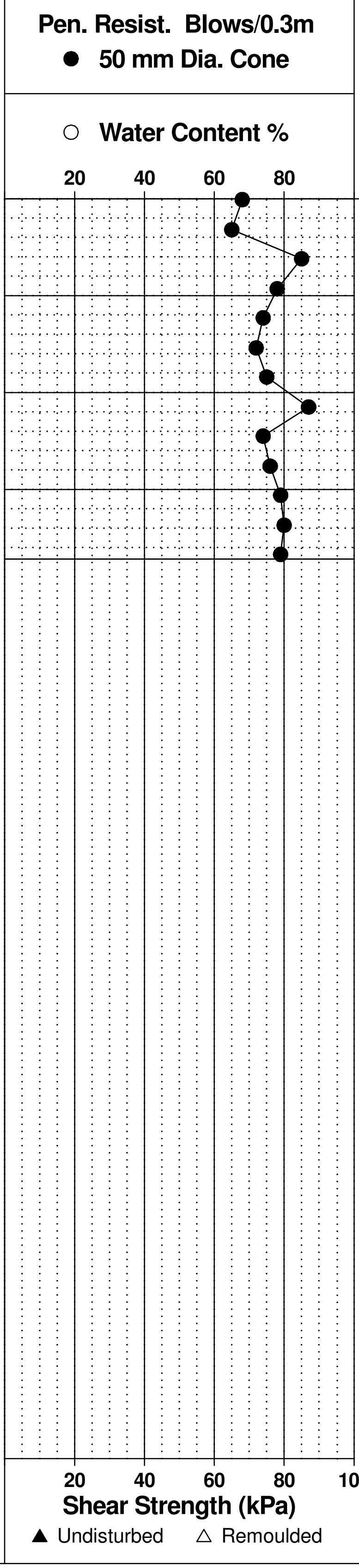
BORINGS BY CME-55 Low Clearance Drill

DATE October 20, 2022

FILE NO. PG6414

HOLE NO. BH 1-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Monitoring Well Construction
GROUND SURFACE								
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.6m depth.						39	12.16	
						40	11.16	
						41	10.16	
						42	9.16	
42.72								
No DCPT refusal encountered by 42.72m depth, borehole terminated. (GWL @ 5.72m - Nov. 7, 2022)								



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

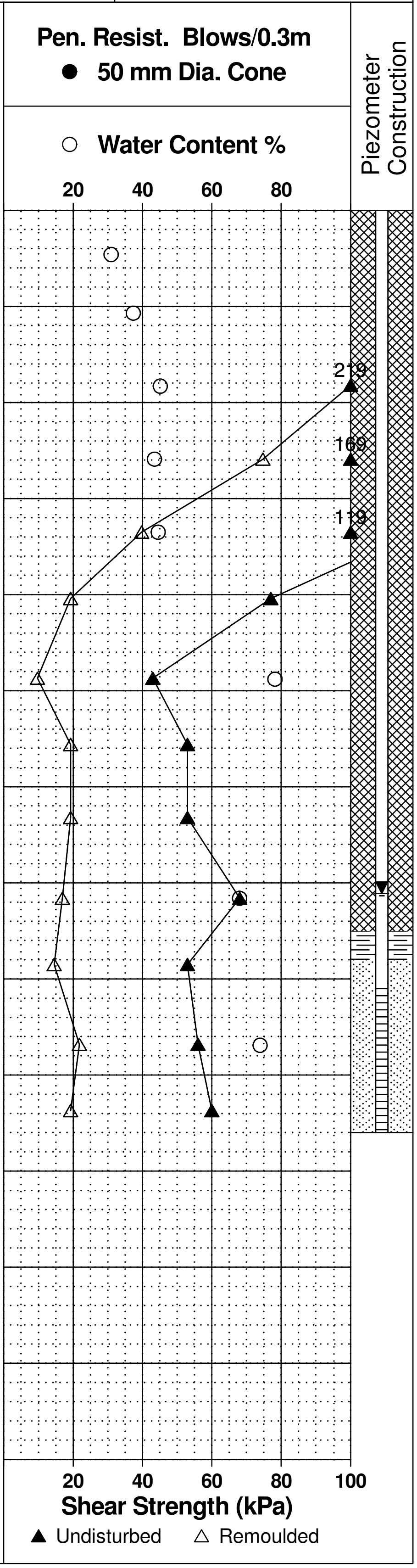
DATE October 20, 2022

FILE NO. PG6414

HOLE NO. BH 2-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.20					
Hard to stiff, brown **SILTY CLAY**		AU	1		
		SS	2	67	14
		SS	3	75	P
		SS	4	83	P
		SS	5	100	P
4.42					
Stiff, grey **SILTY CLAY**		SS	6	100	P
		SS	7	100	P
		SS	8	100	P
9.60					
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 20.1m depth.					

DEPTH (m)	ELEV. (m)
0	52.14
1	51.14
2	50.14
3	49.14
4	48.14
5	47.14
6	46.14
7	45.14
8	44.14
9	43.14
10	42.14
11	41.14
12	40.14
13	39.14



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

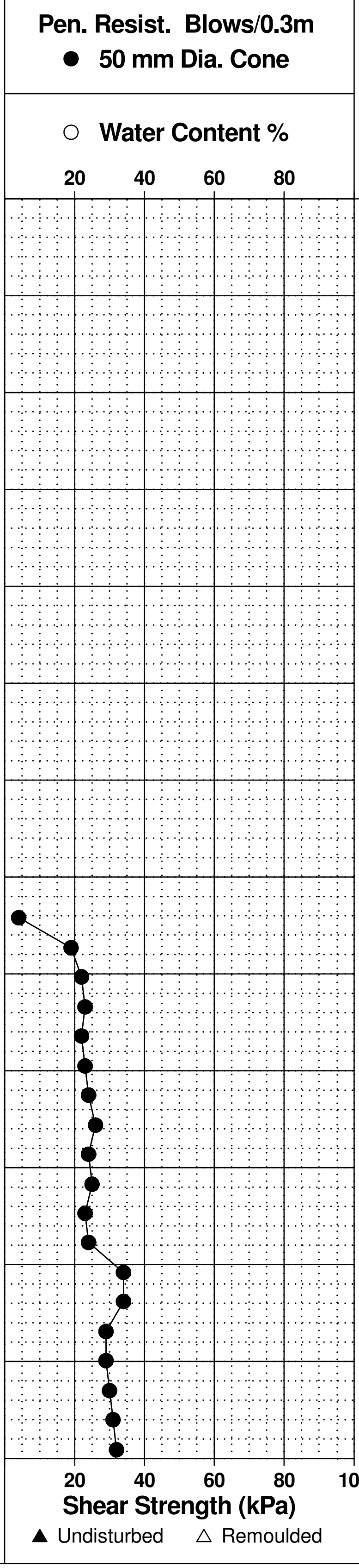
BORINGS BY CME-55 Low Clearance Drill

DATE October 20, 2022

FILE NO. PG6414

HOLE NO. BH 2-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 20.1m depth.						13	39.14
						14	38.14
						15	37.14
						16	36.14
						17	35.14
						18	34.14
						19	33.14
						20	32.14
						21	31.14
						22	30.14
						23	29.14
						24	28.14
						25	27.14
						26	26.14



Piezometer Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

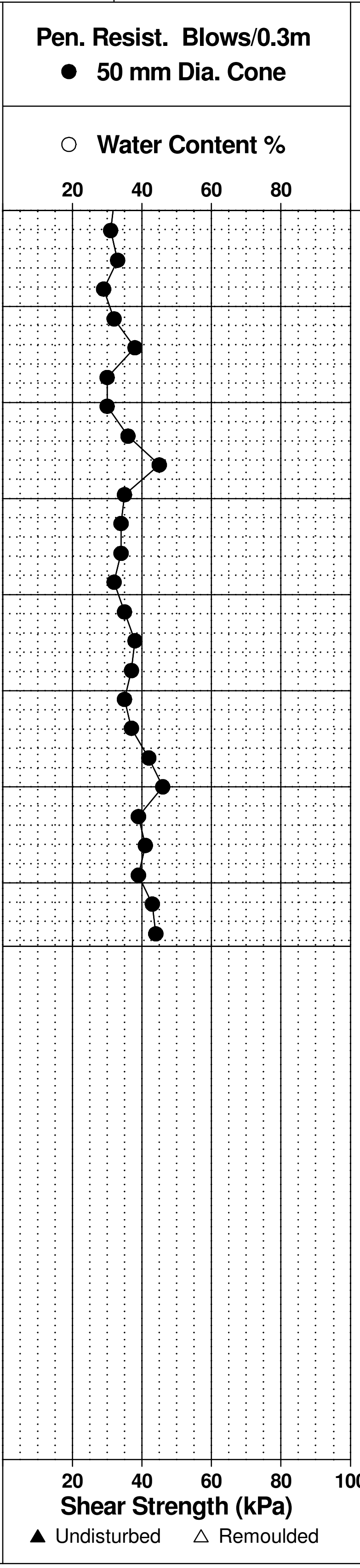
BORINGS BY CME-55 Low Clearance Drill

DATE October 20, 2022

FILE NO. **PG6414**

HOLE NO. **BH 2-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE								
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 20.1m depth.						26	26.14	
						27	25.14	
						28	24.14	
						29	23.14	
						30	22.14	
						31	21.14	
						32	20.14	
						33	19.14	
33.66								
No DCPT refusal encountered by 33.66m depth, borehole terminated. (GWL @ 7.11m - Nov. 7, 2022)								



patersongroup Consulting Engineers
9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

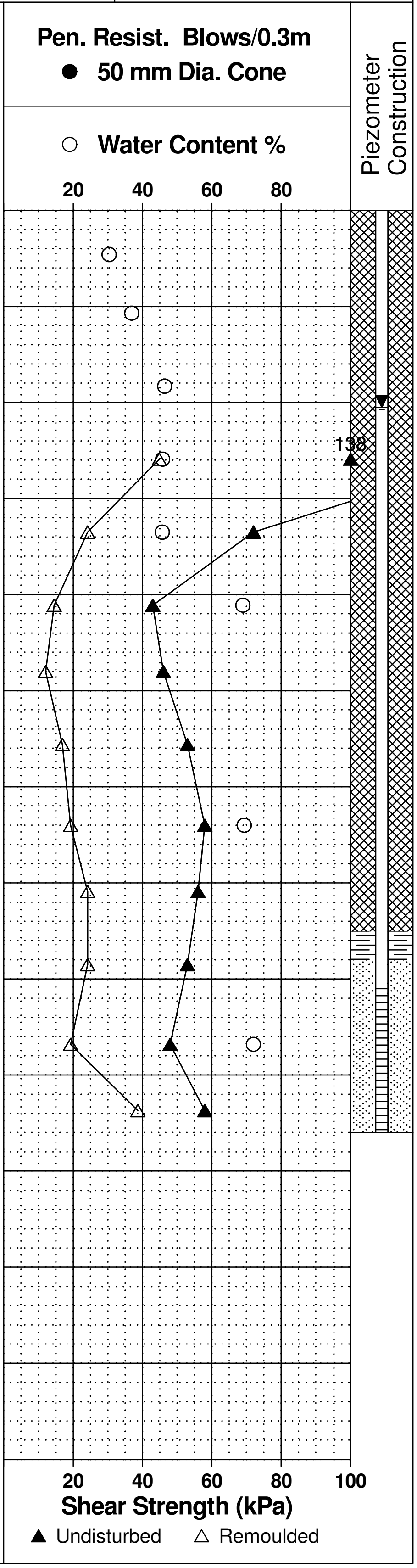
Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY CME-55 Low Clearance Drill **DATE** October 21, 2022

FILE NO. PG6414
HOLE NO. BH 3-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.25		AU	1		
Hard to stiff, brown **SILTY CLAY**		SS	2	67	15
		SS	3	67	9
		SS	4	100	P
3.73		SS	5	100	P
Firm to stiff, grey **SILTY CLAY**		SS	6	100	P
		SS	7	100	P
9.60		SS	8	100	P
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 31.7m depth.					

DEPTH (m)	ELEV. (m)
0	52.67
1	51.67
2	50.67
3	49.67
4	48.67
5	47.67
6	46.67
7	45.67
8	44.67
9	43.67
10	42.67
11	41.67
12	40.67
13	39.67



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 21, 2022

FILE NO. PG6414

HOLE NO. BH 3-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 31.7m depth.						13	39.67		
						14	38.67		
						15	37.67		
						16	36.67		
						17	35.67		
						18	34.67		
						19	33.67		
						20	32.67		
						21	31.67		
						22	30.67		
						23	29.67		
						24	28.67		
						25	27.67		
						26	26.67		

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
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

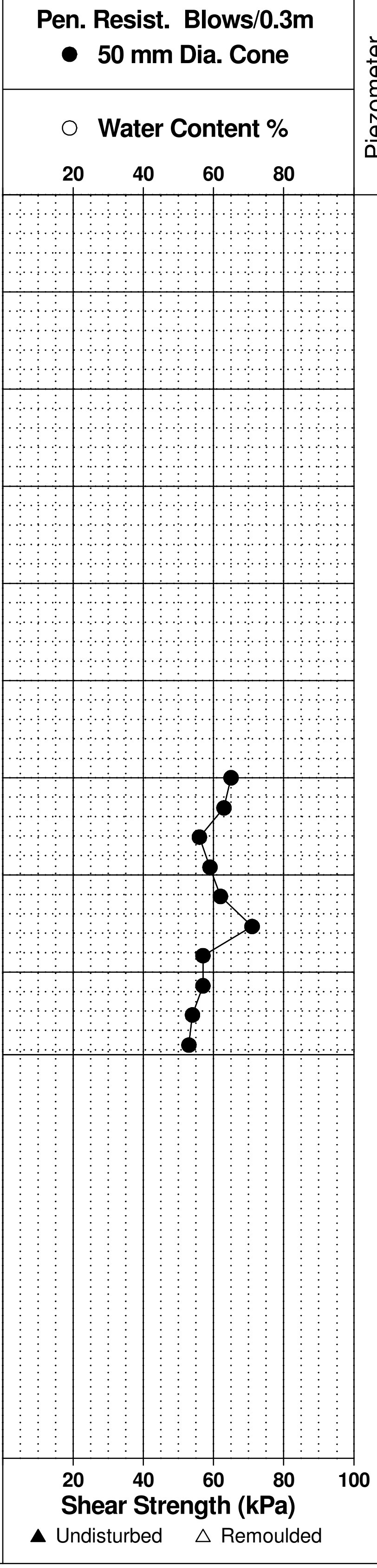
BORINGS BY CME-55 Low Clearance Drill

DATE October 21, 2022

FILE NO. PG6414

HOLE NO. BH 3-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 31.7m depth.						26	26.67
						27	25.67
						28	24.67
						29	23.67
						30	22.67
						31	21.67
						32	20.67
						33	19.67
						34	18.67
34.85							
No DCPT refusal encountered by 34.85m depth, borehole terminated. (GWL @ 2.05m - Nov. 7, 2022)							



Piezometer Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 21, 2022

FILE NO. PG6414

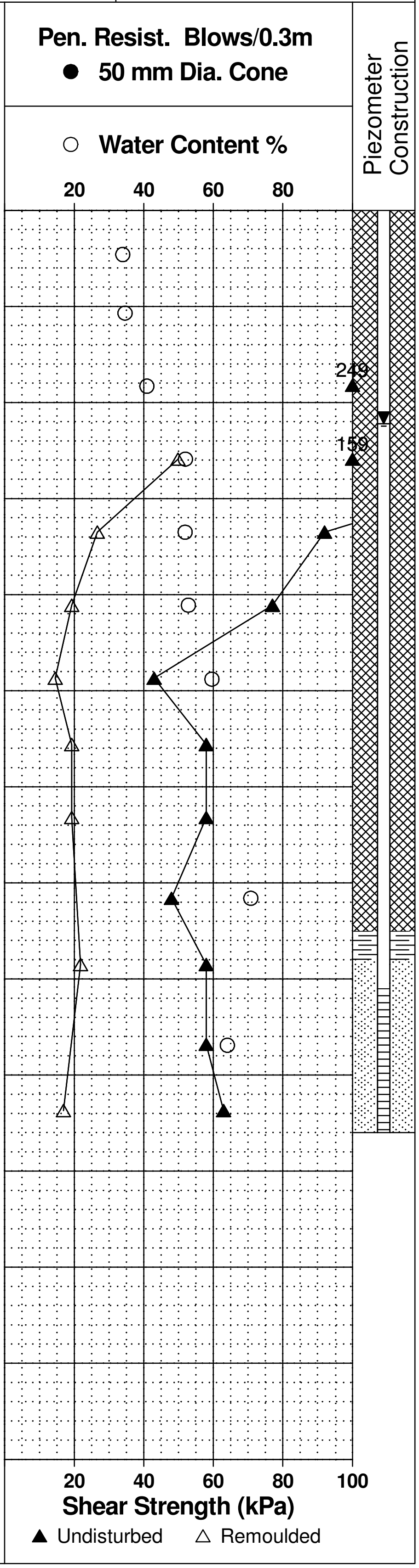
HOLE NO. BH 4-22

GROUND SURFACE

SOIL DESCRIPTION	Depth (m)
TOPSOIL	0.18
Hard to stiff, brown **SILTY CLAY**	4.50
Firm to stiff, grey **SILTY CLAY**	9.60
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 28.9m depth.	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	83	18
SS	3	83	P
SS	4	67	P
SS	5	67	P
SS	6	75	P
SS	7	50	P
SS	8	92	P
SS	9	67	P

DEPTH (m)	ELEV. (m)
0	51.32
1	50.32
2	49.32
3	48.32
4	47.32
5	46.32
6	45.32
7	44.32
8	43.32
9	42.32
10	41.32
11	40.32
12	39.32
13	38.32



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 21, 2022

FILE NO. PG6414

HOLE NO. BH 4-22

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	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 28.9m depth.						13	38.32		
						14	37.32		
						15	36.32		
						16	35.32		
						17	34.32		
						18	33.32		
						19	32.32		
						20	31.32		
						21	30.32		
						22	29.32		
						23	28.32		
						24	27.32		
						25	26.32		
						26	25.32		

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
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

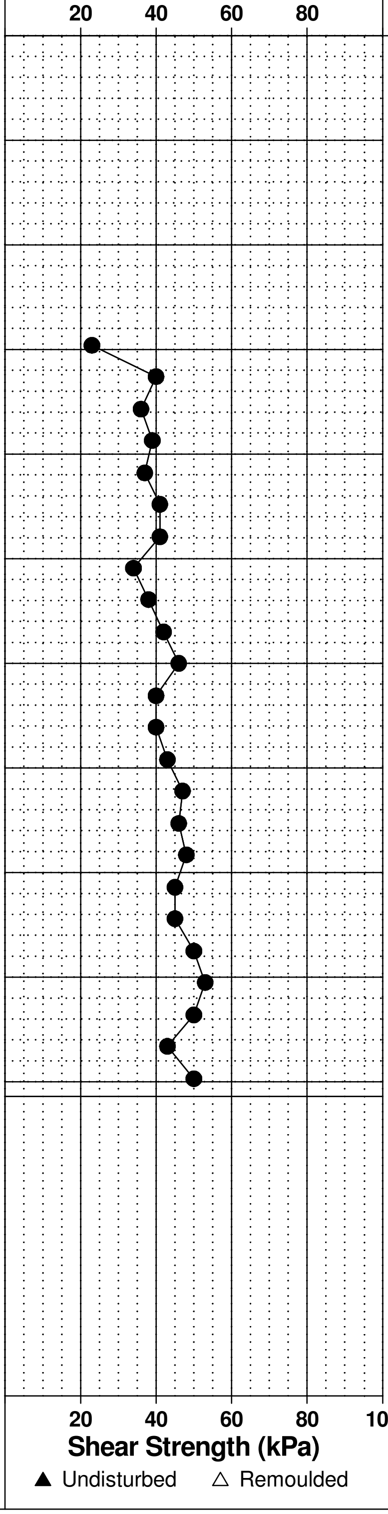
BORINGS BY CME-55 Low Clearance Drill

DATE October 21, 2022

FILE NO. PG6414

HOLE NO. BH 4-22

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 %	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 28.9m depth.						26	25.32		
						27	24.32		
						28	23.32		
						29	22.32		
						30	21.32		
						31	20.32		
						32	19.32		
						33	18.32		
						34	17.32		
						35	16.32		
36.14						36	15.32		
No DCPT refusal encountered by 36.14m depth, borehole terminated. (GWL @ 2.22m - Nov. 7, 2022)									



patersongroup Consulting Engineers
9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

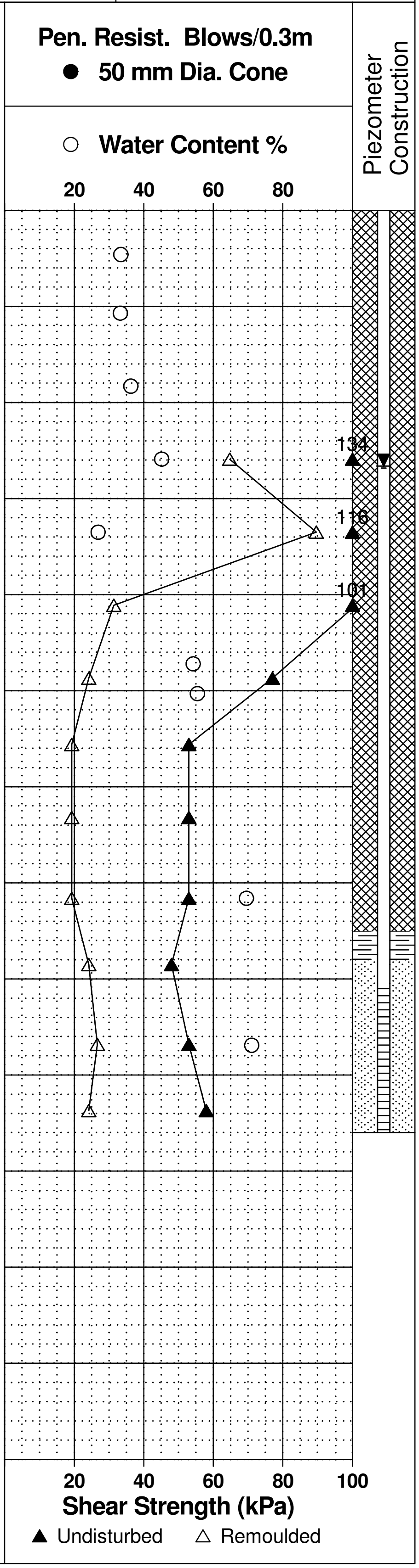
Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY CME-55 Low Clearance Drill
DATE October 24, 2022
FILE NO. **PG6414**
HOLE NO. **BH 5-22**

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.20
Hard to stiff, brown **SILTY CLAY**	4.88
Stiff, grey **SILTY CLAY**	9.60
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.3m depth.	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	75	18
SS	3	83	16
SS	4	83	P
SS	5	75	P
SS	6	0	P
SS	7	100	P
SS	8		P
SS	9		P

DEPTH (m)	ELEV. (m)
0	51.18
1	50.18
2	49.18
3	48.18
4	47.18
5	46.18
6	45.18
7	44.18
8	43.18
9	42.18
10	41.18
11	40.18
12	39.18
13	38.18



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 24, 2022

FILE NO. PG6414

HOLE NO. BH 5-22

SOIL DESCRIPTION GROUND SURFACE	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	Piezometer Construction
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.3m depth.						13	38.18		
						14	37.18		
						15	36.18		
						16	35.18		
						17	34.18		
						18	33.18		
						19	32.18		
						20	31.18		
						21	30.18		
						22	29.18		
						23	28.18		
						24	27.18		
						25	26.18		
						26	25.18		

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
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

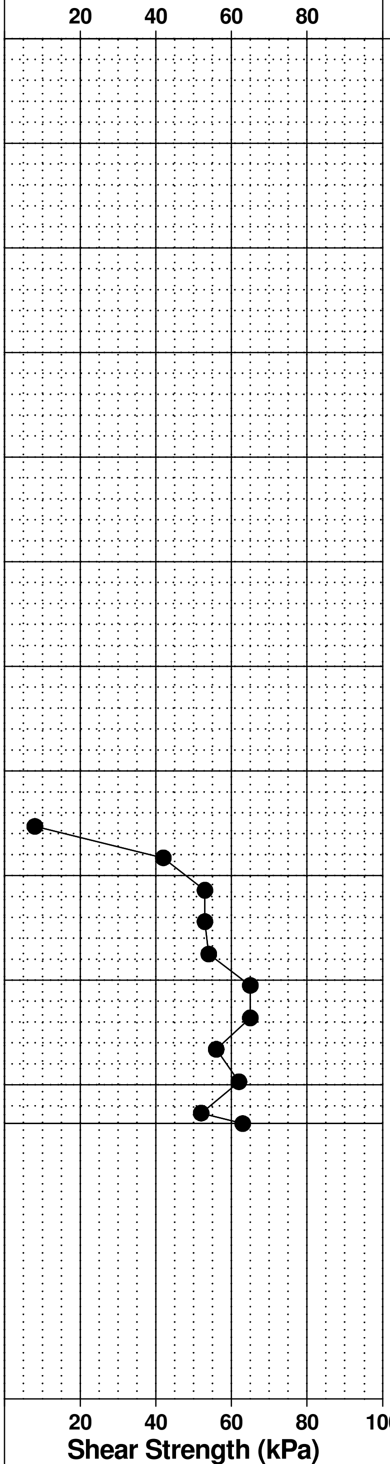
BORINGS BY CME-55 Low Clearance Drill

DATE October 24, 2022

FILE NO. PG6414

HOLE NO. BH 5-22

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 %	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.3m depth.						26	25.18		
						27	24.18		
						28	23.18		
						29	22.18		
						30	21.18		
						31	20.18		
						32	19.18		
						33	18.18		
						34	17.18		
						35	16.18		
						36	15.18		
36.37									
No DCPT refusal encountered by 36.37m depth, borehole terminated. (GWL @ 2.66m - Nov. 7, 2022)									



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 24, 2022

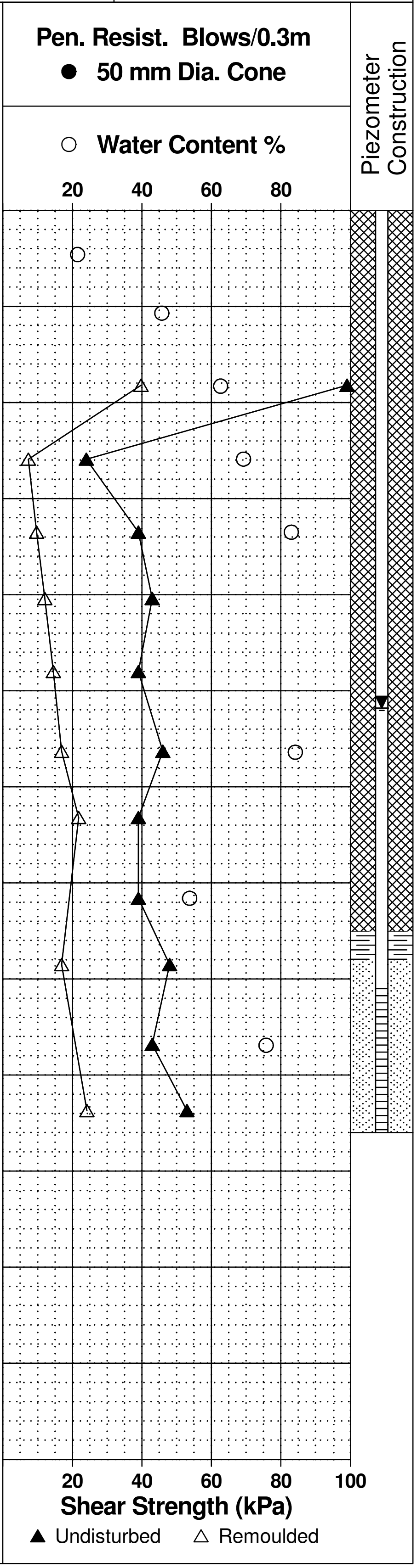
FILE NO. PG6414

HOLE NO. BH 6-22

SOIL DESCRIPTION	STRATA DEPTH
GROUND SURFACE	
TOPSOIL	0.20
Very stiff to stiff, brown **SILTY CLAY**	2.29
Soft to firm, grey **SILTY CLAY** - stiff by 9.1m depth	9.60
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.3m depth.	

TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	100	7
SS	3	67	P
SS	4	83	P
SS	5	100	P
SS	6	100	P
SS	7	100	P
SS	8	100	P

DEPTH (m)	ELEV. (m)
0	53.46
1	52.46
2	51.46
3	50.46
4	49.46
5	48.46
6	47.46
7	46.46
8	45.46
9	44.46
10	43.46
11	42.46
12	41.46
13	40.46



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

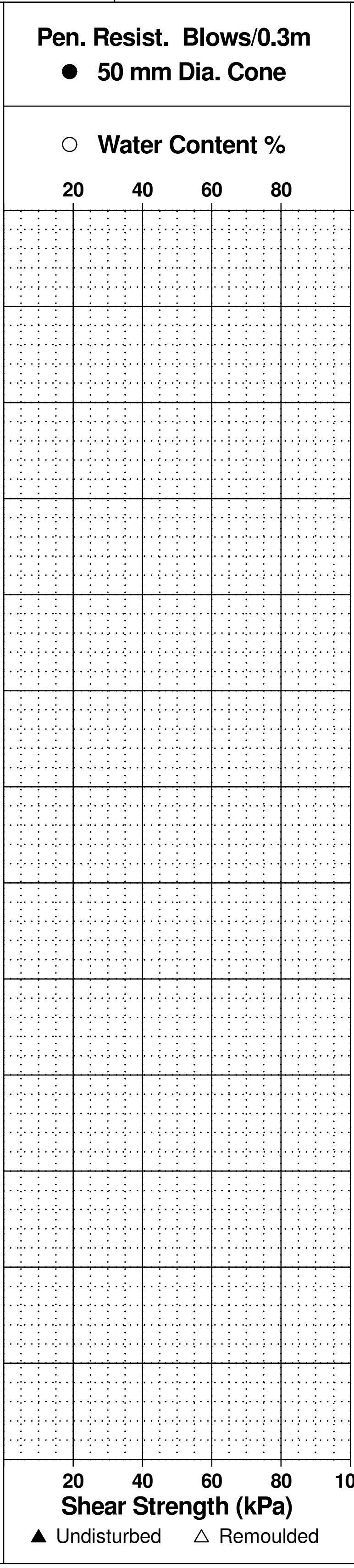
BORINGS BY CME-55 Low Clearance Drill

DATE October 24, 2022

FILE NO. PG6414

HOLE NO. BH 6-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE		TYPE	NUMBER	% RECOVERY	N VALUE or RQD			
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.3m depth.						13	40.46	
						14	39.46	
						15	38.46	
						16	37.46	
						17	36.46	
						18	35.46	
						19	34.46	
						20	33.46	
						21	32.46	
						22	31.46	
						23	30.46	
						24	29.46	
						25	28.46	
						26	27.46	



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

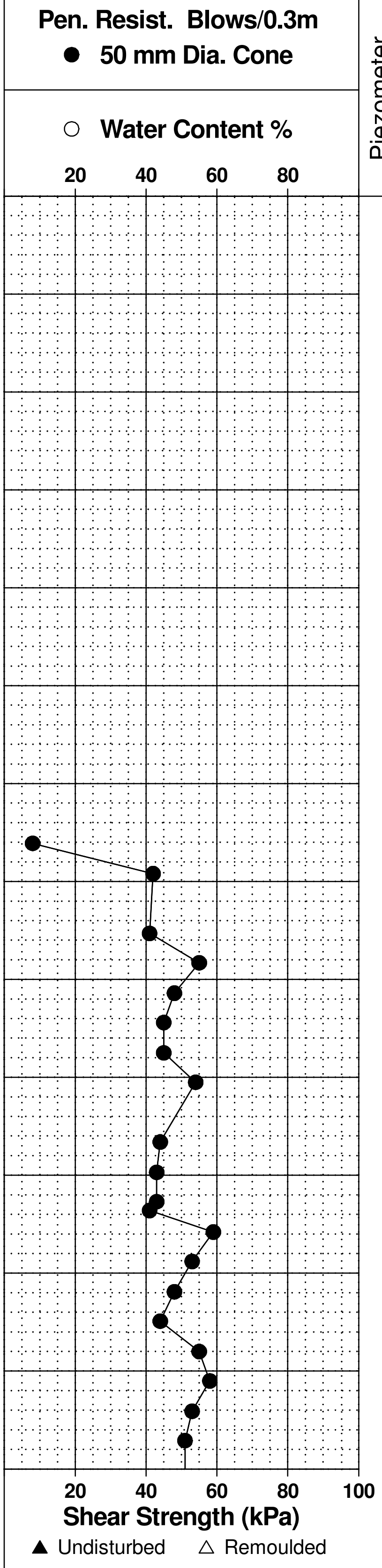
BORINGS BY CME-55 Low Clearance Drill

DATE October 24, 2022

FILE NO. PG6414

HOLE NO. BH 6-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE								
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.3m depth.						26	27.46	
						27	26.46	
						28	25.46	
						29	24.46	
						30	23.46	
						31	22.46	
						32	21.46	
						33	20.46	
						34	19.46	
						35	18.46	
						36	17.46	
						37	16.46	
						38	15.46	
						39	14.46	



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

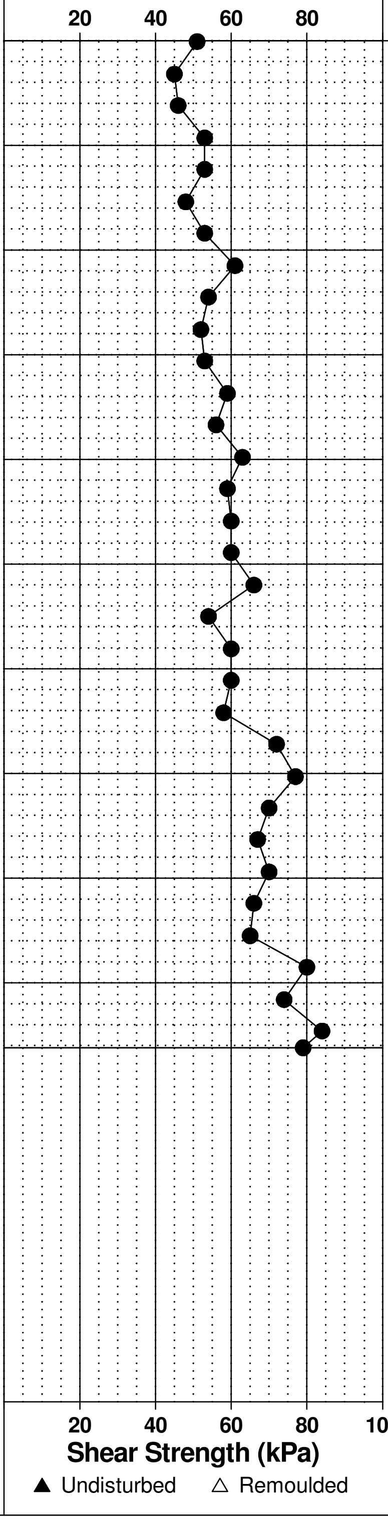
BORINGS BY CME-55 Low Clearance Drill

DATE October 24, 2022

FILE NO. PG6414

HOLE NO. BH 6-22

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 %	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.3m depth.						39	14.46		
						40	13.46		
						41	12.46		
						42	11.46		
						43	10.46		
						44	9.46		
						45	8.46		
						46	7.46		
						47	6.46		
						48	5.46		
48.62									
No DCPT refusal encountered by 48.62m depth, borehole terminated. (GWL @ 5.18m - Nov. 7, 2022)									



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 25, 2022

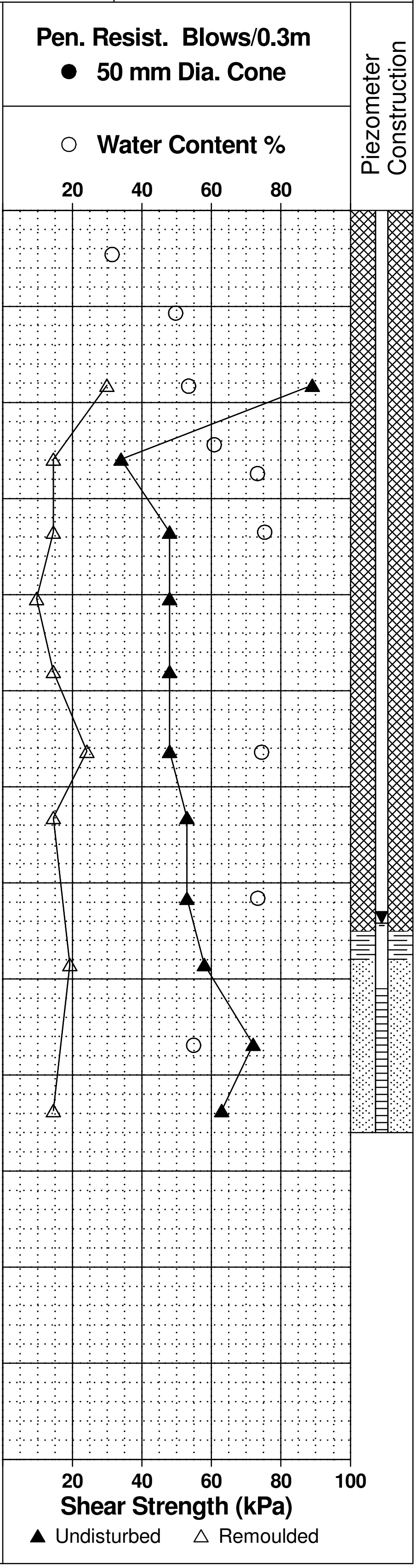
FILE NO. **PG6414**

HOLE NO. **BH 7-22**

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.15
Hard to stiff, brown **SILTY CLAY**	2.67
Firm to stiff, grey **SILTY CLAY**	9.60
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.2m depth.	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	67	6
SS	3	75	P
SS	4	83	P
SS	5	83	P
SS	6	100	P
SS	7	100	P
SS	8	100	P

DEPTH (m)	ELEV. (m)
0	53.33
1	52.33
2	51.33
3	50.33
4	49.33
5	48.33
6	47.33
7	46.33
8	45.33
9	44.33
10	43.33
11	42.33
12	41.33
13	40.33



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 25, 2022

FILE NO. PG6414

HOLE NO. BH 7-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone	Piezometer Construction
GROUND SURFACE		TYPE	NUMBER	% RECOVERY	N VALUE or RQD			○ Water Content % 20 40 60 80	
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.2m depth.						13	40.33		
						14	39.33		
						15	38.33		
						16	37.33		
						17	36.33		
						18	35.33		
						19	34.33		
						20	33.33		
						21	32.33		
						22	31.33		
						23	30.33		
						24	29.33		
						25	28.33		
						26	27.33		

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
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 25, 2022

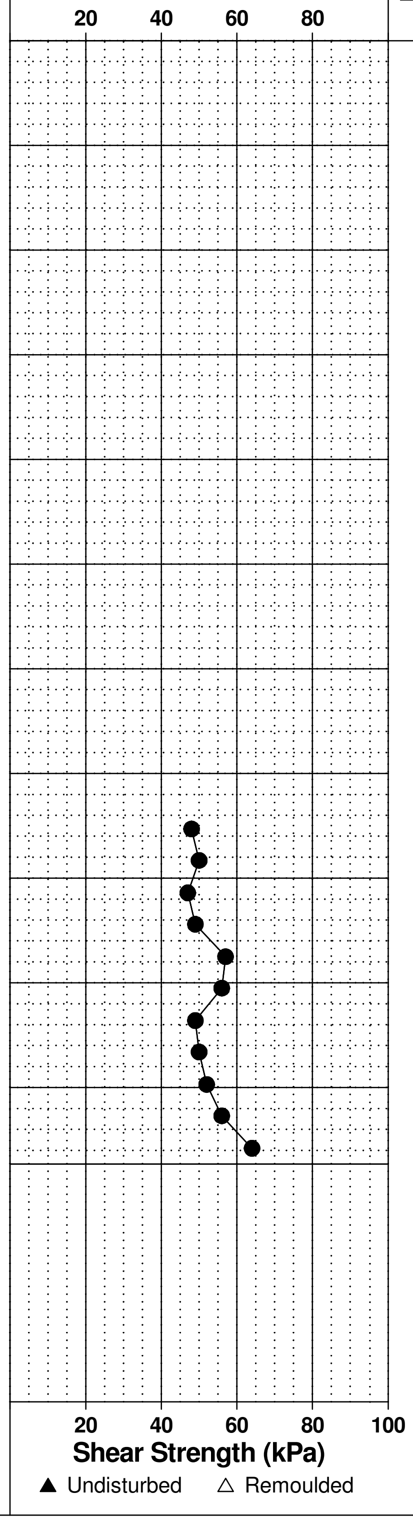
FILE NO. PG6414

HOLE NO. BH 7-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.2m depth.						26	27.33
						27	26.33
						28	25.33
						29	24.33
						30	23.33
						31	22.33
						32	21.33
						33	20.33
						34	19.33
						35	18.33
						36	17.33
36.73							
No DCPT refusal encountered by 36.73m depth, borehole terminated. (GWL @ 7.42m - Nov. 7, 2022)							

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

○ Water Content %



Piezometer Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

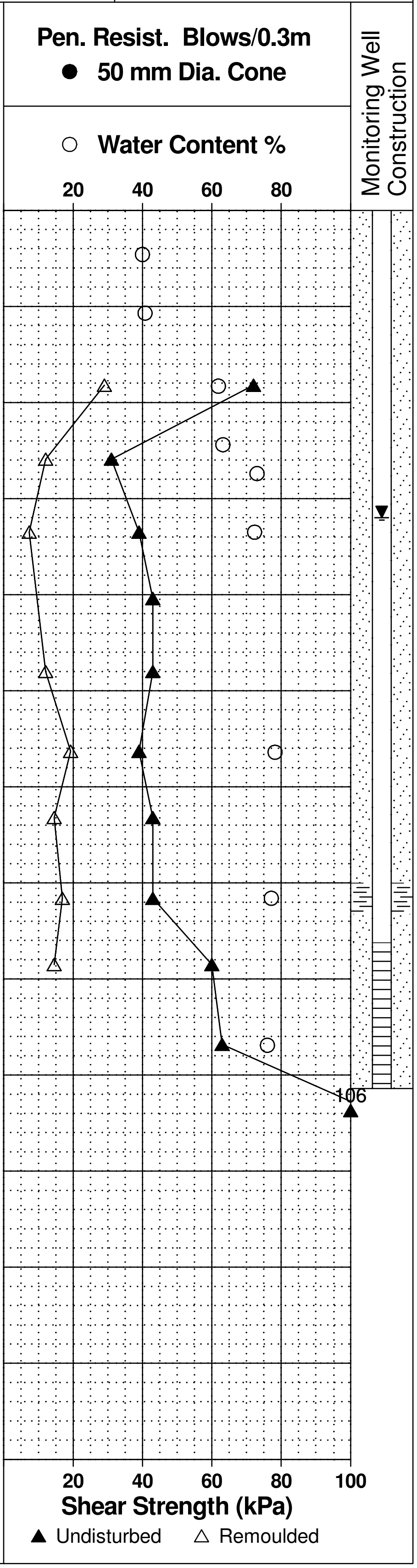
BORINGS BY CME-55 Low Clearance Drill

DATE October 25, 2022

FILE NO. PG6414

HOLE NO. BH 8-22

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	53.04
TOPSOIL 0.13	AU	1				
Hard to stiff, brown SILTY CLAY	SS	2		8	1	52.04
	SS	3	83	P	2	51.04
2.51	SS	4	83	P		
Firm to stiff, grey SILTY CLAY	SS	5	100	P	3	50.04
					4	49.04
					5	48.04
	SS	6	100	P	6	47.04
	SS	7	67	P	7	46.04
					8	45.04
	SS	8		P	9	44.04
9.60						
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.6m depth.					10	43.04
					11	42.04
					12	41.04
					13	40.04



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 25, 2022

FILE NO. PG6414

HOLE NO. BH 8-22

SOIL DESCRIPTION GROUND SURFACE	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
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.6m depth.						13	40.04		
						14	39.04		
						15	38.04		
						16	37.04		
						17	36.04		
						18	35.04		
						19	34.04		
						20	33.04		
						21	32.04		
						22	31.04		
						23	30.04		
						24	29.04		
						25	28.04		
						26	27.04		

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

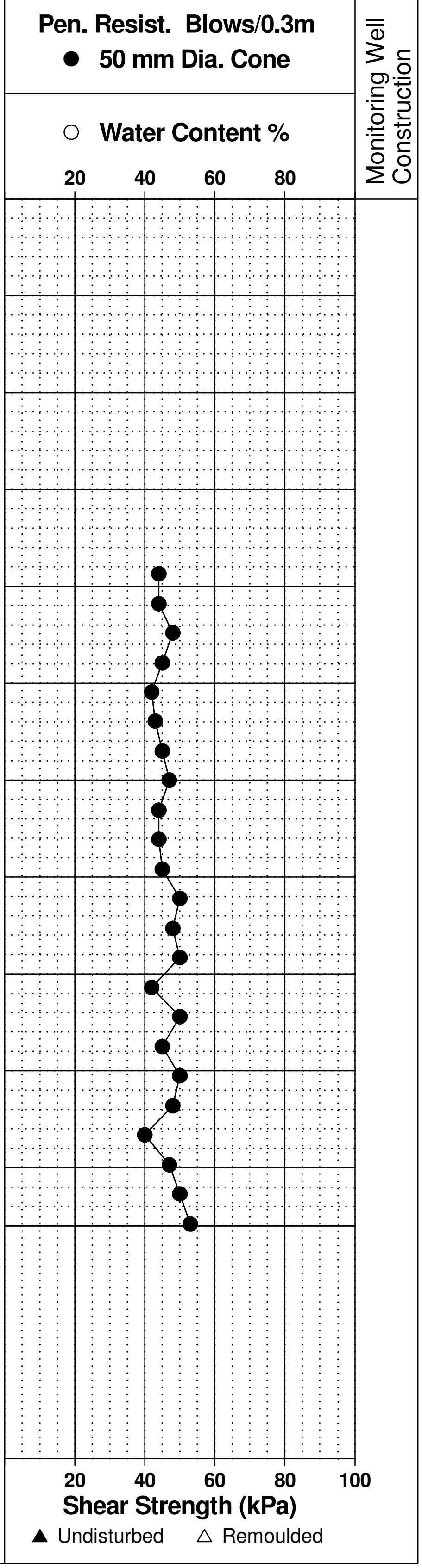
BORINGS BY CME-55 Low Clearance Drill

DATE October 25, 2022

FILE NO. PG6414

HOLE NO. BH 8-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.6m depth.						26	27.04
						27	26.04
						28	25.04
						29	24.04
						30	23.04
						31	22.04
						32	21.04
						33	20.04
						34	19.04
						35	18.04
						36	17.04
36.60							
No DCPT refusal encountered by 36.60m depth, borehole terminated. (GWL @ 3.20m - Nov. 7, 2022)							



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 26, 2022

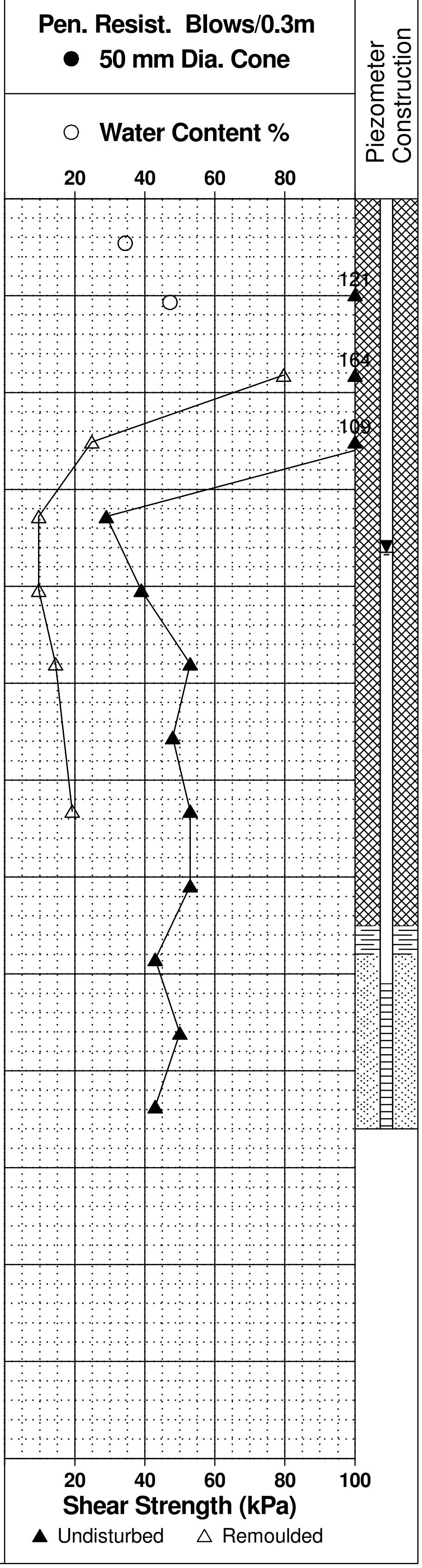
FILE NO. PG6414

HOLE NO. BH 9-22

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
TOPSOIL	0.13
Hard to very stiff, brown **SILTY CLAY**	2.97
Firm to stiff, grey **SILTY CLAY**	9.60
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.3m depth.	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	67	P

DEPTH (m)	ELEV. (m)
0	52.77
1	51.77
2	50.77
3	49.77
4	48.77
5	47.77
6	46.77
7	45.77
8	44.77
9	43.77
10	42.77
11	41.77
12	40.77
13	39.77



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 26, 2022

FILE NO. PG6414

HOLE NO. BH 9-22

SOIL DESCRIPTION GROUND SURFACE	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	Piezometer Construction
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.3m depth.						13	39.77		
						14	38.77		
						15	37.77		
						16	36.77		
						17	35.77		
						18	34.77		
						19	33.77		
						20	32.77		
						21	31.77		
						22	30.77		
						23	29.77		
						24	28.77		
						25	27.77		
						26	26.77		

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

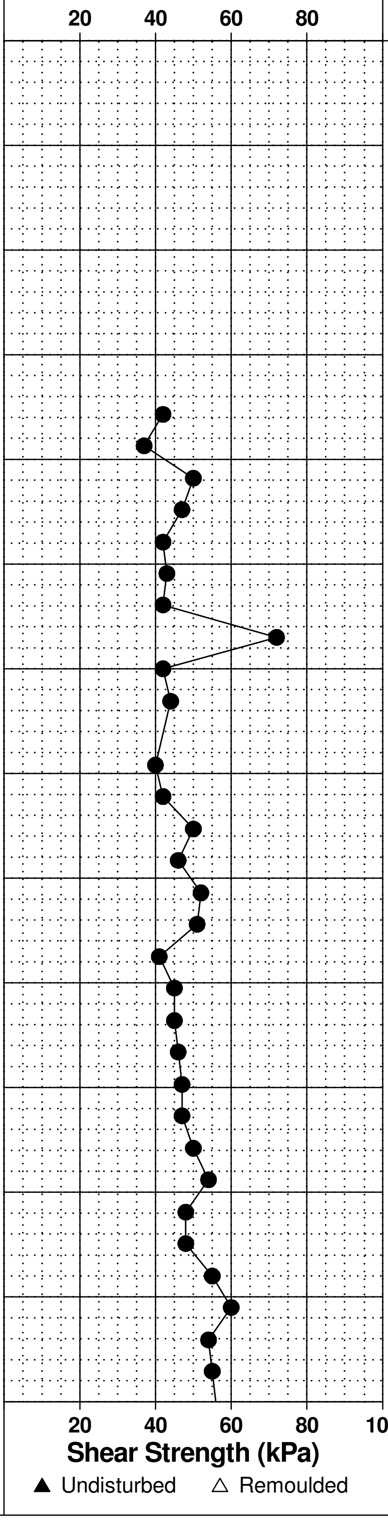
BORINGS BY CME-55 Low Clearance Drill

DATE October 26, 2022

FILE NO. PG6414

HOLE NO. BH 9-22

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 %	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.3m depth.						26	26.77		
						27	25.77		
						28	24.77		
						29	23.77		
						30	22.77		
						31	21.77		
						32	20.77		
						33	19.77		
						34	18.77		
						35	17.77		
						36	16.77		
						37	15.77		
						38	14.77		
						39	13.77		



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 26, 2022

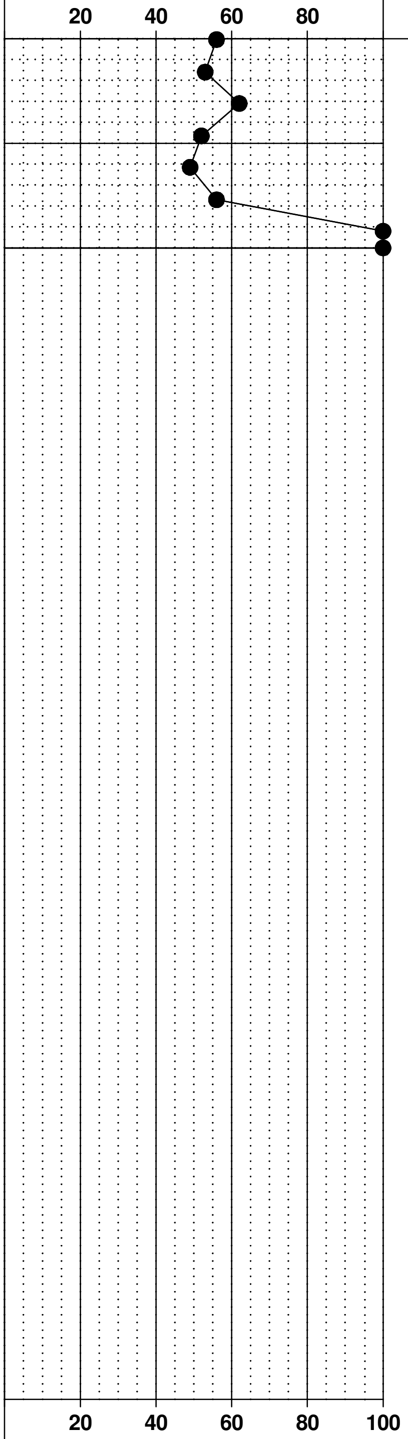
FILE NO. PG6414

HOLE NO. BH 9-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.3m depth.						39	13.77
						40	12.77
41.00						41	11.77
End of Borehole Practical DCPT refusal at 41.00m depth. (GWL @ 3.65m - Nov. 7, 2022)							

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

○ Water Content %



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

Piezometer Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

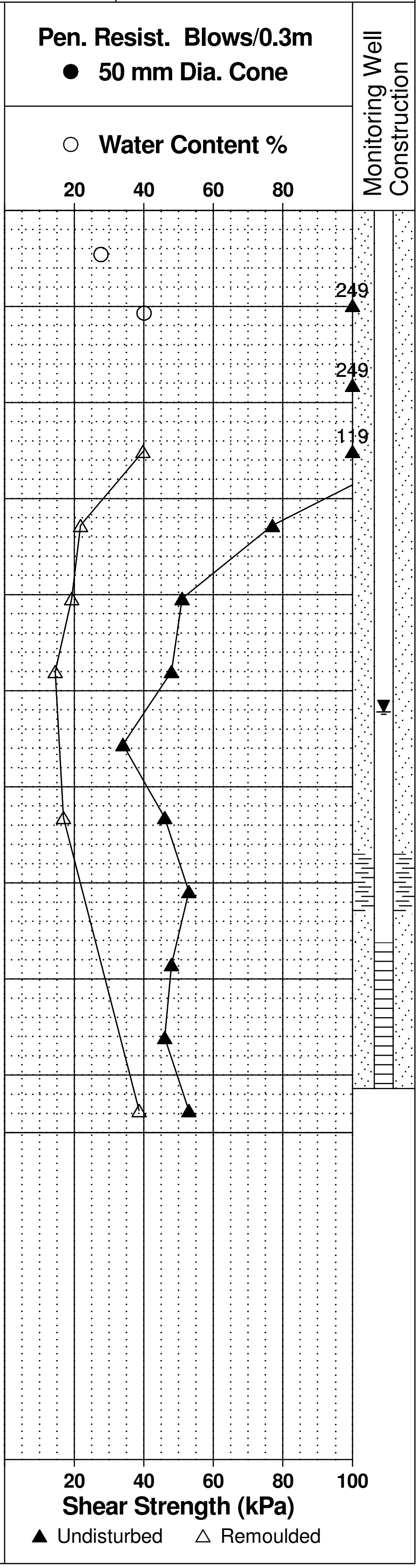
DATE October 26, 2022

FILE NO. PG6414

HOLE NO. BH10-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.18		AU	1		
Hard to stiff, brown **SILTY CLAY** 3.66		SS	2	67	P
Stiff to firm, grey **SILTY CLAY** 9.60					
End of Borehole (GWL @ 5.22m - Nov. 7, 2022)					

DEPTH (m)	ELEV. (m)
0	52.22
1	51.22
2	50.22
3	49.22
4	48.22
5	47.22
6	46.22
7	45.22
8	44.22
9	43.22



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

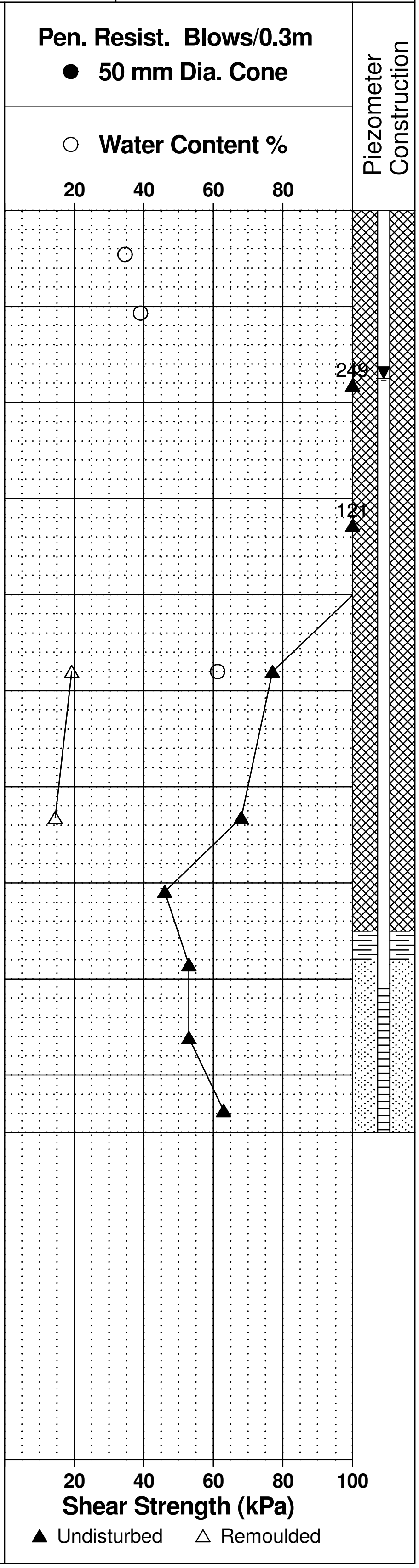
DATE October 26, 2022

FILE NO. PG6414

HOLE NO. BH11-22

SOIL DESCRIPTION	Depth of change (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.18	AU	1		
Hard to stiff, brown **SILTY CLAY**		SS	2	75	P
	5.18	G	3		
Firm to stiff, grey **SILTY CLAY**	9.60				
End of Borehole (GWL @ 1.75m - Nov. 7, 2022)					

DEPTH (m)	ELEV. (m)
0	51.50
1	50.50
2	49.50
3	48.50
4	47.50
5	46.50
6	45.50
7	44.50
8	43.50
9	42.50



patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision, North Service Road
Ottawa, Ontario

DATUM Ground surface elevations provided by McIntosh Perry Surveying Inc.

FILE NO. PG1565

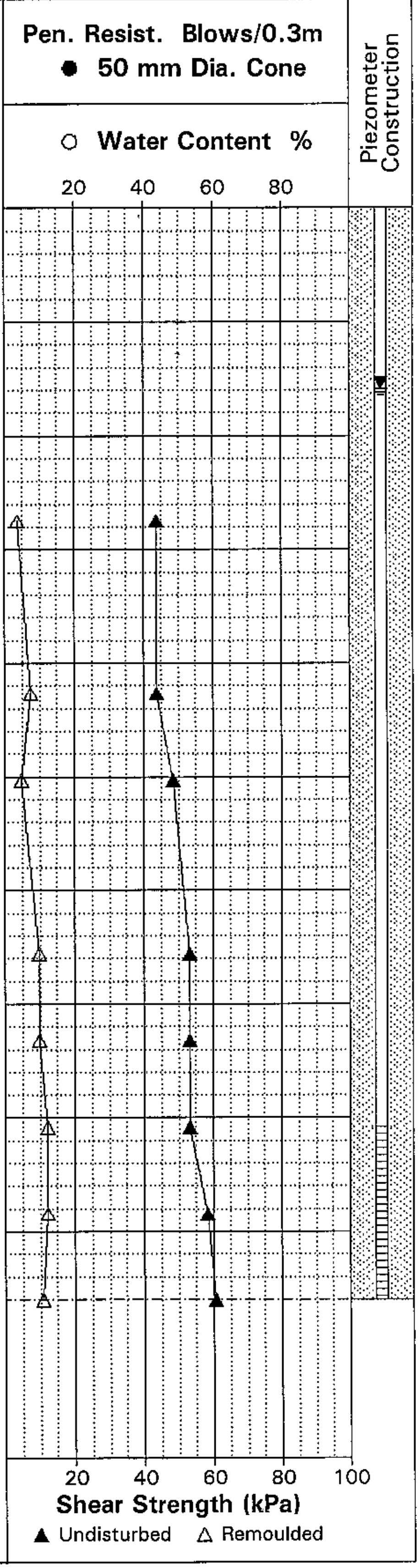
REMARKS

HOLE NO. BH 1

BORINGS BY CME 55 Power Auger

DATE 8 NOV 07

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	53.07
TOPSOIL 0.13						
Brown SILTY CLAY with organic matter 0.46	AU	1				
	SS	2	75	11	1	52.07
Stiff to firm, brown SILTY CLAY, some sand seams	SS	3	100	5		
					2	51.07
- grey by 2.3m depth						
					3	50.07
	TW	4	67			
					4	49.07
					5	48.07
- stiff by 5.6m depth	TW	5	96			
					6	47.07
					7	46.07
					8	45.07
					9	44.07
9.60						
End of Borehole						
(GWL @ 1.59m-Nov. 13/07)						



patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision, North Service Road
Ottawa, Ontario

DATUM Ground surface elevations provided by McIntosh Perry Surveying Inc.

FILE NO. **PG1565**

REMARKS

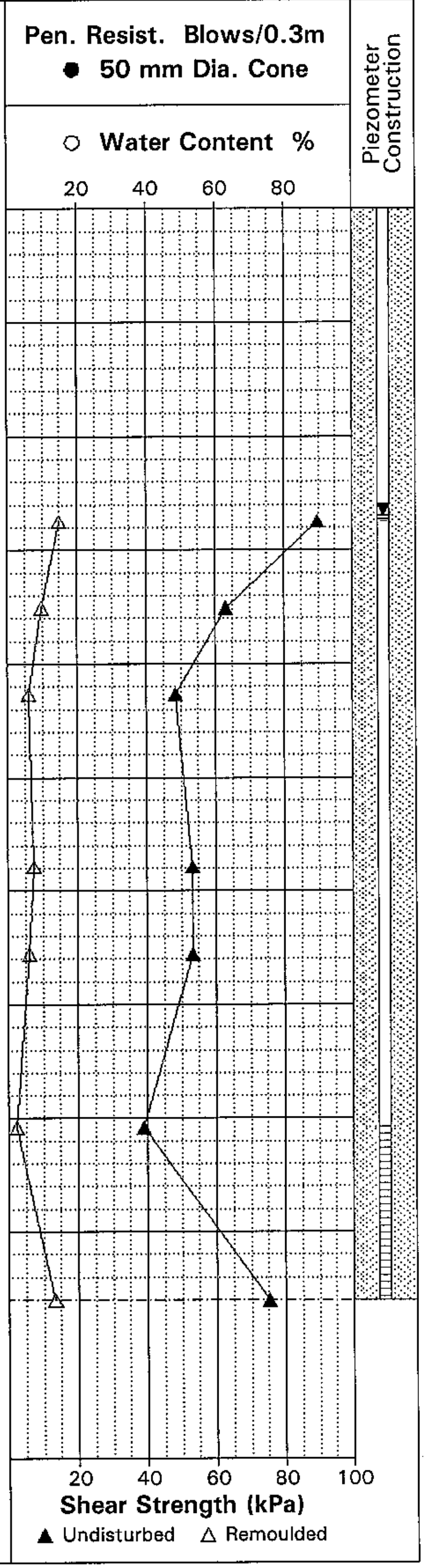
HOLE NO. **BH 2**

BORINGS BY CME 55 Power Auger

DATE 8 NOV 07

SOIL DESCRIPTION		SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.10	AU	1		
Brown **SILTY CLAY** with organic matter	0.46				
Very stiff to stiff, brown **SILTY CLAY** - grey by 3.0m depth		SS	2	75	14
		SS	3	100	9
		TW	4	88	
		TW	5	98	
		TW	6	100	
	9.60				
End of Borehole (GWL @ 2.70m-Nov. 13/07)					

DEPTH (m)	ELEV. (m)
0	52.31
1	51.31
2	50.31
3	49.31
4	48.31
5	47.31
6	46.31
7	45.31
8	44.31
9	43.31



patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision, North Service Road
Ottawa, Ontario

DATUM Ground surface elevations provided by McIntosh Perry Surveying Inc.

FILE NO. PG1565

REMARKS

HOLE NO. BH 3

BORINGS BY CME 55 Power Auger **DATE** 8 NOV 07

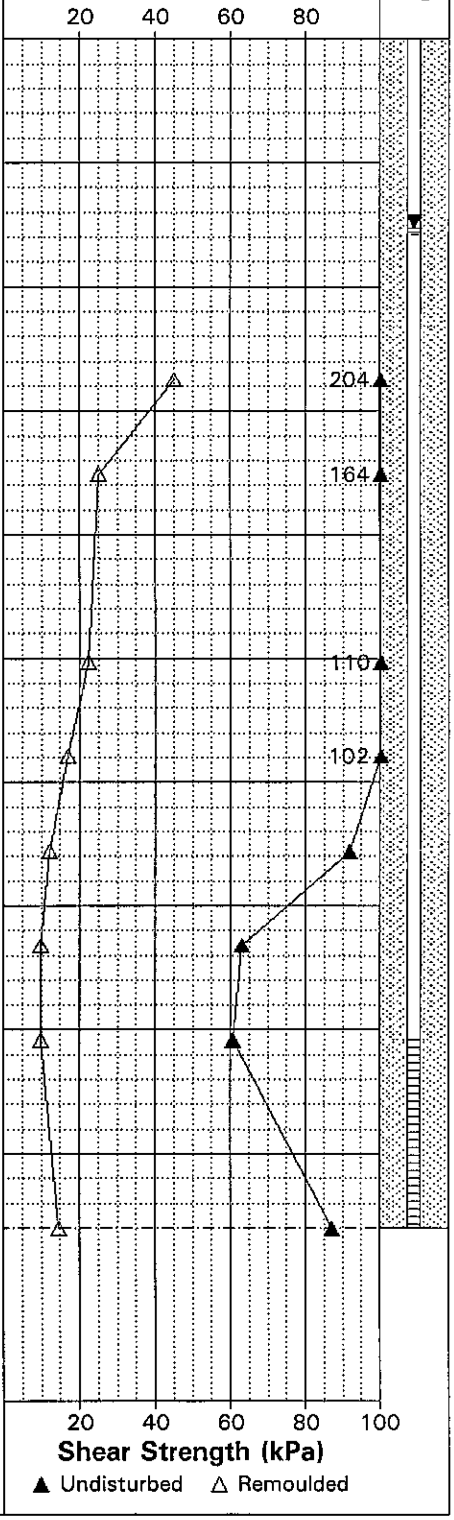
SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.10		AU	1		
		SS	2	100	17
		SS	3	100	16
Hard to very stiff, brown **SILTY CLAY**		SS	4	58	11
- very stiff to stiff and grey by 5.0m depth					
		TW	5	92	
9.60 End of Borehole					
(GWL @ 1.53m-Nov. 13/07)					

DEPTH (m)	ELEV. (m)
0	49.65
1	48.65
2	47.65
3	46.65
4	45.65
5	44.65
6	43.65
7	42.65
8	41.65
9	40.65

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

○ Water Content %

Piezometer Construction



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 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

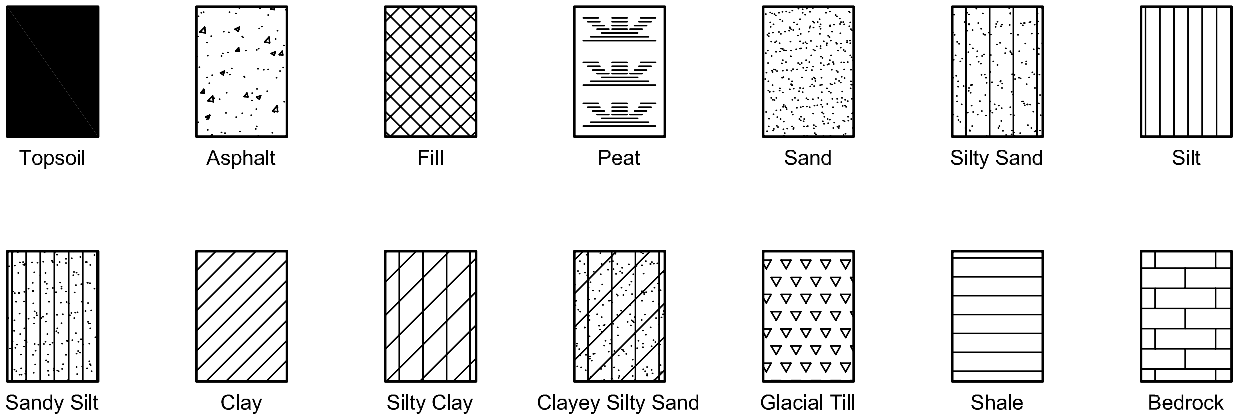
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void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

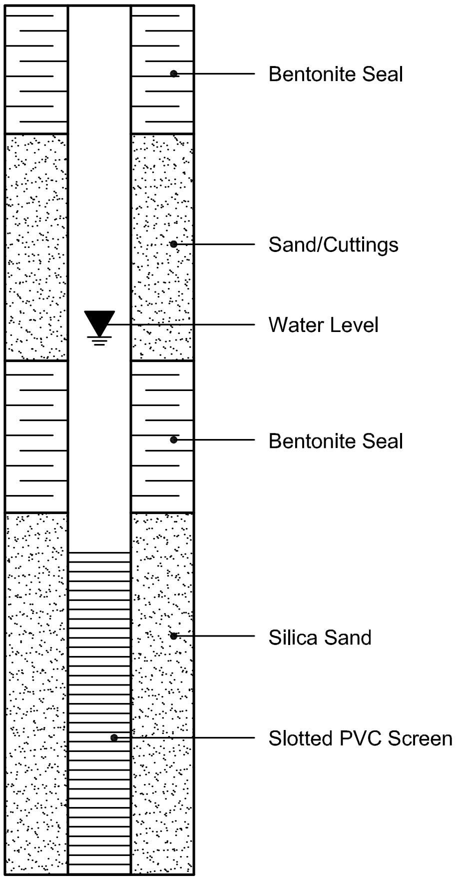
SYMBOLS AND TERMS (continued)

STRATA PLOT

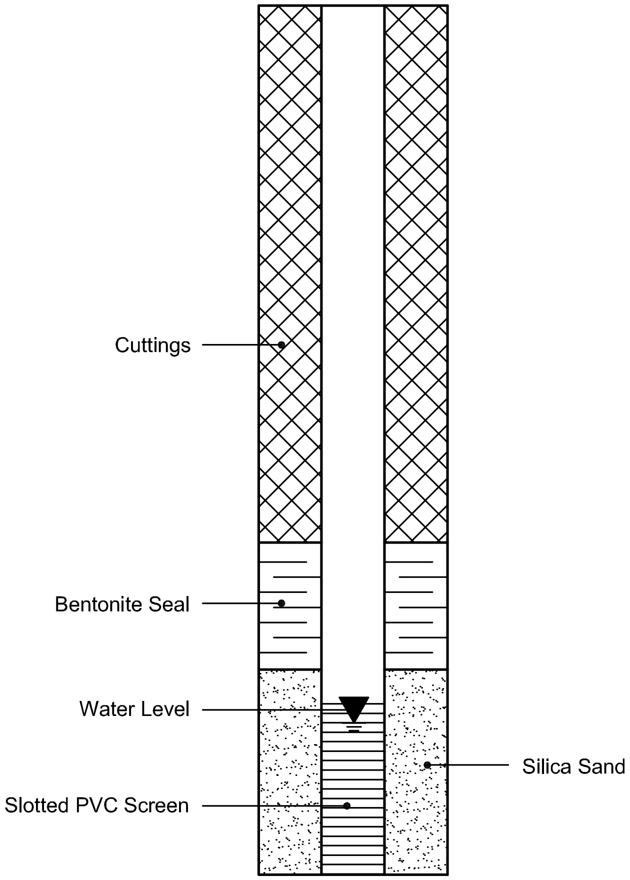


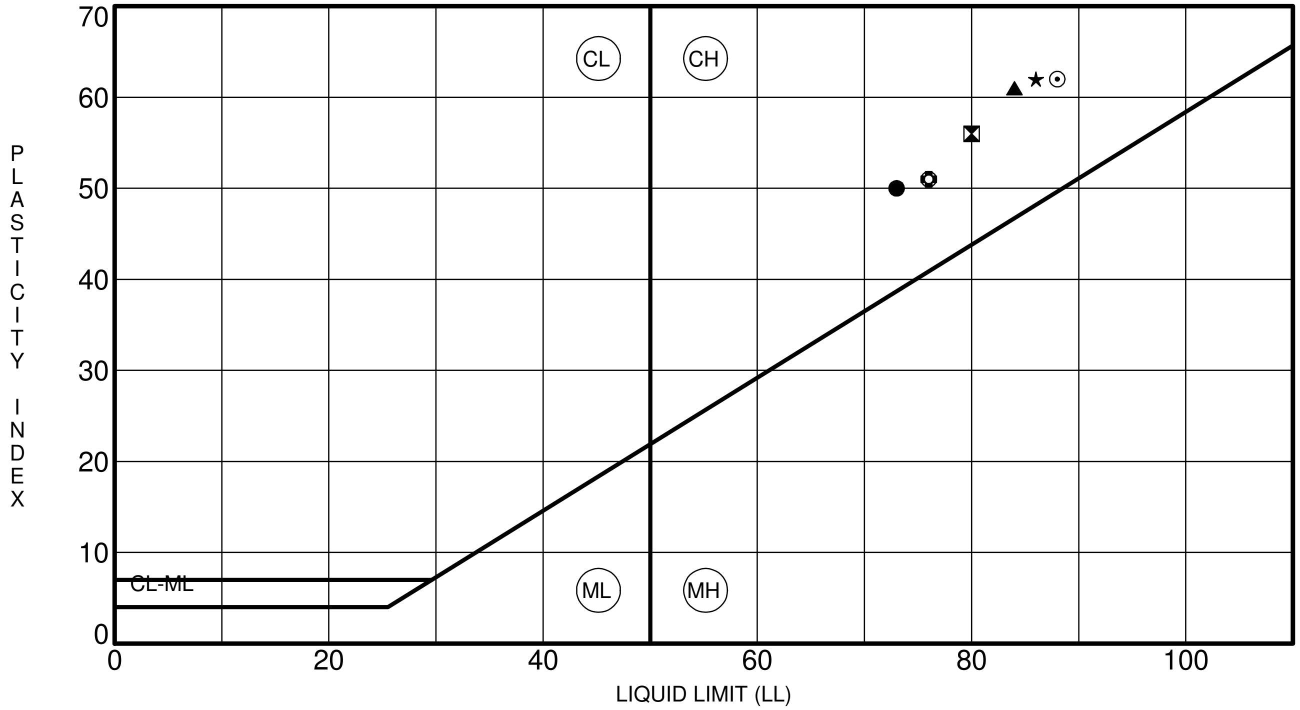
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BH 3-22**	**SS3**	**73**	**23**	**50**		**CH - Inorganic clay of high plasticity**
⧗	**BH 5-22**	**SS3**	**80**	**24**	**56**		**CH - Inorganic clay of high plasticity**
▲	**BH 6-22**	**SS3**	**84**	**23**	**61**		**CH - Inorganic clay of high plasticity**
★	**BH 7-22**	**SS3**	**86**	**24**	**62**		**CH - Inorganic clay of high plasticity**
⊙	**BH 9-22**	**SS2**	**88**	**26**	**62**		**CH - Inorganic clay of high plasticity**
✿	**BH10-22**	**SS3**	**76**	**25**	**51**		**CH - Inorganic clay of high plasticity**
○	**BH11-22**	**SS2**	**76**	**25**	**51**		**CH - Inorganic clay of high plasticity**

CLIENT **Brigil Homes**

FILE NO. **PG6414**

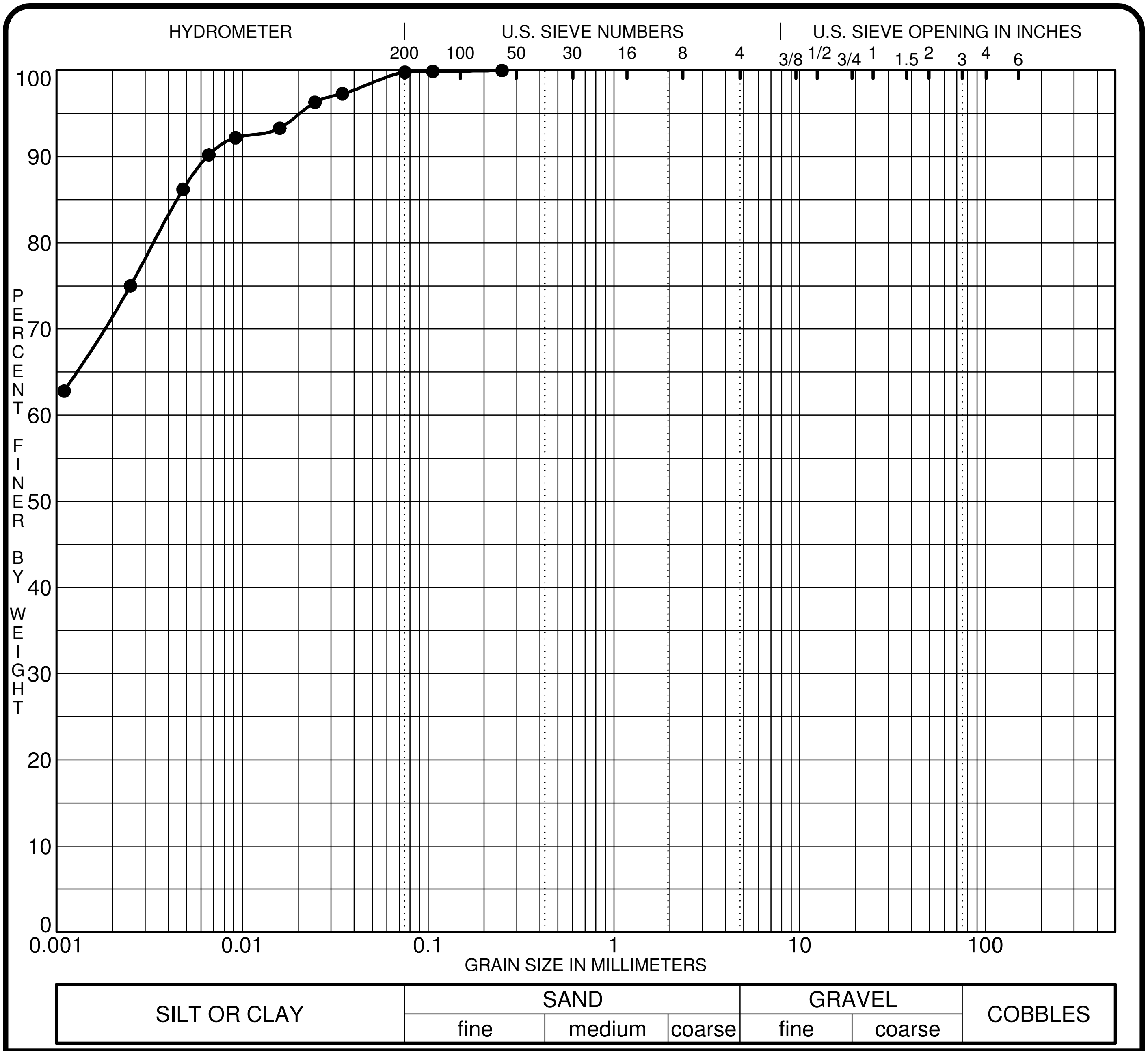
PROJECT **Geotechnical Investigation - Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.**

DATE **26 Oct 22**

patersongroup **Consulting Engineers**

9 Auriga Drive, Ottawa, Ontario K2E 7T9

ATTERBERG LIMITS' RESULTS



	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH10-22**	**SS3**	**CH - Inorganic clay of high plasticity**						
☒									
▲									
★									

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH10-22**	**SS3**	**0.25**				**0.0**	**0.2**	**99.8**	
☒										
▲										
★										

CLIENT **Brigil Homes**

FILE NO. **PG6414**

PROJECT **Geotechnical Investigation - Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.**

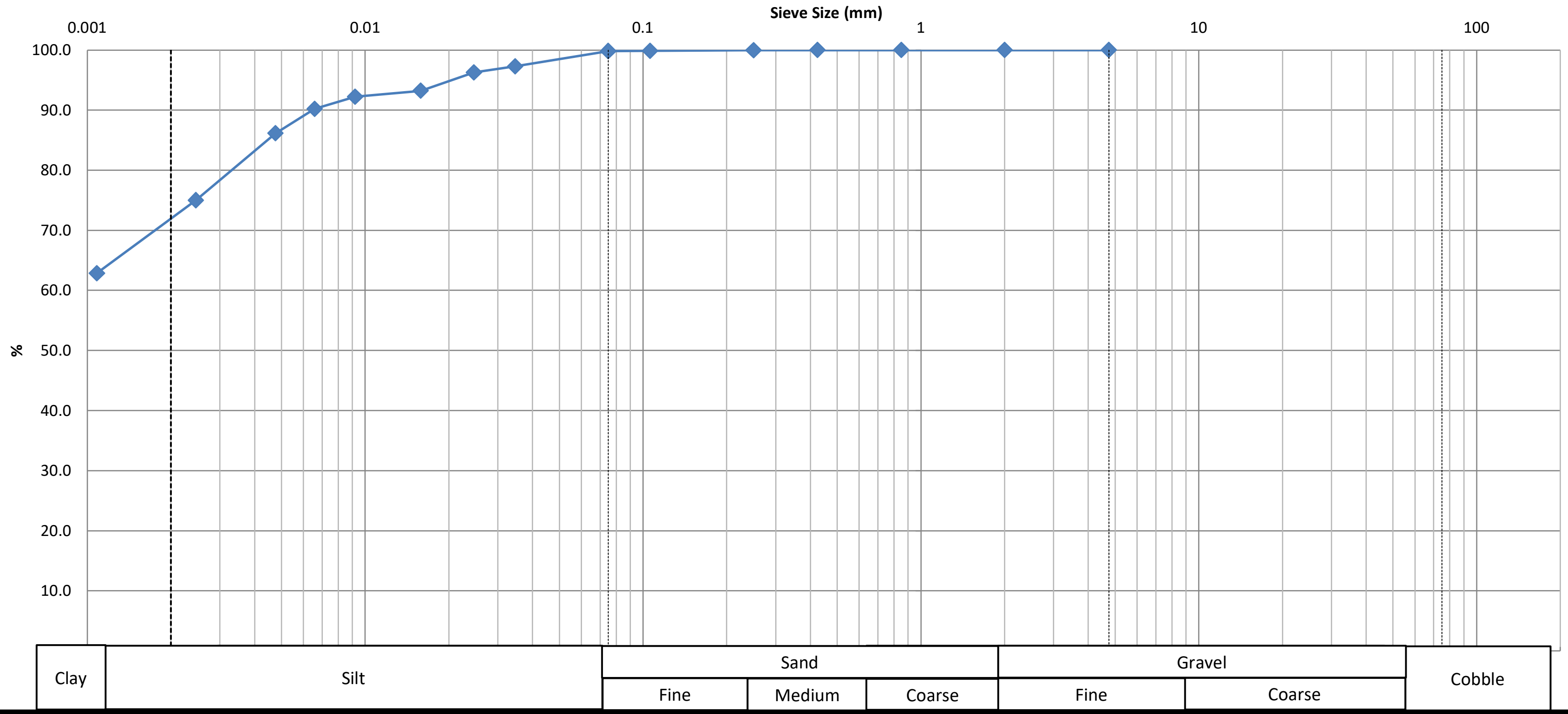
DATE **26 Oct 22**

patersongroup **Consulting Engineers**
9 Auriga Drive, Ottawa, Ontario K2E 7T9

GRAIN SIZE DISTRIBUTION

SIEVE ANALYSIS
ASTM C136

CLIENT:	Brigil Petrie 3	DEPTH:	5'0" to 7'0"	FILE NO:	PG6414
CONTRACT NO.:		BH OR TP No.:	BH10-22 SS3	LAB NO:	40446
PROJECT:	8600 Jeanne D'Arc			DATE RECEIVED:	28-Oct-22
				DATE TESTED:	2-Nov-22
DATE SAMPLED:	24-Oct-22			DATE REPORTED:	7-Nov-22
SAMPLED BY:	JM			TESTED BY:	DK/CS



Identification	Soil Classification	MC(%)	LL	PL	PI	Cc	Cu
		40.7					

D100	D60	D30	D10	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
				0.0	0.2	28.3	71.5

Comments:

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

PATERSON GROUP

HYDROMETER
LS-702 ASTM-422

CLIENT:	Brigil Petrie 3	DEPTH:	5'0" to 7'0"	FILE NO.:	PG6414
PROJECT:	8600 Jeanne D'Arc	BH OR TP No.:	BH10-22 SS3	DATE SAMPLE	24-Oct-22
LAB No. :	40446	TESTED BY:	DK/CS	DATE RECEIVE	28-Oct-22
SAMPLED BY:	JM	DATE REPT'D:	7-Nov-22	DATE TESTED:	2-Nov-22

SAMPLE INFORMATION

SAMPLE MASS	SPECIFIC GRAVITY
78.2	2.700

INITIAL WEIGHT	50.00	HYGROSCOPIC MOISTURE		
WEIGHT CORRECTED	35.52	TARE WEIGHT	50.00	ACTUAL WEIGHT
WT. AFTER WASH BACK SIEVE	0.12	AIR DRY	89.70	39.70
SOLUTION CONCENTRATION	40 g/L	OVEN DRY	78.20	28.20
		CORRECTED	0.710	

GRAIN SIZE ANALYSIS

SIEVE DIAMETER (mm)	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT PASSING
26.5			
19			
13.2			
9.5			
4.75	**0.0**	0.0	**100.0**
2.0	**0.0**	0.0	**100.0**
Pan	**78.2**		
0.850	**0.00**	0.0	**100.0**
0.425	**0.00**	0.0	**100.0**
0.250	**0.02**	0.0	**100.0**
0.106	**0.06**	0.1	**99.9**
0.075	**0.08**	0.2	**99.8**
Pan	**0.12**		
SIEVE CHECK 0.0	MAX = 0.3%		

HYDROMETER DATA

ELAPSED	TIME (24 hours)	Hs	Hc	Temp. (^{o}C)	DIAMETER	(P)	TOTAL PERCENT PASSING
1	8:19	54.0	6.0	23.0	0.0346	97.3	**97.3**
2	8:20	53.5	6.0	23.0	0.0246	96.3	**96.3**
5	8:23	52.0	6.0	23.0	0.0159	93.3	**93.3**
15	8:33	51.5	6.0	23.0	0.0092	92.2	**92.2**
30	8:48	50.5	6.0	23.0	0.0066	90.2	**90.2**
60	9:18	48.5	6.0	23.0	0.0048	86.2	**86.2**
250	12:28	43.0	6.0	23.0	0.0025	75.0	**75.0**
1440	8:18	37.0	6.0	23.0	0.0011	62.8	**62.8**

Moisture = 40.66%

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

PATERSON GROUP

Linear Shrinkage
ASTM D4943-02

CLIENT:	Brigil Petrie 3	DEPTH	5'-0" to 7'-0"	FILE NO.:	PG6414
PROJECT:	8600 Jeanne D'Arc	BH OR TP No:	BH3-22	DATE SAMPLED	24-Oct
LAB No:	40447	TESTED BY:	CP/CS	DATE RECEIVED	28-Oct
SAMPLED BY:	J.M	DATE REPORTED:	7-Nov-22	DATE TESTED	2-Nov

LABORATORY INFORMATION & TEST RESULTS

Moisture	**No. of Blows(6)**	**Calibration (Two Trials)**	**Tin NO.(X24)**	
Tare	5	Tin	4.83	4.83
Soil Pat Wet + Tare	63.2	Tin + Grease	5	4.99
Soil Pat Wet	58.2	Glass	48.97	48.97
Soil Pat Dry + Tare	37.71	Tin + Glass + Water	91.36	91.38
Soil Pat Dry	32.71	Volume	37.39	37.42
Moisture	**77.93**	**Average Volume**	**37.41**	

Soil Pat + String	32.83
Soil Pat + Wax + String in Air	37.28
Soil Pat + Wax + String in Water	13.4
Volume Of Pat (Vdx)	23.88

RESULTS:

Shrinkage Limit	**21.29**
Shrinkage Ratio	**1.733**
Volumetric Shrinkage	**98.120**
Linear Shrinkage	**20.378**

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

Certificate of Analysis

Report Date: 03-Nov-2022

Client: Paterson Group Consulting Engineers

Order Date: 27-Oct-2022

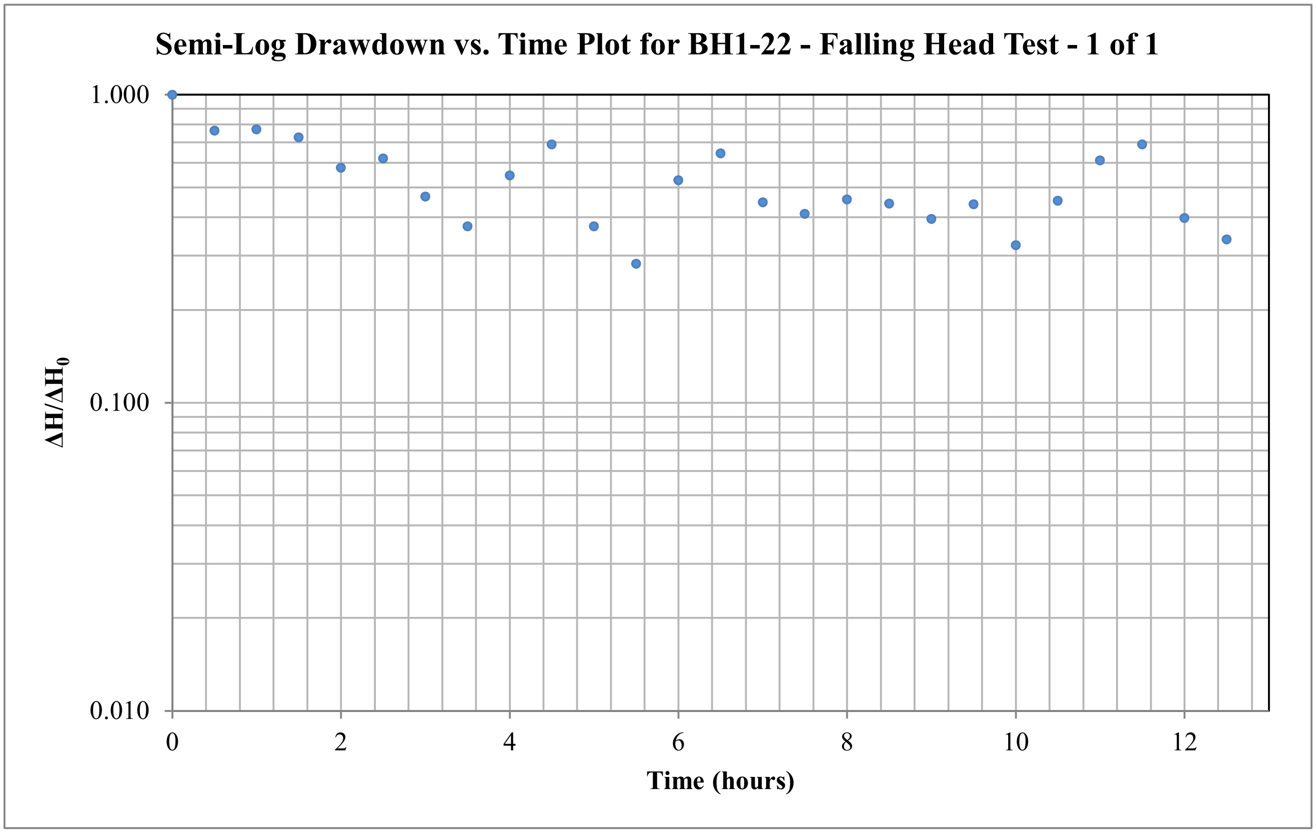
Client PO: 56076

Project Description: PG6414

	Client ID:	BH10-22-SS2	-	-	-	-	-
	Sample Date:	26-Oct-22 09:00	-	-	-		
	Sample ID:	2244404-01	-	-	-		
	Matrix:	Soil	-	-	-		
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	71.0	-	-	-	-	-
General Inorganics							
pH	0.05 pH Units	7.36	-	-	-	-	-
Resistivity	0.1 Ohm.m	44.3	-	-	-	-	-
Anions							
Chloride	5 ug/g	74	-	-	-	-	-
Sulphate	5 ug/g	17	-	-	-	-	-

Hvorslev Hydraulic Conductivity Analysis

Project: Brigil - 8600 Jeanne D'arc
Test Location: BH1-22
Test: Falling Head - 1 of 1
Date: November 29, 2022



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 2.31086

Well Parameters:

L	1.5	m	Saturated length of screen or open hole
D	0.0508	m	Diameter of well
r_c	0.0254	m	Radius of well

Data Points (from plot):

t*: 145.986 minutes

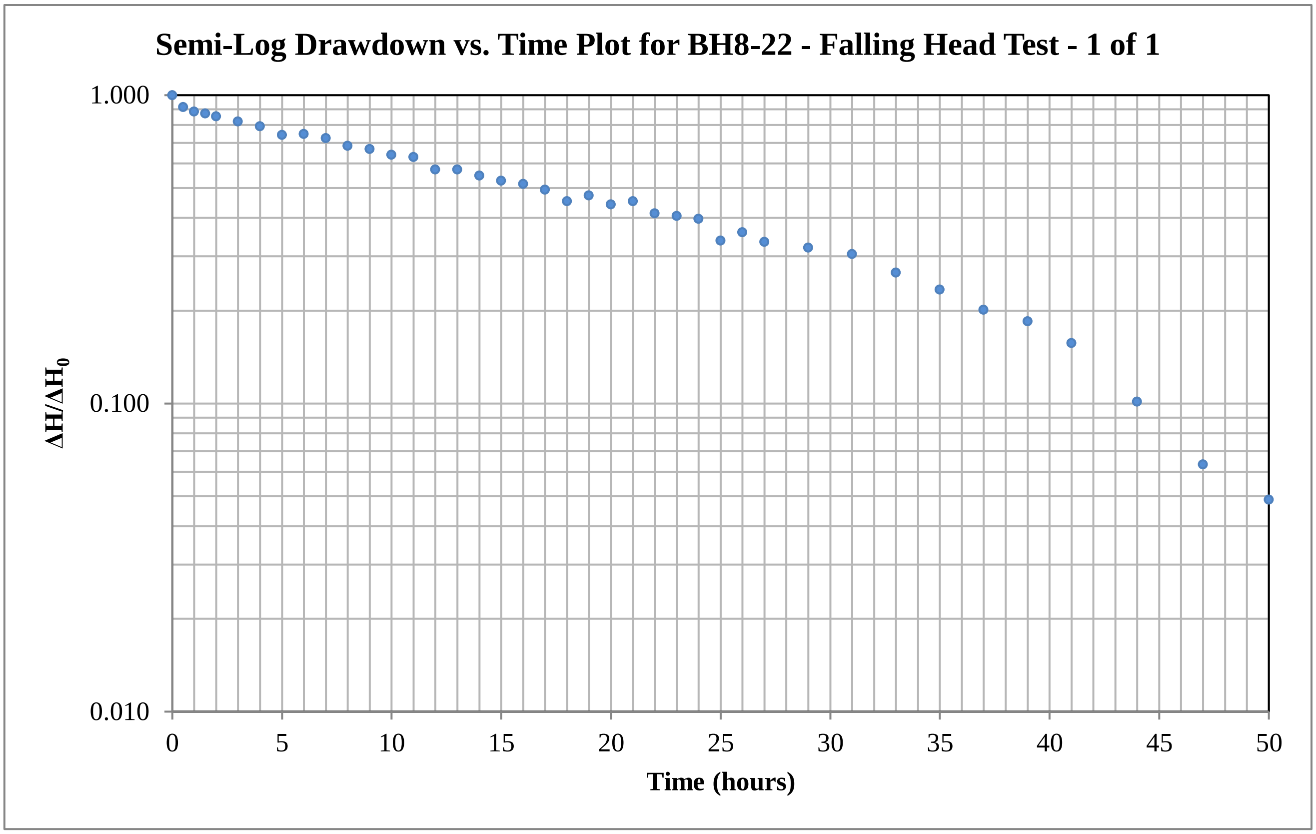
$\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 9.96E-08 m/sec

PATERSON GROUP

Hvorslev Hydraulic Conductivity Analysis

Project: Brigil - 8600 Jeanne D'arc
Test Location: BH8-22
Test: Falling Head - 1 of 1
Date: November 29, 2022



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t*} \ln\left(\frac{\Delta H *}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 2.31086

Well Parameters:

L	1.5	m	Saturated length of screen or open hole
D	0.0508	m	Diameter of well
r_c	0.0254	m	Radius of well

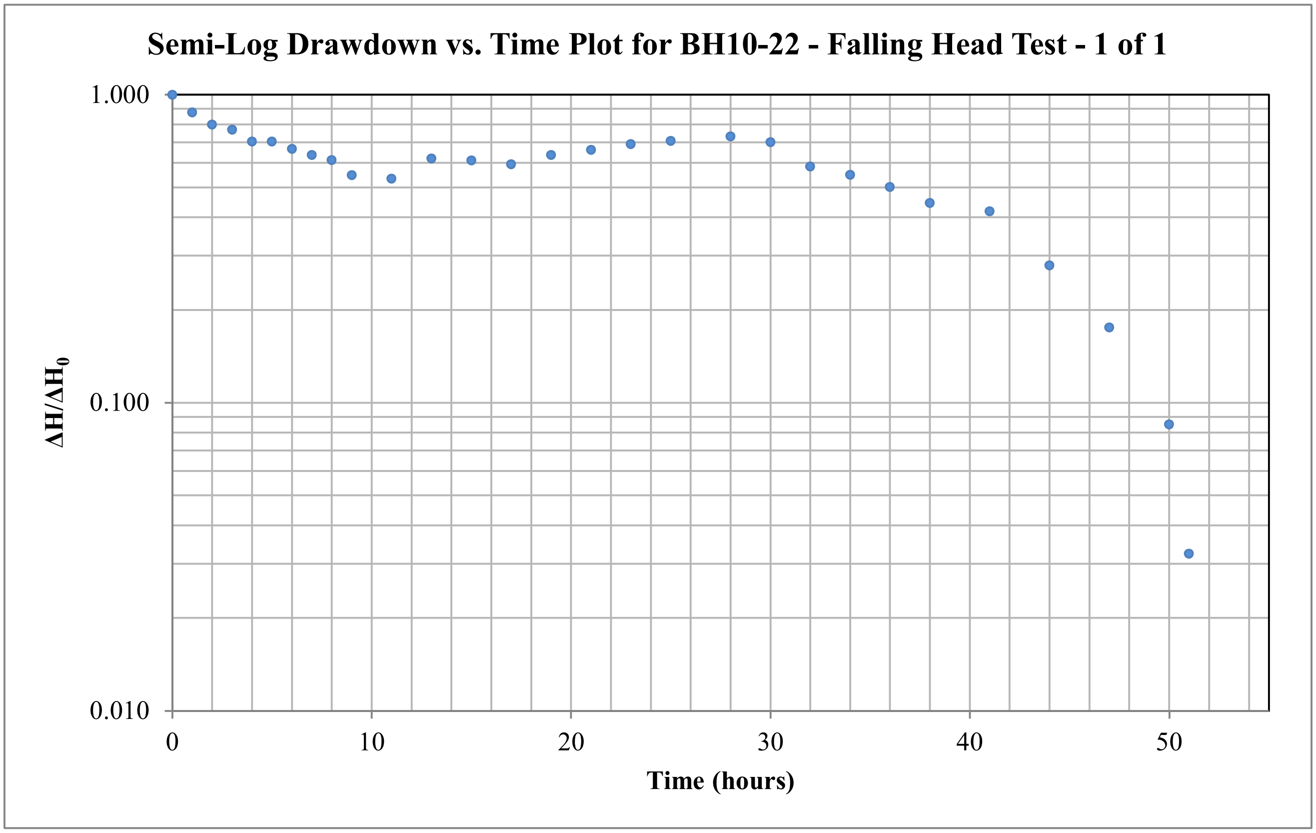
Data Points (from plot):

t*: 2399.333 minutes $\Delta H*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 6.06E-09 m/sec

Hvorslev Hydraulic Conductivity Analysis

Project: Brigil - 8600 Jeanne D'arc
Test Location: BH10-22
Test: Falling Head - 1 of 1
Date: November 29, 2022



Hvorslev Horizontal Hydraulic Conductivity

$$K = \frac{\pi r_c^2}{F} \frac{1}{t^*} \ln\left(\frac{\Delta H^*}{\Delta H_0}\right)$$

Hvorslev Shape Factor

$$F = \frac{2\pi L}{\ln\left(\frac{2L}{D}\right)}$$

Valid for L>>D

Hvorslev Shape Factor F: 2.31086

Well Parameters:

L	1.5	m	Saturated length of screen or open hole
D	0.0508	m	Diameter of well
r_c	0.0254	m	Radius of well

Data Points (from plot):

t*: 2512.232 minutes $\Delta H^*/\Delta H_0$: 0.37

Horizontal Hydraulic Conductivity
K = 5.79E-09 m/sec

APPENDIX 2

FIGURE 1 – KEY PLAN

FIGURE 2 – FOUNDATION DRAINAGE SYSTEM

FIGURE 3 – ELEVATOR PIT WATERPROOFING

FIGURE 4A to 9B – SLOPE STABILITY ANALYSIS SECTIONS

DRAWING PG6414-1 - TEST HOLE LOCATION PLAN

DRAWING PG6414-2 – PERMISSIBLE GRADE RAISE PLAN

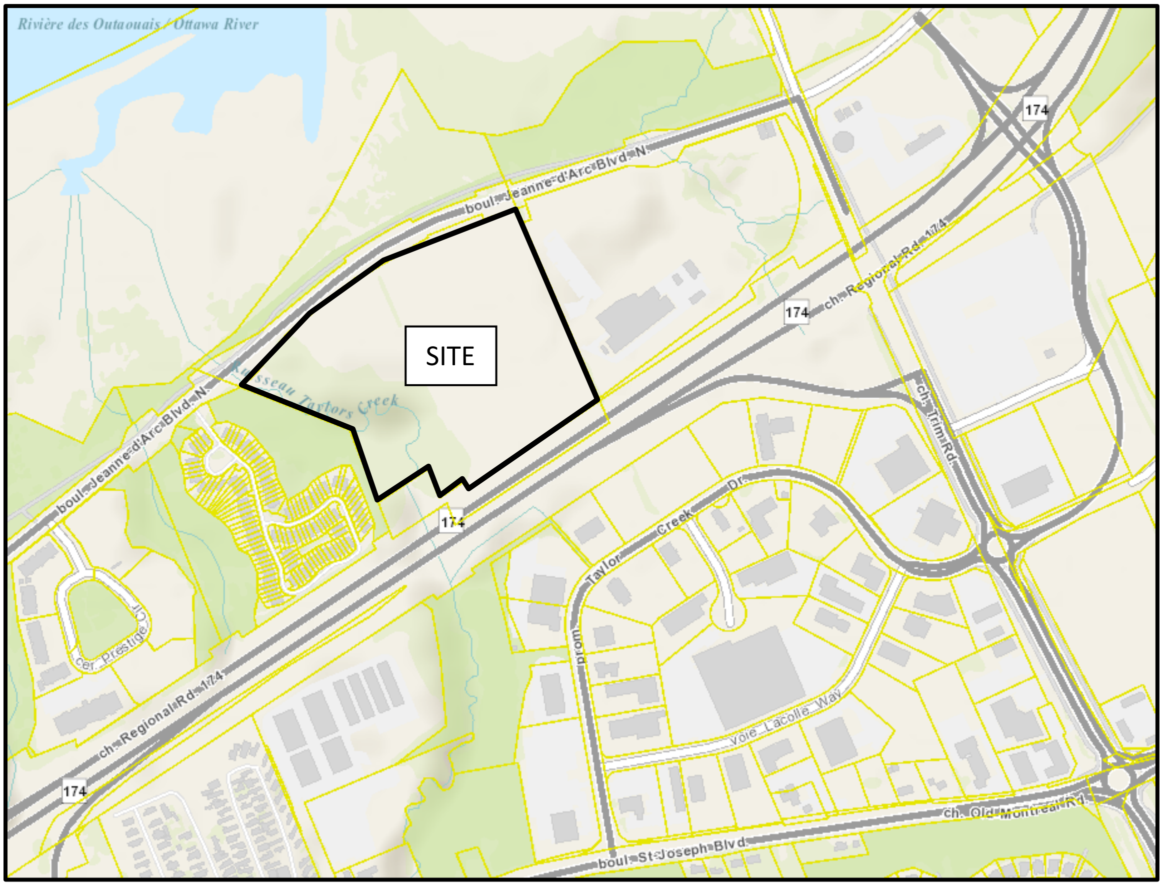
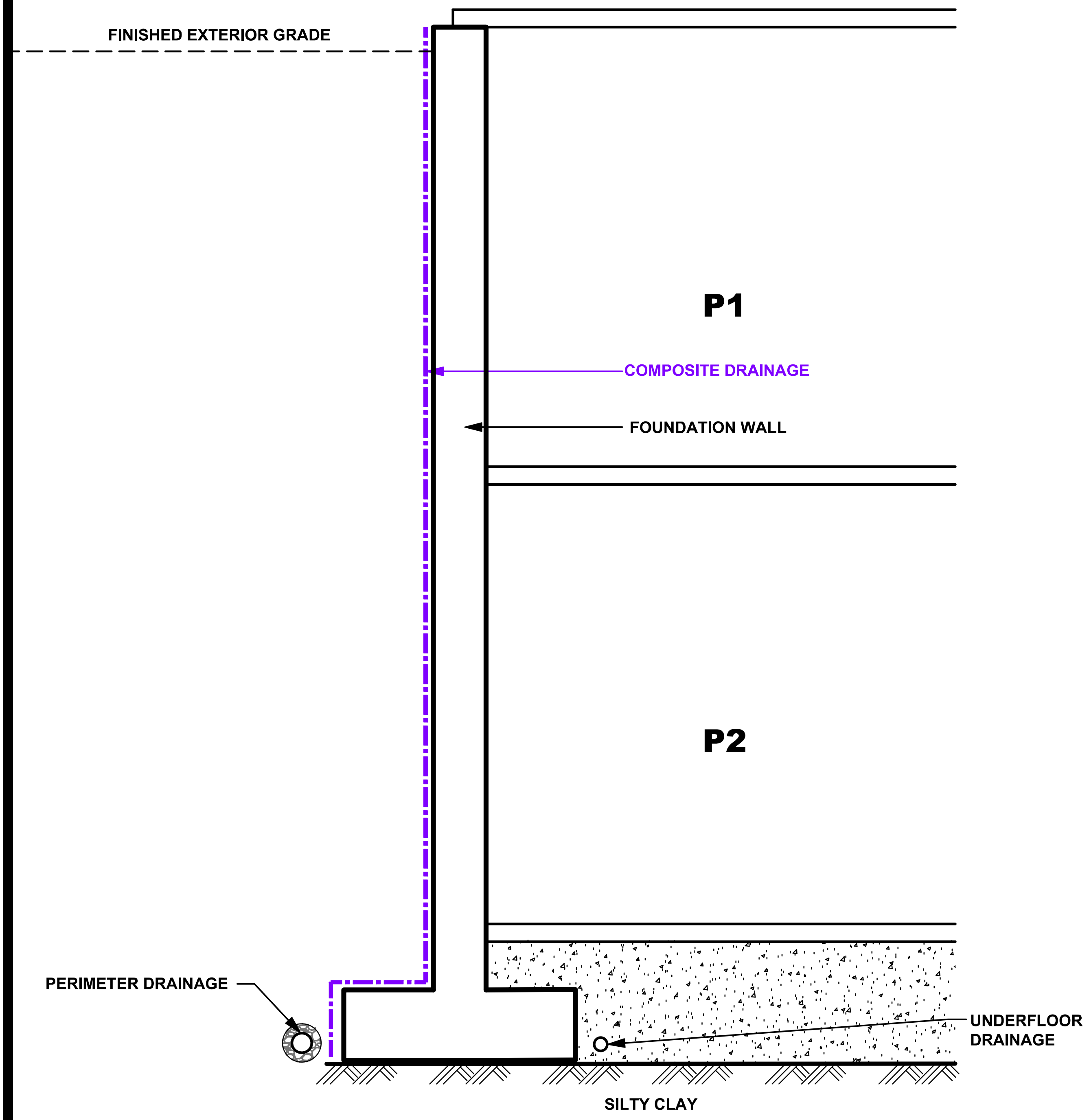


FIGURE 1

KEY PLAN

PATERSON GROUP



PATERSON GROUP

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

BRIGIL

PROPOSED MULTI-STOREY BUILDING
PETRIE'S LANDING III
OTTAWA, ONTARIO

Title:

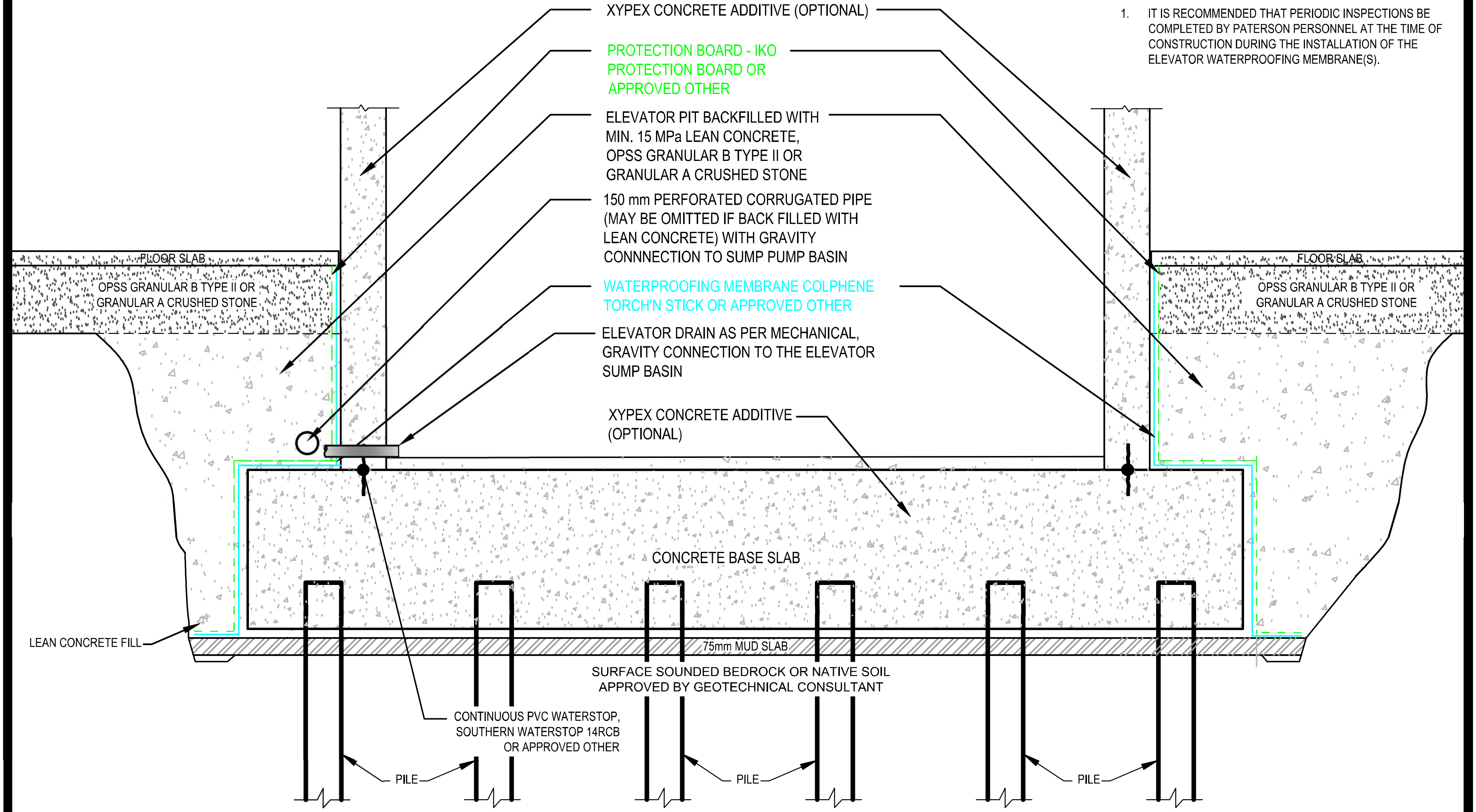
FOUNDATION DRAINAGE DETAIL

Date:	**11/2022**
Report No.:	**PG6414**
Scale:	**N.T.S**
Drawing No.:	**FIGURE 2**
Drawn by:	**NFRV**
Checked by:	**JV**

c:\users\nicholasv\documents\old files\pg3908\pg3908-foundation drainage detail.dwg

NOTES:

1. IT IS RECOMMENDED THAT PERIODIC INSPECTIONS BE COMPLETED BY PATERSON PERSONNEL AT THE TIME OF CONSTRUCTION DURING THE INSTALLATION OF THE ELEVATOR WATERPROOFING MEMBRANE(S).



PATERSON GROUP

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

BIRGIL CONSTRUCTION

PROPOSED MULTI-STOREY BUILDING
PETRIE'S LANDING III

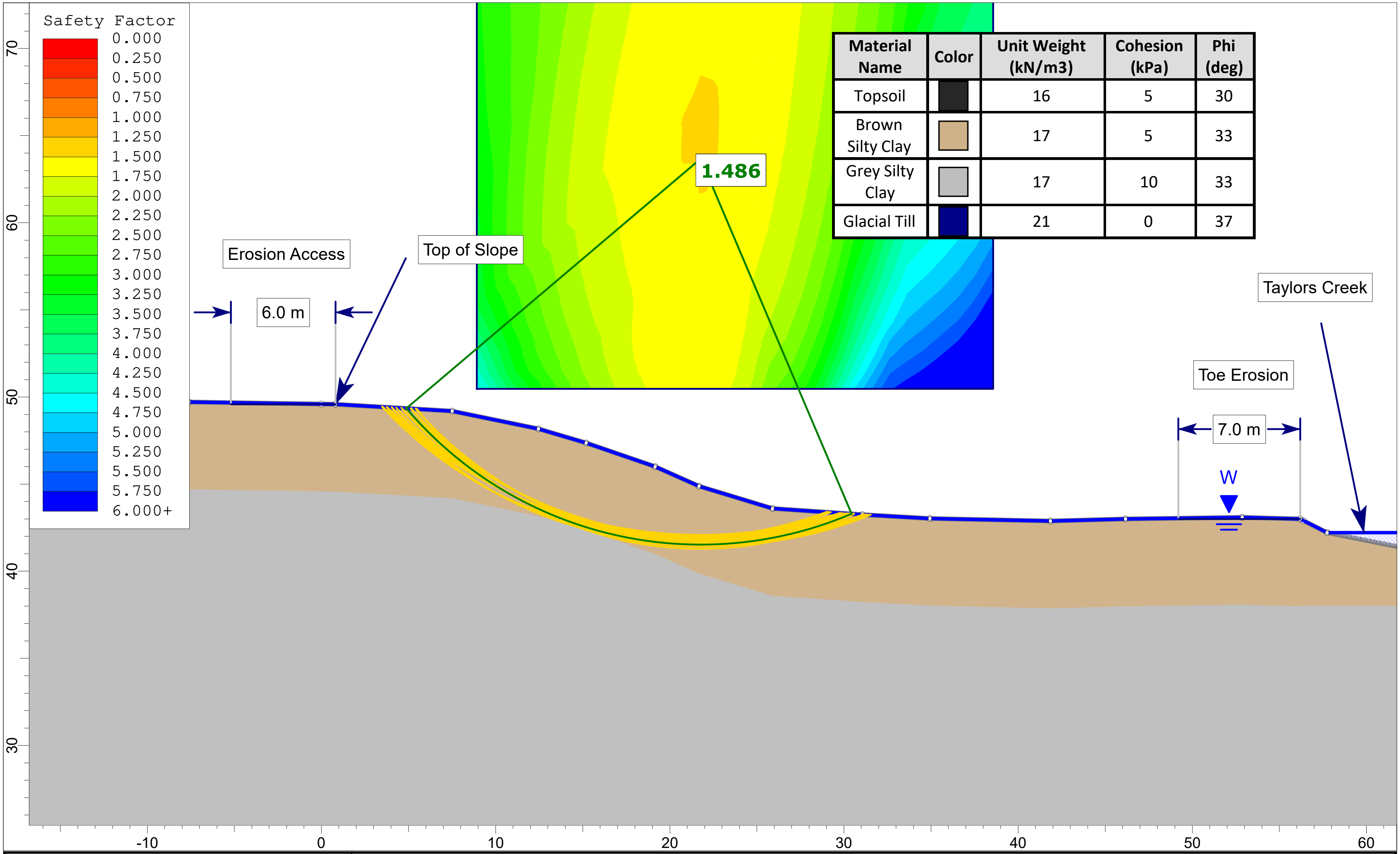
OTTAWA, ONTARIO

Title:

ELEVATOR PIT WATERPROOFING

Scale: N.T.S.	Date: 11/2022
Drawn by: NFRV	Report No.: PG6414
Checked by: JV	Drawing No.: FIGURE 3
Approved by: DJG	Revision No.:

p:\autocad drawings\geotechnical\pg39xx\pg3908\pg3908 fig1-4.dwg

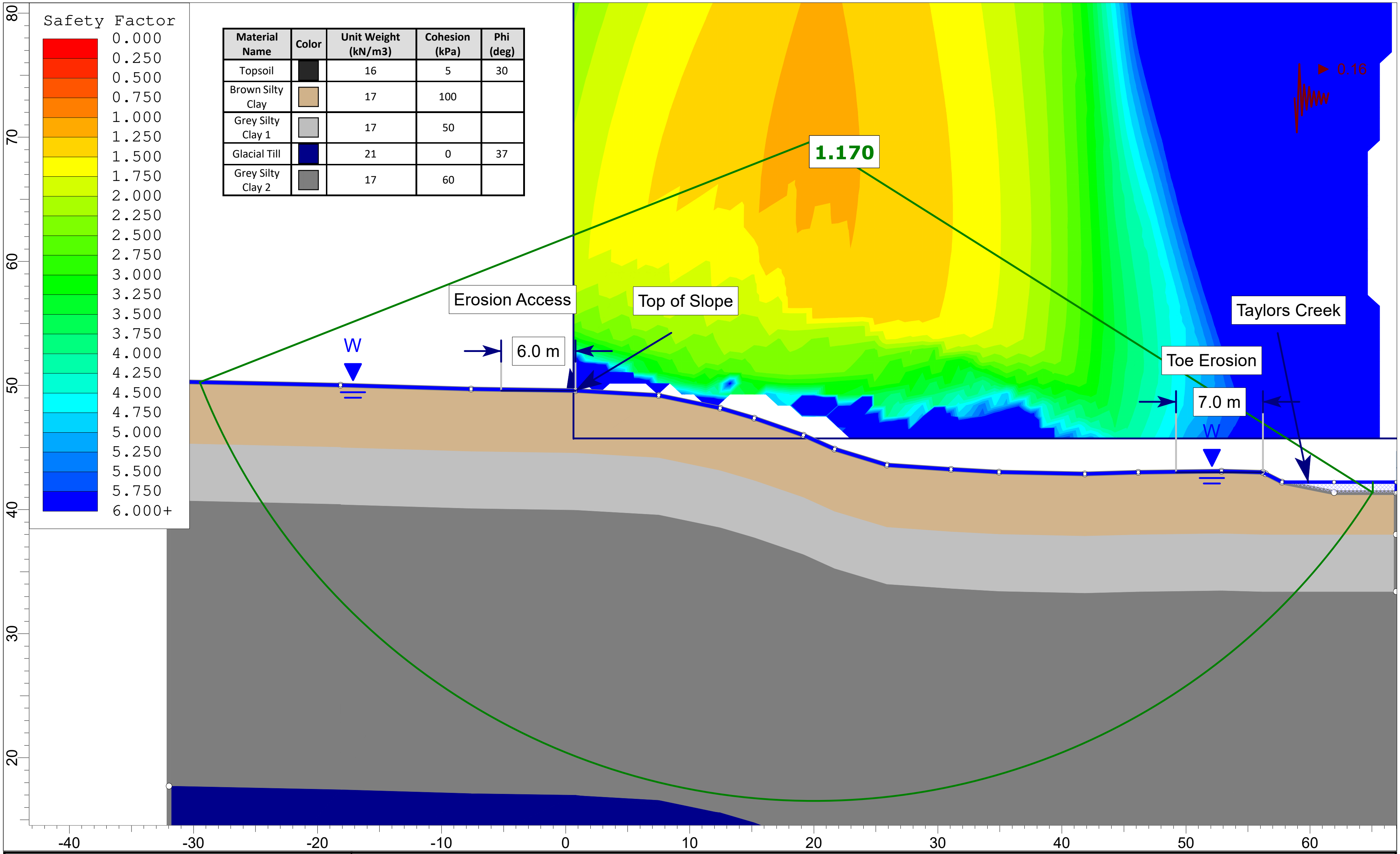


Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	⬛	16	5	30
Brown Silty Clay	🟫	17	5	33
Grey Silty Clay	⬜	17	10	33
Glacial Till	🟦	21	0	37

SLIDEINTERPRET 9.026

Project	**6382983 Canada Inc. Geotechnical Investigation 8600 Jeanne D'Arc Boulevard, Ottawa, Ontario**
Figure No.	**Figure 4A - Section A - Existing Conditions - Static Loading**

Drawn by:	NS	*Company:*	Paterson Group
Date:	2024-08-21	*File No.*	PG6414

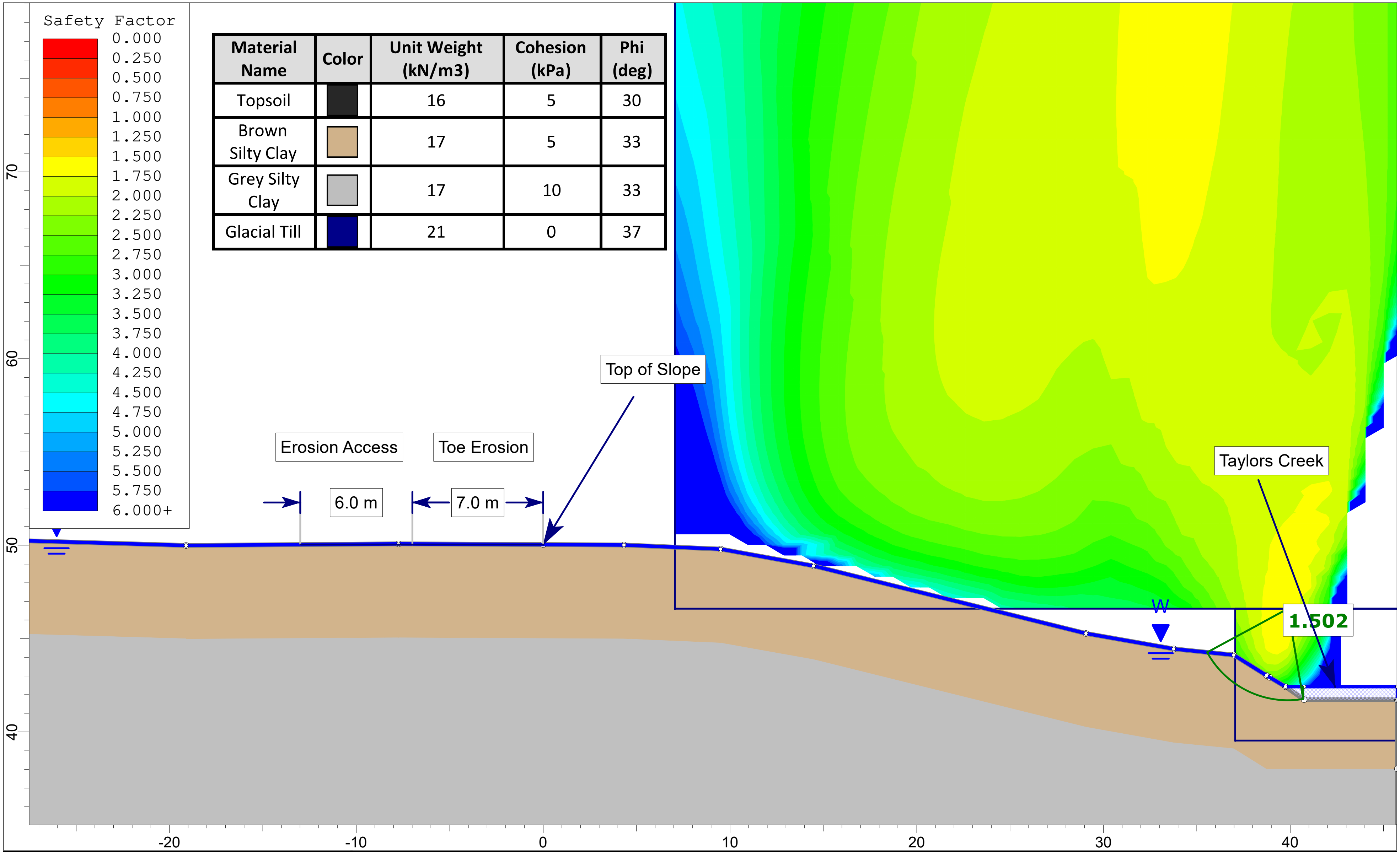


Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	■	16	5	30
Brown Silty Clay	🟫	17	100	
Grey Silty Clay 1	⬜	17	50	
Glacial Till	🟦	21	0	37
Grey Silty Clay 2	■	17	60	

PATERSON GROUP

SLIDEINTERPRET 9.026

Project	6382983 Canada Inc. Geotechnical Investigation 8600 Jeanne D'Arc Boulevard, Ottawa, Ontario		
Figure No.	**Figure 4B - Section A - Existing Conditions - Seismic Loading**		
Drawn by:	NS	*Company:*	Paterson Group
Date:	2024-08-21	*File No.*	PG6414

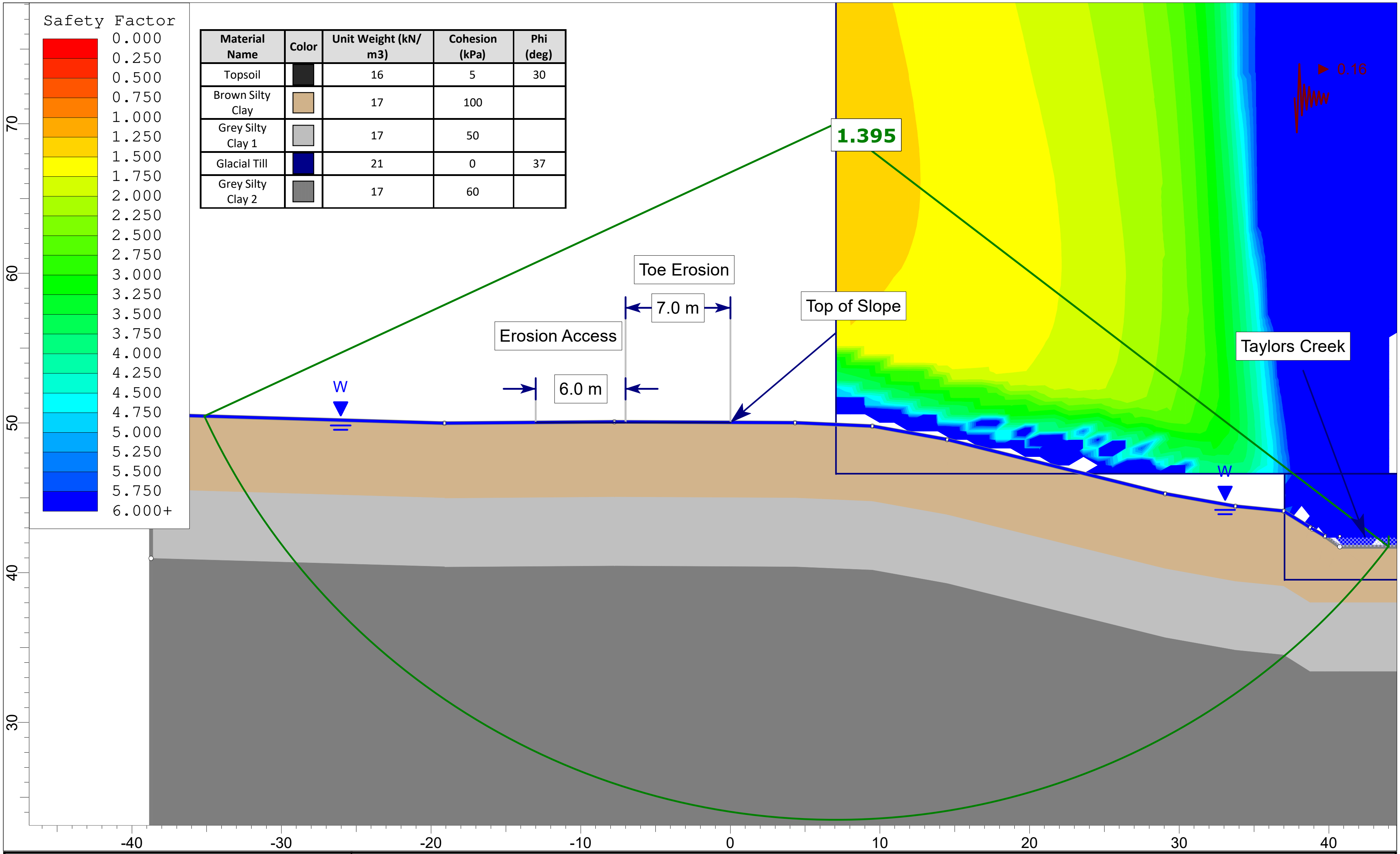


Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	⬛	16	5	30
Brown Silty Clay	🟫	17	5	33
Grey Silty Clay	⬜	17	10	33
Glacial Till	🟦	21	0	37

SLIDEINTERPRET 9.026

PATERSON GROUP

Project	**6382983 Canada Inc.** **Geotechnical Investigation** **8600 Jeanne D'Arc Boulevard, Ottawa, Ontario**		
Figure No.	**Figure 5A - Section B - Existing Conditions - Static Loading**		
Drawn by:	NS	***Company:***	Paterson Group
Date:	2024-08-21	***File No.***	PG6414



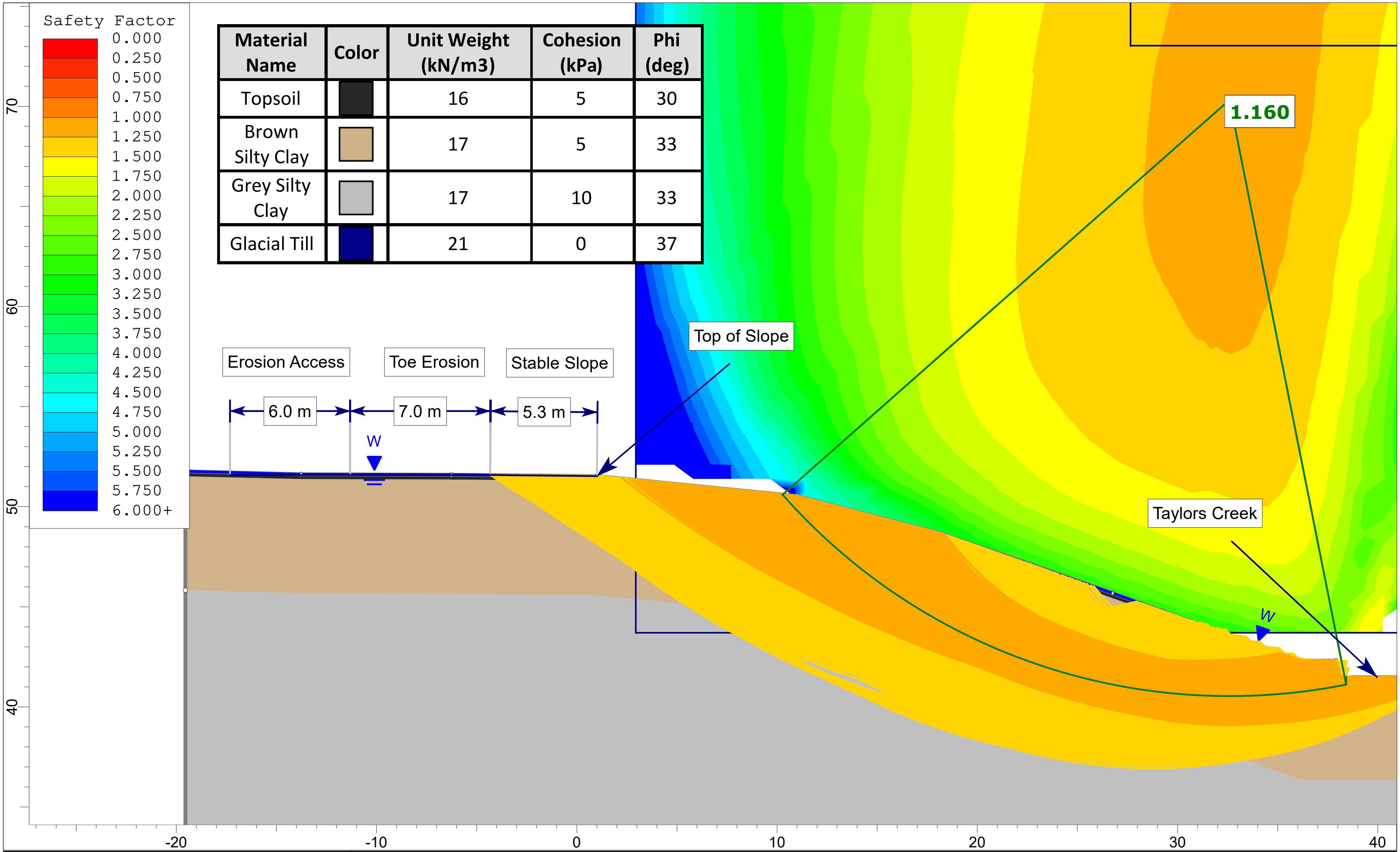
Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	⬛	16	5	30
Brown Silty Clay	🟫	17	100	
Grey Silty Clay 1	⬜	17	50	
Glacial Till	🟦	21	0	37
Grey Silty Clay 2	⬛	17	60	

PATERSON GROUP

SLIDEINTERPRET 9.026

Project	**6382983 Canada Inc. Geotechnical Investigation 8600 Jeanne D'Arc Boulevard, Ottawa, Ontario**
Figure No.	**Figure 5B - Section B - Existing Conditions - Seismic Loading**

Drawn by:	NS	*Company:*	Paterson Group
Date:	2024-08-21	*File No.*	PG6414



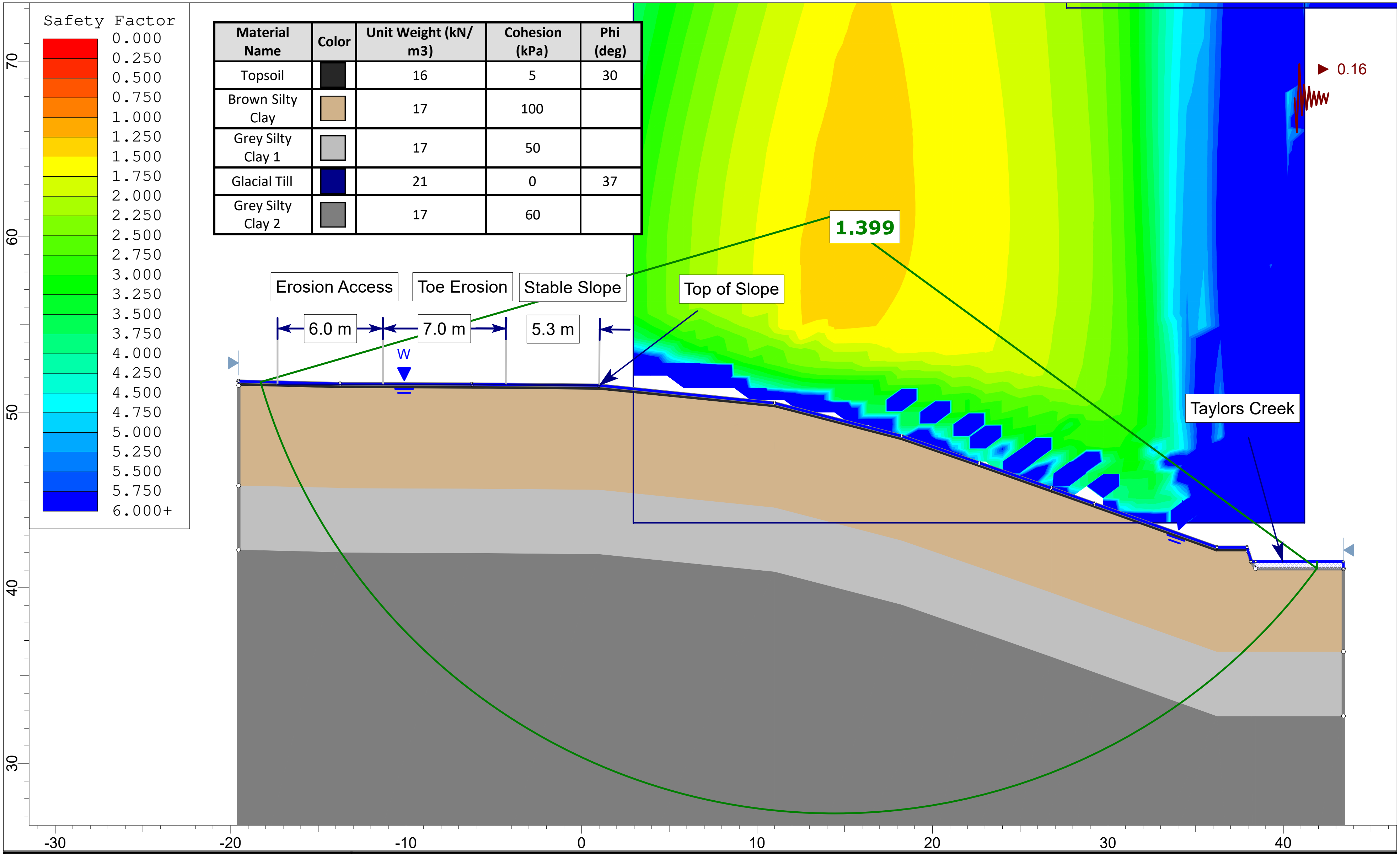
Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	⬛	16	5	30
Brown Silty Clay	🟫	17	5	33
Grey Silty Clay	⬜	17	10	33
Glacial Till	🟦	21	0	37

PATERSON GROUP

SLIDEINTERPRET 9.026

Project	**6382983 Canada Inc.** **Geotechnical Investigation** **8600 Jeanne D'Arc Boulevard, Ottawa, Ontario**
Figure No.	**Figure 6A - Section C - Existing Conditions - Static Loading**

Drawn by:	NS	***Company:***	Paterson Group
Date:	2024-08-21	***File No.***	PG6414

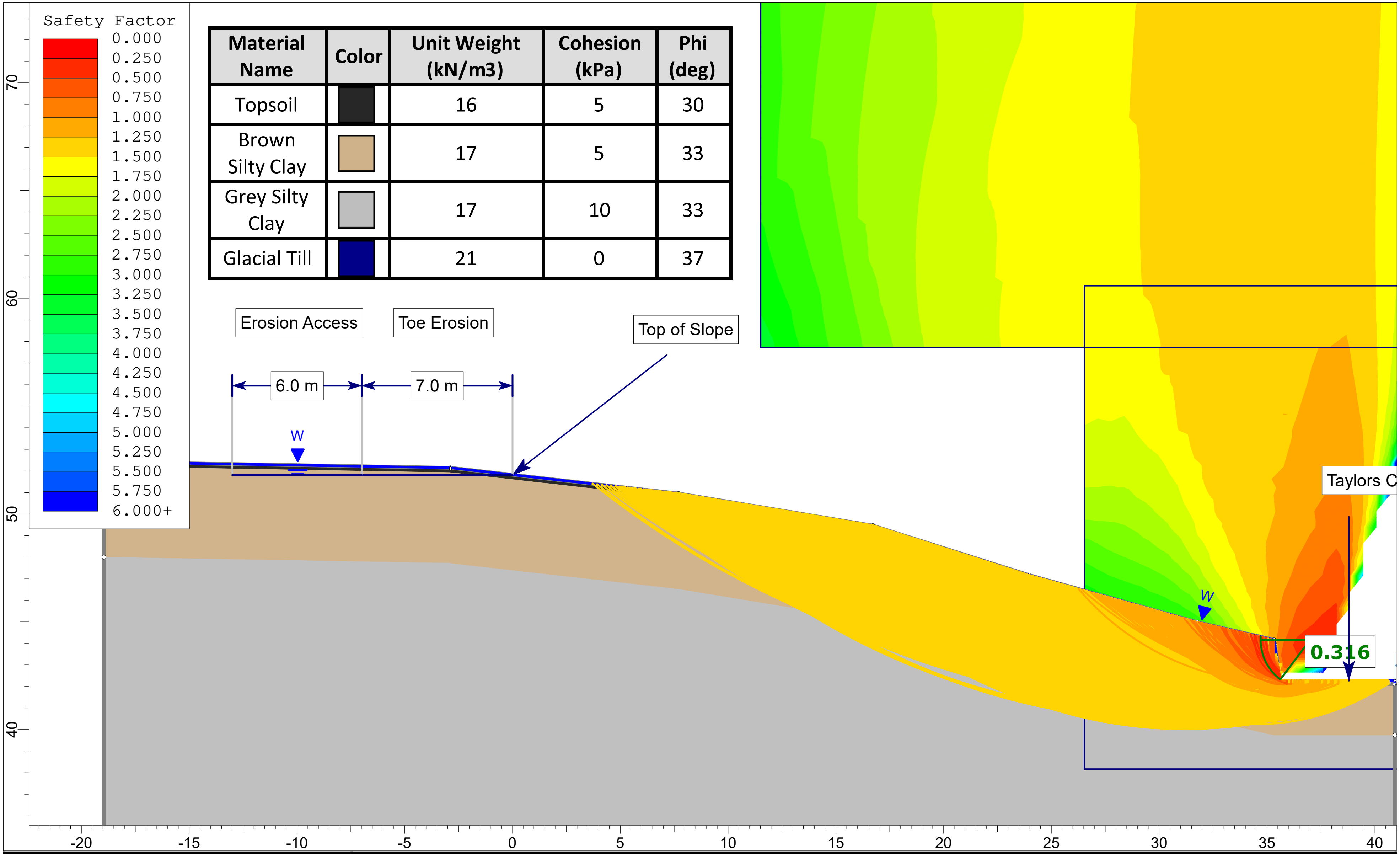


Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	⬛	16	5	30
Brown Silty Clay	🟫	17	100	
Grey Silty Clay 1	⬜	17	50	
Glacial Till	🟦	21	0	37
Grey Silty Clay 2	⬛	17	60	

PATERSON GROUP

SLIDEINTERPRET 9.026

Project	**6382983 Canada Inc. Geotechnical Investigation 8600 Jeanne D'Arc Boulevard, Ottawa, Ontario**		
Figure No.	**Figure 6B - Section C - Existing Conditions - Seismic Loading**		
Drawn by:	NS	*Company:*	Paterson Group
Date:	2024-08-21	*File No.*	PG6414



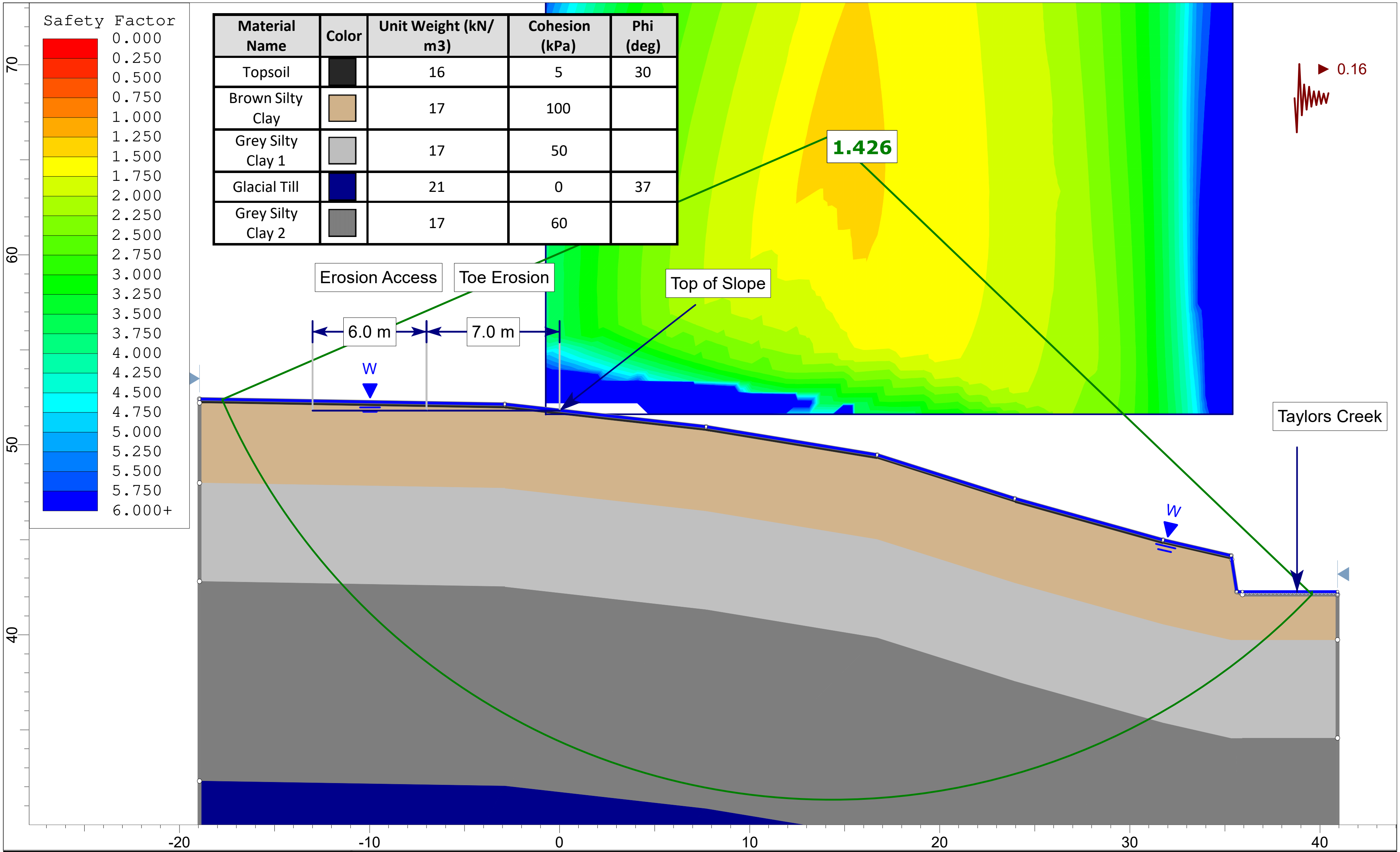
Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	■	16	5	30
Brown Silty Clay	🟫	17	5	33
Grey Silty Clay	⬜	17	10	33
Glacial Till	🟦	21	0	37

PATERSON GROUP

SLIDEINTERPRET 9.026

Project	**6382983 Canada Inc.** **Geotechnical Investigation** **8600 Jeanne D'Arc Boulevard, Ottawa, Ontario**
Figure No.	**Figure 7A - Section D - Existing Conditions - Static Loading**

Drawn by:	NS	***Company:***	Paterson Group
Date:	2024-08-21	***File No.***	PG6414



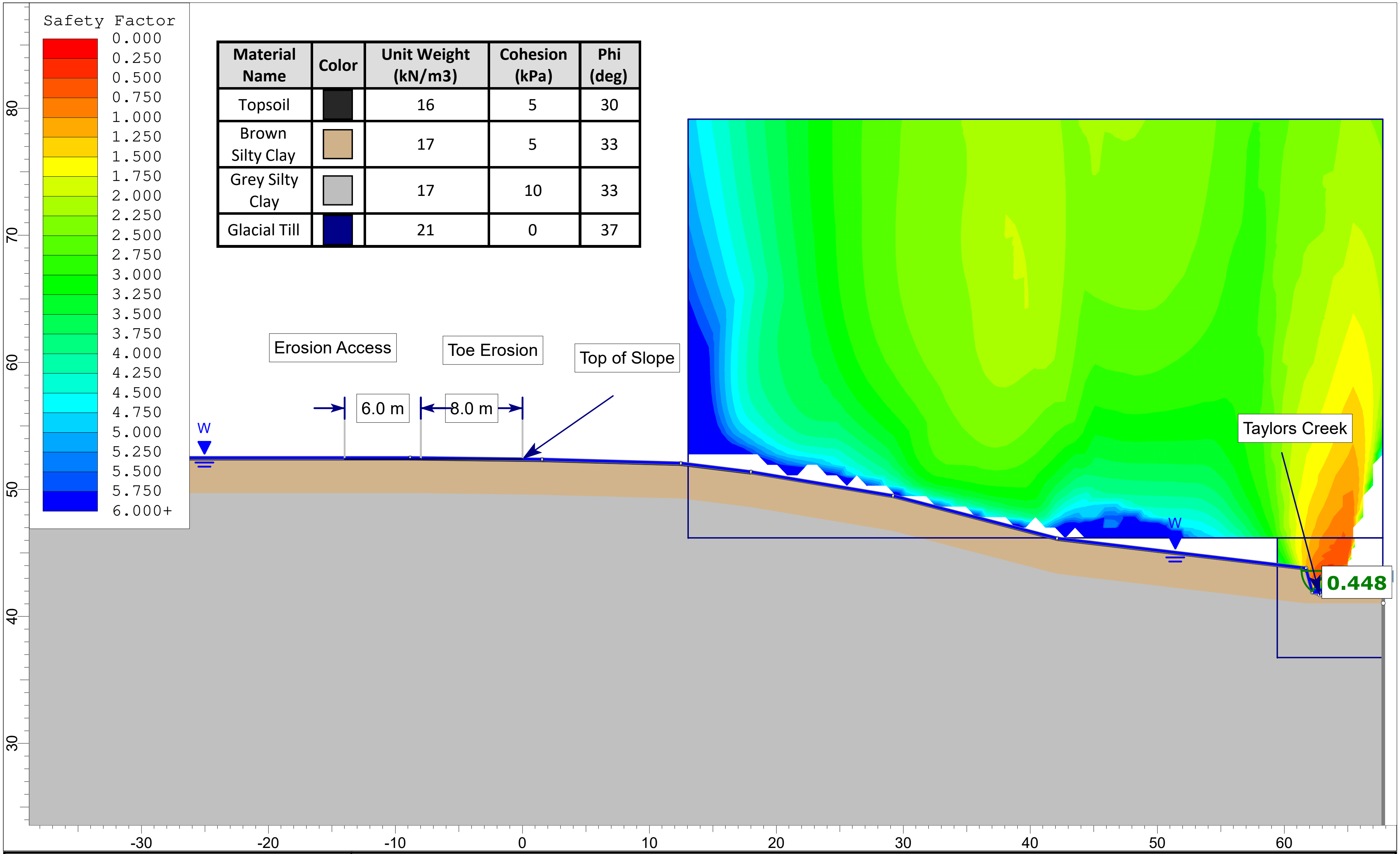
Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	⬛	16	5	30
Brown Silty Clay	🟫	17	100	
Grey Silty Clay 1	⬜	17	50	
Glacial Till	🟦	21	0	37
Grey Silty Clay 2	⬛	17	60	

PATERSON GROUP

SLIDEINTERPRET 9.026

Project	**6382983 Canada Inc. Geotechnical Investigation 8600 Jeanne D'Arc Boulevard, Ottawa, Ontario**
Figure No.	**Figure 7B - Section D - Existing Conditions - Seismic Loading**

Drawn by:	NS	*Company:*	Paterson Group
Date:	2024-08-21	*File No.*	PG6414



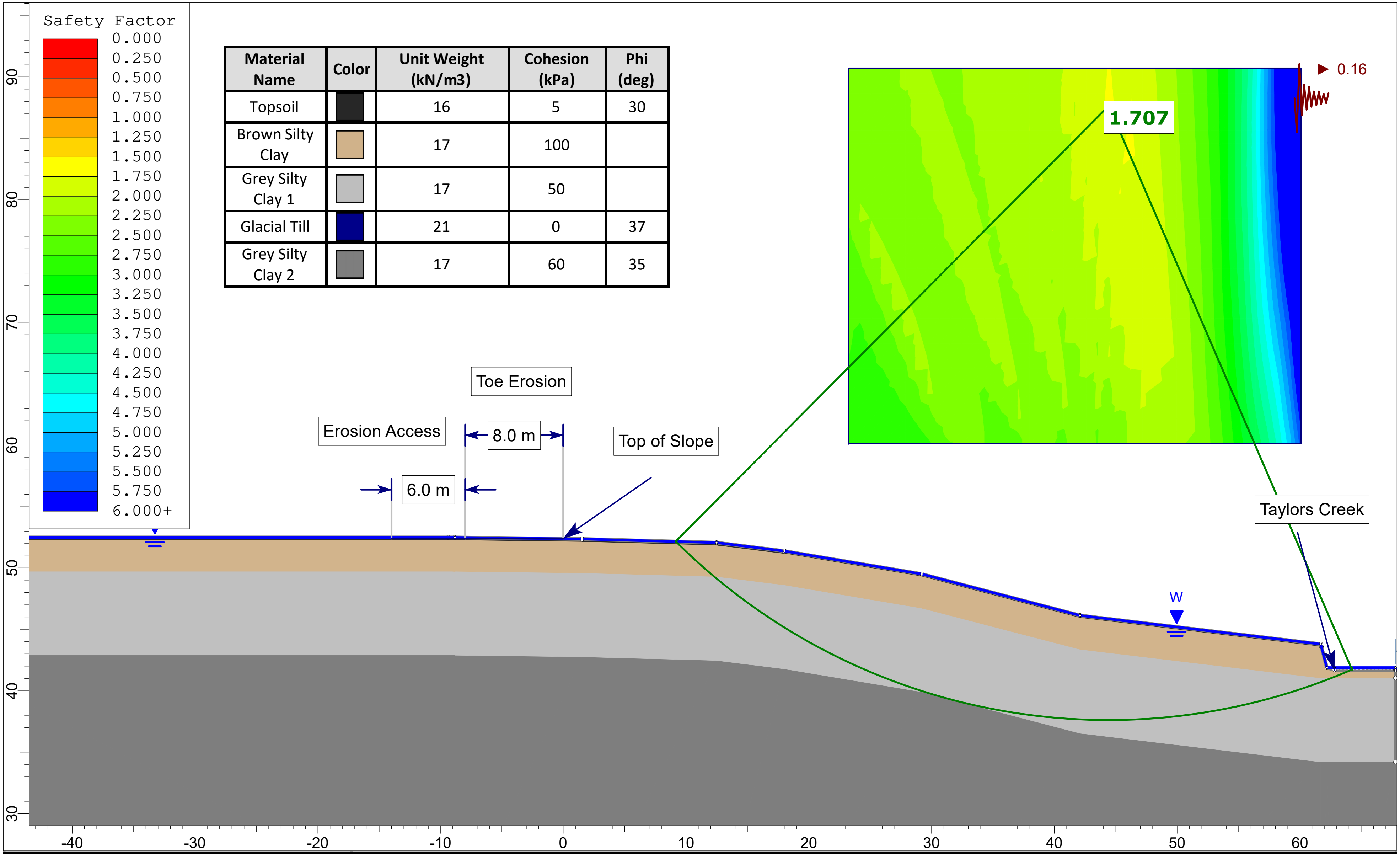
Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	⬛	16	5	30
Brown Silty Clay	🟫	17	5	33
Grey Silty Clay	⬜	17	10	33
Glacial Till	🟦	21	0	37

PATERSON GROUP

SLIDEINTERPRET 9.026

Project	**6382983 Canada Inc.** **Geotechnical Investigation** **8600 Jeanne D'Arc Boulevard, Ottawa, Ontario**
Figure No.	**Figure 8A - Section E - Existing Conditions - Static Loading**

Drawn by:	NS	***Company:***	Paterson Group
Date:	2024-08-21	***File No.***	PG6414

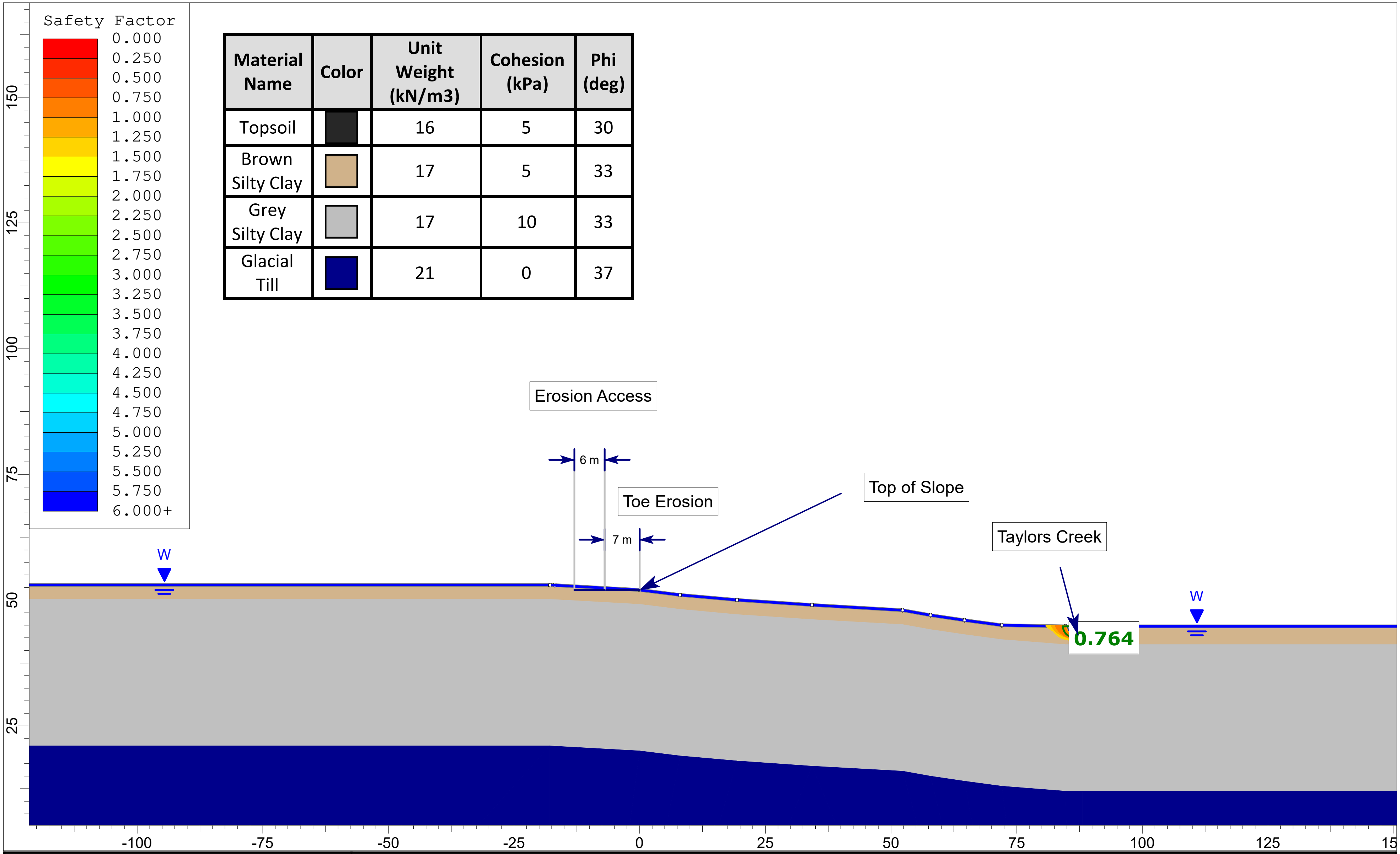


Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	⬛	16	5	30
Brown Silty Clay	🟫	17	100	
Grey Silty Clay 1	⬜	17	50	
Glacial Till	🟦	21	0	37
Grey Silty Clay 2	⬛	17	60	35

Project	**6382983 Canada Inc.** **Geotechnical Investigation** **8600 Jeanne D'Arc Boulevard, Ottawa, Ontario**		
Figure No.	**Figure 8B - Section E - Existing Conditions - Seismic Loading**		
Drawn by:	NS	*Company:*	Paterson Group
Date:	2024-08-21	*File No.*	PG6414

PATERSON GROUP

SLIDEINTERPRET 9.026



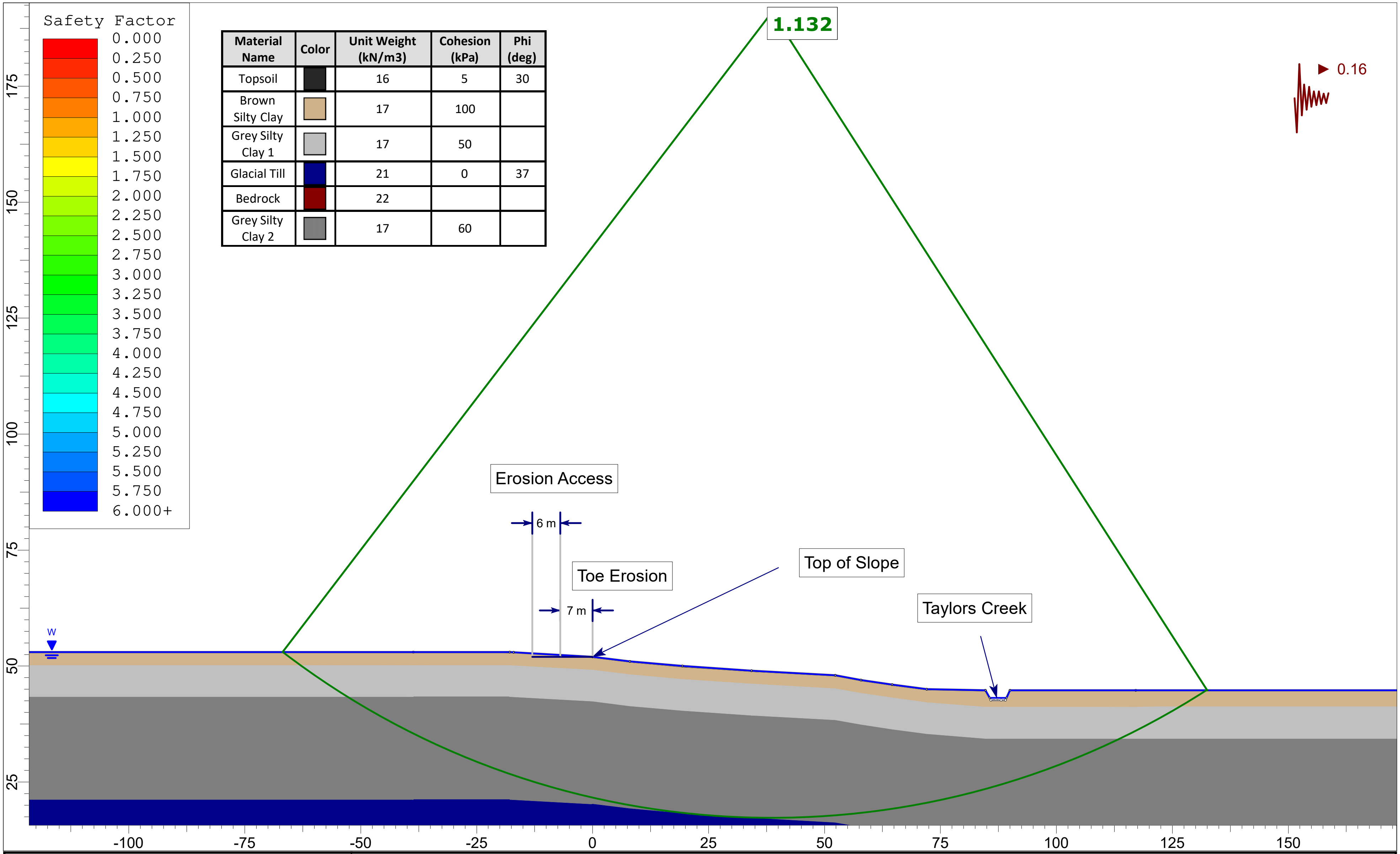
Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	⬛	16	5	30
Brown Silty Clay	🟫	17	5	33
Grey Silty Clay	⬜	17	10	33
Glacial Till	🟦	21	0	37

SLIDEINTERPRET 9.026

PATERSON GROUP

Project	**6382983 Canada Inc.** **Geotechnical Investigation** **8600 Jeanne D'Arc Boulevard, Ottawa, Ontario**
Figure No.	**Figure 9A - Section F - Existing Conditions - Static Analysis**

Drawn by:	NS	*Company*	Paterson Group
Date	2024-08-16	*File No.*	PG6414



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Topsoil	⬛	16	5	30
Brown Silty Clay	🟫	17	100	
Grey Silty Clay 1	⬜	17	50	
Glacial Till	🟦	21	0	37
Bedrock	🟥	22		
Grey Silty Clay 2	▨	17	60	

PATERSON GROUP

SLIDEINTERPRET 9.026

Project
6382983 Canada Inc.
Geotechnical Investigation
8600 Jeanne D'Arc Boulevard, Ottawa, Ontario

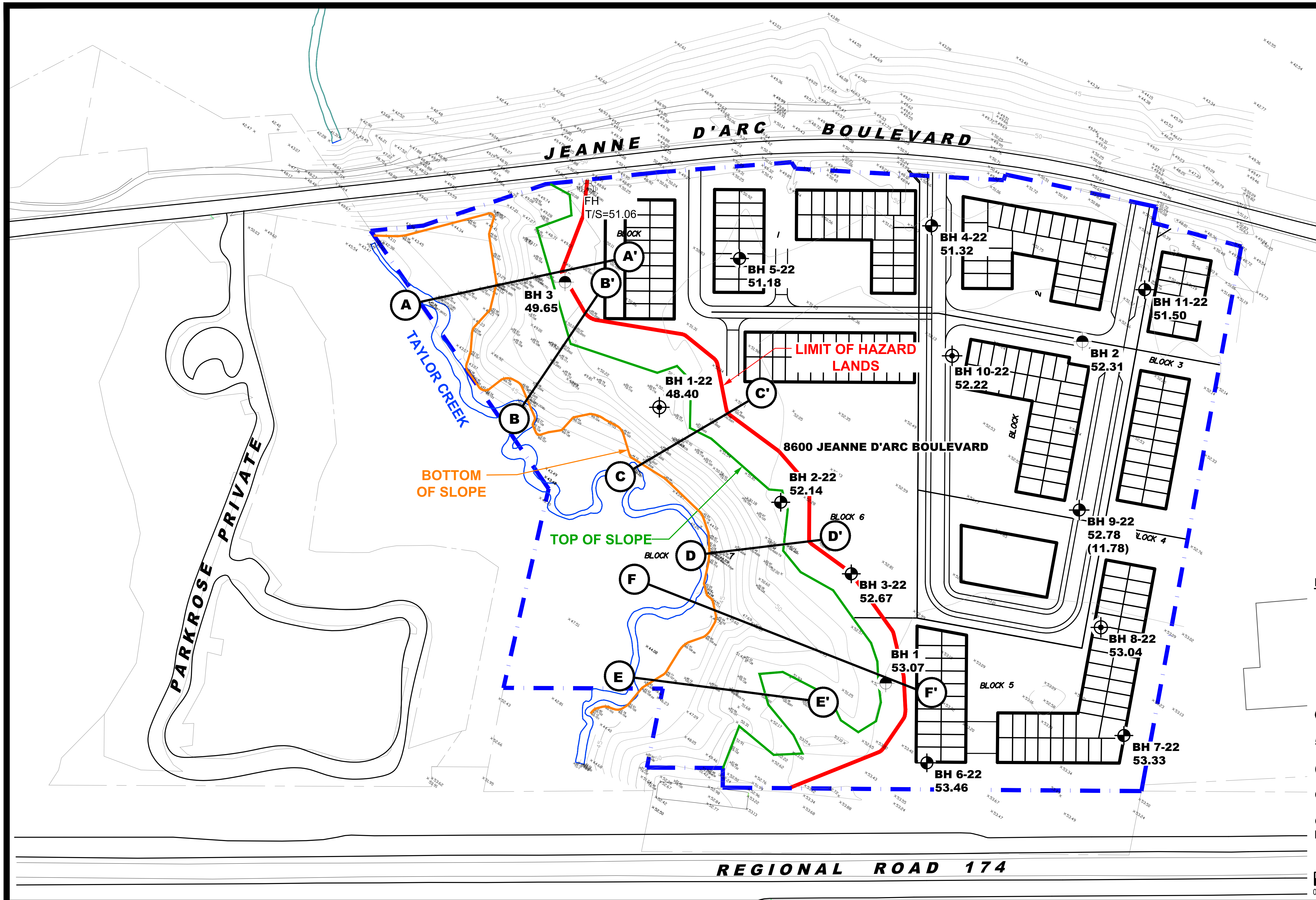
Figure No. **Figure 9B - Section F - Existing Conditions - Seismic Analysis**

Drawn by: NS

Company Paterson Group

Date 2024-08-16

File No. PG6414



LEGEND:

⊕	BOREHOLE LOCATION
⊕	BOREHOLE WITH MONITORING WELL LOCATION
◓	BOREHOLE LOCATION (PREVIOUS INVESTIGATION PG1565 - 12, 2007)
Ⓐ—Ⓐ	SLOPE CROSS-SECTION LOCATION
52.78	GROUND SURFACE ELEVATION (m)
(11.78)	PRACTICAL REFUSAL TO DCPT ELEV.(m)

CONCEPTUAL PLAN PROVIDED BY BRIGIL.

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

SCALE: 1:2000

0 25 50 75 100 125 150m

PATERSON GROUP

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

NO.	REVISIONS	DATE	INITIAL
1	UPDATED TOP OF SLOPE, LIMIT OF HAZARD LANDS AND CONCEPTUAL PLAN	19/08/2024	NS

BRIGIL
GEOTECHNICAL INVESTIGATION
PROPOSED MULTI-STOREY BUILDING
8600 JEANNE D'ARC BOULEVARD

OTTAWA, ONTARIO

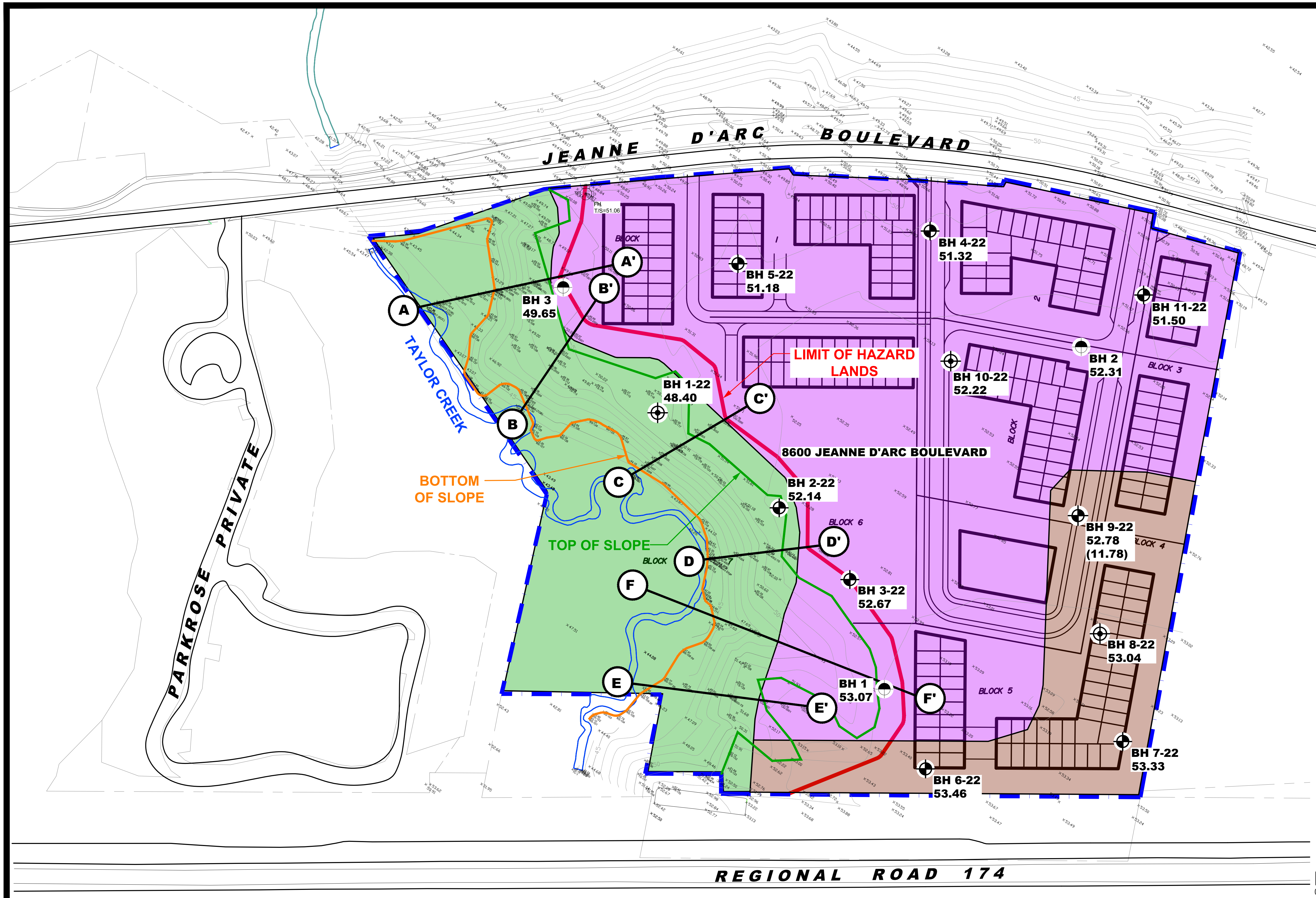
Title:

TEST HOLE LOCATION PLAN

Scale: 1:2000
Date: 10/2022
Drawn by: GK
Report No.: PG6414-1
Checked by: JV
Dwg. No.: PG6414-1
Approved by: DJG
Revision No.: 1

p:\autocad drawings\geotechnical\pg64xx\pg6414\pg6414-1 test hole location plan (rev.01).dwg

11x17



LEGEND:

⌖	BOREHOLE LOCATION
⌖	BOREHOLE WITH MONITORING WELL LOCATION
◒	BOREHOLE LOCATION (PREVIOUS INVESTIGATION PG1565 - 12, 2007)
Ⓐ—Ⓐ	SLOPE CROSS-SECTION LOCATION
52.78	GROUND SURFACE ELEVATION (m)
(11.78)	PRACTICAL REFUSAL TO DCPT ELEV.(m)

CONCEPTUAL PLAN PROVIDED BY BRIGIL.

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

PERMISSIBLE GRADE RAISE

🟩	**NO PERMISSIBLE GRADE RAISE RECOMMENDATION**
🟫	**UP TO 1.0 m**
🟪	**UP TO 1.5 m**

SCALE: 1:2000

0 25 50 75 100 125 150m

PATERSON GROUP

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

NO.	REVISIONS	DATE	INITIAL
1	UPDATED TOP OF SLOPE, LIMIT OF HAZARD LANDS AND CONCEPTUAL PLAN	19/08/2024	NS

BRIGIL

GEOTECHNICAL INVESTIGATION
PROPOSED MULTI-STOREY BUILDING
8600 JEANNE D'ARC BOULEVARD

OTTAWA, ONTARIO

Title:

PERMISSIBLE GRADE RAISE PLAN

Scale: 1:2000
Date: 10/2022
Drawn by: GK
Report No.: PG6414-1
Checked by: JV
Dwg. No.: PG6414-2
Approved by: DJG
Revision No.: 1

p:\autocad drawings\geotechnical\pg64xx\pg6414\pg6414-1 test hole location plan (rev.01).dwg

11x17

APPENDIX 3

TYPICAL FOUNDATION SLEEVE INSTALLATION

Photo 1 – Step 1: It is recommended that the upper 1/3 of the 150 mm drainage sleeve be cut at a 45 degree angle to hydraulically connect the composite foundation drainage board to the interior and underfloor drainage system.

Photo 2 – Step 2: It is recommended that the 150 mm diameter drainage sleeve be installed by carefully cutting an ‘X’ shaped incision through the composite foundation drainage and inserting the 150 mm diameter drainage sleeve inside the ‘X’ by pulling the four (4) triangular flaps towards the installer.

Photo 3 – Step 3: Apply a suitable primer prior to the placement of the adhesive tape such as 3M tape, WP200 BlueSkine or equivalent.

Photo 4 – Step 4: An adhesive such as 3M tape, BlueSkin, or equivalent be utilized to seal the 150 mm drainage sleeve to the composite foundation drainage board to act as a barrier in preventing concrete from blocking connection during the placement of the exterior concrete foundation wall.

Photo 5 – Step 5: As an additional precaution, it is also recommended that an adhesive tape be placed on the interior outlet end of the drainage sleeve between the temporary form work to further prevent concrete from entering the drainage sleeve during the placement of concrete. Once the temporary form work has been removed, the adhesive tape can be cut away to allow groundwater to have a positive gravity connection to the interior perimeter and underfloor drainage system.